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Some of Our CVR Data Are Missing: 92 Airline Accidents & Incidents 2014–2024

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ABSTRACT

In recent years there have been numerous accidents and incidents in which investigators could not retrieve pertinent cockpit voice recorder (CVR) data. As a result, the investigations were hindered and potentially valuable information was not passed on to the wider aviation community to prevent future accidents. Accident investigation agencies have repeatedly called for the introduction of long-duration CVRs to mitigate this problem. In 2021 the European Union introduced regulations requiring newly-manufactured aircraft weighing over 27,000 kg to be equipped with 25-hour CVRs, and in 2024 similar requirements were introduced in the United States. The aim of this paper is to draw attention to the extent of the "missing data" problem and gain a greater understanding of the reasons behind it. Building on previous studies (Cookson, 2019, 2023) the paper examines 92 safety events that occurred from 2014 to 2024. The events are coded according to: (1) CVR recording duration, (2) CVR information provided in the investigation report, and (3) the reason why data were not available. The study identifies 48 events in which the CVR was not promptly deactivated and/or there was a delay in notifying the investigating agency, and a smaller set of 12 events in which pertinent data were overwritten due to excessive flight time. The paper also highlights a worrying lack of standardization in the way in which CVR data are presented in accident and incident reports.

Keywords: Accident investigation, Airline accident, CVR, ICAO, NTSB, Regulations, Safety

INTRODUCTION

On January 5th, 2024, an Alaska Airlines Boeing 737 Max 9 jet took off from Portland International Airport in Oregon, USA, on a scheduled flight to Ontario International Airport in California. As the aircraft climbed through 14,800 feet there was a loud bang followed by a rapid loss of cabin pressure. The pilots declared an emergency and returned to land at Portland fourteen minutes later. One cabin attendant and seven passengers suffered minor injuries, but fortunately there were no serious injuries or fatalities.

The decompression was caused by the failure of a fuselage plug fitted at an unused emergency exit location. There was extensive media coverage due to the unusual nature of the accident and the potentially catastrophic consequences. The investigation by the National Transportation Safety Board (NTSB) was hindered because cockpit voice recorder (CVR) data were not available. After the plane landed the CVR circuit breaker was not immediately pulled, which meant the device continued recording and

pertinent audio was erased (NTSB, 2024a). The NTSB Chair commented, "Any investigation in which the CVR audio is overwritten and unavailable to us, means that we may miss opportunities to address safety issues identified on recordings. And that's unacceptable" (NTSB, 2024b).

This paper examines why CVR data were not available for the Alaska Airlines accident and numerous other safety events over the last decade.

Cockpit Voice Recorders

The cockpit voice recorder is a device that records speech and sounds on the flight deck while an aircraft's electrical system is switched on. In the event of a crash, the loss of electrical power automatically deactivates the CVR. This means that audio information prior to the accident is preserved. In the case of accidents or incidents where the electrical system continues to function, pilots are required to deactivate the CVR promptly once the aircraft is on the ground by removing circuit breakers so that pertinent audio information is preserved.

CVRs are valuable tools for accident investigation. Recorded speech can provide information about pilots' situational awareness, intentions, coordination, decision-making, procedural compliance and announcements to passengers, as well as indicating problems such as distraction, fatigue or excessive workload. Recorded sounds include automated warnings, the activation of a stick shaker, or the movement of control surfaces and landing gear. To give one example, sounds recorded by the CVR helped accident investigators make sense of the explosive decompression experienced by a United Airlines Boeing 747–100 after the in-flight loss of a cargo door near Hawaii in 1990 (NTSB, 1992).

When a CVR is recording it continually overwrites old data, which means that a 2-hour device retains only the last two hours of audio information. Until recently, aircraft have been equipped with 30-minute or 2-hour CVRs, or no device at all. The duration is determined by regulations, and depends on factors such as when an aircraft received its certificate of airworthiness (CofA), the number of passenger seats, the number of pilots, and the type of flight operations.

Because CVR recording duration is limited, the audio record of a safety event is vulnerable to being overwritten. This may happen for the following reasons:

- Excessive flight time – the remaining flight time after the event exceeds the recording duration.
- No prompt deactivation – the CVR is not promptly deactivated when the aircraft is back on the ground after the event.
- Notification delay – there is a delay in notifying the investigating agency about the event and further flight operations take place in the interim.

Changes to CVR Regulations

The 2024 Alaska Airlines accident is one of many examples of investigations being hindered because CVR data could not be retrieved. In response to this problem, there have been repeated calls for the introduction of long-duration

CVRs (AAIB, 2010; AAIS, 2021; BEA, 2015; NTSB, 2018a, 2024c; TAIC, 2022).

Accordingly, the European Union (EU) and the International Civil Aviation Organization (ICAO) introduced requirements stating that newly-manufactured transport aircraft with a maximum certificated take-off mass (MCTOM) of over 27,000 kg must have 25-hour CVRs, with 2-hour recorders on smaller aircraft. The new European Union regulations apply to aircraft with a CofA issued on or after January 1st 2021, and the ICAO requirements are from January 1st 2022. As yet, neither the EU nor ICAO require older aircraft to be retrofitted with long-duration CVRs (EU, 2015; ICAO, 2018).

In the USA, the FAA Reauthorization Act of 2024 specified that 25-hour CVRs must be installed on newly-manufactured aircraft with a capacity of 30 or more passengers from May 2025. In addition, existing aircraft must be retrofitted with 25-hour CVRs by May 2030 (FAA, 2024).

Aims of This Study

There are two main aims of this study: (1) to draw attention to a significant number of accidents and incidents for which relevant CVR data could not be retrieved; and (2) to understand why CVR data were not available for these events. Building on previous studies (Cookson, 2019, 2023) this paper uses a modified methodology to examine a larger set of safety events. Privacy issues, such as concerns that CVR recordings might be leaked or used to monitor pilot performance, while important are beyond the scope of this study.

METHOD

Safety Events

The phrase "safety event" is used in this paper as an umbrella term to denote accidents, serious incidents and incidents. The NTSB uses the same terminology (e.g. NTSB, 2018a), while other agencies – such as the TSB in Canada – use the word "occurrence" in a similar way.

A review of official investigation reports and SKYbrary bulletins was conducted to identify safety events involving passenger-carrying flights for which CVR data were not available. This yielded 92 accidents and incidents in the 2014–2024 period. For each event the following data were recorded: date, location, description of the event, flight phase[1], operator, investigating agency, aircraft type and maximum take-off weight (MTOW).

A number of other "missing data" events were identified by the review but not included in the analysis because they did not involve passenger-carrying aircraft. Most of these events featured cargo aircraft or repositioning flights. Some were serious, such as the engine fire experienced by a United Parcel Service (UPS) Boeing 747-8F freighter in Hong Kong in July 2021 (AAIA, 2022).

The safety events selected for analysis involved 75 airlines and took place in 35 countries in Africa, Asia, Australasia, Europe, North America and

[1]ICAO flight phase definitions were used (ICAO, 2013).

South America. The issue of missing CVR data is evidently a worldwide problem. The countries with the most events were the USA (19 events), France (9), the UK (6), India (5) and Spain (5). As for airlines, American Airlines, Delta Air Lines, KLM and Ryanair were each involved in 5 events, and Air France in 4 events.

A range of regional aircraft (26 events), narrow-body jets (42) and wide-body jets (28) were featured, and 28.3% of the events involved more than one airplane. The most common types of aircraft were from the Airbus A320 (21 events) and Boeing 737 (22) families of narrow-body jets. The most numerous flight phases were approach (33 events), en route (30) and take-off (19).

Research Questions

The safety events were coded using the following research questions. The same questions were used in the previous study (Cookson, 2023), but the order has been changed to make the results clearer.

RQ1: What was the recording duration of the CVR?
- A. 30 minutes
- B. 2 hours
- C. 25 hours
- D. No CVR
- E. Unknown

RQ2: What information does the report provide about the CVR?
- A. Recording duration
- B. Audio quality
- C. Reason for CVR data not being available
- D. How missing CVR data could have helped the investigation
- E. None

RQ3: Why were CVR data of the safety event not available?
- A. Excessive flight time (the remaining flight time after the safety event exceeded the CVR recording duration)
- B. No prompt deactivation (the CVR was not promptly deactivated when the aircraft was on the ground after the safety event)
- C. Notification delay (there was a delay in notifying the investigating agency about the safety event)
- D. Other reason
- E. Unknown

RESULTS

The following paragraphs present the main results for each research question, with a summary shown in Table 1. To illustrate key points, the text includes descriptions of notable accidents and incidents. Appendix 1 has an overview of the safety events that are mentioned.

RQ1: CVR Recording Duration

The first research question concerns the recording duration of the CVRs involved in the safety events. As indicated in Table 1, either a 30-minute or 2-hour CVR featured in 47 events. For the other 45 events the recording duration is unknown because the reports did not include this information.

A 30-minute CVR featured in 7 events. The majority were regional aircraft, but they also included two narrow-body planes and a Boeing 747–300 wide-body jet manufactured in the 1980s. In event #51, an Air Georgian CRJ200 regional jet carried out a runway incursion, take-off without ATC clearance and then a rejected take-off in Toronto, Canada, in August 2019. This aircraft subsequently completed its scheduled flight to Columbus, Ohio, but under FAA and ICAO regulations it should have been equipped with a 2-hour CVR for the international flight to the USA (TSB, 2021).

A 2-hour CVR featured in 40 events. These involved 12 regional aircraft, 19 narrow-body jets and 17 wide-body jets. Event #24 was the fuel exhaustion crash of an Avro 146-RJ85 regional jet in Antioquia, Colombia, in November 2016. This accident was widely reported in the news media because the aircraft was carrying a football squad and there were 71 fatalities. The plane had a 2-hour CVR, but it stopped recording during the flight, 1 hour 45 minutes *before* the crash. The report states: "It was not possible to determine the reasons why the recorder stopped working early" (GRIAA, 2017, p. 40).

Table 1: Summary of results for RQ1-3.

Research Questions	How Many Events
RQ1: CVR recording duration	
A. 30 minutes	7
B. 2 hours	40
C. 25 hours	0
D. No CVR	0
E. Unknown	45
RQ2: CVR information in report	
A. Recording duration	47
B. Audio quality	8
C. Reason for CVR data not being available	64
D. How missing CVR data could have helped the investigation	26
E. None	21
RQ3: Reason for CVR data not being available	
A. Excessive flight time	12
B. No prompt deactivation	30
C. Notification delay	20
D. Other reason	7
E. Unknown	27

RQ2: CVR Information in Accident & Incident Reports

The second research question addresses the type of information that investigation reports provide about CVRs. Some reports include extensive information while others have little or none at all.

In 42 reports there is information about the recording duration and the reason for CVR data not being available. Furthermore, 13 of these reports also indicate how the missing CVR data could have helped the investigation.

For instance, in the previously mentioned 2019 occurrence at Toronto (event #51), the report notes that: the aircraft had a 30-minute CVR; the device was not deactivated until the plane had completed its flight to Columbus, Ohio; and investigators could not determine how long it took the flight crew to do pre-departure checklists because the relevant audio had been overwritten (TSB, 2021).

By contrast, other reports provide minimal information. In 15 events there is no mention of recording duration and the only information is the reason for CVR data not being available. As an example, event #39 was a runway excursion by a Boeing 737–900 jet after a rejected take-off in Kathmandu, Nepal, in April 2018. The report for this serious incident simply states: "CPT [Captain] informs the company that he did not pull out the CB [circuit breaker] after the incident and before he left the aircraft" (AAIB, 2019, p. 6).

The reports for 21 events provide no CVR information at all, merely noting in some cases that "data was not preserved". These include 3 accidents and 7 serious incidents. In event #28, a flight attendant suffered fractured vertebrae in March 2017 when an American Airlines MD-83 jet encountered turbulence during cruise from Toronto, Canada, to Dallas, USA (NTSB, 2018b). In event #59, a Qantas A330-200 wide-body experienced a hydraulic system malfunction, diversion and emergency evacuation in which a passenger was seriously injured on a flight from Sydney, Australia, in December 2019 (ATSB, 2022). In event #76, the captain of a Corsair International A330-900 aircraft became incapacitated during a flight from Martinique to Paris, France, in January 2022, necessitating a diversion to the Azores (BEA, 2024).

RQ3: Reasons for CVR Data Not Being Available

The third research question concerns the reasons why investigators were unable to retrieve CVR data for the safety events.

In 12 events, the remaining flight time after the safety event exceeded the recording duration. Two of the events involved regional turboprops which weigh less than 27,000 kg and have a capacity of 50–80 passengers. The other events featured narrow-body and wide-body jets. In half of the cases, a wide-body aircraft on a long-haul flight experienced a safety event during the take-off or en route phases. In event #48 an Emirates Airbus A380 wide-body encountered severe turbulence that seriously injured one passenger during a flight from Auckland, New Zealand, to Dubai, UAE, in July 2019. The accident occurred in the cruise stage, and relevant audio on the 2-hour CVR was overwritten as the 17-hour flight continued to its destination (AAIS, 2020).

In 48 events, CVR data were not available because the device was not promptly deactivated when the aircraft was on the ground after the event and/or there was a delay in notifying the investigating agency. Two of these events have already been mentioned: the Boeing 737 captain did not pull the circuit breaker after a rejected take-off and runway excursion in Kathmandu (event #39); and the Air Georgian pilots proceeded to fly to Ohio after a runway incursion, take-off without clearance and rejected take-off in Toronto

(event #51). In some cases commercial pressures influenced the actions of airline personnel. For example, in event #16 a Fokker 50 regional turboprop experienced a near mid-air collision with a private plane near Friedrichshafen, Germany, in April 2016. The Fokker captain wanted to preserve the CVR recording for a possible investigation but was overruled by the airline's technical division (STSB, 2018).

The reports for 20 events indicate there was a notification delay. In some cases the flight crew initially assessed the event as a non-reportable occurrence, and the aircraft made one or a few more flights before an investigating agency was notified. However, there were at least 5 serious incidents after which aircraft continued to fly for 5 days or more. In event #31, an Air Canada Airbus A320 attempted to land on a parallel taxiway at San Francisco International Airport in July 2017. Before going around the plane descended to an altitude of 60 feet, overflying 4 passenger aircraft awaiting take-off. This Air Canada jet went on to make 8 further flights totalling 41 hours before the airline secured the recorder data (NTSB, 2018c).

Miscellaneous circumstances led to 7 events being coded as "Other reason". There were two accidents in which aircraft crashed into the ocean and the CVRs were not recovered. Other cases were more mundane. Event #30 was an ATR72 turboprop that experienced a landing gear failure and diversion during approach at Nelson, New Zealand, in April 2017. After landing the circuit breakers were removed in order to preserve the CVR data, but maintenance personnel then reset the circuit breakers and reapplied power to the aircraft, resulting in audio being overwritten (TAIC, 2019). In some reports the frustration of investigators is palpable. In event #38, a Delta Air Lines Airbus A330-300 experienced an engine fire and diversion shortly after taking off from Atlanta, USA, in April 2018. The airplane landed back at Atlanta about 26 minutes after take-off. According to a CVR report in the NTSB online docket, the device was powered up again for more than 2 hours during the night after the event and the relevant audio recording was overwritten (NTSB, 2021, 2022).

Finally, for 27 events the reason for CVR data not being available is unknown. These include 7 accidents and 7 serious incidents. The recordings would clearly have benefited most if not all of these investigations. Two previously mentioned events illustrate this point. In event #59, CVR data could have shed light on crew announcements and communication prior to and during the Qantas emergency evacuation at Sydney, as well as resolving conflicting accounts of the events by the captain and customer service manager. Likewise in event #76, CVR audio would have provided more information about the Corsair co-pilot's workload as she handled the incapacitation of the captain on a long-haul flight from Martinique to Paris. Moreover, after both of these events the recordings could have provided valuable input into the airlines' human factor training courses.

CONCLUSION

This study has identified 92 safety events for which cockpit voice recorder data were not available between 2014 and 2024. The events included

21 accidents and 38 serious incidents. This is a significant problem affecting airlines and aviation authorities around the world. CVR audio recordings are an important resource for accident and incident investigations, but the resource is not being used to its full potential. As the NTSB Chair observed, we are missing opportunities to address safety issues because of the missing CVR data.

In 12 safety events (13.0% of the total) CVR data were not available because the remaining flight time exceeded the recording duration (e.g. event #48). Had these aircraft hypothetically been subject to the new requirements, in every case the recording duration would have been sufficient to retain the relevant audio *if* the CVR was promptly deactivated when the aircraft was on the ground.

In a larger set of 48 cases (52.2% of the total) there was no prompt deactivation of the device and/or there was a delay in notifying the investigating agency. For many of these, it is difficult to say whether the new requirements would have been effective. In cases where, following a safety event, a plane made another short- or medium-haul flight before the device was deactivated (e.g. event #51), then a long-duration CVR might have retained the pertinent audio. If, however, there was a significant delay in notifying the investigating agency and the aircraft made a series of flights (e.g. event #31) then even a 25-hour recorder would not have preserved safety event data. Unfortunately many reports do not provide enough information for the likely effectiveness of the new requirements to be assessed.

There were 21 events, including 3 accidents and 7 serious incidents, for which the reports had no CVR information. Three cases are highlighted in this paper: an American Airlines flight attendant seriously injured during turbulence (event #28); a passenger seriously injured during an emergency evacuation after a Qantas flight experienced a hydraulic system malfunction and diversion (event #59); and the incapacitation of the captain on a two-pilot long-haul Corsair flight (event #76). It is difficult to understand why there is no CVR information in the reports of these accidents and serious incidents.

As noted at the start of the paper, the EU, ICAO and the FAA have in recent years introduced new requirements for long-duration CVRs. This study indicates that, for the requirements to be effective, they should be accompanied by a greater focus on the prompt deactivation of CVRs after safety events. This will require the cooperation of airlines and aviation authorities.

One major difference in the new regulations is that the EU requirements only apply to aircraft manufactured after January 1st 2021, while the FAA requires all existing aircraft to be retrofitted with 25-hour CVRs by May 2030. Given the size of the civil aviation fleet and the fact that many aircraft stay in service for decades, there have been numerous calls for the retrofitting of all aircraft with long-duration devices (AAIS, 2021; DSB, 2022; NTSB, 2018a, 2024b, 2024c).

Another difference is that the EU requires 25-hour CVRs on aircraft weighing more than 27,000 kg, but the FAA requirement applies to aircraft carrying 30 or more passengers. This difference is exemplified by the CRJ200

regional jet that featured in event #51, which had a 24,000 kg MTOW and 50 passenger seats. The new EU requirements require this type of aircraft to have a 2-hour CVR, but it would need a 25-hour CVR under the FAA regulations.

Finally, this study has highlighted a lack of standardization in the way in which investigation reports present CVR data. Accident and incident reports help prevent future tragedies by providing a valuable record of safety lessons learned. In order to improve the quality of this record, it is highly recommended that agencies include the following CVR metadata in their reports:

1. Duration – the start time, end time and length of the CVR recording;
2. Quality – an assessment of the quality of the audio recording (e.g. the rating scale in NTSB, 2016);
3. Missing Data – details of any CVR data pertinent to the investigation that were not preserved and the reason for non-retention.

APPENDIX 1

Table 2 below has information about the safety events referred to in this paper.

Table 2: Summary of safety events cited in the paper.

Event	Date	Location	Description
#16	Apr 21st 2016	Friedrichshafen, Germany	Serious incident: near mid-air collision (STSB, 2018)
#24	Nov 29th 2016	Antioquia, Colombia	Accident: fuel exhaustion crash during holding descent (GRIAA, 2017)
#28	Mar 9th 2017	Dallas-Fort Worth, USA	Accident: unexpected turbulence during cruise (NTSB, 2018b)
#30	Apr 9th 2017	Nelson, NZ	Incident: landing gear failure & diversion (TAIC, 2019)
#31	Jul 7th 2017	San Francisco, USA	Incident: attempted landing on parallel taxiway (NTSB, 2018c)
#38	Apr 18th 2018	Atlanta, USA	Accident: engine fire & diversion (NTSB, 2022)
#39	Apr 19th 2018	Kathmandu, Nepal	Serious incident: runway excursion after rejected take-off (AAIB, 2019)
#48	Jul 10th 2019	Bay of Bengal, India	Accident: severe turbulence during cruise (AAIS, 2020)
#51	Aug 9th 2019	Toronto, Canada	Occurrence: runway incursion, take-off with-out clearance & rejected take-off (TSB, 2021)

Continued

Table 2: Continued

Event	Date	Location	Description
#59	Dec 15th 2019	Near Sydney, Australia	Accident: hydraulic system malfunction, diversion & evacuation (ATSB, 2022)
#76	Jan 17th 2022	East of Antigua & Barbuda	Serious incident: incapacitation of captain in climb & cruise then diversion (BEA, 2024)
#92	Jan 5th 2024	Near Portland, USA	Accident: rapid decompression after failure of exit door plug during climb (NTSB, 2024a)

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