



TSB Recommendation A00-019

Deficiencies in in-flight odour/smoke checklists

The Transportation Safety Board of Canada recommends that appropriate regulatory authorities ensure that emergency checklist procedures for the condition of odour/smoke of unknown origin be designed so as to be completed in a timeframe that will minimize the possibility of an in-flight fire being ignited or sustained

Air transportation safety investigation report	A98H0003
Date the recommendation was issued	04 December 1999
Date of the latest response	October 2022
Date of the latest assessment	February 2023
Rating of the latest response	Fully Satisfactory
File status	Closed

Summary of the occurrence

On 2 September 1998, Swissair Flight 111, a McDonnell Douglas MD -11 aircraft, departed John F. Kennedy Airport in New York, New York, en route to Geneva, Switzerland. Approximately one hour after take-off, the crew diverted the flight to Halifax, Nova Scotia, because of smoke in the cockpit. While the aircraft was manoeuvring in preparation for landing in Halifax, it struck the water near Peggy's Cove, Nova Scotia, fatally injuring all 229 occupants on board. The investigation revealed that the flight crew had lost control of the aircraft as a result of a fire in the aircraft's ceiling area, forward and aft of the cockpit bulkhead.

On 4 December 2000, the Board released interim safety recommendations as part of its investigation (A98H0003) into this occurrence.

Rationale for the recommendation

Aircraft accident data indicate that a self-propagating fire can develop in a short period of time. Therefore, odour/smoke checklists must be designed such that the appropriate troubleshooting procedures are completed quickly and effectively. The Board is concerned that this is not the case and recommended that

Appropriate regulatory authorities ensure that emergency checklist procedures for the condition of odour/smoke of unknown origin be designed so as to be completed in a timeframe that will minimize the possibility of an in-flight fire being ignited or sustained.

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Previous responses and assessments

January 2001: response from the Federal Aviation Administration

The FAA responded that it has added TSB's recommendations to the FAA's Safety Recommendation Program to ensure that they are assigned to the appropriate program offices for evaluation and action as necessary. The FAA also indicates that it has agreed to meet with TC over this matter and that the Office of Aircraft Certification, specifically the Manager of the Transport Airplane Directorate, has been assigned to lead the FAA team in this regard.

March 2001: response from Transport Canada

On 19 December 2000, Transport Canada (TC) sent a letter to the United States Federal Aviation Administration (FAA) and the European Joint Aviation Authorities (JAA). The letter supported the intent of the recommendations, acknowledged that none of the issues can be addressed in isolation, and invited the major civil aviation regulatory authorities to harmonize a strategy for their resolution.

In this letter, TC also proposed to hold a meeting in March 2001 to discuss the recommendations, to identify existing initiatives and groups that may already address some aspects covered by the recommendations, and to establish a team to develop an appropriate action strategy. The FAA responded positively on 19 January 2001 and a positive response is anticipated from the JAA.

TC will keep the TSB apprised of the outcome of the meeting and of its progress towards achieving the goals of these recommendations.

March 2001: TSB assessment of the responses (Satisfactory Intent)

It is apparent that both Transport Canada and the United States Federal Aviation Administration agree with the thrust of the deficiencies and are committed, at least in the short term, to examine these issues and map out a course of action. Collectively, these responses are adequate and constitute a logical "first step." Until such time as the details of the proposed action plan are known, it will remain unclear the extent to which the identified deficiencies will be reduced or eliminated. Although the declared initiatives will not yield any immediate substantive change, the planned action, when fully implemented, will substantially reduce or eliminate the safety deficiency.

Therefore, the responses are considered to be **Satisfactory Intent**.

December 2005: response from Transport Canada

In its letter to the TSB dated 14 December 2005, Transport Canada (TC) stated that, in 2005, TC and Bombardier Aerospace participated in an International Air Transport Association workshop, which had as an objective to produce generic industry-wide guidance material on smoke and fire cockpit checklist procedures.

Consequently, Bombardier committed to draft proposed improvements to the aircraft flight manual smoke and fire procedures and will submit updates to the procedures when complete.

July 2006: TSB assessment of the response (Satisfactory Intent)

As of 14 December 2005, Transport Canada (TC) indicated that it is working with Bombardier Aerospace to improve aircraft flight manual procedures with respect to fire and smoke. Bombardier is to submit proposed improvements to TC. Consequently, the actions, if fully implemented, will substantially reduce or eliminate the safety deficiency.

Therefore, the assessment remains at **Satisfactory Intent**.

February 2007: response from Transport Canada

Transport Canada (TC)'s response states that its co-sponsorship with other regulatory authorities of the Flight Safety Foundation's workshop dealing with smoke and fire cockpit checklist procedures has had some positive results. The workshop whose objective was to produce generic industry wide guidance material on smoke and fire cockpit checklist procedures has resulted in various aircraft manufacturers proposing improvements to their respective aircraft flight manuals (AFM).

Consequently, Bombardier Aerospace initiated the amendment process to their AFM and emergency checklist procedures for their products. The amendments were published in January 2007.

TC is not planning any further action following the completion of this activity.

July 2007: TSB assessment of the response (Satisfactory in Part)

The guideline generated by the Flight Safety Foundation (FSF) workshop emphasizes the need for checklist designers to ensure that the emergency checklists for smoke of unknown origin be able to be accomplished in a timely manner. The template produced by this workshop has already produced positive changes in the form of aircraft flight manuals' amendments such as those produced by Bombardier Aerospace.

However, internationally, there is no indication as to whether manufacturers have adopted the use of the FSF emergency checklist template or that regulatory authorities have mandated its use. Therefore, as the use of the template is voluntary, emergency checklists can continue to be designed without regard for the timeliness of their completion.

In summary, the actions taken by the various industry leaders and regulators in this regard could substantially reduce the risks associated with the deficiency identified in Recommendation A00-19, but only if voluntarily implemented by checklist designers.

Therefore, the reassessment is assigned **Satisfactory in Part**.

March 2008: response from Transport Canada

Transport Canada (TC)'s response indicates that both Bombardier Aerospace (BA) and Bell Helicopter Textron Canada (BHTC) are reviewing their products' aircraft flight manuals' (AFM) emergency smoke, fire and fumes checklist procedures with a view to improving their effectiveness. These AFM improvements are being designed using a generic industry-developed checklist template.

Additionally, TC states that it is not planning any further action once the BA and BHTC AFM improvements are complete.

August 2008: TSB assessment of the response (Satisfactory in Part)

Transport Canada (TC)'s support of Bombardier Aerospace (BA) and Bell Helicopter Textron Canada (BHTC) in their efforts to improve their respective emergency checklists is commendable. The checklist template, being used by both BA and BHTC to review and amend their products' aircraft flight manuals (AFM), emphasizes the time critical nature of a checklist designed to respond to a smoke, fire and fumes event; therefore, the AFM amendments should mitigate the risks identified in Recommendation A00-19 for both BA and BHTC manufactured aircraft.

Because TC's response states that it is not planning any further action with respect to Recommendation A00-19, risks will remain for those AFMs of foreign-certified aircraft being operated by Canadian operators that do not voluntarily implement checklist design changes in accordance with the FSF guideline.

The planned action will reduce, but not substantially reduce the deficiency. Therefore, the reassessment rating is **Satisfactory in Part**.

September 2009: TSB review of Recommendation A00-19 deficiency file status (response: Satisfactory in Part; file status: Dormant)

In its latest position statement regarding the deficiency identified in Recommendation A00-19 TC states that "safety improvements have adequately optimized risk to an acceptable level." Additionally, Transport Canada (TC) considers this recommendation closed and plans no further action.

Therefore, the assessment remains at **Satisfactory in Part**.

The Board also concludes that, as no further action is planned by TC, continued reassessment will not likely yield further results.

This deficiency file is **Dormant**.

May 2018: TSB review of Recommendation A00-19 deficiency file status (response: Satisfactory in Part; file status: Active)

The Board requested that all recommendations 10 years old or more be reviewed to determine if the deficiency file status was appropriate. After an initial evaluation, it was determined that the safety deficiency addressed by Recommendation A00-19 needed to be reassessed.

A request for further information was sent to Transport Canada (TC) and a reassessment will be conducted upon receipt of TC's response. In the interim, the assessment remains at **Satisfactory in Part**.

Consequently, the status of Recommendation A00-19 is changed to **Active**.

November 2018: response from Transport Canada

Transport Canada (TC) agrees with the recommendation.

In the fall of 2019, as one of the appropriate regulatory authorities, TC will survey Canadian operators of foreign-certified aircraft to verify if they have voluntarily implemented checklist design changes in accordance with the Flight Safety Foundation guideline. Responses are expected to be received in 2020.

Following an analysis of the responses received, TC will identify remaining gaps and take further action if necessary.

March 2019: TSB assessment of the response to Recommendation A00-19 (Satisfactory Intent)

Since the publication of Recommendation A00-19, the following actions have been taken to address the safety deficiency identified in Recommendation A00-19, regarding emergency checklist procedures for the condition of odour/smoke of unknown origin to be designed so as to be completed in a timeframe that will minimize the possibility of an in-flight fire being ignited or sustained:

- In 2004, an international initiative, sponsored by the Flight Safety Foundation (FSF), was undertaken with an aim of improving checklist procedures regarding fire/smoke/fume events. The group involved was comprised of international stakeholders; Transport Canada (TC) and Bombardier Aerospace were active participants.
- In 2005, a series of meetings and conference calls culminated in a symposium that produced generic industry-wide guidance material on smoke and fire cockpit checklist procedures. These checklist procedures led various aircraft manufacturers to propose improvements to their respective aircraft flight manuals (AFMs).
- In 2007, Bombardier Aerospace's amended AFMs were published, followed by those from Bell Helicopter Textron Canada in 2008.

However, internationally, there still is no indication as to whether manufacturers have adopted the use of the FSF guidance material or that regulatory authorities have mandated its use.

TC's next proposed action is to survey Canadian operators operating foreign-certified aircraft to determine if they have implemented checklist design changes in accordance with FSF guidelines. Upon receipt of the survey responses, in 2020, TC plans to conduct an analysis and identify remaining gaps. Further action will be taken if necessary.

The Board considers that the actions taken to date by TC, and by manufacturers, have reduced the risks associated with the safety deficiency identified in Recommendation A00-19. The Board looks forward to TC's analysis of the survey results to see if there are remaining gaps.

Therefore, the response to Recommendation A00-19 is assessed as **Satisfactory Intent**.

September 2021: response from Transport Canada

Transport Canada (TC) agrees with the recommendation.

Since the recommendation was issued in 1999, TC communicated with the United States Federal Aviation Administration (FAA) and the former European Joint Aviation Authorities (JAA) to support the intent of the recommendation, to acknowledge that none of the issues can be addressed in isolation, and to invite the major civil aviation regulatory authorities to harmonize a strategy for their resolution.

In 2004, TC also actively participated in an international initiative, sponsored by the Flight Safety Foundation (FSF), with the objective of improving checklist procedures regarding fire/smoke/fume events and this led various aircraft manufacturers to propose improvements to their respective aircraft flight manuals (AFMs). For example, in 2005, TC worked with Bombardier Aerospace to improve aircraft flight manual procedures with respect to fire and smoke and the amendments were published in 2007.

In 2008, the work to address this recommendation had resulted in a Board assessment of "Satisfactory in Part." The Board noted that TC's work with Canadian manufacturers would likely address the risks associated with the safety deficiency for Canadian manufactured aircraft. The Board also noted it believed a risk remained for foreign certified aircraft operated in Canada that did not voluntarily implement checklist design changes in accordance with the FSF guidelines.

In 2009, the recommendation was assigned a "Dormant" status given that TC indicated that safety improvements had adequately reduced risk to an acceptable level, and the Department did not plan to carry out further work on this issue.

In 2018, as part of a review of all recommendations 10 years or older, the TSB elected to change the status of the recommendation to "Active" and requested an update from TC. When the recommendation was reactivated in 2018, the department committed to:

- Survey Canadian operators of foreign-certified aircraft to verify if they have voluntarily implemented checklist design changes in accordance with the FSF guidelines. Responses are expected to be received in 2020. Following an analysis of the responses received, TC will identify remaining gaps and take further action if necessary.

TC's update was assessed as "Satisfactory Intent" with the note that: "The Board considers that the actions taken to date by TC, and by manufacturers, have reduced the risks associated with the safety deficiency identified in Recommendation A00-19. The Board looks forward to TC's analysis of the survey results to see if there are remaining gaps."

Given other priorities, this survey has not been carried out and TC has no additional information to provide at this time. Following this update, TC will assess whether the survey described in the 2018 update is still warranted and advise the Board accordingly.

March 2022: TSB assessment of the response (Satisfactory Intent)

In its most recent response, Transport Canada (TC) indicated that it agrees with the recommendation, but the survey, originally planned to be conducted in 2019, had not been carried out and that TC will assess whether the survey is still warranted. The purpose of the survey was to verify if Canadian operators of foreign-certified aircraft had implemented checklist design changes in accordance with the voluntary guidelines established by the Flight Safety Foundation (FSF). Following receipt of the survey responses, TC planned to conduct an analysis of the results and identify remaining gaps and take further action if necessary.

The TSB recently conducted a cursory review of certain manufacturers' checklists and it appears some progress has been made. However, the Board is unable to assess whether this progress is widespread throughout the industry and thus supports the implementation of a survey to determine the prevalence of checklist design changes in accordance with FSF guidelines and to see if there are any remaining gaps.

Therefore, the response to Recommendation A00-19 is assessed as **Satisfactory Intent**.

Latest response and assessment

October 2022: response from Transport Canada

Transport Canada (TC) agrees with the recommendation.

Since the recommendation was issued in 1999, TC communicated with the United States Federal Aviation Administration (FAA) and the former European Joint Aviation Authorities (JAA) to support the intent of the recommendation, to acknowledge that none of the issues can be addressed in isolation, and to invite the major civil aviation regulatory authorities to harmonize a strategy for their resolution.

In 2004, TC also actively participated in an international initiative, sponsored by the Flight Safety Foundation (FSF), with the objective of improving checklist procedures regarding

fire/smoke/fume events and this led various aircraft manufacturers to propose improvements to their respective aircraft flight manuals (AFMs). For example, in 2005, TC worked with Bombardier Aerospace to improve aircraft flight manual procedures with respect to fire and smoke and the amendment were published in 2007.

In 2008, the work to address this recommendation had resulted in a Board assessment of “Satisfactory in Part.” The Board noted that TC’s work with Canadian manufacturers would likely address the risks associated with the safety deficiency for Canadian manufactured aircraft. The Board also noted it believed a risk remained for foreign certified aircraft operated in Canada that did not voluntarily implement checklist design changes in accordance with the Flight Safety Foundation guidelines.

In 2009, the recommendation was assigned a “Dormant” status given that TC indicated that safety improvements had adequately reduced the risk, and that the Department did not plan to carry out further work on this issue.

In 2018, as part of a review of all recommendations 10 years or older, the TSB elected to change the status of the recommendation to active and requested an update from TC. Although the Board assessed safety action previously taken by TC to have reduced the risks associated with this safety issue for aircraft manufactured in Canada, a question remained as to the extent that guidance material developed for checklists for smoke and fire of unknown origin had been adopted by foreign manufacturers. When the recommendation was re-activated in 2018, TC committed to:

- Survey Canadian operators of foreign-certified aircraft to verify if they have voluntarily implemented checklist design changes in accordance with the Flight Safety Foundation (FSF) guideline. Responses are expected to be received in 2020. Following an analysis of the responses received, TC will identify remaining gaps and take further action if necessary.

TC’s update was assessed as “Satisfactory Intent” with the note that: “The Board considers that the actions taken to date by TC, and by manufacturers, have reduced the risks associated with the safety deficiency identified in Recommendation A00-19. The Board looks forward to TC’s analysis of the survey results to see if there are remaining gaps.”

In TC’s September 2021 update, the Department committed to:

- Assess whether the survey described in the 2018 update is still warranted and advise the Board accordingly.

At this time, TC has determined that it will not be carrying out the survey described in the 2018 update. Having worked to confirm that Canadian manufacturers had implemented the guidelines that TC helped develop prior to 2008, the Department believes it has carried out its mandate related to this recommendation.

Additional work to ensure foreign manufacturers and certification authorities have implemented the guidelines is outside TC's mandate. However, to ensure that foreign certification authorities are aware of the potential need for action in this area, TC will raise the issue through the Certification Management Team (CMT), a body that aims to enhance collaboration between the four main certification authorities (FAA, EASA, ANAC, TC).

February 2023: TSB assessment of the response to Recommendation A00-19 (Fully Satisfactory)

In its most recent response, Transport Canada (TC) indicated that it agrees with the recommendation, but that it would not be carrying out a survey it had mentioned in its 2018 response. The purpose of the survey was to verify if Canadian operators of foreign-certified aircraft had implemented checklist design changes in accordance with the voluntary guidelines established by the Flight Safety Foundation (FSF).

Although TC deemed that it is outside of its mandate to ensure that foreign manufacturers and certification authorities have implemented the guidelines, TC has identified that it will raise the issue through the Certification Management Team (CMT).

Since Recommendation A00-19 was issued, many actions have been taken that will substantially reduce the safety deficiency, including the following:

- In 2005, an international initiative, sponsored by the FSF, brought industry together to develop a checklist template for smoke/fire/fumes (SFF);
- TC worked with Bombardier to improve aircraft flight manual (AFM) procedures with respect to fire and smoke, which was published in 2007;
- TSB completed a cursory review of checklists of certain manufacturers of large aircraft and it appears that progress has been made:
 - In 2002, Airbus combined 3 different smoke procedures into one smoke/fumes/avnics [avionics] procedure;
 - In 2007, Boeing used the FSF template to develop a combined checklist that addressed several smoke and fume scenarios in its AFM and quick reference handbooks (QRHs) for the 7X7 fleet (737 to 777);
 - The TSB also reviewed QRH checklists for de Havilland (Bombardier), Embraer, and Avions de Transport Régional (ATR) aircraft.
- The U.S. National Aeronautics and Space Administration (NASA) published a study titled "Integrated Checklists for Un-alerted Smoke, Fire and Fumes: Adherence to Guidance from the Industry." The study included an analysis of 7 North American airlines in 2016, 10 years after the FSF template was published, that showed that "to a large degree, content and structure of checklists/QRHs were consistent with guidance proposed by the template."
- TC Advisory Circular (AC) 521-002 (which replaced AC 500-014 that was referenced in Recommendation A00-18) identifies in section 8.1.2.2 (g)(ii) that "the AFM procedures dealing with smoke or fire *will minimize the possibility of an in-flight fire being ignited or*

sustained” [italics added to indicate wording verbatim to Recommendation A00-19]. The AC also contains an example to the effect that “in the event of smoke or fire, prepare to land the aircraft without delay while completing fire suppression and/or smoke procedures,” and that “if it cannot be visually verified that the fire has been completely extinguished, [...] land immediately[...].”

These changes in industry, which are reflected in emergency checklists that use the voluntary guidelines developed in 2005, should assist flight crews in optimizing their response to conditions of smoke, fire, or fume events of unknown origin, and thus reduce the risk of an in-flight fire being ignited or sustained.

The Board believes that the actions taken by industry and TC will substantially reduce the safety deficiency identified in Recommendation A00-19.

Therefore, the response to Recommendation A00-19 is assessed as **Fully Satisfactory**.

File status

This deficiency file is **Closed**.