



## REASSESSMENT OF THE RESPONSE TO TSB RECOMMENDATION A06-09

### Design standards for new aeroplanes

#### Background

On 30 May 2000, the pilot of a Cessna 177B Cardinal was attempting to take off from a grass airstrip at Calling Lake, Alberta. The aircraft struck trees during the initial climb, struck the ground, and burst into flame. The two occupants were exposed to smoke and flame for some time. One occupant was fatally injured due to the effects of fire, and one sustained serious burns.

The accident investigation identified fuel system crashworthiness as a small-aircraft safety deficiency. In light of that finding, the Transportation Safety Board of Canada (TSB) identified a need to examine the extent to which fuel system crashworthiness and other safety deficiencies contribute to the risks associated with post-impact fire (PIF) in otherwise survivable accidents, and to consider the risk control options available to mitigate those risks.

According to TSB data from 1976 to 2002, PIF occurs in approximately 4 per cent of accidents involving small aircraft; however, these accidents account for approximately 22 per cent of the fatalities and 11 per cent of the serious injuries caused by all accidents. Overall, 6.2 per cent of fatal injuries and 3.8 per cent of serious injuries that resulted from small-aircraft PIF accidents were related to fire. Because small aircraft have a higher accident rate with a correspondingly greater number of PIF accidents, more defences are required to mitigate the risk of PIF. Considering these factors, the Board identified the need to conduct a Safety Issues Investigation.

The Board concluded its investigation and released report SII A05-01 on 29 August 2006.

#### TSB Recommendation A06-09 (August 2006)

Aircraft design is fundamentally important to preventing PIF in impact-survivable accidents. There are currently no design standards that specifically address countermeasures to reduce the incidence of PIF in impact-survivable accidents involving newly manufactured small, production aeroplanes, other than during gear-up landings; therefore, occupants remain at risk of fire-related injury and fatality in accidents involving new aeroplane models. There are numerous engineering concepts and products that are known to eliminate potential ignition sources and protect against impact-induced fuel spillage in impact-survivable accidents. Requirements to consider and adapt these countermeasures in new aeroplane designs may significantly reduce the risk and incidence of PIFs in impact-survivable accidents.

Therefore, the Board recommends that:

To reduce the number of post-impact fires in impact-survivable accidents involving new production aeroplanes weighing less than 5700 kg, Transport Canada, the Federal Aviation Administration, and other foreign regulators include in new aeroplane type design standards:

- methods to reduce the risk of hot items becoming ignition sources;
- technology designed to inert the battery and electrical systems at impact to eliminate high-temperature electrical arcing as a potential ignition source;
- requirements for protective or sacrificial insulating materials in locations that are vulnerable to friction heating and sparking during accidents to eliminate friction sparking as a potential ignition source;
- requirements for fuel system crashworthiness;
- requirements for fuel tanks to be located as far as possible from the occupied areas of the aircraft and for fuel lines to be routed outside the occupied areas of the aircraft to increase the distance between the occupants and the fuel; and
- improved standards for exits, restraint systems, and seats to enhance survivability and opportunities for occupant escape.

**TSB Recommendation A06-09**

### **Transport Canada's response to Recommendation A06-09 (November 2006 and January 2007)**

Transport Canada's (TC) response dated 20 November 2006 makes a general statement that many amendments to Airworthiness Manual (AWM) 523/FAR 23 regulations have been adopted and may address certain elements of Recommendation A06-09. Furthermore, it states that many of the aircraft identified in the TSB report were certified to earlier design standards and would not have benefited from subsequent regulatory changes. Additionally, TC's response expresses support for the intent of this recommendation but concludes by declaring that TC is not in a position to commit the necessary resources at this time.

TC's updated response dated 29 January 2007 declares that it still holds the fundamental position outlined in the Minister's response. It restates that there have been many amendments to AWM 523/FAR 23 regulations and that current standards are more stringent than those which prevailed during the time when the aircraft cited in SII A05-01 were built. The response goes on to explain that elements of Recommendation A06-09 will be taken into consideration as the regulator performs due diligence on any proposed regulatory change. The remainder of the response explains the certification process and how proposed modifications to an aircraft or component are evaluated against the standards in force at the time of certification.

### **TSB assessment of Transport Canada's responses to Recommendation A06-09 (September 2007)**

TC's 20 November 2006 response implies but does not state which amendments to Airworthiness Manual 523/FAR 23 have addressed elements of Recommendation A06-09. Additionally, the response does not provide any insight into TC's assessment of the merits of amending new aeroplane type design standards as suggested in Recommendation A06-09.

Furthermore, it is not clear why TC's response focuses on existing certificated aircraft rather than addressing the need to reduce the number of post-impact fires in impact-survivable accidents by amending new aeroplane type design standards as Recommendation A06-09 suggests.

The updated response dated 29 January 2007 is a clarification of TC's position as originally stated in the Minister's response dated 20 November 2006. As in the original response, a general reference is made to Airworthiness Manual 523/FAR 23 amendments but no specifics are provided as to whether or not these amendments address the deficiencies to the aeroplane type design standards as identified in Recommendation A06-09. Additionally, although TC indicates that it will consider the "safety concerns" identified in Recommendation A06-09, as the standards evolve, no definitive action plan to cause a review of the aeroplane type design standards is provided. In summary, the status quo is maintained as TC states that it still holds the fundamental position outlined in the Minister's response dated 20 November 2006.

Because TC's responses contain no action or proposed action that will reduce or eliminate the risks associated with this deficiency, the overall response to Recommendation A06-09 is assessed as **Unsatisfactory**.

### **Transport Canada's response to Recommendation A06-09 (January 2010)**

TC's response indicates that it supports the TSB objective of reducing fatalities and serious injuries due to post-impact fires in general aviation aircraft however; implementation of these recommendations would require an immense resource effort. The response further states that other safety initiatives have a higher priority.

### **TSB reassessment of the response to Recommendation A06-09 (July 2010)**

TC's latest response makes no effort to explain its conclusions that an immense resource effort would be required to execute the objectives of Recommendation A06-09 and that such resources would detract from other safety initiatives.

Meanwhile the PIF experience remains high. Preliminary research reveals that since 01 January 2005 the Board has recorded 99 occurrences that involve a PIF phase/event combination. The majority of these occurrences involved aircraft weighing less than 5700 kg. A word string search of the NTSB database for the same timeframe turned up records of over 300 general aviation accidents where post-impact fire is referenced.

Again TC has failed to address the risks associated with the deficiency identified in Recommendation A06-09 it would appear the TC has in fact declared that it plans no further action.

Because TC's responses contain no action or proposed action that will reduce or eliminate the risks associated with this deficiency, the overall response to Recommendation A06-09 is assessed as **Unsatisfactory**.

## **TSB review of the status of the A06-10 deficiency file (October 2012, as amended in April 2013)**

The Board notes that a review of the TSB's Aviation Safety Information System reveals that the PIF experience continues. From 01 January 2005 to 09 October 2012, the TSB recorded 93 occurrences of aircraft weighing less than 5700 kg that included a PIF phase/event combination.

The Board believes that the risks identified in Recommendation A06-09 have not abated and remain substantial. The Board therefore determined that these risks deserve a renewed effort by TSB to improve its data gathering of PIF-related events, and that TC should take appropriate safety actions to mitigate the risks associated with Recommendation A06-09 in order to reduce injuries and death associated with PIF.

## **The Federal Aviation Administration's response to Recommendation A06-09 (November 2012)**

TSB Safety recommendations A06-09 and A06-10 were responded to by the FAA on December 21, 2007. [This response was again faxed to Mr. Joliceour(sic) on November 12, 2012.] As you will note from our response, we believe that many of the TSBC's concerns were already addressed through various amendments to our part 23 regulations. Additionally, some of the TSBC concerns would require additional rulemaking, which the FAA could not justify from service history. Therefore, TSB recommendations A06-09 and A06-10 were classified as "Closed," with no further FAA activity planned.

## **Transport Canada's response to Recommendation A06-09 (December 2012)**

TCCA is aware of the FAA work in the 1980s leading to NPRM 85-7A, titled 14 CFR Part 23 Airworthiness Standards: Crash-Resistant Fuel Systems, issued on 28 February 1990. The NPRM was subsequently withdrawn on 28 February 1999. The NPRM 85-7A withdrawal notice stated that the FAA had completed a revised economic evaluation of the safety recommendations as a result of the comments received and concluded that the costs of the proposed changes were not justified by the potential benefits, in addition to identifying some technical questions that remained unanswered.

As the TSB has asserted, some estimates of VSL have increased in the intervening years. However, TCCA would observe that the costs of aircraft modification have also increased in this period, by a factor that may have outpaced the VSL. Therefore, it may be unlikely that a revised economic analysis would yield a different outcome at this time. Consequently, TCCA would be unable to satisfy CDSR criteria in putting forward new rulemaking on this subject. However, work in other areas of general aviation (GA) safety is progressing that is likely to have a more holistically positive effect.

It has been noted that, despite all the advancements in design standards since the 1960s, the FAA observes that only 7% of the general aviation fleet has a modern set of applicable standards in its basis of certification. As many as 93% of general aviation airplanes in operation today have a basis of certification dating back to Civil Air Regulation (CAR) 3, designed in the 1950s through 1970s. The main barrier to the introduction of newer airplanes to the GA market is cost. Substantial fleet renewal with newer model airplanes, meeting the latest design standards, is necessary to obtain significant improvement in GA safety.

A holistic approach to renewing the GA sector, and its safety, is presently underway with the FAA's Part 23 ARC. An international group of aviation authorities and industry are currently redesigning the requirements for "Part 23" airplanes in an attempt to accomplish two goals: improve safety by a factor of two, and reduce costs to certify by half. The reduction of costs is necessary to enable the GA fleet renewal that would be necessary to obtain a fleet-wide safety improvement; the safety of the existing legacy and aging fleet of GA airplanes cannot be expected to improve with time.

In particular, the hope for the reorganization of Part 23 would be to facilitate the introduction of lifesaving technologies in GA airplanes in an attempt to reduce fatal accidents by half (i.e. loss of control (stall/spin close to ground), controlled flight into terrain, and engine mismanagement, collectively contributing to 50% of all GA accidents). A secondary objective is to reduce type certification (and production certification) costs by half.

FAA, TCCA, EASA, ANAC-Brazil and other aviation authorities are focussing on this vision for general aviation for the next 25 years, a vision that offers an economically viable means to have an overall improvement in GA safety.

### **TSB reassessment of Transport Canada's response to Recommendation A06-09 (March 2013)**

Transport Canada provided a collective response to recommendations A06-08, A06-09, and A06-10.

Paragraphs 4 to 6 of the response identify an opportunity for Transport Canada to promote and address the recommendation pertaining to design standards for new aircraft. While Transport Canada is unwilling to act on Recommendation A06-09 at present, it is known that the FAA convened a 55-member FAA Part 23 Aviation Rulemaking Committee (ARC) in August 2011 to look at simplifying the Part 23 regulations. The goal is to improve small aircraft safety by a factor of two and to reduce certification costs by half. There is strong international involvement, including Transport Canada and EASA.

Aircraft design is fundamentally important to preventing post-impact fire in impact-survivable accidents. While there are numerous engineering concepts and products available that are known to eliminate potential ignition sources and reduce fuel spillage in impact-survivable accidents, current design standards intended specifically to reduce the incidence of post-impact fire are minimal. The TSB recognizes it may be easier to mandate the necessary post-impact fire countermeasures into FAR 23 regulations in the future, if the FAR 23 regulations are simplified and certification costs are reduced as a result of Part 23 ARC work.

Since the last Transport Canada response to A06-09 was received on 15 January 2010, Transport Canada has taken no action toward upgrading design standards for new small aircraft, in order to reduce the risk and impact associated with post-impact fires.

### **TSB reassessment of the Federal Aviation Administration's response to Recommendation A06-09 (March 2013)**

Note that the FAA responded jointly to recommendations A06-09 and A06-10 in one paragraph.

The TSB disagrees with the FAA view that many of the TSBC's concerns have already been addressed through various amendments of the FAA Part 23 regulations. All of the rulemakings referred to in the original response predate the publication of the TSB post-impact fire report by several years, and the majority of those rulemakings appear to exist primarily to reduce the risk of in-flight fires. As the dynamics of in-flight fires that occur in functioning aircraft are substantially different from post-impact fires that occur in impact-damaged aircraft, regulations intended to reduce the risk and adverse effect of post-impact fires must be specific to post-impact fires. This was shown in the case of FAR 27 (Normal category rotorcraft) and FAR 29 (Transport category rotorcraft) regulations following the adoption of NPRM 94-24 (Airworthiness Standards; Crash Resistant Fuel Systems in Normal and Transport Category Rotorcraft). NPRM 94-24 resulted in the adoption of FAR 27.952 (Fuel system crash resistance) and FAR 29.952 (Fuel system crash resistance) regulations specifically intended to reduce the risk and impact of post-impact fires in rotorcraft.

The TSB disagrees with the FAA view that additional rulemaking pertaining to post-impact fire countermeasures cannot be justified based on service history. The TSB notes that the primary service history aviation database is the service difficulty reporting (SDR) database. As the service difficulty database is not an accident database, it is an unsuitable source of data for post-impact fire analysis, and therefore an unsuitable database to use as a basis to reject additional rulemaking. More appropriate databases for post-crash fire analysis are the NTSB database and the TSB database, both of which continue to record significant numbers of small aircraft post-impact fire accidents each year. A TSB text search (using word string of "post-crash fire" and "post-impact fire") of the Aviation Accident Database, available on the NTSB website, and a review of the results for the year 2011 and 2012 identified 189 small aircraft occurrences, including 17 foreign occurrences that had resulted in post-impact fire.

While the FAA is unwilling to act on Recommendation A06-09 at present, it is known that the FAA convened a 55-member FAA Part 23 Aviation Rulemaking Committee (ARC) in August 2011 to look at simplifying the Part 23 regulations. The goal is to improve small aircraft safety by a factor of two and to reduce certification costs by half. There is strong international involvement, including Transport Canada and EASA. The TSB recognizes it may be easier to mandate post-impact fire countermeasures into FAR 23 regulations in the future, if the FAR 23 regulations are simplified and certification costs are reduced as a result of Part 23 ARC work. This opportunity is not identified in the FAA response to Recommendation A06-09.

Since the last FAA response to Recommendation A06-09 was received on 09 January 2008, the FAA has taken no action to upgrade design standards for new aircraft, in order to reduce the risk and impact of post-impact fires; as well, no further FAA activity is planned.

### **TSB reassessment of the responses from Transport Canada and the Federal Aviation Administration to Recommendation A06-09 (March 2013)**

The Board believes that the risks identified in Recommendation A06-09 have not abated and remain significant. The Board therefore determined that these risks deserve a renewed effort by TSB to improve its data gathering of PIF-related events. In addition, Transport Canada should consider appropriate safety actions, including the introduction of new design standards to mitigate the risks associated with Recommendation A06-09, in order to reduce injuries and death associated with post-impact fire. While the primary focus of FAR 23 ARC, as described by Transport Canada, appears to be the introduction of lifesaving technologies to prevent

accidents, the TSB considers the Part 23 ARC deliberations an opportune time for regulators and industry to consider adapting new aircraft design standards to reduce the risk and impact of post-impact fire when accidents occur.

To date, no action has been taken or proposed that will reduce or eliminate the deficiency. Therefore, the responses in aggregate are assessed as **Unsatisfactory**.

### **Transport Canada's response to Recommendation A06-09 (November 2013)**

TC's response dated 26 November 2013 stated that it had provided a detailed response in December 2012 with respect to the department's approach and work in this. Transport Canada will continue to monitor these issues in the context of working with the FAA and other regulatory authorities.

### **The Federal Aviation Administration's response to Recommendation A06-09 (November 2013)**

The FAA's response dated 14 November 2013 restated its response from December 2007 and again on November 2012. In these responses the FAA indicated that many of the TSB's concerns were already addressed through various amendments to part 23 of the FARs and that any additional rulemaking could not be justified after reviewing the aircraft service history. These recommendations (A06-09 and A06-10) were classified closed and no future activity is planned.

### **TSB reassessment of the response to Recommendation A06-09 (April 2014)**

On 05 June 2013, a report from the 14 CFR Part 23 Reorganization Aviation Rulemaking Committee (ARC) to the FAA was issued containing recommendations for increasing the safety of small general aviation airplanes certificated to 14 CFR part 23. The report contained no specific type design standards relating to crash worthiness as listed in Recommendation A06-09, but did state that implementation of the ARC's recommendations would result in:

... safer new airplanes and improvements in the safety of existing fleet through the ability to more easily and rapidly incorporate new technology that can reduce pilot workload provide better situation awareness and afford other safety enhancements. It also has the potential for a significant reduction of certification costs through reduced need for Special Conditions, Equivalent Level of Safety findings or other activities.

Although encouraged by the FAA's efforts to amend the certification process, the Board believes that the risks identified in Recommendation A06-09 have not abated and remain significant.

To date, no direct action has been taken or proposed that will reduce or eliminate the deficiency. Therefore, the overall response to Recommendation A06-09 is assessed as **Unsatisfactory**.

## The Federal Aviation Administration's response to Recommendation A06-09 (November 2014)

Thank you for providing us with the Transport Safety Board of Canada's Annual Reassessment of Active Aviation Recommendations for year 2014/2015. Your recommendations in question; A11-02, A11-01, A06-10 and A06-09, have been addressed in last year's FAA response to your annual reassessment and were considered closed, with no further action planned by the FAA.

## Transport Canada's response to Recommendation A06-09 (January 2015)

Note that Transport Canada responded jointly to A06-09 and A06-10 with the following:

Transport Canada does not agree with the recommendation, and over the past few years has provided a detailed response with respect to the Department's approach and work in this area.

As opposed to dealing with post impact fires as a separate issue, as stated in Transport Canada's December 2012 update, a holistic approach to renewing the GA sector, and its safety, is presently underway with the FAA's Part 23 ARC. An international group of aviation authorities and industry are currently redesigning the requirements for "Part 23" airplanes in an attempt to accomplish two goals: improve safety by a factor of two, and reduce costs to certify by half. The reduction of costs is necessary to enable the GA fleet renewal that would be necessary to obtain a fleet-wide safety improvement; the safety of the existing legacy and aging fleet of GA airplanes cannot be expected to improve with time.

Transport Canada will continue to monitor post-impact fire events as part of our ongoing work. Transport Canada considers this recommendation closed.

## TSB reassessment of the response to Recommendation A06-09 (March 2015)

On 23 July 2014, the FAA advised the House Aviation Subcommittee that it will miss the December 2015 deadline set by the *Small Airplane Revitalization Act* (signed into law 27 November 2013) to reform the aircraft certification process. It is estimated that the rulemaking would not be complete until 2017.

To date, no direct action has been taken or proposed that will reduce or eliminate the deficiency. Therefore, the overall response to Recommendation A06-09 is assessed as **Unsatisfactory**.

## Transport Canada's response to Recommendation A06-09 (November 2015)

Note that Transport Canada responded jointly to recommendations A06-09 and A06-10 with the following:

As per the 2014 update, Transport Canada does not agree with the recommendation, and over the past few years has provided a detailed response with respect to the department's approach and work in this area.

2014 update:



As opposed to dealing with post impact fires as a separate issue, as stated in Transport Canada's December 2012 update, a holistic approach to renewing the GA sector, and its safety, is presently underway with the FAA's Part 23 ARC. An international group of aviation authorities and industry are currently redesigning the requirements for "Part 23" airplanes in an attempt to accomplish two goals: improve safety by a factor of two, and reduce costs to certify by half. The reduction of costs is necessary to enable the GA fleet renewal that would be necessary to obtain a fleet-wide safety improvement; the safety of the existing legacy and aging fleet of GA airplanes cannot be expected to improve with time.

Transport Canada will continue to monitor post-impact fire events as part of our ongoing work.

### **TSB reassessment of the response to Recommendation A06-09 (March 2016)**

There has been no new response from the Federal Aviation Administration (FAA) as of 14 December 2015. The last response from the FAA, in November 2014, indicated that they considered the recommendation closed and proposed no further action beyond amending the certification process for *Federal Aviation Regulations* (FAR) 23 aircraft.

The Board believes that the risks identified in Recommendation A06-09 have not abated and remain significant. To date, no direct action has been taken or proposed that will reduce or eliminate the deficiency. Therefore, the overall response to Recommendation A06-09 is assessed as **Unsatisfactory**.

### **Transport Canada's response to Recommendation A06-09 (January 2017)**

TC does not agree with the recommendation, and has provided a detailed response with respect to the Department's approach and work in this area.

TC has no further activities planned on this recommendation, but will continue to monitor the effect of new design standards on the rate of PIFs in new construction.

### **TSB reassessment of Transport Canada's response to Recommendation A06-09 (March 2017)**

TC's response indicates that it does not agree with the recommendation and has no further planned activities to address the risks identified in Recommendation A06-09.

The FAA has not provided any new response to Recommendation A06-09 since November 2014. The last response from the FAA indicated that it considers the recommendation closed and proposes no further action beyond amending the certification process for FAR 23 aircraft.

The FAA released the amended certification process for FAR 23 aircraft in December 2016. The amendments addressed the hazards of in-flight fires, but did not address crashworthiness and the prevention of PIF in either electrical or fuel systems.

The Board believes that the risks identified in Recommendation A06-09 have not decreased and remain significant. Since January 2015, there have been 4 survivable aircraft accidents<sup>1</sup> in Canada that resulted in PIF, in which occupants suffered injuries ranging from minor to fatal (2 minor injuries, 2 serious injuries, and 2 fatalities). There has been no direct action taken or proposed by either TC or the FAA that will reduce or eliminate the deficiency identified in Recommendation A06-09.

Therefore, the response to Recommendation A06-09 is assessed as **Unsatisfactory**.

### **Next TSB action**

TC and the FAA have no further planned activities to address the risks identified in Recommendation A06-09. The TSB will continue to investigate accidents where a PIF occurs, and monitor the industry for advances in technology to reduce the risk and incidence of PIF in impact-survivable accidents, and communicate those to TC and the FAA. However, as continued assessments will not likely yield further results, this recommendation will not be reassessed on a regular basis.

The deficiency file is **Dormant**.

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<sup>1</sup> TSB occurrence numbers A15C0102, A15P0147, A16O0079, and A16Q0119.