

No. 21

Serviços Aéreos Cruzeiro do Sul S. A., Convair 340, PP-CDW, accident at Congonhas Airport, São Paulo, Brazil, on 3 May 1963. Report released by the Brazilian Air Ministry.

1. Investigation1.1 History of the flight

The aircraft was on a scheduled domestic flight from São Paulo to Janeiro with 5 crew and 45 passengers aboard. Following an eight-minute delay to heavy traffic, the flight was cleared to take off* from São Paulo. One minute after take-off the pilot-in-command reported to the tower that the aircraft's No. 2 engine was on fire, and he would return to the airport. A left turn was begun, and it is presumed that the pilot feathered No. 2 propeller. He began the down-wind leg of runway 16 and asked the tower operators whether anything abnormal could be seen regarding the aircraft's No. 2 engine. The tower operators, from whom No. 2 engine was hidden by the fuselage, reported that they could not see anything abnormal. Presumably the pilot then unfeathered the propeller which started windmilling. Approximately abeam the tower, the aircraft began to lose altitude and when it started the final turn its altitude was very low. The aircraft was probably nosed up and stalled with a bank angle of 45°; it first struck a house with its nose and left wing, then hit the ground (elevation - 800 m) and made a 260° turn on its left wing. The accident occurred at night in a well illuminated, densely populated area.

1.2 Injuries to persons

Injuries	Crew	Passengers	Others
Fatal	4	33	
Non-Fatal	1	12	
None			

1.3 Damage to aircraft

The aircraft was destroyed.

1.4 Other damage

The aircraft struck a house.

* Aside from one reference in the report to a São Paulo weather bulletin for 1936 hours local time, no mention of time was made.

1.5 Crew information

All the pilot-in-command's ratings were valid. He had flown a total of 11 997 hours including 8 010 hours as pilot-in-command and instructor on Convair 340 aircraft.

The co-pilot had flown 2 536 hours including 800 hours on the Convair 340.

Both the pilot-in-command and the co-pilot had considerable flying experience including night flying. Their recent activities and working hours did not indicate the possibility of fatigue.

No information regarding the qualifications or experience of the other three crew members was provided in the report.

1.6 Aircraft information

The aircraft had flown a total of 17 960 hours. It had undergone progressive maintenance, the last overhaul having been carried out on 14 December 1962.

The operating times of the engines were as follows:

	<u>No. 1</u>	<u>No. 2</u>
total hours	1 708	7 126
since last overhaul	593	1 095

The aircraft's maintenance history revealed no severe, continuous or irreparable discrepancies in the engines. The temperature readings had never exceeded the maximum permissible.

At take-off the aircraft's gross weight was 1 260 kg below the maximum permissible. Its centre of gravity was also within the allowable limits at take-off.

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

1.7 Meteorological information

Not relevant to the accident.

1.8 Aids of navigation

The non-directional radio beacon and rotating beacon at São Paulo were operating normally.

1.9 Communications

No difficulties were mentioned in the report regarding the communications between the flight and the tower.

1.10 Aerodrome and ground facilities

The airport at São Paulo is at an elevation of approximately 800 m.

All aerodrome facilities were operating normally and did not contribute in any way to the accident.

1.11 Flight recorders

Flight recorders were not mentioned in the report.

1.12 Wreckage

Following impact with the ground the fuselage broke at its centre section.

1.13 Fire

Fire broke out following impact.

1.14 Survival aspects

There was no panic aboard the aircraft during the emergency.

The steward was in the cockpit at take-off when the emergency occurred. The pilot-in-command told him to take a seat in the passenger cabin and fasten his seat belt. He did so, taking a seat on the left-hand side of the aircraft in the penultimate row. Although he was injured at the time of the accident, he was the only surviving crew member.

1.15 Tests and research

Two test flights were carried out Galeão Airport/Rio de Janeiro, which is at sea level, to try and establish the cause of the subject accident using all available data. A Convair 340, at the same weight as PP-CDW, carried out two simulated take-offs at an altitude of 800 m over the airport, which corresponds to the elevation of Congonhas Airport/São Paulo. The take-off run was reconstructed from the performance curves. The aircraft climbed to a simulated altitude of 150 m (950 m over the airport), then the sound of the overheating warning bell was simulated, and No. 2 propeller was feathered immediately. Following a 180° turn the No. 2 propeller was unfeathered but although the shut-off valve was opened to prevent engine damage the fuel tank valve was left closed, and the propeller began windmilling. The instruments for No. 2 engine indicated the following:

rpm: 1 500 to 1 600; fuel flow: zero; manifold pressure: variable, i. e. according to the position of the throttle, BMEP: zero.

When the propeller was unfeathered the aircraft could not maintain altitude. Speed was maintained at 105 kt (12 kt below V_2), and the aircraft gradually lost altitude at the rate of 300 to 500 ft/min. The power on engine No. 1 was increased to take-off power, and speed was reduced to 100 kt. About 1 000 m past the point where the aircraft arrived abeam the runway threshold, a turn was begun to enter the simulated base leg. The aircraft stalled at 95 kt and passed through the altitude of 800 m, the same elevation as at the accident site.

No flaps were used during the test flights. The flaps of PP-CDW were found about 50% open. If the pilot had not retracted the flaps during the feathering procedure, the aircraft should have climbed at least about 70 m. If he had been using the flaps in

the final stage of the flight this should have reduced the stall speed to 90 kt. However, this would not have altered the results very much.

It was, therefore, concluded that whatever the reason was for the unfeathering of the right propeller, it was carried out immediately after the aircraft entered the down-wind leg.

1.16 Convair 340 aircraft - engine fire and overheating warning system

Exhaust pipes of the Convair 340 are equipped with butterfly valves, which are controlled from the cockpit and are designed to regulate the ejection of exhaust gas.

When overheating occurs, a bell rings and an automatic control moves the butterfly valves to the "trail" position. This facilitates the expulsion of the exhaust gas and results in the reduction of the temperature. When the temperature arrives below 600°F the bell stops ringing. The bell's ringing can only be interrupted when:

- 1) its electric circuit is disconnected; or
- 2) its respective fuse is pulled "off" on the fuse panel.

In order to determine which engine is overheating, the speed of one engine is reduced and the position of the butterfly valve control is noted. If the bell continues to ring, power is again applied to this engine and the same procedure is repeated for the other engine. However, if it still continues ringing, the feathering of each propeller is carried out in turn. The temperature of the feathered engine is quickly reduced, and the bell will cease to ring. If the bell still continues ringing, this indicates a short circuit in the system. On the other hand, fire in the engines is indicated by two lights for each engine without any sound warning.

2. Analysis and conclusions

2.1 Analysis

Although the surviving steward and one ground witness mentioned a fire in engine No. 1, the Board did not believe that such was the case. The steward, who went to sit at the rear of the passenger cabin at the time of the emergency, said that he heard a bell, and that it ceased to ring when the pilot-in-command applied the appropriate procedure recommended in case of engine fire. However, it was found during the test flights that with the cockpit door closed, the fire warning bell could only be heard up to the second row of seats. Furthermore, when listeners were told of the bell and the door was left open, the bell could be heard up to the fifth row. It was therefore believed that the steward would not have been able to hear the warning bell from where he was seated. It was also believed that the ground witness may have mistaken the glare of the anti-collision light for a fire in No. 1 engine.

In view of its engine exhaust system, the aircraft does not show, even at night, the characteristic glare of flame ejection.

Because of the shape of the Convair 340 engines fairing, the only exits available for the flames of an engine fire would be the cowl flaps. Pilots, who had experienced engine fires, confirmed unanimously that the glare of flames coming out through the cowl flaps is so intense that hardly any engine fire could fail to be seen.

When the pilot-in-command notified the tower that he would return to the airport because of a fire in engine No. 2, he did not indicate how he had reached that conclusion. He probably interpreted incorrectly the ringing of the bell as a fire warning and presumed it was in No. 2 engine. Evidence showed that he carried out the procedure recommended in cases of engine fire. He feathered the propeller and, among other things, he pulled out the shut-off valve handle as a safety procedure and also in order to be able to trigger the fire extinguisher. With No. 2 propeller feathered, the aircraft entered the down-wind leg and continued flying level. It was considered that the pilot probably unfeathered the propeller at this time for any of the three following reasons:

- 1) he had no confirmation that there actually was a fire in engine No. 2;
- 2) he concluded that the warning was false and everything was normal; or
- 3) No. 1 engine on its own could not keep the aircraft flying.

These three possibilities are discussed hereunder:

- 1) After having carried out the procedures for fire in No. 2 engine the pilot-in-command found that the warning bell was still ringing. Having no confirmation of abnormality on No. 2 engine from the tower operators, he decided to unfeather No. 2 propeller. However he did not re-open the shut-off valve and therefore No. 2 engine did not restart, and its propeller windmilled. Under these circumstances the aircraft, at its present weight and altitude, could not keep its altitude even with No. 1 engine at maximum take-off power. Although the indications of the No. 2 engine instruments, which the tests showed to be 1 500 to 1 700 rpm, zero fuel flow, and zero BMEP, should have clearly indicated the situation, it might have taken some time for the pilots to realize the reason for these abnormal indications.

A possible explanation for the improper unfeathering operations was that they were carried out hurriedly on the assumption that a fire or an overheating existed in No. 1 engine.

- 2) This hypothesis was considered unlikely. Should the pilot have reached the conclusion of a false warning, there was no reason for a hurried unfeathering of the propeller. As it appears that between the time of feathering and unfeathering of propeller No. 2 the necessary procedures were not carefully followed, it was concluded by the crew that it was unlikely that some malfunction had occurred in the wiring of the alarm system.
- 3) The third hypothesis considered the possibility that following the unfeathering of propeller No. 2, engine No. 1 could not keep the aircraft in the air. Based on testimony of the steward, ground witnesses and the tower controllers, it was concluded that the false fire interpretation occurred just after take-off. The unfeathering should actually have occurred before completion of the first 180° turn prior to entering the down-wind leg. The aircraft should have climbed a little. Examination of engine No. 1 did not reveal any failure which would have caused lack of power. The unfeathering of No. 2 propeller should have improved flight conditions if, on restarting the engine, every step of the unfeathering procedure had been carried out correctly.

2.2. Conclusions

Findings

The crew were properly certificated and had considerable flying experience including night flying, on the subject aircraft.

No reference was made in the report to the aircraft's certificate of airworthiness. The most recent overhaul of the aircraft prior to the accident was carried out on 14 December 1962. The aircraft's gross weight and centre of gravity were within the permissible limits.

For unknown reasons, the alarm bell, which indicated overheating, rang immediately after take-off. The pilot-in-command, believing engine No. 2 was on fire presumably feathered No. 2 propeller. As the flight entered the down-wind leg, it was unfeathered, but the shut-off valve was not re-opened, and the propeller began windmilling. Although engine No. 1 was still operating at take-off power, the altitude could not be maintained. When entering the last turn to base leg, the aircraft was very low, and the pilot presumably tried to lift the nose to avoid striking buildings near the airport. This caused the aircraft to stall. At this time one of the crew probably used the flaps. Shortly thereafter the aircraft banked 45°, struck a house and crashed to the ground.

It is highly probable that if the pilot had refeathered No. 2 engine when he started losing altitude, he could have maintained altitude and landed safely.

Cause or Probable cause(s)

PRIMARY

Probable pilot error. Improper procedure on unfeathering No. 2 engine.

SECONDARY

Probable material failure of one or both engines overheating.

3. Recommendations

No recommendations were made in the report.