

Investigation Report

CX006-0/99
April 2000

Factual Information

Classification	Accident
Date:	April 29, 1999
Location:	Straubing
Type:	Aircraft
Manufacturer/Model:	Beriev BE103
Injuries to persons:	one person fatally injured
Nature of Damage:	aircraft destroyed
Third Party Damages:	none

History of the Flight

A testflight for the purpose of vibration measurements on the propellers was to be carried out with the a.m. aircraft.

The Beriev BE103 is the prototype of a 6 seater, twin engine amphibious aircraft of russian design. It was powered by two piston engines Teledyne Continental IO-360 E5 which operated hydraulical variable pitch propellers. In the course of the russian type certification the vibration behavior and the stiffness of the propeller blades had to be proven. Therefore a test propeller, fitted with wire strain gauges was attached to the L/H engine at the propeller manufacturer's facilities in Straubing. The transducers and transmitters were fitted instead of the spinner by means of special brackets. The data recording system was installed in the aircraft's cabin. As during the testflights a maximum of 105% of the maximum allowable rpm had to be achieved the L/H propeller governor was adjusted to 2940 rpm.

Furthermore the R/H propeller and governor were changed from prototypes to the serial components.

After these modifications several engine test runs were carried out for calibration of the test equipment and data recording.

The testflight was recorded on a camcorder. The film showed that the pilot in command taxied to the far end of the 940 m long pavement runway, adjusted the engines while standing and thereafter commenced his take-off run which should have been approx. 300 m long with view to the aircraft weight according to information gained from the a/c manufacturer. The a/c, however, taxied far beyond the ½ marking of the runway, rotated fairly long and went airborne after approx. 700 m with a high angle of attack. After gaining 10 to 15 m of altitude the pilot in command retracted the landing gear. Right after that the a/c entered a shallow descend in a nose-up attitude and turned to the left before it left the camera view some seconds before the impact. During the entire flight a constant and normal engine noise was audible.

Approx. 600 m behind the runway end the aircraft hit the bank of a street and caught fire. The pilot in command was fatally injured, the aircraft was destroyed by the impact and the post impact fire.

Investigation

The accident was initially handled by a local representative. The further investigation was accomplished by two BFU investigators.

As the sequence of the accident pointed towards a lack of power both engines were examined which did not reveal any evidence for an engine malfunction. The spark plugs of both engines indicated an equal normal combustion, the injectors contained

equal quantities of residual fuel. The engines could be cranked by hand and a boroscopic inspection showed no evidence for a mechanical defect on the cylinders, pistons or valves.

The blades of both propellers were broken next to the hubs. The teardown inspection of the hubs did not reveal any evidence for a malfunction of the variable pitch mechanism. The actuating mechanism of the R/H hub showed, however, a significant impact mark which developed when the blade actuating pin hit the sliding fork. By adjusting the pin onto the mark the pitch angle at the moment of impact could be determined. The angle was 8,5° which corresponds to the low pitch stop. This is remarkable as at maximum power setting even with the a/c not moving at all this value would lead to an rpm exceeding the maximum allowable value and thus would be adjusted by the governor to a higher blade pitch.

Both governors were bench-tested. Although traces of heat were evident both governors proved to be still functional. The settings as per the manufacturer's data-sheet could be established.

Analysis of the Flight Data Recorder

As the aircraft was a prototype it was fitted with a flight data recording system. The recorder itself was a russian made solid state recorder (BUR-LK) which recorded 39 parameters. The unit was severely damaged by impact and fire to such an extent that a normal readout was not possible. Therefore the memory module was separated and opened at the manufacturer's plant in St. Petersburg, Russian Federation. The internal heat isolation had protected the memory comprising two 1 Mb chips so well that the data could be retrieved using a test wiring. The conversion of the raw-data to a synchronized file as well as the further analysis was accomplished in the BFU's flight data recorder laboratory.

A total of 5:44 hours was recorded. The data ended at the moment of impact. The engine parameters of the accident flight were compared with data from previous flights which led to the following remarkable results:

On all previous flights the power levers were adjusted to a setting of 60° for take off which gave a value of 2800 rpm and a manifold pressure of approx. 28 inHg. This corresponds to the engine's take off power setting. When commencing the take off run of the last flight the pilot in command initially set the throttles to 35° (left eng.) and 37° (right eng.), leading to 2800 rpm and a manifold pressure of 17 inHg (L/H) and 19 inHg (R/H). These settings correspond to a power output next to the lower limit of cruise power which is inappropriate for take off. During take off run the manifold pressure dropped continuously which was normal with view to the

system. After lift-off the power levers were pulled back by 3° which caused a manifold pressure drop that in turn reduced the power output to a value insufficient for a continuation of the flight. The air-speed showed values of about 120 km/h during the entire flight. In the last portion the stall warning came on.

Analysis

As documented by the findings a lack of engine power output caused the aircraft to take off after an unusual long take-off run only not gaining altitude and finally colliding with the bank of a street.

According to the evaluation of the flight data recorder the pilot in command did not set the power levers to the maximum power setting but to a position which led to a reduced power output. After take-off he further reduced the power setting. Technical malfunctions which might explain this were not determined.

The control of the so called constant-speed-propellers works in such a way that the engine rpm which is preselected through the prop-rpm-levers is held constant by hydraulic variation of the propeller pitch. If the engine speed drops below the set value the pitch is being reduced, if it exceeds the value the pitch increases. To set take-off power the engine rpm lever are brought to the maximum rpm setting and then power is being applied. The propeller blades will remain in the low pitch setting until the maximum rpm is reached and then change pitch analog to the further power increase. The pitch variation already starts at a medium power setting while the aircraft is not moving. This means that the power levers have to be moved further after reaching the maximum allowable rpm to the take-off power setting to achieve maximum power. Any overspeed of the propellers is avoided by the governors.

For this flight the governor of the left engine was, for test purposes, set in a way that the rpm could exceed the maximum allowable value by 5%. It was therefore necessary to reduce the rpm of this engine using the prop lever to the maximum setting after applying take off power to avoid overspeed. The short-time overspeeding of the engine while doing this wouldn't have had any effect.

As the findings indicate with utmost probability the pilot in command did not follow this procedure but instead advanced the power lever only until the prop rpm reached the maximum values. This was documented by the engine parameters, the power lever setting and the impact mark in the right propeller hub which indicated a setting at the low pitch stop at the moment of impact.

With the increasing airspeed upon take off the rpm increased as a result of the decreasing relative angle of attack and thus drag on the prop blades. The pilot tried to correct this by further reduction of the power.

As documented by the data analysis the pilot in command operated the system properly during previous flights by setting the power levers to maximum power which resulted in a normal behavior of the constant speed mechanism. The procedure he applied was obviously related to the L/H engine's governor setting which was modified for the testflight. To avoid overspeed he used the power levers instead of the rpm control levers which led to a power output insufficient for the continuation of the flight.

According to statements of the propeller manufacturer's employees the procedures were extensively explained to the pilot before the flight. Anyhow it was uncertain to what extent the explanations were being understood. While the other employees of the aircraft manufacturer used an interpreter's service for communication, he didn't. It was stated that the pilot spoke some sentences of German language without any accent. Only later in the conversation it was noted that he was unable to follow up. It was then tried to explain the program and related procedures to him partly using the English language.

The video tape of the flight clearly showed the low acceleration and the unusually long take-off run. It would have been possible at any time to abort the take-off especially as the area behind the runway was flat and unobstructed over several hundred meters.

Conclusions

The accident was caused by the pilot in command trying to depart at an extremely reduced powersetting and not aborting the take-off in time. Technical causes were not determined. The wrong powersetting was related to a misinterpretation of the function and procedures in connection with the constant-speed propeller system.

Although these are part of the basic knowledge of a pilot on aircraft of this category they were explained to him by employees of the propeller manufacturer and the aircraft manufacturer's test flight engineer as part of the preflight briefing. With a high probability the pilot did not understand these explanations in all details. The service of an interpreter was refused by him.

The planned testflights wouldn't have led to a power reduction when accomplished properly.

Investigator in Charge

Hasenfuss

FDR-Readout

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