Bombardier CL-600-2B16 (604), D-AAAY	**In the climb after departing Farnborough Airport, Hampshire**	**10 August 2022**	**Serious Incident**

Investigation Synopsis

At 1733 hours on 14 August 2022, The AAIB was informed that a Bombardier Challenger 604, registration D-AAAY, had an uncommanded flap extension, above the maximum flaps-extemded speed. The event occurred at 1640 hours on 10 August 2022, while the aircraft was in the climb after departing Farnborough Airport. The aircraft returned to Farnborough where it landed without further incident.

Safety Recommendation 2022-017

Justification

On this occasion the crew, who were actively monitoring the aircraft during climb, quickly noticed the uncommanded flap extension and were able to respond appropriately to control the aircraft and reduce its speed to below the flap limit speed. Even so, the flap overspeed reached up to about 103 kts and the speed was not reduced below the flaps 45 limit speed for some 170 seconds.

Had the aircraft been in the cruise, the crew may not have been able to recognise the uncommanded flap extension so promptly and take corrective action within the time required for the flaps to fully extend.

To ensure that operators are aware of the actions to take in the event of an uncommanded flap operation, which may occur without warning, the following Safety Recommendation is made.

Therefore, the following safety recommendation was made:

> **Safety Recommendation 2022-017**
>
> It is recommended that Bombardier inform operators of the Challenger 600 series of aircraft of the actions to take in the event of uncommanded flap operation in flight.

Date Safety Recommendation made: 16 September 2022

LATEST RESPONSE

Response received: 14 February 2023

On January 30th, 2023, Bombardier's Corrective Action Review Board (CARB) mandated that Bombardier revise the Challenger 600 series AFMs to include a procedure for in-flight uncommanded unarrested flaps operation, no later than June 30th, 2024. The CARB further mandated that Bombardier recommend Transport Canada issue an Airworthiness Directive (AD) requiring that operators incorporate the new procedure in their flight manuals. Bombardier submits that this CARB decision meets the intent of AAIB Safety Recommendation 2022-017.

Safety Recommendation Status **Open**

AAIB Assessment	**Response Received - Awaiting IiC review**
Action Status	**Planned Action Ongoing Update Due** 30 June 2024

Feedback rationale

The mandated action by the CARB meets the intent of the Safety Recommendation, and Bombardier Aviation has shown that given the complexity of introducing a new AFM procedure the timescale set in the CARB is realistic as a 'Do not exceed date'. The AAIB would request an update on the actions taken by 30 June 2024. (EU Regulation 996/2010 article 18 refers).

RESPONSE HISTORY

Response received: 14 December 2022

Bombardier is still evaluating the flight crew actions which could be taken in the event of uncommanded unarrested flap operation, and what those actions might be. A final decision will be taken on January 27th, 2023.

AAIB Assessment – Partially Adequate Open

Safety Recommendation 2023-004

Justification

The failure of the relays was caused by damage to the D contacts which switch electrical power to the BDUs. The damage was consistent with arcing between the contacts, which caused metal transfer and the welding of the contacts. As all the contacts in the relay are mounted on a common shaft, the welding of the D contacts would stop the other three sets of contacts from working properly.

Therefore, the following safety recommendation was made:

> **Safety Recommendation 2023-004**
>
> It is recommended that Bombardier Aviation introduce a modification on the Challenger 600 series of aircraft to protect the D contacts within the extend and retract relays of the flap operating system from unsuppressed back-EMF electrical arcing.

Date Safety Recommendation made: 01 March 2023

LATEST RESPONSE

Response received: 04 June 2023

Bombardier is still collecting data and evaluating potential design changes to address the findings from the investigation. The AAIB's specific proposals will be taken into consideration. Bombardier has committed to introducing a design change to the Challenger 604/605/650 flaps system no later than February 28th, 2025, and a design change to the Challenger 600/601 flaps system no later than November 30th, 2025.

Safety Recommendation Status **Open**

AAIB Assessment **Partially Adequate**

Action Status **Planned Action Ongoing Update Due** 28 March 2024

Feedback rationale

The planned action by Bombardier Aviation meets the intent of the Safety Recommendation to prevent damage to the flap operating relays from unsuppressed back- EMF electrical arcing. The AAIB would request an update on the revised design and its implementation by 28 March 2024. (EU Regulation 996/2010 article 18 refers).

RESPONSE HISTORY

N/A

Safety Recommendation 2023-005

Justification

The relays have a component manufacturer inductive load life of 20,000 operating cycles. During a normal flight there will be four flap extensions and two flap retractions, with each movement energising and deenergising the BDU brake solenoids. This would mean the relays would reach their life after 5,000 flight cycles for the extend relays and 10,000 flight cycles for the retract relays. The three aircraft on which the relays had failed had flown 3,900 (retract), 4,687 (extend) and 4,344 (extend) flight cycles.

The maintenance policy is for the relays to remain fitted to the aircraft until a failure is detected; however, detection can be many flight hours after a failure has occurred. The correct function of these relays is required for the operation of the safety critical, uncommanded flap movement arrest system.

Therefore, the following safety recommendation was made:

> **Safety Recommendation 2023-005**
>
> It is recommended that Bombardier Aviation introduce a life policy for the flap operating system relays on the Challenger 600 series of aircraft, which takes account of the component's specified life and is sufficient to ensure that any in-service damage on the D contacts on the extend and retract relays remains acceptable for continued operation.

Date Safety Recommendation made: 01 March 2023

LATEST RESPONSE

Response received: 04 June 2023

Bombardier is still collecting data and evaluating potential design changes to address the findings from the investigation. The AAIB's specific proposals will be taken into consideration. Bombardier has committed to introducing a design change to the Challenger 604/605/650 flaps system no later than February 28th, 2025, and a design change to the Challenger 600/601 flaps system no later than November 30th, 2025.

Safety Recommendation Status **Open**

AAIB Assessment **Not Adequate**

Action Status **Not Enough Infomation** 22 January 2024

Feedback rationale

The response does not contain enough information regarding satisfying the intent of the Safety Recommendation, which is to address the existing risk to the fleet from accumulated damage on the flap extend and retract D contacts.

It is recognised that Bombardier Aviation is still collecting and evaluating in-service data.

The AAIB request a further response on the actions that Bombardier intend to take to mitigate the risk to in-service aircraft by 31 October 2023 (EU Regulation 996/2010 article 18 refers).

RESPONSE HISTORY

N/A

Safety Recommendation 2023-006

Justification

The uncommanded, unarrested movement of the flaps is potentially catastrophic and requires two concurrent failures. The original safety case considered this to be extremely improbable. However, this investigation has identified that on at least three different aircraft a relay was in a failed condition for a significant number of flights, and the failure was not detected even though the flaps moved in one direction at half speed. The failure of any one of these relays is a latent failure because it is not annunciated to the operating crew or maintenance staff. The undetected latent failure of these relays suggests that the original safety case for the uncommanded, unarrested flap movement may no longer be valid. This is because the protection offered by the flap brake system is no longer available and a single failure of another part of the system could be sufficient to cause a catastrophic outcome. This possibility is unlikely to satisfy the 'extremely improbable' requirement. At the time of certification, FAR 25.1309 required that the occurrence of any failure condition which would prevent the continued safe flight of the airplane is 'extremely improbable'.

Therefore, the following safety recommendation was made:

> **Safety Recommendation 2023-006**
>
> It is recommended that Transport Canada reassess the safety case for the flap operating system on the Challenger 600 series of aircraft to ensure it meets the requirements of Title 14 of the Code of Federal Regulations Part 25.1309.

Date Safety Recommendation made: 01 March 2023

LATEST RESPONSE

Response received: 05 April 2023

Transport Canada Civil Aviation concurs with the intent of the safety recommendation.

On February 24th, 2023, after review of the initial facts related to the un-commanded flap extension which occurred on aircraft D-AAAY, Transport Canada Civil Aviation issued Airworthiness Directive (AD) CF-2023-07 as an interim risk mitigation measure for the CL-600-1A11, CL-600-2A12, and CL-600-2B16 aeroplane models.

Transport Canada Civil Aviation continues to investigate this serious incident with the full cooperation of the type certificate holder. The objective of this continuing airworthiness investigation is to determine what further mandatory corrective actions may be required to ensure that an acceptable level of safety is maintained for the CL-600 aircraft type. An assessment of the flap system Part 25.1309 safety case will be conducted as part of the investigation.

Safety Recommendation Status **Open**

AAIB Assessment **Partially Adequate**

Action Status **Planned Action Ongoing Update Due** 06 November 2023

Feedback rationale

The AAIB notes the response from Transport Canada Civil Aviation which meets the intent of the Safety Recommendation. Transport Canada Civil Aviation is requested to provide an update on their progress by 6 November 2023. (EU Regulation 996/2010 article 18 refers).

RESPONSE HISTORY

N/A