



REASSESSMENT OF THE RESPONSES TO AVIATION SAFETY RECOMMENDATION A07-08

Propulsion system reliability

Background

On 21 January 2006, the Cessna 208B aircraft (registration C-GRXZ, serial number 208B0469) was en route at 9000 feet above sea level (asl), from Tofino, to Vancouver International Airport, British Columbia, when the engine failed.

The flight was over a designated mountainous region, on an instrument flight plan, in visual meteorological conditions above broken layers of cloud. Following the engine failure, the pilot began a right turn, declared an emergency to the Vancouver Area Control Centre and requested a range and bearing to the nearest airport. At this time, the aircraft's rate of turn increased, and the aircraft rolled out on a heading direct to the Port Alberni Regional Airport about 17 nautical miles (nm) to the northwest. The pilot had to enter cloud during the descent, and he requested navigational information to help keep the aircraft clear of the mountains.

Communication with the aircraft was lost as it descended through 7000 feet asl. Radar data show that, at about 6000 feet asl, the pilot entered a tight, left-hand, 360° turn, during which the rate of descent increased to about 2500 feet per minute. The aircraft came out of the turn at 4500 feet asl on a heading toward the Port Alberni Regional Airport. Aircraft in the area heard the pilot transmit a Mayday call indicating that he was attempting a forced landing on a logging road. The aircraft struck trees during a steep right-hand turn and crashed. Although fuel leaked into the cabin after the crash, there was no fire.

The accident occurred at about 1420 Pacific standard time, approximately 11 nm south-southeast of the Port Alberni Regional Airport. Five passengers survived with serious injuries; the pilot and the other two passengers were fatally injured.

The engine (PT6A-114A, serial number PCE19352) was removed from the wreckage and transported to an approved teardown facility. All of the compressor turbine (CT) blades were fractured, but one particular blade had fractured near the airfoil root platform, and the topography of the fracture surface showed signs of fatigue cracking. The compressor had seized because of bearing damage following the CT blade failure.

Single-engine instrument flight rules (SEIFR) authorization is based in part on the improved reliability of turbine engines as compared to piston engines. An essential element for SEIFR approval is that mean time between failure (MTBF) of the engine must remain high. Canadian Aviation Regulations (CARs) require the MTBF of the engine to be better than 0.01 per 1000 hours (that is, less than 1 failure per 100 000 hours of flight time).

The Board concluded its investigation and released report A06P0010 on 10 January 2008.

Board Recommendation A07-08 (10 January 2008)

While the engine type that was involved in this accident met the established reliability standard, it is important to note that, had the total number of In Flight Shut Down (IFSD) events (that is, loss of propulsion for all causes) been considered, the failure rate for the entire propulsion system would not have met the CARs standard in 7 of the last 10 years.

Any system failure that results in a loss of power and an emergency landing represents an elevated risk to the travelling public. Because the outcome of an engine failure in SEIFR operations can be catastrophic, the propulsion system reliability assessment should take into account all relevant variables and should not be limited to MTBF values alone.

Therefore, the Board recommended that:

The Department of Transport take into account all propulsion system failures when assessing the safety of single-engine commercial operations.

TSB Recommendation A07-08

Transport Canada's response to A07-08 (04 April 2008)

In its response, Transport Canada (TC) stated that, to address this and other safety issues related to Canadian SEIFR operations, it will undertake a complete review of commercial SEIFR related the CARs.

Board assessment of the response to A07-08 (21 July 2009)

TC has completed a review of SEIFR and has produced an interim report "Review of Single Engine Instrument Flight Rules (SEIFR) Operations Under Part 7 of the Canadian Aviation Regulations." The interim report, which was completed in April 2009, is intended to be reviewed by TC management in late June 2009.

TC is undertaking a review of its regulations as they pertain to commercial SEIFR; however, the review is not complete and in the meantime there is residual risk to the travelling public, should an engine fail in SEIFR operations.

The response is assessed as **Satisfactory Intent**.

Next TSB action (21 July 2009)

The Board will follow up with TC to determine to what extent its review of SEIFR operations was able to assess the reliability of propulsion systems used in single-engine commercial operations.

Transport Canada response to A07-08 (21 January 2011)

SEIFR Working Group recommendations were presented at a CARAC Technical Committee meeting and approved at the CARC. As a result, TC is in the process of drafting NPAs with anticipated presentation at the Spring 2012 CARAC Technical Committee.

Board reassessment of the response to A07-08 (09 March 2011)

TC is moving along the lengthy process to change regulations and it will not be until the draft changes are accepted that a final assessment can be made. In the meantime there is residual risk to the travelling public, should an engine fail in SEIFR operations.

The response is still assessed as **Satisfactory Intent**.

Next TSB action (09 March 2011)

TSB staff will follow up with TC to determine to what extent the NPAs address the risk of SEIFR operations with regard to assessing the reliability of propulsion systems used in single-engine commercial operations.

Transport Canada's response to A07-08 (30 September 2011)

May 2011 input

Drafting of NPA is continuing with anticipated presentation at the Spring 2012 CARAC Technical Committee and will take into consideration the recommendations of the SEIFR Working Group Final Report and risk assessment.

September 2011 update

No change

Board assessment of Transport Canada's response to A07-08 (07 March 2012)

In its response, TC indicated that drafting of NPAs is continuing and that it will take into consideration the recommendations of the SEIFR Working Group Final Report and risk assessment. It is anticipated that the NPAs will be presented at the Spring 2012 CARAC Technical Committee.

While TC is progressing its drafting of the NPAs, the Board is concerned that in the meantime there is residual risk should an engine fail in SEIFR operations, as any system failure that results in a loss of power and an emergency landing represents an elevated risk to the travelling public.

The planned action, if and when fully implemented, may substantially reduce or eliminate the safety deficiency. However, for the present, the action has not been sufficiently advanced to reduce the risks to transportation safety.

The response is still assessed as **Satisfactory Intent**.

Next TSB action (07 March 2012)

The TSB will continue to monitor TC's actions to determine to what extent regulatory changes address the risk of SEIFR operations with regard to assessing the reliability of propulsion systems used in single-engine commercial operations.

The deficiency file is assigned an **Active** status.

Transport Canada's response to A07-08 (04 December 2012)

The recommendations from the SEIFR Working Group Final Report are under review. TCCA will provide a more detailed response to the TSB in 2013.

Board assessment of the response to A07-08 (06 March 2013)

Shortly after Recommendation A07-08 was issued, TC informed the TSB that it would undertake a complete review of commercial SEIFR related CARs. However, for the past 5 years, while TC provided general information on the different milestones of this project, it did not provide any details on the contents and results of this review. In addition, in its latest response, TC did not provide an update on the progress accomplished in its drafting of the NPAs. Based on this lack of information, the Board is unable to update its assessment of TC's response to this recommendation.

The response is considered **Unable to Assess**.

Next TSB action (06 March 2013)

The TSB will monitor the progress of the planned actions and will reassess the deficiency on an annual basis or when otherwise warranted.

The deficiency file is assigned an **Active** status.

Transport Canada's response to A07-08 (26 November 2013)

Authorizations for single-engine aeroplanes that conduct air transport services involving the carriage of passengers under instrument flight rules (SEIFR) are granted on an individual basis, subject to a risk assessment that takes into account all situations in which an engine becomes inoperative, regardless of the cause.

Transport Canada would appreciate an opportunity to brief the board to more fully explain Transport Canada's procedures.

April 2014 update

Transport Canada has taken the required action to fully implement this recommendation by incorporating the requirement into the approval process when considering applications for the operations specification required for commercial air operators wishing to conduct air taxi operations in single-engine aeroplanes under instrument flight rules.

The requirements for air operators transporting passengers in single-engine aeroplanes under instrument flight rules are specified in CAR 723.22 and include, among other things, specified aircraft equipment, specified pilot training, and a turbine-powered, factory-built aeroplane with an engine that has a proven mean time between failure of 0.01/1000 or less (that has been established over at least 100 000 hours in service). In addition, the operator's air operator certificate must include an operations specification allowing operations under instrument flight rules using single-engine aeroplanes.

Air operators seeking authority to use single-engine aeroplanes for operations under instrument flight rules must apply for the associated operations specification. Such applications, while few in number, are managed in the Commercial Flight Standards division of Transport Canada's Civil Aviation Standards Branch in the Ottawa headquarters. The onus is on the applicant to provide sufficient information to demonstrate the in-service reliability of the propulsion system used in the aeroplane it intends to use. Data provided are reviewed by operational specialists and certification specialists to confirm its compliance with regulatory requirements, including confirmation that the data provided include information about any of the loss-of-propulsion situations as described below.

Issuance of the required operations specification involves a review of the information provided by the operator, including information about the in-service reliability of the propulsion system. To determine the mean time between failure, the reliability rate of the propulsion system is determined by considering all propulsion system failures, regardless of cause or origin. Engine failures or in-flight shutdown of the engine resulting from any of the following situations are considered in determining the in-service reliability of the propulsion system:

- Oil temperature exceeding limit
- Oil pressure below minimum
- Drive shaft failure
- Main shaft bearing failures
- Propeller shaft bearing failures
- Turbine blade failures
- Fuel control unit failures
- Compressor failures
- Engine vibration

- Chip detection
- Uncommanded torque
- Engine flame-out
- Boost pump failures leading to fuel starvation
- Fuel contamination
- Fuel starvation
- Fire in the engine area
- Propeller vibration – whether due to mechanical failure, icing or other causes
- Engine vibration
- Engine intake icing
- Foreign object damage
- Bird strike
- Maintenance lapses
- Any other factor that causes loss of power required for sustained flight or that results in an in-flight shutdown of the engine

Some operators seek authority to use aircraft with other than factory-original engine installations. In these cases (and in addition to the requirement for the operations specification as described above), operators also request an exemption from the base requirement specified in CAR 723.22 to use a factory-built aeroplane. When considering such requests, Transport Canada specialists require the operator to provide the same information listed above to demonstrate the in-service reliability of the propulsion system used in the aeroplane; the same standard is applied, requiring a mean time between failure of 0.01/1000 or less established over at least 100 000 hours in service.

As a condition of the operations specification, air operators conducting operations under instrument flight rules using single-engine aeroplanes must notify Transport Canada of instances of engine failure or in-flight shutdown. Transport Canada monitors these reports and has the ability to withdraw the operations specification in cases where the data warrant it.

Board assessment of the response to A07-08 (01 May 2014)

In its most recent response, TC states that it has changed the approval process for an operations specification that would allow for the transportation of passengers in single-engine aeroplanes under instrument flight rules. Beyond the requirements specified in CAR 723.22 and a demonstration that the engine's mean time between failure is 0.01/1000 or less, an applicant must demonstrate the in-service reliability of the entire propulsion system. Not merely depending on the engine's reliability data, TC's approval process now factors in reliability data for an expanded list of parameters, establishing an overall in-service reliability for the propulsion system.

This enhanced SEIFR approval methodology should mitigate the risks identified in Recommendation A07-08.

The Board assesses the response to the recommendation as **Fully Satisfactory**.

Next TSB action

No further action is required.

This deficiency file is assigned a **Closed** status.