



TSB Recommendation A13-03

Passenger shoulder harnesses

The Transportation Safety Board of Canada recommends that the Department of Transport require that all seaplanes in commercial service certificated for 9 or fewer passengers be fitted with seatbelts that include shoulder harnesses on all passenger seats.

Air transportation safety investigation report	A12O0071
Date the recommendation was issued	23 October 2013
Date of the latest response	September 2020
Date of the latest assessment	March 2021
Rating of the latest response	Unsatisfactory
File status	Dormant

Summary of the occurrence

On 25 May 2012, the Cochrane Air Service de Havilland DHC-2 Mk.1 Beaver floatplane (registration C-FGBF, serial number 168) departed Edgar Lake, Ontario, with 2 passengers and 300 pounds of cargo on board. The aircraft was destined for the company's main base located on Lillabelle Lake, Ontario, approximately 77 miles to the south. On arrival, a southwest-bound landing was attempted across the narrow width of the lake, as the winds favoured this direction. The pilot was unable to land the aircraft in the distance available and executed a goaround. At 1408, Eastern Daylight Time, shortly after full power application, the aircraft rolled quickly to the left and struck the water in a partially inverted attitude. The aircraft came to rest on the muddy lake bottom, partially suspended by the undamaged floats. The passenger in the front seat was able to exit the aircraft and was subsequently rescued. The pilot and rear-seat passenger were not able to exit and drowned.

The Board concluded its investigation and released report A12O0071 on 23 October 2013.

Rationale for the recommendation

The TSB has found that the risk of serious injury or death is increased for occupants of light aircraft who are not wearing upper-torso restraints or shoulder harnesses. The results of previous safety studies completed by the TSB (SA 9401, TP 8655E) have been more recently

supported by a Federal Aviation Administration (FAA) study into fatal and serious injury accidents in Alaska.

A significant portion of the commercial floatplane fleet in Canada was manufactured before shoulder harnesses were required for passenger seats, and remains in this configuration today.

In the event of a seaplane accident, the occupants of the aircraft may drown if they are unconscious; loss of consciousness is normally caused by head trauma. If restrained and protected during the impact sequence, occupants may maintain consciousness and stand a better chance of successfully exiting a sinking aircraft. The use of a three-point safety restraint (safety belt and shoulder harness) is known to reduce the severity of upper body and head injuries and more evenly distribute impact forces.

The TSB has previously recommended (A94-08, A92-01) that small commercial aircraft be fitted with seatbelts and shoulder harnesses in all seating positions. Following these recommendations, changes to regulations were made to require shoulder harnesses in all commercial cockpits and on all seats in aircraft with 9 or fewer passengers manufactured after 1986.¹ This regulatory change did not address the vast majority of the commercial floatplane fleet, which was manufactured prior to 1986.

The TSB considers that, given the additional hazards associated with accidents on water, shoulder harnesses for all seaplane passengers will reduce the risk of incapacitating injury, thereby improving their ability to exit the aircraft.

Therefore, the Board recommended that

the Department of Transport require that all seaplanes in commercial service certificated for 9 or fewer passengers be fitted with seatbelts that include shoulder harnesses on all passenger seats.

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Previous responses and assessments

January 2014: Transport Canada's response to Recommendation A13-03

Transport Canada (TC) has devoted significant effort to seaplane safety. In 2006 a risk assessment team met to analyze the risks associated with egress from submerged aircraft and identify potential risk reduction measures. The team considered the option of making shoulder restraints available to all occupants. The team's analysis showed that this option would not reduce the risks by any significant factor.

On August 22-25, 2011, TC inspectors, floatplane industry representatives, and aircraft manufacturers formed a Focus Group which undertook a risk assessment and discussed TSB recommendations to determine what would be the best mitigation strategy to improve levels of

¹ *Canadian Aviation Regulations (CARs)*, 605.24, "Shoulder Harness Requirements".

safety for commercial sea plane operations in an effective and sustainable way. The group discussed the use of shoulder harnesses but concluded other measures offered more promise than mandating shoulder harnesses.

Most commercially-operated seaplanes in Canada are in the normal/utility category. The cabin designs and configurations of most of these likely do not readily lend themselves to installation of shoulder restraints for all passengers without substantial aeroplane redesign and/or structural modification. Most of the aircraft structures are not robust enough to support shoulder restraints in a crash and may hinder egress. Mandating the retrofitting of shoulder restraints for all occupants is not feasible. Each application to install shoulder harnesses would need to be assessed on a case by case basis.

Since fleet-wide installation of shoulder harnesses is not feasible, Transport Canada will continue its efforts at safety education and promotion.

In December 2013, Transport Canada published a Civil Aviation Safety Alert (CASA) on Safety Belts, and an article in the Aviation Safety Letter (ASL) Issue 4/2013 titled "Shoulder Harnesses and Seat Belts- Double Click for Safety". Transport Canada will also be revising Advisory Circular (AC) 605-004 Use of Safety Belts by Passengers and Crew Members, to align with Federal Aviation Administration (FAA) AC No.21-34.

March 2014: TSB assessment of Transport Canada's response to Recommendation A13-03

The benefits of wearing shoulder harnesses to reduce the risk of incapacitation have been proven. The TSB's recommendation is supported by the results from the study completed by the FAA in Alaska in 2010.

In its response, TC indicated that the cabin designs and configurations of most of the commercially operated float planes in Canada likely do not readily lend themselves to installation of shoulder restraints for all passengers without substantial aeroplane redesign and/or structural modification.

There are approximately 600 aircraft on the Canadian commercial aircraft registry that are potentially operated on floats, certificated for 9 or fewer passengers and manufactured before 1986. Of these aircraft approximately 200 are DHC-2's and 300 are Cessna's. There are already shoulder harness installation kits available for the Cessna's as described in Cessna Single Engine Service Bulletin SEB92-28. Additionally, Transport Canada approved a Limited Supplementary Type Certificate (O-LSA09-360/D) for the installation of rear shoulder harnesses in several DHC-2's in 2009. These facts support the feasibility of retrofitting many floatplane designs with shoulder harnesses.

TC further stated that most of the aircraft structures are not robust enough to support shoulder restraints in a crash and may hinder egress.

TC has not demonstrated that the risk of hindering egress outweighs the benefits of rear-seat shoulder harnesses. Shoulder harnesses in all seating positions for normal/utility category of

aircraft have been required by regulation since 1986, and have been installed since that time in similar albeit newer aircraft to the ones previously described. The availability of these installations, the existing kits, and TC issued STC's show that the aircraft structures are robust enough to support these restraints.

Transport Canada has not provided any objective information to demonstrate that it is not feasible to install rear-seat shoulder harnesses. Nor has TC demonstrated that the risk would not be reduced significantly if rear-seat shoulder harnesses were installed.

Because TC's response does not contain details of any action which has been taken or proposed that will reduce or eliminate the safety deficiency, the deficiency will continue to put persons at risk.

Therefore, the response to Recommendation A13-03 is assessed as **Unsatisfactory**.

January 2015: Transport Canada's response to Recommendation A13-03

Transport Canada agrees with the intent of this recommendation.

Transport Canada has devoted significant effort to seaplane safety. Most commercially-operated seaplanes in Canada are in the normal/utility category. The cabin designs and configurations of most of these likely do not readily lend themselves to installation of shoulder restraints for all passengers without substantial aeroplane redesign and/or structural modification. Most of the aircraft structures are not robust enough to support shoulder restraints in a crash and may hinder egress. Therefore, mandating the retrofitting of shoulder restraints for all occupants is not deemed feasible. Each application to install shoulder harnesses would need to be assessed on a case by case basis. Since fleet-wide installation of shoulder harnesses is not feasible, Transport Canada will continue to promote safety and the use of seatbelts and shoulder harnesses through education and awareness campaigns.

No further updates will be provided. Transport Canada considers this recommendation closed.

March 2015: TSB reassessment of Transport Canada's response to Recommendation A13-03

This response from Transport Canada reiterates the feasibility statement made in its previous response without addressing the counterpoints made in the TSB's assessment of that response.

Transport Canada still has not provided any objective information to demonstrate that it is not feasible to install rear-seat shoulder harnesses.

The Board believes that the risks identified in Recommendation A13-03 have not abated and remain significant.

Therefore, the response to Recommendation A13-03 is assessed as **Unsatisfactory**.

November 2015: Transport Canada's response to Recommendation A13-03

Transport Canada (TC) does not agree with this recommendation. Please see 2014 update.

2014 Update:

TC has regulations that require operators of aircraft to provide a seat and safety belt for each person on board the aircraft. The regulations include whether or not the operator of the aircraft is required to have a shoulder harness available for use dependant on the type of aircraft, the type of operation and, in some instances, the age of the aircraft. For example, section 605.24 has a general aircraft equipment requirement and sections 702.44, 703.69, 704.68, and 705.75 for commercial air services, set out when a safety belt must consist of both a lap strap and a shoulder harness.

Additionally, it should be noted that most of the seaplanes in commercial use are older aircraft and the cabin designs/configurations of most of these older aircraft likely do not readily lend themselves to the desired changes without substantial aeroplane redesign and/or structural modification. As a result of the recommendation, TC conducted a search of Canadian design Supplemental Type Certificates (STC). The department was unable to locate any Canadian (STC) retrofit kits for rear seat passengers. Although there may be retrofit kits available, they have not been tested or proven to effectively protect rear seated passengers as most of the aircraft structures are not robust enough to support shoulder restraints in a crash and actually may hinder egress.

The department actively participates in the Federal Aviation Administration's work under a U.S. Aviation Rulemaking Committee (ARC) to make recommendations on how to improve safety of general aviation. TC will continue to work in collaboration with international partners (e.g. the FAA) to reduce the likelihood of accidents in this sector by providing an overall improvement in safety.

March 2016: TSB reassessment of Transport Canada's response to Recommendation A13-03

TC's January 2015 response stated that it agreed with the intent of the recommendation. However, TC's November 2015 response states that it does not agree with this recommendation.

The response also reiterates statements made in its January 2014 response regarding TC's opinion that the older aircraft designs do not lend themselves to modifications. However, the response does not address the counterpoints put forward in the TSB assessment of March 2014.

TC continues to assert in its latest response that the addition of rear seat shoulder harnesses may actually hinder egress. The TSB is concerned with the logic supporting this assertion, which suggests that the addition of rear shoulder harnesses to a 1977 Cessna 185 may hinder egress, even though such harnesses are legally required in a 1980 Cessna 185.

TC has not provided any objective information to demonstrate that it is not feasible to install rear-seat shoulder harnesses.

The Board believes that the risks identified in Recommendation A13-03 have not abated and remain significant.

Therefore, the response to Recommendation A13-03 is assessed as **Unsatisfactory**.

January 2017: Transport Canada's response to Recommendation A13-03

Most of the seaplanes in commercial use are older aircraft and the cabin designs/configurations of most of these older aircraft likely do not readily lend themselves to the desired changes without substantial aeroplane redesign and/or structural modification. Transport Canada does not agree with this recommendation because it is not likely to enhance passenger safety. Transport Canada continues to pursue other means to enhance floatplane safety.

March 2017: TSB reassessment of Transport Canada's response to Recommendation A13-03

TC's January 2017 response continues to reiterate statements made in its January 2014 and November 2015 responses regarding TC's opinion that the older aircraft designs do not lend themselves to modifications. However, the responses do not address the counterpoints put forward in the TSB assessment of March 2014 and reiterated in March 2016, specifically:

There are approximately 600 aircraft on the Canadian commercial aircraft registry that are potentially operated on floats, certificated for 9 or fewer passengers, and manufactured before 1986. Of these aircraft, approximately 200 are DHC-2s and 300 are Cessnas. There are already shoulder harness installation kits available for the Cessna, as described in Cessna Single Engine Service Bulletin SEB92-28. Additionally, in 2009, TC approved a Limited Supplementary Type Certificate (O-LSA09-360/D) for the installation of rear shoulder harnesses in several DHC-2s. These facts support the feasibility of retrofitting many floatplane designs with shoulder harnesses.

TC has not provided any objective information to demonstrate that it is not feasible to install rear-seat shoulder harnesses in older aircraft.

The Board believes that the risks identified in Recommendation A13-03 have not decreased and remain significant.

Therefore, the response to Recommendation A13-03 is assessed as **Unsatisfactory**.

March 2018: Transport Canada's response to Recommendation A13-03

TC does not agree with the recommendation.

The small, single engine aircraft used in the Air Taxi Sector (CAR 703) are certified to standards applicable at the time of manufacture. For example the DHC2 Beaver and DHC3 Otter aircraft meet 1948 and 1949 standards respectively. The structures of these aircraft were not designed and constructed to support modern, robust seat installations which could absorb high G forces during a collision with terrain.

Page 5 of TSB Aviation Investigation Report A1400105 contains the following passage:

“...Additionally, TC approved a Limited Supplementary Type Certificate (L-STC) (0-LSA09-360/D) for the installation of rear shoulder harnesses in several DHC-2 ‘s in 2009. These facts support the feasibility of retrofitting many floatplane designs with shoulder harnesses.” TC obtained a copy of the L-STC and found it was unclear. The text mentions mid-cabin seats but the approved engineering drawings all depict front seat installations. Certification Standards Engineers found the L-STC described frontseat shoulder restraint installations only.

To confirm, TC followed up with the STC holder to determine whether the L-STC included rear seat installations. The L-STC holder confirmed that the modification refers to the installation of shoulder harnesses for the pilot and copilot seats only for the DHC-2 MKIII aeroplane; it does not provide for installation of shoulder harnesses at other seat locations or for other models.

TC maintains that the structures and interior designs of these older aircraft are not robust enough to support shoulder restraints.

September 2018: TSB reassessment of Transport Canada’s response to Recommendation A13-03

In the most recent response Transport Canada (TC) states that older aircraft such as the DHC2 and DHC3 do not have the structure to support modern seat installation to absorb the high G forces involved during a collision with terrain.

The focus of this recommendation is on adding shoulder harnesses to existing seat installations on commercial seaplanes certified for 9 or fewer passengers to enhance safety in the event of an accident on water.

The TSB considers that, given the additional hazards associated with accidents on water, shoulder harnesses for all seaplane passengers will reduce the risk of incapacitating injury, thereby improving their ability to exit the aircraft.

One of the two aircraft mentioned in the response (DHC3) is certified for 11 passengers and therefore not within the scope of the recommendation.

The section of the response that describes the details of the limited STC (L-STC) (0-LSA09-360/D) may need further review by TC in light of the following:

- The L-STC was issued in 2009, many years after shoulder harnesses were required in the cockpit, and installed in the referenced aircraft.

- The operator of the aircraft listed in the L-STC does low level inspection with rear seat passengers, and therefore requires rear seat shoulder harnesses as per CARs 605.24(5)(c).
- TSB investigators have flown in the rear mid-cabin seats of these aircraft and have used the shoulder harnesses.
- Recent TSB communication with the L-STC holder re-confirmed that the L-STC is for mid-cabin seats, and not seats in the cockpit.

There are rear seat shoulder harnesses kits currently available for many of the aircraft (mostly Cessnas) which are referenced in the recommendation, and it is feasible to retrofit other applicable aircraft, such as some DHC-2s, as demonstrated by the L-STC. TC has routinely suggested that the retrofit is not feasible, but has not provided any data to substantiate this.

The Board believes that the risks identified in Recommendation A13-03 have not abated and remain significant.

Therefore, the response to Recommendation A13-03 is assessed to be **Unsatisfactory**.

October 2019: Transport Canada's response to Recommendation A13-03

TC has previously stated that it does not agree with the recommendation given the challenges associated with retrofitting shoulder harnesses in older aircraft and the inability to assess the potential safety benefits of doing so. The TSB has assessed TC's response to this recommendation as unsatisfactory, stating that TC has provided insufficient data to substantiate its position.

TC does not have further information to provide on this recommendation. Given TC's initial assessment that the addition of shoulder harnesses to older aircraft would be problematic and provide questionable safety enhancements, no additional resources will be assigned to pursue this issue.

March 2020: TSB reassessment of Transport Canada's response to Recommendation A13-03

In its response, Transport Canada (TC) indicated that it does not agree with Recommendation A13-03.

In its most recent response, TC reiterates its assertion that fitting shoulder harnesses is challenging, despite the TSB's previous response that modifications or supplementary type certificates are already available for the majority of aircraft in question.

TC also reiterates its position that it is unable to assess the potential safety benefits, even though the TSB has previously pointed out that information and studies have shown the clear benefits, and that the current standard requires these belts for enhanced safety.

TC has not provided studies or evidence supporting its statements that retrofitting shoulder harnesses is problematic and offers questionable safety enhancements. The Board believes that the risks associated with the safety deficiency identified in Recommendation A13-03 remain.

Therefore, the Board considers the response to the recommendation to be **Unsatisfactory**.

Latest response and assessment

September 2020: Transport Canada's response to Recommendation A13-03

TC does not agree with the recommendation.

In addition to the concerns related to the practicability of requiring the installation of shoulder harnesses in older aircraft described in previous updates, the safety benefit of such a requirement is not clear.

TC conducted a review² of 30 Transportation Safety Board (TSB) reports of seaplane accidents that occurred between 1990 and 2009. Based on the information in these reports it is evident that a complex combination of factors influence the ability of an occupant, who survives an aircraft collision with water, to escape a sinking aircraft cabin. They include, among others, aircraft attitude, aircraft exit design, water depth, water temperature, illumination conditions, occupant injuries, occupant training, occupant fitness, occupant lung capacity, etc. These factors are concurrent, most are unpredictable, and their contribution to the inability of an occupant to escape is difficult to isolate after the accident. This complexity makes the determination of the weight of each factor very difficult, if not impossible.

For this reason, the quantification of the number of lives that would be saved by the adoption of the recommendation A13-03 is not feasible. The complex combination of factors described above prevents this determination. Even if head trauma is prevented, nothing guarantees that the same individual protected by a better-restraint system would not perish from the effects of other factors (hypothermia, other injuries, disorientation, inability to open the exit, inability to hold their breath, physical weakness, etc.). Therefore, it is impossible to quantify the cost-benefit ratio of implementation for a federal regulation mandating all seaplanes in commercial service certificated for nine or fewer passengers to be fitted with seatbelts that include shoulder harnesses on all passenger seats.

In conclusion, the qualitative analysis of the interaction of the factors affecting the ability of an occupant to escape a sinking aircraft, described above, provides sufficient insight to allow an estimate of the impact of adopting the proposed recommendation. It predicts that better occupant restraint for the target fleet would not produce a significant reduction in fatalities and would not offset the cost of modifying multiple models of seaplanes to install shoulder harnesses.

² Transport Canada (2016). *Floatplane Accidents - 1990-2009 Fatalities*. Available at: RDIMS 16793229.

TC does not plan to take further action in response to this recommendation.

March 2021: TSB reassessment of Transport Canada's response to Recommendation A13-03

In its latest response, Transport Canada (TC) reiterated that it does not agree with Recommendation A13-03.

TC's response states that the quantification of the number of lives potentially saved by improved occupant restraint is not possible given the numerous other survivability factors involved, including aircraft attitude, aircraft exit design, water depth, water temperature, illumination conditions, occupant injuries, occupant training, occupant fitness, and occupant lung capacity.

The TSB agrees that all of these listed factors may have an effect on survivability and the relative influence of each factor cannot be determined with certainty. However, the majority of these factors are, as stated, unpredictable and cannot be controlled by regulation. The only factors that are controllable are improved restraints, aircraft exit design, and, to some extent, occupant training.

To address these predictable and controllable factors, in addition to this recommendation, the TSB has issued two other recommendations: TSB Recommendation A13-02 (underwater egress training for flight crews) and Recommendation A11-05 (improved exits). In contrast to this response, the responses to these other recommendations were assessed as fully satisfactory (March 2019) and satisfactory in part (March 2017), respectively.

The risk presented by inadequate occupant restraint is well known to exist, is reflected in current airworthiness standards, was found to have caused or contributed to fatal injuries in previous TSB investigations, and was detailed in safety studies completed by both the TSB and the U.S. Federal Aviation Administration. Therefore, it is not clear why TC takes the position in this response that because the relative influence of this hazard cannot be quantified precisely, action will not be taken to address the safety deficiency.

Therefore, the Board considers the response to Recommendation A13-03 to be **Unsatisfactory**.

File status

TC has indicated that it does not plan to take further action in response to this recommendation; therefore, the TSB will continue to monitor the influence of the safety deficiency in future investigations and advocate for reconsideration, as appropriate.

This deficiency file is **Dormant**.