European Aviation Safety Agency

Notice of Proposed Amendment 2018-03

Recorders installation and maintenance thereof – certification aspects

RMT.0249 (MDM.051)

EXECUTIVE SUMMARY

The objective of this Notice of Proposed Amendment (NPA) is to improve the availability and the quality of data recorded by flight recorders, in order to better support safety investigations of accidents and incidents.

This NPA proposes to enhance and modernise the specifications for the installation of flight recorders on board large aircraft, and addresses the following subjects:

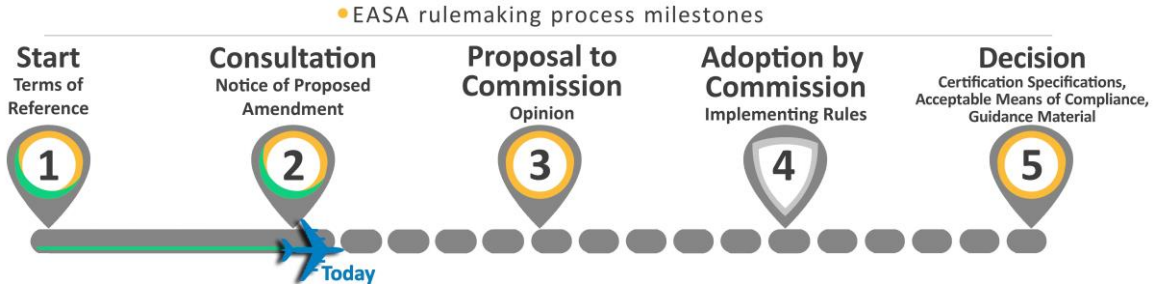
— cockpit voice recorder (CVR) power supplies;
— automatic stopping of the recording after a crash;
— combination recorders;
— deployable recorders; and
— performance specifications for flight recorders.

The proposed changes are expected to:

— increase the level of safety;
— address safety recommendations;
— save costs;
— transpose International Civil Aviation Organization (ICAO) standards into EU rules; and
— achieve greater harmonisation with Federal Aviation Administration (FAA) regulations.

A second NPA that provides a proposal for further issues identified in the Terms of Reference (ToR) for rulemaking task (RMT).0249 will be published at a later stage.

Action area:	Aircraft tracking, rescue operation and accident investigations
Affected rules:	Annex IV (Part-CAT) of Regulation (EU) No 965/2012, CS-25, CS-29
Affected stakeholders:	— Operators — Type certificate (TC) holders and applicants for TC / supplemental type certificate (STC) of large aeroplanes and large rotorcraft required to be equipped with flight recorders — Competent authorities
Driver:	Safety
Rulemaking group:	No
Impact assessment:	Light
Rulemaking Procedure:	Standard



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1. About this NPA

1.1. How this NPA was developed

The European Aviation Safety Agency (EASA) developed this NPA in line with Regulation (EC) No 216/2008[1] (hereinafter referred to as the 'Basic Regulation') and the Rulemaking Procedure[2]. This rulemaking activity is included in the EASA 2017-2021 Rulemaking and Safety Promotion Programme[3] under RMT.0249 (MDM.051). The text of this NPA has been developed by EASA, based on the input of the European Flight Recorder Partnership Group[4]. It is hereby submitted to all interested parties[5] for consultation.

1.2. How to comment on this NPA

Please submit your comments using the automated **Comment-Response Tool (CRT)** available at **http://hub.easa.europa.eu/crt/**[6].

The deadline for submission of comments is **27 June 2018.**

1.3. The next steps

Following the closing of the public commenting period, EASA will review all the comments received.

Based on the comments received, EASA will develop:

— a decision amending the certification specifications (CSs) and the related acceptable means of compliance (AMC) for large aeroplanes (CS-25) and large rotorcraft (CS-29);

— an opinion proposing amendments to Regulation (EU) No 965/2012[7] ('AirOPS regulation') and a decision with the related AMC and GM. The opinion is addressed to the European Commission, which will use it as a technical basis in order to develop the amending Regulation.

The comments received and the EASA responses will be reflected in a comment-response document (CRD). The CRD will be annexed to the respective decision and to the opinion.

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1 Regulation (EC) No 216/2008 of the European Parliament and of the Council of 20 February 2008 on common rules in the field of civil aviation and establishing a European Aviation Safety Agency, and repealing Council Directive 91/670/EEC, Regulation (EC) No 1592/2002 and Directive 2004/36/EC (OJ L 79, 19.3.2008, p. 1) (http://eur-lex.europa.eu/legal-content/EN/TXT/?qid=1467719701894&uri=CELEX:32008R0216).

2 EASA is bound to follow a structured rulemaking process as required by Article 52(1) of Regulation (EC) No 216/2008. Such a process has been adopted by the EASA Management Board (MB) and is referred to as the 'Rulemaking Procedure'. See MB Decision No 18-2015 of 15 December 2015 replacing Decision 01/2012 concerning the procedure to be applied by EASA for the issuing of opinions, certification specifications and guidance material (http://www.easa.europa.eu/the-agency/management-board/decisions/easa-mb-decision-18-2015-rulemaking-procedure).

3 http://easa.europa.eu/rulemaking/annual-programme-and-planning.php

4 The EFRPG is a voluntary group of experts dedicated to evaluating issues related to the design, operation and serviceability of flight recorders. It is composed of delegates from safety investigation authorities, national aviation authorities, industry and pilot associations. In February 2016 the organisations represented in the EFRPG were: AAIB UK, Airbus, ANSV Italy, BEA France, BFU Germany, Boeing, CAA UK, DGAC France, Airbus Helicopters, European Cockpit Association, FAA, Fedex, Lufthansa Technics, Pilatus.

5 In accordance with Article 52 of Regulation (EC) No 216/2008, and Articles 6(3) and 7 of the Rulemaking Procedure.

6 In case of technical problems, please contact the CRT webmaster (crt@easa.europa.eu).

7 Commission Regulation (EU) No 965/2012 of 5 October 2012, laying down technical requirements and administrative procedures related to air operations pursuant to Regulation (EC) No 216/2008 of the European Parliament and of the Council (OJ L 296 25.10.2012, p. 1) (http://eur-lex.europa.eu/legal-content/EN/TXT/?qid=1503665335129&uri=CELEX:32012R0965).

A second NPA proposing means to address the issues below, as identified in the ToR for RMT.0249[8], will be published at a later stage:

— flight data recordings (FDR) power supplies;
— specifications for data link recording;
— provisions for ensuring the serviceability of flight recorders; and
— the quality of recording of cockpit voice recorders.

[8] 'Recorders installation and maintenance thereof – certification aspects' (https://www.easa.europa.eu/document-library/terms-of-reference-and-group-compositions/tor-rmt0249-mdm051)

2. In summary — why and what

CS-25 and CS-29 contain certification specifications (CS XX.1457 and CS XX.1459) which are related to the installation of CVRs and FDRs, when required by the AirOPS regulation.

2.1. Why we need to change the rules — issue/rationale

2.1.1. CVR power supplies

It was found during the investigations of accidents that the CVRs had been depowered prematurely while they could have kept recording useful information if an alternate power source had been installed. It also appeared during some of the investigations that some installations had both the FDR and the CVR powered by the same electrical bus, so that a failure of this bus disabled both the flight recorders while the aircraft was still flying and controllable (cf. Annex 1 in the Appendix).

The following safety recommendations (SRs) addressed to EASA and/or FAA in aircraft accident investigation report(s) were considered during this RMT. Their aim is to address the issue of CVR/FDR functions being disabled after an interruption of normal power. The need here is to enable the CVR to continue recording after its main power source is lost, and to prevent the failure of a single power supply from disabling both the FDR and the CVR:

SR CAND-1999-003: 'As of 01 January 2005, for all aircraft equipped with CVRs having a recording capacity of at least two hours, a dedicated independent power supply be required to be installed adjacent or integral to the CVR, to power the CVR and the cockpit area microphone for a period of 10 minutes whenever normal aircraft power sources to the CVR are interrupted.' (Accident to McDonnell Douglas MD11, registered HB-IWF, on 02 September 1998).

SR UNKG-2005-074: 'For newly manufactured aircraft, the European Aviation Safety Agency should require that no single electrical bus failure terminates the recording on both cockpit voice recorder and flight data recorder.' (Serious incident on an Airbus A320-214, registered G-BXKD, on 15 January 2005).

SR UNKG-2005-075: 'For newly manufactured aircraft, the European Aviation Safety Agency should require that the cockpit voice recorder and cockpit area microphone are provided with an independent 10 minute back-up power source, to which the cockpit voice recorder and cockpit area microphone are switched automatically, in the event that normal power is interrupted.' (Serious incident on an Airbus A320-214, registered G-BXKD, on 15 January 2005).

SR IRLD-2012-003: 'European Aviation Safety Agency (EASA) should introduce a requirement that the CVR should continue to record in the event of power failure.' (Serious incident on an Boeing 737-8AS, registered EI-ENB, on 21 December 2010, investigated by AAIU Ireland).

ICAO Annex 6 Part I contains Standard and Recommended Practices (SARPs) which require that large commercial air transport aeroplanes, for which the application for type certification is submitted on or after 1 January 2018, be fitted with an 'alternate power source' for the CVR and its associated cockpit area microphone components (refer to Standard 6.3.2.4.1). It also contains a recommendation that 'all aeroplanes of a maximum certificated take-off mass of over 27 000 kg for which the individual certificate of airworthiness is first issued on or after 1 January 2018 should be provided with an alternate power source, as defined in 6.3.2.4.1, that powers at least one CVR'.
In addition, the FAA published a rule on 7 March 2008 on 'Revisions to Cockpit Voice Recorder and Digital Flight Data Recorder Regulations' (Docket No FAA-2005-20245). This rule amended Part-25 and

Part-29 with new requirements to address the fact that any single electrical failure should not disable both the CVR and FDR functions, and the need for a 10-minute backup power source for the CVR.
Certification Specifications for European Technical Standard Orders (CS-ETSO) already contain requirements applicable to 'recorder independent power supply' (refer to ETSO-C155a). However, there is no corresponding specification for the installation of such independent power supplies in the CS for large aeroplanes (CS-25) or for large rotorcraft (CS-29). There is also no air operation rule addressing such a requirement for already certified aircraft.
Note: EASA has also received several SRs that recommend an alternate power source for the FDR. However, this topic will be addressed in the second NPA envisioned under this RMT.

2.1.2. Automatic stopping of the recording after an accident

Several safety investigation bodies have reported reliability issues with negative acceleration sensors, i.e. so-called 'g-switches', which are used to stop the flight recorders after a crash impact. In several occurrences involving high levels of airframe vibrations, some 'g-switches' were triggered prematurely during the occurrence and, therefore, the recording of voices or data stopped before the end of the flight (cf. Annex 2 of the Appendix).
The following SRs addressed to EASA and/or the FAA in aircraft accident investigation report(s) are considered during this RMT. Their aim is to address the issue of the premature stopping of recordings:

SR UNKG-2008-074: 'It is recommended that the Federal Aviation Administration and the European Aviation Safety Agency review the certification requirements for automatically stopping flight recorders within 10 minutes after a crash impact, with a view to including a specific reference prohibiting the use of 'g-switches' as a means of compliance as recommended in ED-112 issued by EUROCAE Working Group 50.' (Accident to Bombardier BD-700, registered VP-CRC, on 29 January 2008).

SR UNKG-2011-045: 'It is recommended that the European Aviation Safety Agency require the 'crash sensor' in helicopters, fitted to stop a Cockpit Voice Recorder in the event of an accident, to comply with EUROCAE ED62A.' (Accident to AS332-L2 Super Puma, registered G-REDL, on 1 April 2009).
EUROCAE has also addressed this issue and introduced the following provision in EUROCAE document 112A[9], I-6.1.2: 'Negative acceleration sensors ('g' switches) shall not be used as sole means of detection because their response is not considered to be reliable'.

2.1.3. Combination recorders

Recorders designated in this NPA by the term 'combination recorders' combine two functions: the FDR function and the CVR function. They may also have other recording functions (such as data link or image recording). The installation of combination recorders can bring various benefits compared to installing an FDR and a separate CVR:
When permitted by the operating requirements (typically on helicopters), a combination recorder that replaces an FDR and a CVR allows savings in weight and maintenance costs. Furthermore, when two combination recorders are installed on a large aeroplane, this can increase the likelihood that the FDR and CVR data are fully retrieved after an accident (which has safety benefits). In addition, the conditions provided by the CS-MMEL when two combination recorders are installed are more flexible than for an FDR and a CVR (operational benefit).

[9] EUROCAE Document 112A - Minimum Operational Performance Specification for Crash Protected Airborne Recorder Systems, September 2013.

However, the certification specifications related to combination recorders and the means of compliance with the operational requirements for them are not consistent or complete.

Firstly, CS 25.1457 and CS 25.1459 for Large Aeroplanes recommend that the FDR and the CVR be located as far as practicable in order to maximise the probability that the crash-protected memory survives the impact forces and a potential fire. However, in these paragraphs, the specifications for the location of the flight recorders are too prescriptive.

Note: EASA currently addresses the certification of combination recorders through specific certification review items (CRIs).

Secondly, the AMC to CAT.IDE.A.200[10] recommends that when two flight data and cockpit voice combination recorders are installed on board an aeroplane, one should be located near the flight crew compartment and the other should be located in the rear section of the aeroplane.

The provisions in CS-25 should therefore be more performance-based regarding the location of the flight recorders, and they should also address the case where two combination recorders are installed.

In addition, there is a need to address other aspects that are not specific to aeroplanes, such as power supplies or the means of performing a pre-flight check when a combination recorder is installed.These other aspects also need to be addressed in CS-25 and in CS-29.

2.1.4. Deployable recorders

A 'deployable flight recorder' or 'deployable recorder' is a crash-protected flight recorder which is designed to be automatically separated from the aircraft in the event of an accident. It is sometimes designated with the acronym ADFR (automatic deployable flight recorder).

The deployable recorder is a technology that can also greatly facilitate the localisation of an aircraft after an accident over an oceanic area or a remote area, because it is designed to be buoyant and fitted with an emergency locator transmitter (ELT), which starts emitting shortly after deployment. While the automatic ELT fixed on the aircraft may be destroyed by crash forces or post-impact fire, the ELT integrated in the deployable recorder is expected to survive the crash conditions in most accident scenarios, and to transmit in any case a signal which can be located by COSPAS-SARSAT. In addition, compared to a fixed flight recorder, which might be resting on the sea floor at a depth of several thousand meters, a deployable recorder could be collected from the surface of the sea within a few hours after the accident.

For these reasons, the use of a deployable recorder has been identified as one possible way to comply with CAT.GEN.MPA.210, requiring that some categories of large aeroplanes first issued with an individual Certificate of Airworthiness (CofA) on or after 1 January 2021 are equipped with 'robust and automatic means to accurately determine, following an accident where the aeroplane is severely damaged, the location of the point of end of flight'.

However, the current provisions in CS 25.1457 and CS 25.1459 are not adequate for deployable flight recorders. For instance, the provisions for facilitating the localisation and identification of a deployable recorder at the scene of an accident are missing, as are any provisions to ensure the safety and effectiveness of the deployment.The proposed requirements will therefore establish the basis for the certification of deployable recorders.

Furthermore, ICAO SARPs addressing the installation of a deployable recorder were introduced in ICAO Annex 6, Part I, Amendments 38 and 40.

[10] Annex IV (Part-CAT) to the Air OPS Regulation (EU) 965/2012, CAT.IDE.A.200.

2.1.5. Performance specifications for flight recorders

The AMC to CS 25.1457 and CS 25.1459 lack any reference to up-to-date industry standards regarding the performance of the installed system. AMC 25.1457 still refers to EUROCAE Document ED-56, although this document was superseded by ED-112 in 2003, which in turn was superseded by ED-112A in 2013. None of the AMC to CS-25.1459, CS-29.1457 or CS-29.1459 specifies any industry standard regarding the performance of the installed system.

In addition, references to ED-112 and ED-112A have already been introduced in ICAO Annex 6 (refer to Part I, Chapter 6, Section 6.3) and Part III (refer to Section II, Chapter 4, 4.3), as well as in the AMC to the EU rules for air operations (refer to AMC1 CAT.IDE.A.185 and AMC1.2 CAT.IDE.A.190). Hence the performance specifications applicable to the FDR system and the CVR system in CS-25 and CS-29 need to be updated.

2.2. What we want to achieve — objectives

The specific objective of this proposal is to improve the availability and quality of the data recorded by flight recorders in order to better support safety investigation authorities in the investigation of accidents and incidents. This includes, in particular, the objectives to:

- increase the robustness of flight recorders to the loss of their power supplies;
- prevent the premature termination of recording due to the untimely triggering of a negative acceleration sensor;
- define the certification requirements for combination recorders; and
- define the certification requirements for deployable recorders.

2.3. How we want to achieve it — overview of the proposals

2.3.1. CVR power supply

This NPA proposes to introduce in CS-25 and CS-29 new provisions to enable a CVR to continue recording after its main power source goes down, and to prevent the failure of a single power supply from disabling both the FDR and the CVR. These provisions partially implement the stipulations of ICAO Annex 6 Part I and they are also partially harmonised with FAR Part 25. The proposal also covers the case of one (or two) flight data and cockpit voice combination recorder(s). In particular, the introduction of the following new items is proposed:

- CS 25.1457 (d)(4) to (d)7) ;
- CS 29.1457 (d)(4) to (d)(7);
- AMC1 25.1457(d) and GM1 25.1457(d);
- AMC1 29.1457(d) and GM1 29.1457(d);
- CS 25.1459(a)(7) and (a)(8);
- CS 29.1459 (a)(6) and (a)(7);
- AMC1 25.1459(d).

Finally, EASA proposes to introduce provisions in the AirOPS Regulation related to CVR alternate power sources for newly-manufactured aeroplanes with an MCTOM of over 27 000 kg. In particular, it is proposed to make amendments to the following:

- CAT.IDE.A.185 (in Part-CAT), NCC.IDE.A.160 (in Part-NCC) and SPO.IDE.A.140 (in Part-SPO) ;
- AMC1 to CAT.IDE.A.185;
- AMC1 to CAT.IDE.A.200;

— AMC1 to NCC.IDE.A.160;
— AMC1 to NCC.IDE.A.175;
— AMC1 to SPO.IDE.A.140;
— AMC1 to SPO.IDE.A.155.

2.3.2. Automatic stopping of the recording after an accident

It is proposed to update the certification specifications to require that a negative acceleration sensor ('g-switch') is not used as the sole means to detect a crash impact and to automatically stop the CVR after the detection of such a crash impact. In addition, conditions are introduced to address the use of the recorder start-and-stop logic to provide a means to automatically stop the CVR after a crash impact. In particular, the following changes are proposed:

— amendment of CS 25.1457(d)(2);
— introduction of a new AMC1 to 25.1457(d)(2);
— amendment of CS 25.1459(f);
— amendment of CS 29.1457(d)(2);
— introduction of a new AMC1 to 29.1457(d)(2);
— amendment of CS 29.1459(e).

2.3.3. Combination recorders

It is proposed to introduce provisions in CS-25 to accommodate the installation of combination recorders in line with the requirements set forth in the AirOPS Regulation, which implement ICAO Annex 6, Part I, and which are harmonised with FAR Part 25. In particular, the following changes are proposed:

— amendment of CS 25.1457 (d) and (e);
— amendment of CS 25.1459 (a) and (b);
— amendment of AMC 25.1457;
— creation of GM1 to 25.1457(e);
— creation of AMC1 to 25.1459;
— creation of AMC1 to 29.1457;
— creation of AMC1 to 29.1459.

2.3.4. Deployable recorders

It is proposed to introduce provisions in CS-25 on deployable recorders that implement ICAO Annex 6 Part I, and which take into account the specifications from ED-112A. In particular, the following changes are proposed:

— amendment of CS 25.1457(d), (e) and (g);
— amendment of CS 25.1459(a), (b) and (d);
— amendment of the AMC to 25.1457 (introduction of subparagraph (c));
— introduction of the new AMC1 to 25.1459.

2.3.5. Performance specifications for the CVR and the FDR

It is proposed to introduce a reference to EUROCAE document 112A in the AMC to CS-25 and CS-29. In particular, the following changes are proposed:

— amendment of AMC to 25.1457;
— amendment of AMC to 29.1457;

— creation of AMC1 to 25.1459;
— creation of AMC1 to 29.1459.

2.4. What are the expected benefits and drawbacks of the proposals

The expected benefits and drawbacks of the proposals are summarised below. For the full impact assessment of the alternative options, please refer to Chapter 4.

2.4.1. CVR power supply

An alternate power source for the CVR and its dedicated sensor (the cockpit area microphone) can, in some cases, provide for a prolonged recording, and therefore help in better understanding the circumstances that led to an accident, or how the accident developed and was managed by the flight crew. Installing the FDR system and the CVR system so that a single power supply cannot disable both flight recorders also provides for a prolonged recording. The proposal partially aligns the EASA certification specifications with the SARPs of ICAO Annex 6, Part I, and is harmonised with the FAA requirements.

The related economic impact is expected to be negligeable. Indeed, aircraft designs are already required to have an alternate power source in order in order to comply with the equivalent FAA certification and operating rules. Therefore, the necessary design effort has already been made by most of the manufacturers.

2.4.2. Automatic stopping of the recording after an accident

The proposal addresses, in the Certification Specifications for Large Aeroplanes and Large Rotorcraft, the issue of the premature ending of recording due to nuisance triggers of crash detection sensors. It also offers a framework for relying on the start-and-stop logic of the flight recorder, rather than on dedicated crash detection sensors. The availability of exploitable data would help in better understanding the circumstances that led to an accident.

No drawbacks, including adverse economic impacts, are expected.

2.4.3. Combination recorders

The proposal gives a common framework for the installation of combination recorders on board large aeroplanes, as an alternative to single-function FDRs and CVRs. The proposal implements the SARPs of ICAO Annex 6 and adresses an inconsistency between the certification specifications and the air operation rules. In addition, the proposal is harmonised with FAA requirements.

No drawbacks, inlcuding advserse economic impacts, are expected.

2.4.4. Deployable recorders

The proposal implements the SARPs of ICAO Annex 6 and facilitates the approval of installation of deployable recorders on board large aeroplanes.

An additional safety benefit is expected: deployable recorders are expected to provide for a more reliable means of locating an aircraft after an accident (thanks to the integrated ELT), hence increasing the chance of saving lives after the accident. This would also provide for a quick means to locate the wreckage and retrieve flight recorder data in case of an accident over water or a remote area, saving costs for the State(s) in charge of the investigations (several millions to several tens of millions of euros).

No drawbacks are expected.

3. Proposed amendments and rationale in detail

The text of the amendment is arranged to show deleted text, new or amended text as shown below:

— deleted text is struck through;

— new or amended text is highlighted in grey;

— an ellipsis '[…]' indicates that the rest of the text is unchanged.

Wherever necessary, a rationale is provided in *blue italics* immediately after the proposed amendments.

3.1. Draft regulation (Draft EASA opinion)

Annex IV

COMMERCIAL AIR TRANSPORT OPERATIONS

[Part-CAT]

Subpart D
INSTRUMENTS, DATA, EQUIPMENT

SECTION 1
Aeroplanes

1. CAT.IDE.A.185 is amended as follows

CAT.IDE.A.185 Cockpit voice recorder

[…]

(i) Aeroplanes with an MCTOM of over 27 000 kg and first issued with an individual CofA on or after [date of publication + 3 years] shall be equipped with an alternate power source to which the CVR and cockpit-mounted area microphone are switched automatically in the event that all other power to the recorder is interrupted.

Rationale
While the need for alternate power sources for CVRs appears to be well supported by investigations of accidents involving aeroplanes with an MCTOM of over 27 000 kg, this is not true for other categories of aircraft. Therefore, when considering air operation rules, a requirement to carry an alternate power source is only justified for aeroplanes with an MCTOM of over 27 000 kg .
Only newly manufactured aeroplanes are in the scope of the proposed rules, because the safety benefit brought by an alternate power source is not considered significant enough to outweigh the economic impact of retrofitting.

3.2. Draft acceptable means of compliance and guidance material (Draft EASA decision)

3.2.1. Draft AMC/GM to Annex IV (Part-CAT)

1. AMC1 CAT.IDE.A.185 is amended as follows

AMC1 CAT.IDE.A.185 Cockpit voice recorder

[…]

(c) if required to be installed, the alternate power source should provide electrical power to operate both the CVR and the cockpit area microphone for at least 9 minutes. If the cockpit voice recorder has a recording duration of less than 25 hours, the alternate power source should not provide electrical power for more than 30 minutes.

2. AMC1 CAT.IDE.A.200 is amended as follows

AMC1 CAT.IDE.A.200 Flight data and cockpit voice combination recorder

GENERAL

(a) When two flight data and cockpit voice combination recorders are installed, one should be located near the flight crew compartment, in order to minimise the risk of data loss due to a failure of the wiring that gathers data to the recorder. The other should be located at the rear section of the aeroplane, in order to minimise the risk of data loss due to recorder damage in the case of a crash.

(b) When two flight data and cockpit voice combination recorders are installed and an alternate power source is required for the CVR function, it is acceptable to provide this alternate power source only to the cockpit area microphone and the recorder located closer to the flight crew compartment.

Rationale

An appropriate duration for the engagement of the alternate power source is essential for the preservation of the CVR recording. Hence, lower and upper boundaries should be defined for the duration of the alternate power source. When the alternate power source is implemented by the means of a recorder independent power supply (RIPS), CS-ETSO, ETSO-C155a (Recorder independent power supply) is applicable. ETSO-C155a refers to Section 5 of EUROCAE Document 112, which specifies an engagement duration of 10 ± 1 minutes.

While a minimum engagement duration of 10 – 1 = 9 minutes is recognised as necessary for the alternate power source to bring any benefits at all, it is not considered safety-effective to require the maximum engagement duration to be 10 + 1 = 11 minutes. Data from historical accidents shows that after a loss of all engines at cruise altitude, a large aeroplane may glide for up to or slightly more than 20 minutes. Annex 2 of the Appendix contains examples of accidents and serious incidents with a loss of all engines (and sometimes the auxiliary power unit (APU)) while in flight. Adding 10 minutes to the previous value for recording the landing roll and first evacuation actions, an engagement duration of up to 30 minutes may be beneficial in some cases. However, when considering the CVR recording duration, in order to not overwrite too much of the recording of the events before the normal CVR power supply was lost, ideally the maximum engagement duration of the APS should not exceed a given portion of the CVR recording duration. In practice, while losing 1 hour of older recordings could be acceptable for a CVR with a recording duration of 25 hours or more, it would not be the case for a CVR with a recording duration of 2 hours (nowadays there is almost no aeroplane equipped with a

CVR model that has a recording duration of between 2 and 25 hours) . In the latter case, it is proposed to limit the maximum engagement duration of the alternate power source to 30 minutes when the CVR recording duration is less than 25 hours. The proposed AMC is less constraining than ICAO Annex 6 Part I and the FAA operating requirements, which prescribe that the engagement duration of the alternate power source is 10 ± 1 minutes.
When two combination recorders are installed instead of one FDR and one CVR, there is no need to provide an alternate power source to both recorders. In that case, it is preferable to power the recorder closer to the flight crew compartment, because the link between this recorder and the cockpit area microphone is shorter than between the cockpit area microphone and the recorder located at the rear of the aircraft, so it is less likely that this link would be cut due to a structural failure or fire.

3.3. Draft certification specifications (Draft EASA decision)

3.3.1. Draft Certification Specifications for Large Aeroplanes (Draft EASA decision amending CS-25)

BOOK 1: SUBPART F — EQUIPMENT

1. CS 25.1457 is amended as follows

CS 25.1457 Cockpit voice recorders

[…]

(d) Each cockpit voice recorder must be installed so that –

(1) It receives its electric power from the bus that provides the maximum reliability for operation of the cockpit voice recorder without jeopardising service to essential or emergency loads and without jeopardising emergency operations of the aeroplane;

Rationale

To harmonise with the equivalent FAA requirement (refer to FAR 25.1457(d)(1)).

[…]

(2) There is an automatic means to ~~simultaneously~~ stop the recorder ~~and prevent each erasure feature from functioning~~, within 10 minutes after crash impact.~~; and~~

Rationale

The deleted part is is already included in the provisions of 25.1457 (f). The means for automatically stopping the CVR after a crash impact shall stop the CVR even if power can still be supplied by the CVR normal power source or the CVR alternate power source.

(3) There is an aural or visual means for pre-flight checking of the recorder for proper operation.

(4) Any single electrical failure external to the recorder does not disable both the cockpit voice recorder function and the flight data recorder function;

Rationale

To harmonise with the equivalent FAA requirement (see FAR 25, 25.1457(d)(4)).

(5) There is a means for the flight crew to stop the cockpit voice recorder function upon completion of the flight in a way such that re-enabling the cockpit voice recorder function is only possible by dedicated manual action;

Rationale

In order to preserve most of the useful CVR recording after a serious incident, there should be a means for the flight crew to stop any CVR function when the aircraft is on the ground. Indeed CAT.GEN.MPA.105(10)(iii) in Part-CAT requires the commander of a flight to ensure that 'in the event of an accident or a serious incident, or if preservation of recordings of flight recorders is directed by the investigating authority:

(A) flight recorders' recordings are not intentionally erased;

(B) flight recorders are deactivated immediately after the flight is completed; and

(C) precautionary measures to preserve the recordings of flight recorders are taken beforeleaving the flight crew compartment;'

In addition, a means for the flight crew to stop the CVR upon completion of the flight becomes particularly relevant for serious incidents, where the CVR will not be stopped by the automatic means to stop the CVR within 10 minutes of a crash impact, and the serious incident may have occurred hours before landing. In that case, as much of the recording of the flight as possible should be preserved, which means that the flight crew should have means to stop the CVR immediately after completion of the flight.

When the CVR is stopped by the flight crew, only a manual and dedicated action should enable the restarting of the CVR function: this is to avoid inadvertent restarting of the CVR (e.g by re-powering the aircraft for troubleshooting), which would result in the overwriting of the relevant part of the CVR recording.

(6) It has an alternate power source:

— that provides at least 9 minutes of electrical power to operate both the recorder and cockpit-mounted area microphone; and

— to which the recorder and cockpit-mounted area microphone are switched automatically in the event that all other power to the recorder is interrupted either by a normal shutdown or by any other loss of power from the electrical power bus.

Rationale

For the alternate power source (APS) to be of any benefit, it should not stay engaged for less than 10 – 1 = 9 minutes.

(7) If the recorder is deployable:

(i) It is capable of being automatically deployed.

(ii) The automatic deployment capability is engaged at least while the aeroplane is airborne and it may also be engaged while the aeroplane is moving on the ground at high speed;

Rationale

This is to harmonise with the standards in ICAO Annex 6 Part I, Appendix 8, 4.1 and to address the deployment criteria, including the timing and conditions under which the recorder shall deploy. While the aircraft is moving on the ground at low speeds (such as during taxying or the first part of the take-off roll), deployment of the recorder might affect the capability for safe flight and landing (for example because the relative airstream would typically not be strong enough to ensure that the trajectory of the recorder would take it clear of the airframe). Therefore the deployment feature could be locked during this period, and released once the aircraft takes off.

(iii) The deployment occurs upon the detection of severe structural damage that causes the immediate break-up of the aeroplane;
(iv) The deployment occurs upon the immersion of the aeroplane in water;

Rationale

These conditions rely on the deployment criteria provided in ED-112A, Section 3, 3-1.7 Deployment Criteria. In addition, ICAO Annex 6 Part I, Appendix 8, 4.1 states that:

- *'deployment shall take place when the aeroplane structure has been significantly deformed;*
- *deployment shall take place when an aeroplane sinks in water'.*

(v) An assessment of the effects of unintended deployment is made in accordance with the specifications of CS 25.1309 and it includes effects on third parties;

Rationale

The risk is that people on the ground may be injured by the deployed recorder. While the scope of CS 25.130911 and AMC 25.1309 is limited to injuries to aircraft occupants and the safe continuation of the flight, the system of classification offered by these provisions could also be used for the risk to people on the ground. Given the size and weight of a deployable flight recorder12, it is unlikely that it could seriously injure more than one person or cause extensive damage, if there is no scattered debris. Therefore, the severity associated is not expected to exceed a level that corresponds to 'hazardous' in AMC 25.1309: 'Hazardous: Failure Conditions, which would reduce the capability of the aeroplane or the ability of the crew to cope with adverse operating, conditions to the extent that there would be:
A large reduction in safety margins or functional capabilities;
Physical distress or excessive workload such that the flight crew cannot be relied upon to perform their tasks accurately or completely; or
Serious or fatal injury to a relatively small number of the occupants other than the flight crew.'
For such a level of severity, an acceptable probability would be less than 10 E-7 per flight hour according to AMC 25.1309. In addition, it should be considered that only a small proportion of unintended deployments will result in the most severe effect as described above. This assumption could be justified by the proportion of the areas overflown that have a low or very low population density. Even in the case of an unintended deployment over a dense urban area, the probability that the recorder would hit anyone is certainly low. A conservative probability value of 10 % (i.e. 10 E-1) of deployment cases is proposed as an assumption. In order to not cause an unacceptable level of safety, the probability of deployment (intended and unintended) should be less than 10 E-6 per flight hour in order for the probability to seriously injure someone on the ground to be less than 10 E-7 per flight hour.
Note: ED-112A recommends 'The overall quantitative probability (per flight hour) of the failure event 'non-commanded deployment' shall be <10 E-7. This probability objective addresses such hardware and software components, which contribute directly to the deployment event'.

(vi) There is no means to manually deploy the recorder when the aircraft is capable of moving under its own power; and

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[11] CS 25.1309: '(b) The aeroplane systems and associated components, considered separately and in relation to other systems, must be designed so that:
(1) Any catastrophic failure condition
(i) is extremely improbable; and
(ii) does not result from a single failure; and
(2) Any hazardous failure condition is extremely remote; and
(3) Any major failure condition is remote."

[12] Example of a deployable recorder model installed on military aeroplanes: weight 3.8 kg, dimensions: 600 mm × 325 mm × 90 mm.

Rationale

For search and rescue purposes it is always preferable for the ELT signal to be emitted from the place where the flight ended. From an investigation point of view, a premature deployment of the flight recorder may deprive investigators of the data needed in order to understand the cause of an accident. ICAO Annex 6 Part I, Appendix 8, 4.1 states that 'ADFR shall not be capable of manual deployment;'.

(vii) An indication is made to the flight crew when the flight recorder is no longer attached to the aeroplane.

Rationale

It is essential that the flight crew is informed without delay after the deployment of the recorder or the loss of the recorder (e.g. due to a failure of the attachment) (except during critical flight phases such as take-off or landing) because:
— this would also trigger the integrated ELT, resulting in a false alert that the local ANSP, the local Research Coordination Center and the aircraft operator would need to be quickly informed about;
— a flight recorder is a MMEL item and therefore the aircraft operator would need to be informed without delay that a flight recorder is missing in order to have a spare unit ready;
— in a case of deployment during the take-off roll or the landing roll, the aircraft could potentially leave on the runway an object that might create damage to following aircraft;
— it is important to recover the deployed recorder in order to aid failure investigation to understand the reason for unintended deployment.
ICAO Annex 6 Part I, Appendix 8, 4.1 states that 'an alert shall be made to the flight crew when the ADFR is no longer captive to the aircraft'.
The deployment indication could be temporarily delayed until the end of critical flight phases such as take-off or landing in order not to disturb the flight crew, except if the recorder might hit the airframe and affect the safe conduct of the flight (e.g. because the air speed is too low): in this case an indication should be immediately provided to the flight crew.

(e) ~~The record container must be located and mounted to minimise the probability of rupture of the container as a result of crash impact and consequent heat damage to the record from fire. In meeting this requirement, the record container must be as far aft as practicable, but may not be where aft mounted engines may crush the container during impact. However, it need not be outside of the pressurised compartment.~~ The container of the cockpit voice recorder is located and mounted to minimise the probability of the container rupturing as a result of a crash impact or deployment and consequent heat damage to the recording from fire, and to minimise the risk of compromising a continued safe flight and landing.

Rationale

Deployment should be achieved without affecting the capability for safe flight and landing for the whole flight envelope, including when the aircraft is airborne and when the aircraft is moving at high speed on the ground. ICAO Annex 6 Part I, Appendix 8, 4.1 states that 'the ADFR deployment shall not compromise the safe continuation of the flight;'.

When a deployable recorder is installed, it is installed such that:

(1) Deployment can be achieved without significantly reducing the chance of survival of the container of the recorder and its integrated emergency locator transmitter when the aeroplane is airborne;

Rationale

This is to address the risk of the recorder or its integrated ELT being damaged during the deployment sequence, so that the recorder could not be localised using the ELT signal, or recorded data could be lost due to the deployment. This could be the case if the integrated ELT or its antenna was damaged, the recorder airfoil was damaged and no longer buoyant, or no longer capable of making itself upright in the water (making transmission of the ELT signal impossible because the ELT remained immersed).
ICAO Annex 6 Part I, Appendix 8, 4.1 states that 'the ADFR deployment shall not significantly reduce the chance of survival of the recorder and of successful transmission by its ELT;'.

(2) The deployment capability cannot be manually disengaged from the cockpit when the aeroplane is capable of moving under its own power.

Rationale
This is to avoid non-deployment when deployment is needed. ICAO Annex 6 Part I, Appendix 8, 4.1 states that 'the flight crew shall have no means to disable ADFR deployment when the aircraft is airborne'.

(f) If the cockpit voice recorder has ~~a bulk~~ an erasure device, the installation is designed to minimise the probabilities of inadvertent operation and of actuation of the device during crash impact

Rationale
The term 'bulk erasure' is specific to the use of magnetic media (magnetic tape or magnetic wire) for recording, and therefore a more generic term should be used.

(g) ~~Each recorder~~ The container of the cockpit voice recorder –

(1) is ~~either~~ bright orange ~~or bright yellow,~~; however, when the recorder is deployable, the surface visible from outside the aeroplane, when the recorder is installed, may be of another colour;

Rationale
This is to address the need to identify (by the use of colour and reflective tapes) the crash-protected memory when installed on the aircraft, and after deployment.
In Amendment 41 of Annex 6 Part I, the possibility for the flight recorders to be bright yellow has been removed for deployable recorders (refer to Annex 6 Part I, Appendix 8, 1.2). In order to facilitate the search for the flight recorders at the scene of the accident, and given that in practice most models of flight recorders are already bright orange, it is proposed to only retain this colour.
However, for a deployable recorder, when considering the surface visible from outside the aeroplane, the colour may depend on the external livery of the airline.
ICAO Annex 6 Part I, Apppendix 8, 1.2 states that: '1.2 Automatic deployable flight recorder containers shall: a) be painted a distinctive orange colour, however the surface visible from outside the aircraft may be of another colour;'.

(2) Ha~~v~~es reflective tape affixed to its external surface to facilitate its location ~~under water~~; ~~and~~

(3) Ha~~v~~es, when the recorder is not deployable, an underwater locating device~~, when required by the operating rules,~~ on or adjacent to the container which is secured in such a manner that they are not likely to be separated during crash impact~~.~~;

Rationale
'When required by operating rules' is not necessary: basically all fixed crash-protected flight recorders are required to be equipped with an underwater locating device (ULD) per ICAO Annex 6, FAA and EU rules, etc.

In addition, a ULD is necessary for locating a flight recorder under water. In the case of a deployable recorder, because it should float, no underwater search operations will be necessary to locate it.

(4) Has, when the recorder is deployable, an integrated emergency locator transmitter that automatically starts emitting during or after deployment, and

Rationale
This is In order to facilitate the immediate alerting of S&R centres, to allow localisation of the crash site, and the actual position of the Recording Memory Unit to be detected.

(5) Is, when the recorder is deployable, able to float on water and self-oriented so that emergency signal transmission is not impeded.

Rationale
Given that a deployable recorder is not fitted with a ULD, it relies on the ELT signal for its localisation after an accident over water. Therefore the ELT that is integrated with the deployable recorder must be out of the water, which in turn implies that the recorder has to float and be capable of righting itself in the water in a way such that its integrated ELT does not stay immersed.
ICAO Annex 6 Part I, Appendix 8, 4.1 states that 'the ADFR shall be able to float on water;'.

2. CS 25.1459 is amended as follows

CS 25.1459 Flight data recorders

(a) Each flight data recorder required by the operating rules must be installed so that –
[…]

Rationale
'Flight recorder' is replaced by 'flight data recorder' in the title and the text of CS 25.1459, in order to align the designation of this piece of equipment with ICAO Annex 6 Part I, FAA Part 25 and the EU rules for air operation.
[...]

(3) It receives its electrical power from the bus that provides the maximum reliability for operation of the ~~flight~~ recorder without jeopardising service to essential or emergency loads and without jeopardising the emergency operation of the aeroplane;

Rationale
This is to harmonise with the equivalent FAA requirement (see FAR 25, 25.1459(a)(3)(ii)).
[...]

(5) Except for recorders powered solely by the engine-driven electrical generator system, there is an automatic means to ~~simultaneously~~ stop ~~a~~ the recorder ~~that has a data erasure feature and prevent each erasure feature from functioning,~~ within 10 minutes after crash impact~~.~~; ~~and~~

Rationale
This is to align it with the similar requirement in CS 25.1457.
[…]

(7) If the cockpit voice recorder function is also performed by the recorder and no other recorder is installed, any single electrical failure external to the recorder does not disable both the cockpit voice recorder function and the flight data recorder function;

Rationale
To harmonise with equivalent FAA requirement (see FAR 25, 25.1459(a)(7)).

(8) If another recorder is installed to perform the cockpit voice recorder function, any single electrical failure external to the recorder dedicated for the flight data recorder function does not disable both recorders;
(9) If the recorder is deployable, it complies with CS 25.1457(d)(7).

Rationale
This is to harmonise the text with ICAO Annex 6 Part I.

(b) ~~Each non-ejectable record~~The container of the flight data recorder must be located and mounted so as to minimise the probability of container rupture or deployment resulting from crash impact and subsequent damage to the recording from fire, and to minimise the risk of compromising a continued safe flight and landing~~. In meeting this requirement~~
~~(1) T~~the ~~record~~container ~~must be located as far aft as practicable~~, ~~but need not be aft of the pressurised compartement, and may not be where aft mounted engines may crush the container upon impact (See AMC 25.1459(b))~~.
When a deployable recorder is installed, the installation must comply with CS 25.1457(e)(3).

Rationale
This is to ensure that the deployment does not compromise the safe continuation of the flight, in whichever flight phase the deployment occurs (including ground phases).

(c) A correlation must be established between the flight data recorder readings of airspeed, altitude, and heading and the corresponding readings (taking into account correction factors) of the first pilot's instruments.
[…]

(d) ~~Each recorder~~ The container of the flight data recorder must comply with CS 25.1457(g).

Rationale
These requirements on the container do not depend on the type of flight recorder (FDR, CVR, etc), therefore they do not need to be repeated in CS 25.1459.

~~(1) Be either bright orange or bright yellow;~~
~~(2) (1) Have reflective tape affixed to its external surface to facilitate its location under water; and~~
~~(23)Have an underwater locating device, when required by the operating rules, on or adjacent to the container which is secured in such a manner that they are not likely to be separated during crash impact.~~

(e) Any novel or unique design or operational characteristics of the aircraft must be evaluated to determine whether any dedicated parameters must be recorded on the flight data recorder~~s~~ in addition to, or in place of, existing requirements.

(f) If the flight data recorder has an erasure device, the installation must be designed to minimise the probability of the inadvertent operation or actuation of the erasure device during a crash impact.

Rationale
This is to align the text with the similar requirement for CVRs.

3.3.2. Draft Certification Specifications for Large Rotorcraft (Draft EASA decision amending CS-29)

1. CS 29.1457 is amended as follows

CS 29.1457 Cockpit voice recorders

[…]

d) Each cockpit voice recorder must be installed so that:

(1) It receives its electric power from the bus that provides the maximum reliability for operation of the ~~cockpit voice~~ recorder without jeopardising service to essential or emergency loads and without jeopardising the emergency operation of the rotorcraft~~:~~;

Rationale

This is to harmonise with the equivalent FAA requirement (see FAR 29, 29.1457(d)(1)).

(2) There is an automatic means to ~~simultaneously~~ stop the recorder~~and prevent each erasure feature from functioning,~~ within 10 minutes after crash impact;~~ and~~

Rationale

The deleted part is is already included in the provisions of 29.1457 (f). The means for automatically stopping the CVR after a crash impact shall stop the CVR even if power can still be supplied by the CVR normal power source or the CVR alternate power source.

(3) There is an aural or visual means for pre-flight checking of recorder the for proper operation;

(4) If the flight data recorder function is also performed by the recorder and no other recorder is installed, any single electrical failure external to the recorder does not disable both the cockpit voice recorder function and the flight data recorder functions;

(5) If another recorder is installed to perform the flight data recorder function, any single electrical failure external to the recorder that is dedicated to the cockpit voice recorder function does not disable both recorders;

Rationale

This is to harmonise with the equivalent FAA requirement (see FAR 29, 29.1457(d)(4)).

(6) There is a means for the flight crew to stop the cockpit voice recorder function upon completion of the flight in a way such that re-enabling the cockpit voice recorder function is only possible by dedicated manual action.

Rationale

In order to preserve most of the useful CVR recording after a serious incident, there should be a means for the flight crew to stop any CVR function when the aircraft is on the ground. When the CVR is stopped by such a means, only a manual and dedicated action should enable the restarting of the CVR function.

(7) It has an alternate power source:

— That provides 10 ± 1 minutes of electrical power to operate both the recorder and cockpit-mounted area microphone;

— To which the recorder and cockpit-mounted area microphone are switched automatically in the event that all other power to the recorder is interrupted either by a normal shutdown or by any other loss of power from the electrical power bus.

Rationale

This is to harmonise with the FAA Requirement (see FAR 29, 29.1457(d)(5)). For a helicopter, it is assumed that the flight phase after the loss of all engines would in any case not last more than 10 minutes (including the evacuation phase), therefore the maximum engagement duration of the APS does not need to be more than 10 + 1 minutes. Indeed, the rate of descent for a standard autorotative descent is typically between 2 000 ft/min et 3 000 ft/min and most helicopters have a flight ceiling of around 20 000 ft or less. In addition, in the vast majority of cases, the height above terrain is much less than 20 000 ft when engine power is lost, so the autorotative descent lasts much less than 10 minutes (typically a few tens of seconds to 2 or 3 minutes).

(e) The ~~record~~ container of the cockpit voice recorder is ~~must be~~ located and mounted to minimise the probability of rupture of the container as a result of crash impact and consequent heat damage to the record from fire.

(f) If the cockpit voice recorder has ~~a bulk~~ an erasure device, the installation is designed to minimise the probabilities of inadvertent operation and of actuation of the device during crash impact.

Rationale

The term 'bulk erasure' is specific to the use of magnetic media (magnetic tape or magnetic wire) for recording, and therefore a more generic term should be used.

(g) ~~Each~~ The ~~recorder~~ container of the cockpit voice recorder is ~~must be~~ ~~either~~ bright orange ~~or bright yellow~~.

Rationale

In order to facilitate the search for the flight recorders at the scene of the accident, and given that, in practice, most models of flight recorders are already bright orange, it is proposed, as for CS-25, to only retain this colour.

2. CS 29.1459 is amended as follows

CS 29.1459 Flight data recorders

(a) Each flight data recorder required by the applicable operating rules is ~~must be~~ installed so that: […]

Rationale
Flight recorder' is replaced by 'flight data recorder' in the title and the text of CS 29.1459, in order to align the designation of this piece of equipment with ICAO Annex 6 Part III, FAA Part 29 and the EU rules for air operations.

(3) It receives its electrical power from the bus that provides the maximum reliability for operation of the ~~flight~~ recorder without jeopardising service to essential or emergency loads and without jeopardising the emergency operation of the rotorcraft;

[…]

Rationale
This brings harmonisation with the equivalent FAA requirement (see FAR 29, 29.1459(a)(3)).

(5) Except for recorders powered solely by the engine-driven electrical generator system, there is an automatic means to ~~simultaneously~~ stop ~~a~~ the recorder ~~that has a data erasure feature and prevent each erasure feature from functioning,~~ within 10 minutes after crash impact;~~.~~

Rationale
This is to align with CS 29.1457.

(6) If the cockpit voice recorder function is also performed by the recorder and no other recorder is installed on board the rotorcraft, any single electrical failure external to the recorder does not disable both the cockpit voice recorder function and the flight data recorder functions; and

(7) If another recorder is installed on board the rotorcraft to perform the cockpit voice recorder function, any single electrical failure external to the recorder dedicated to the flight data recorder function does not disable both recorders.

Rationale
This brings harmonisation with the equivalent FAA requirement (see FAR 29, 29.1459(a)(6)).

[…]

(b) ~~Each non-ejectable~~ The container of the flight data recorder is ~~must be~~ located and mounted so as to minimise the probability of container rupture resulting from crash impact and subsequent damage to the recording from fire.

(c) A correlation is established between the flight data recorder readings of airspeed, altitude, and heading and the corresponding readings (taking into account correction factors) of the first pilot's instruments.[…]

(d) ~~Each recorder~~ The container of the flight data recorder ~~must~~:

(1) ~~Be either~~ is bright orange ~~or brigh yellow~~;

(2) ~~have~~ has a reflective […]…

(e) If the flight data recorder has an erasure device, the installation is designed to minimise the probability of the inadvertent operation or actuation of the erasure device during crash impact.

Rationale
This is to align the text for FDRs with the similar requirements for CVRs.

3.4. Draft acceptable means of compliance and guidance material (Draft EASA decision)

3.4.1. Draft AMC/GM to CS-25 Large Aeroplanes

AMC — SUBPART F– EQUIPMENT

1. AMC 25.1457 is amended as follows

AMC 25.1457 Cockpit Voice Recorders

1. General

In showing compliance with CS 25.1457, the applicant should take into account EUROCAE document No. ED-112A 'MOPS for Crash Protected Airborne Recorder Systems'. ~~ED-56 'Minimum Operational Performance Requirement for Cockpit Voice Recorder System', as referred to in ETSO-C123a.~~

Rationale

ED-56A was superseded by ED-112 in 2003, which in turn was superseded in 2013 by ED-112A. ICAO Annex 6, Part I, Chapter 6, 6.3, Note 5, states: 'For aeroplanes for which the application for type certification is submitted to a Contracting State on or after 1 January 2016, specifications applicable to flight recorders may be found in EUROCAE ED-112A, Minimum Operational Performance Specification (MOPS), or equivalent documents.'

2. Combination recorders

a. If the recorder performs several recording functions (i.e. it is a combination recorder), the means for pre-flight checking the recorder for proper operation should indicate which recording functions have failed.

Rationale

The flight recorders are MMEL items. The CVR recording function or the FDR recording function of a combination recorder may be inoperative, provided the other function is operative (refer to CS-MMEL)

b. When two flight data and cockpit voice combination recorders are installed because they are required or because they are an acceptable alternative to a flight data recorder and a cockpit voice recorder, then these two flight data and combination recorders should be connected to separate power buses.

Rationale

When considering the case of two flight data and cockpit voice combination recorders, ED-112A specifies that the FDR functions (respectively the CVR functions) in the combination recorders shall be powered by two different electrical sources unless it is shown that any single electrical failure external to a recorder does not disable both FDR functions (respectively both CVR functions). This is interpreted as meaning that combination recorders should be connected to separate power buses that also rely on different power sources, as far as practicable.

3. Automatic means to stop the recorder after a crash impact

The automatic means to stop the recorder should operate even if a power supply is still available. The automatic means to stop the recorder within 10 minutes after a crash impact may rely on:

(a) dedicated crash impact detection sensors. In that case, negative acceleration sensors (also called 'g-switches') should not be used as the sole means of detecting a crash impact; or

Rationale

G-switches have been pointed out as being unreliable by EUROCAE Documents ED-56A and ED-112, so instead of using them, other means for stopping the recording in case of a crash impact are recommended;
G-switches continue to be pointed out as being unreliable by EUROCAE Documents ED-112A, which recommends that they should not be used as the sole means for detecting a crash impact;
There have been 10 cases of premature endings of recording being caused by undesired g-switch triggers (see Annex 2). These cases did not affect aeroplanes with an MCTOM of over 27 000 kg, for which g-switches have not been used as a means to comply with CS 25.1457;
The MOPS for aircraft emergency locator transmitters contained in ED-62A include specifications for g-switches; however, these specifications are not expected to provide for a better detection of crash impact because they are meant for another purpose (rescuing survivors), and therefore, they are based on a trade-off between nuisance warnings and missed alerts that is different from the appropriate trade-off for a flight recorder.

(b) the recorder start-and-stop logic, provided that this start-and-stop logic stops the recorder between 9 and 10 minutes after power is lost on all engines (and, when applicable, the APU) when the aircraft is on the ground.

Rationale
If the start-and-stop logic is used to comply with CS 29.1457(d)(2), it should be ensured that this logic does not stop the recorder before the APS has fulfilled its purpose of delivering backup electrical power to the recorder for its minimum engagement duration (9 minutes) after engine power is lost, in order to record gliding approaches, landing rolls without power (in cases of a loss of all engines in flight) and emergency evacuations (e.g. if there is a fire on board). Therefore, the condition is that the aircraft is on the ground and that the recorder is stopped not earlier than 9 minutes after power is lost on all engines.
On the other hand, CS 29.1457(d)(2) requires the automatic means to stop the recorder within 10 minutes of a crash impact. As a result, the start-and-stop logic must stop the recorder between 9 and 10 minutes after a loss of power on all engines.

4. Means for the flight crew to stop the recorder

The means required for the flight crew to be able to stop the cockpit voice recorder function after completion of the flight is needed in order to preserve the CVR recording for the purpose of investigating accidents and serious incidents. In fulfilling this requirement, it is acceptable to use circuit breakers to remove the power to the equipment. Such a means to stop the cockpit voice recorder function is not in contradiction to 25.1357(f), because its use would not be under normal operating conditions, but after an accident or a serious incident has occurred.

Rationale
CAT.GEN.MPA.105(10)(iii) requires the commander of a flight to ensure that 'in the event of an accident or a serious incident, or if preservation of recordings of flight recorders is directed by the investigating authority:
(A) flight recorders' recordings are not intentionally erased;
(B) flight recorders are deactivated immediately after the flight is completed; and
(C) precautionary measures to preserve the recordings of flight recorders are taken before leaving the flight crew compartment;'
In addition, a means for the flight crew to stop the CVR upon completion of the flight becomes particularly relevant for serious incidents, where the CVR will not be stopped by the automatic means to stop the CVR within 10 minutes of a crash impact.

5. Power sources

(a) If the recorder supports a data link recording function, this function does not require a separate power bus.

(b) An alternate power source is a power source that is different from the source that normally provides power to the cockpit voice recorder function. In CS 25.1457(d)(7), a 'normal shutdown' of power to the cockpit voice recorder means a commanded interruption of the power supply from the normal cockpit voice recorder power bus, for example, after the termination of a normal flight. If an alternate power source is installed:

i. The use of aeroplane batteries or other power sources is acceptable, provided that electrical power to essential and critical loads is not compromised.
ii. If the alternate power source relies on dedicated stand-alone batteries (such as a recorder independent power supply), then these batteries should be located as close as practicable to the recorder.

Rationale

With regard to the use of aeroplane batteries, refer to ICAO Annex 6 Part I, Chapter 6, 6.3.2.4, Note 1: 'Note 1.— 'Alternate' means separate from the power source that normally provides power to the CVR. The use of aeroplane batteries or other power sources is acceptable provided that the requirements above are met and electrical power to essential and critical loads is not compromised.' In addition, alternative installation designs such as those that use the aircraft emergency battery were already accepted by the FAA through their equivalent level of safety (ELOS) findings for several aircraft models. (Refer to ELOS Memo TD0774IB-T-SA-1 for Airbus models A330 and A340, and to ELOS Memo SP0778IB-T-SE-101 for ATR models ATR 42-500 and ATR 72-200). EASA has concurred with these ELOS finding. When the APS relies on stand-alone batteries, they should be close to the recorder in order to reduce the risk that the power line between the APS and the recorder is cut prematurely (i.e. in the first 9 minutes after it became engaged). ED-112A, Chapter 5-6, 5-6.2 states: 'The RIPS and the recorder to be powered should be located as close as practical so as to minimize the length of the interwiring'.

iii. The means for performing a pre-flight check of the recorder for proper operation should include a check on the availability of the alternate power source.
iv. When the cockpit voice recorder function is combined with other recording functions within the same unit, the alternate power source may also power the other recording functions.

Rationale

This is to harmonise with ICAO Annex 6, Part I, Amendment 38.

v. If two flight data and cockpit voice combination recorders are installed because they are required or because they are an acceptable alternative to single-function recorders, then only one recorder needs to have an alternate power source for the cockpit voice recorder function. This should be the combination recorder located closer to the cockpit area.

Rationale

The combination recorder that has the CVR function should have an alternate power source.

(c) If the cockpit voice recorder function has a recording duration of less than 25 hours, electrical power should not be supplied for more than 30 minutes after power is lost on all engines.

Rationale

When considering the duration of the CVR recording, in order to not overwrite too much of the recording of events, the recording should stop after the power on all engines is lost. In practice, while

losing 1 hour of older recordings could be acceptable for a CVR with a recording duration of 25 hours or more, it would not be the case for a CVR with a recording duration of 2 hours. It is proposed to not power the CVR more than 30 minutes after power on all engines is lost.
It should be noted that in ELOS Memo TD0774IB-T-SA-1, it was stressed that power would be supplied 'until aircraft total immobilisation', not just for 10 ± 1 minutes. In addition, the investigation of the accident of the B-737 registered EI-ENB on 21/12/2010 pointed out the need to record, when possible, the evacuation phase.
It should also be noted that (b) applies to all aeroplanes, whether or not they have an alternate power source. Indeed some aeroplane models already use the aircraft emergency batteries as the main power supply to the CVR: in that case, even if the aeroplane emergency battery is capable of powering the CVR for a longer period, it is not desirable to keep the CVR powered for more than 30 minutes when it has a recording duration of less than 25 hours.

6. Recorder container
The attachment of the recorder container should comply with the specifications given in EUROCAE Document No ED-112A.

The recorder container should be installed in the rear section of the aeroplane in an area that increases the chances of the equipment surviving crash impact forces and heat damage caused by fire. For this purpose, the recorder container should be installed in the rear section of the fuselage. However, it should not be installed where aft mounted engines may crush the container during impact.

When two separate combination flight data and cockpit voice recorders are installed, then the container of the recorder dedicated to the cockpit voice recorder function may be located near the flight crew compartment if at least one recorder is installed in the rear section and meets crashworthiness specification applicable to fixed flight recorders.

Rationale
This is to address the issue of the location of the combination recorders. The CVR should be located near the flight crew compartment, in order to minimise the risk of data loss due to a failure of the wiring that carries data to the recorder.
For consistency with air operations requirements: CS 25.1457 and CS 25.1459 recommend that the FDR and the CVR be located as far aft as practicable in order to maximise the probability that the crash-protected memory survives the impact forces and a potential fire. However, these parapgraphs do not contain any specific provisions for combination recorders. The Air Operations requirements, on the other hand, recommend that when two flight data and cockpit voice combination recorders are installed, one should be located near the flight crew compartment (…). The other one should be located at the rear section of the aeroplane (refer to Annex IV to Commission Regulation (EU) 965/2012 (Part-CAT), CAT.IDE.A.200).

7. Deployable recorder
When the recorder is deployable:

(a) The deployable recorder installation should comply with CS 25.1457(e)(3).

Rationale
This is to address the fact that the deployment should not compromise the safe continuation of the flight, in whichever flight phase the deployment occurs (including ground phases).

(b) There may be a means to manually disengage the deployment capability when the aircraft is not capable of moving under its own power; however, in this case, an indication should

be made to the flight crew during the pre-flight checks if the deployment capability is disengaged.

Rationale
Such a manual disengagement is to avoid an undesirable deployment during maintenance.

(c) The deployable recorder installation should be such that the recorder deploys in the event of an explosion or collision. However, the installation should not be such that the recorder deploys in a non-catastrophic occurrence such as a hard landing or a tail strike.

(d) Deployment should take place without the deployed recorder striking any part of the airframe when the aircraft is airborne or when the aeroplane is moving on the ground at high speed. This should be achieved for the whole flight envelope, including a margin outside the normal flight envelope which might be expected during the initial stages of an accident sequence. Similarly, deployment from an aircraft in an unusual attitude should not make the survival of the recorder less likely.

Rationale
This is in order to limit undesirable deployments, which have several consequences: the loss of a MMEL item, a foreign object being left on the runway, unnecessary transmission of an emergency signal to COSPAS-SARSAT, etc.

(e) The indication that the recorder is no longer attached to the aircraft should be presented as early as permitted by the principles of AMC 25.1322.

Rationale
It is essential that the flight crew is informed without delay regarding the deployment of the recorder or the loss of the recorder (e.g. due to a failure of the attachment) (except during critical flight phases such as take-off or landing) because:
— this would also trigger the integrated ELT, resulting in a false alert that the local ANSP, the local Research Coordination Center and the aircraft operator would need to be quickly informed about.
— a flight recorder is a MMEL item and therefore the aircraft operator would need to be informed without delay that a flight recorder is missing in order to have a spare unit ready.
—in a case of deployment during the take-off roll or the landing roll, the aircraft could potentially leave on the runway an object that might create damage to following aircraft.
—it is important to recover the deployed recorder in order to aid failure investigation to understand the reason for unintended deployment.

(f) The deployment capability should perform under all environmental conditions for which the aircraft is certificated.

(g) The effect of exposure to environmental conditions (such as temperature, rain, lightning strikes, etc.) on the serviceability of the flight recorder and of its deployment capability should be addressed by protection and/or maintenance instructions. Instructions should also be defined to avoid operations on aircraft external surfaces (such as painting, cleaning, applying anti-icing fluids, etc.) affecting the serviceability of the flight recorder and its deployment capability.

(h) The risk of injuries caused to persons on the ground due to unintended deployment of the recorder during aircraft maintenance, taxying or ground handling should be adressed by:
— detailed instructions; and

— the fact that the deployment mechanism can only release the recorder in one piece.

Rationale
Unlike fixed recorders (not located at the surface of the aircraft), deployable recorders are exposed to environmental conditions.The deployment does not release more than one piece, in order to limit the hazard of foreign objects on a runway, as well as the risk to people on the ground. ICAO Annex 6 Part I, Appendix 8, 4.1 states that 'the ADFR deployment shall not release more than one piece;'.

2. AMC 25.1459(a)(4) and AMC 25.1459(b) are deleted, and a new AMC 25.1459 is created as follows

AMC 25.1459 Flight Data Recorders

1. General
In showing compliance with CS 25.1459, the applicant should take into account EUROCAE document No. ED-112A 'MOPS for Crash Protected Airborne Recorder Systems'.

2. Automatic means to stop the recorder after a crash impact
Refer to the Section of AMC 25.1457 titled 'Automatic means to stop the recorder after a crash impact'.

3. Means for pre-flight checking of the recorder
The means for pre-flight checking of the recorder should be able to detect and indicate the following:

a. loss of electrical power to the flight recorder system;
b. failure of the data acquisition and processing stages;
c. failure of the recording medium and/or drive mechanism; and
d. failure of the recorder to store the data in the recording medium as shown by checks of the recorded data including, as reasonably practicable for the storage medium concerned, its correct correspondence with the input data.

4. Recorder container
Refer to the Section of AMC 25.1457 titled 'Recorder container'.

5. Combination recorder
Refer to the Section of AMC 25.1457 titled 'Combination recorder'.

6. Deployable recorder
Refer to the Section of AMC 25.1457 titled 'Deployable recorder'

3.4.2. Draft AMC/GM to CS-29 Large Rotorcraft

AMC — SUBPART F – EQUIPMENT

1. AMC 29.1457 is created as follows:

AMC 29.1457 Cockpit Voice Recorders

1. General

In showing compliance with CS 29.1457, the applicant should take into account EUROCAE document No. ED-112A 'MOPS for Crash-Protected Airborne Recorder Systems'.

2. Automatic means to stop the recorder after a crash impact

The automatic means to stop the recorder within 10 minutes after a crash impact may rely on:

(a) dedicated crash impact detection sensors. In that case, negative acceleration sensors (also called 'g-switches') should not be used as the sole means of crash impact detection; or

Rationale

G-switches have been pointed out as being unreliable by EUROCAE Documents ED-56A and ED-112, so instead of using them, other means for stopping the recording in case of a crash impact are recommended;
G-switches continue to be pointed out as being unreliable by EUROCAE Documents ED-112A, which recommends that they should not be used as the sole means for detecting a crash impact;
There have been 10 cases of premature endings of recording being caused by undesired g-switch triggers. These cases did not affect aeroplanes with an MCTOM of over 27 000 kg, for which g-switches have not been used as a means to comply with CS 25.1457;
There is neither evidence nor substantiation that an acceleration-based sensor is reliable enough for detecting a crash impact for the purpose of stopping the flight recorders;
The MOPS for aircraft emergency locator transmitters contained in ED-62A include specifications for g-switches, however, these specifications are not expected to provide for a better detection of crash impact because they are meant for another purpose (rescuing survivors), and therefore they are based on a trade-off between nuisance warnings and missed alerts that is different from the appropriate trade-off for a flight recorder.

(b) the recorder start-and-stop logic, provided that this start-and-stop logic stops the recorder between 9 and 10 minutes after the loss of power on all engines.

Rationale

It should be ensured that if the start-and-stop logic is used to comply with CS 29.1457(d)(2), then this logic does not stop the recorder before the APS has fulfilled its purpose of delivering backup electrical power to the recorder for its minimum engagement duration (9 minutes) after engine power is lost, in order to record autorotation and emergency evacuations (e.g if there is a fire on board). Therefore, the condition is that the recorder should be stopped not earlier than 9 minutes after power is lost on all engines. On the other hand, CS 29.1457(d)(2) requires the automatic means to stop the recorder within 10 minutes of a crash impact. As a result, the start-and-stop logic must stop the recorder between 9 and 10 minutes after a loss of power on all engines.

3. Means for the flight crew to stop the CVR

The means for the flight crew to stop the cockpit voice recorder function after completion of the flight is needed in order to preserve the cockpit voice recorder recording for the purpose of investigating incidents and serious incidents. In fulfilling this requirement, it is acceptable to use circuit breakers to remove the power to the equipment. Such a means to stop the cockpit voice recorder function is not in contradiction to 25.1357 f), because its use would not be under normal operating conditions, but after an accident or a serious incident has occurred.

4. Power sources

(a) The alternate power source is a power source different from the source that normally provides power to the recorder. In CS 29.1457(d)(7), a normal shutdown of power to the recorder means a

commanded interruption of the power supply from the normal cockpit voice recorder power bus, for example after termination of a normal flight. If an alternate power source is installed:

i. The use of helicopter batteries or other power sources is acceptable, provided that electrical power to essential and critical loads is not compromised.

ii. If the alternate power source relies on dedicated stand-alone batteries (such as a recorder independent power supply) then these batteries should be located as close as practicable to the recorder.

iii. When the cockpit voice recorder function is combined with other recording functions within the same unit, the alternate power source may also power the other recording functions.

iii. The means for pre-flight checking of the recorder for proper operation should include a check of the availability of the alternate power source.

(b) If the recorder supports a data link recording function, this function does not require a separate power bus.

5. Combination recorder

In cases where the recorder performs several recording functions, the means for pre-flight checking of the recorder for proper operation should indicate which recording functions (e.g. FDR, CVR, data-link recording, etc.) have failed.

2. A new AMC 29.1459, is created as follows:

AMC 29.1459 Flight Data Recorders

1. General

In showing compliance with CS 29.1459, the applicant should take into account EUROCAE document No. ED-112A 'MOPS for Crash-Protected Airborne Recorder Systems'.

2. Automatic means to stop the recorder after a crash impact

Refer to the Section of AMC 29.1457 titled 'Automatic means to stop the recorder after a crash impact'.

3. Combination recorder

Refer to the Section of AMC 29.1457 titled 'Combination recorder'.

4. Impact assessment (IA)

4.1. What is the issue

CS-25 and CS-29 contain certification specifications (CS XX.1457 and CS XX.1459) and related AMCs for the installation of CVRs and FDRs, when required by the AirOPS Regulation.
This RMT proposes to improve the availability of flight recorders, by amending the CS. In particular, the following issues are addressed:

— FDR and CVR power supplies;
— automatic stopping of a recording after an accident;
— combination recorders;
— deployable recorders; and
— performance specifications for flight recorders.

Each of these issues has been detailed in Chapter 2 above.

4.2. Safety risk assessment

All five issues are related to the availability of data from flight recorders.
Flight recorders are not critical for the safe conduct of a flight; however, they are essential safety investigation tools. The unavailability of flight recorder data may delay or hinder the identification of a hazard that led to an accident. Ultimately, a similar accident on other aircraft at risk could occur because the root cause of the first accident was not identified.

4.3. Who is affected

The stakeholders affected by this issue are:

— large aeroplane and large rotorcraft type certificate (TC)/supplemental type certificate (STC) holders and applicants;
— operators of large aeroplanes and large rotorcraft used in commercial air transport;
— civil aviation safety investigation authorities;
— EASA and national aviation authorities of the Member States.

4.4. How could the issue/problem evolve

If no corrective action is taken by EASA, the issues identified in Section 4.1 above are expected to remain unchanged.

4.5. What we want to achieve — objectives

The goal of this RMT is to improve the availability of data for the investigation of accidents, and in doing that, to improve the level of safety of aircraft by updating the requirements and CSs regarding flight recorders for large aeroplanes and large rotorcraft.

4.6. How it could be achieved — options

Tables of selected policy options

Table 1: A – FDR and CVR power supply

Option No	***Short title***	**Description**
0	Do nothing	No policy change (no change to the rules; risks remain as outlined in the issue analysis).
1	CS-25 and CS-29 update	Require in CS-25 and CS-29 alternate power supplies for CVRs and that a single power supply failure does not disable both the CVR and the FDR.
2	Part-CAT update	Require that all aeroplanes with an MCTOM over 27 000 kg and first issued with an individual CofA on/or after [date of publication + 3 years] be equipped with an alternate power source for their CVRs.
3	CS-25 and CS-29 + Part-CAT update	Option 1+2.

Table 2: B - Automatic stop of the recording after a crash

Option No	***Short title***	**Description**
0	Do nothing	No policy change (no change to the rules; risks remain as outlined in the issue analysis).
1	CS-25 and CS-29 update	Require that the automatic means for stopping the recorder after a crash impact operates even if a power supply is still available. Create an AMC to recommend that a negative acceleration sensor is not used as the sole means to detect a crash impact and to provide the conditions under which relying on the start-and-stop logic of the recorder is acceptable.

Table 3: C - Combination recorders

Option No	***Short title***	**Description**
0	Do nothing	No policy change (no change to the rules; risks remain as outlined in the issue analysis).
1	CS-25 update	Include provisions in CS-25 that define the conditions for the installation of combination recorders.

Table 4: D - Deployable recorders

Option No	***Short title***	**Description**
0	No change	No policy change (no change to the rules; risks remain as outlined in the issue analysis).
1	CS-25 update	Include provisions in CS-25 that define the conditions for the installation of deployable recorders.

Table 5: E – Performance specifications

Option No	***Short title***	**Description**
0	No change	No policy change (no change to the rules; risks remain as outlined in the issue analysis).
1	CS-25 and CS-29 update	Include in the AMC to CS-25 and to CS-29 references to EUROCAE Document 112A.

4.7. What are the impacts

4.7.1. Safety impact

For the five subjects, the safety risk identified in Section 4.2 would remain unchanged with Option 0 (no rule change).

For subject A (for which three options are proposed): Option 3 (which includes a requirement on newly manufactured large aeroplanes, i.e., a production cut-in), would allow EASA to address the safety risk sooner than Option 1 (in which the requirement is limited to new designs).

For subjects B & E, (for which two options are proposed): the update of CS-25/CS-29 and the related AMC would help to improve the availability of FDR and CVR recordings after an accident or a serious incident, thereby facilitating the investigations conducted by civil aviation safety investigation bodies. This, in turn, would contribute to better identifying and mitigating the causes of accidents/serious incidents.

For subjects C & D (for which two options are proposed): giving a common framework for the installation of combination recorders and deployable recorders would facilitate the approval of installations that use these technologies. This would, in turn, increase the probability that flight recorder data can be retrieved by safety investigation authorities, hence accelerating the understanding of accident causes and the identification of corrective actions.

4.7.2. Environmental impact

For the five subjects, no environmental impact is expected.

4.7.3. Social impact

An unexplained accident may have a temporary negative impact on the brand image of the parties involved and on the public perception of aviation safety in general, as long as uncertainty regarding the causes of the accident remains.

For each subject, this negative impact would remain unchanged with Option 0, while any other option would contribute to mitigating this potential negative social impact.

4.7.4. Economic impact

Option 0 (A, B, C, D, E)

For each of the subjects, the cost induced with Option 0 would remain unchanged or would increase:

- for additional extended safety investigations because flight recorder data would not be available (A, B);
- for extended missions searching for lost recorders, such as in the examples of AF 447 or MH 370 (D);
- for design organisations when designing new products without any available certification specifications. The certification of such designs would need to be handled through special conditions, which would involved costs in time and resources for both EASA and the applicant. (A, B, C, D).
- for re-designs because unacceptable solutions would have been designed and EASA expectations were not available in the certification specifications.

Option 1 (A, B, C, D, E)

The economic impact would be negligible, since only new designs would be affected. Aircraft designers would have time to take into account the new certification specifications for flight recorders at an earlier stage, and include their cost in the global design cost of the entire product.

Option 2 and 3 (A)

The economic impact here would also be negligible. Current designs of newly manufactured aeroplanes would need to be modified. However, this is mitigated by the fact that aircraft designers are already required to comply with the equivalent FAA certification and air operation requirements to have an alternate power source[13]. Therefore the re-design efforts have already been made by most of the manufacturers.

Globally, Options 1, 2 and 3 allow the costs resulting from Option 0 as mentioned above to be avoided.

4.7.5. Impact on harmonisation

The proposed amendments would globally have a positive impact on harmonisation, since some of them (in particular, the provisions for CVR power supplies, for deployable recorders, and for combination recorders) are aligned with ICAO Annex 6 and/or with the equivalent FAA requirements.

[13] This means that all U.S. registered turbine-engine aeroplanes that have a seating capacity of more than 20 or a maximum payload capacity of 6 000 lb or more, and which were manufactured after 7 April 2010, are required to carry a CVR installed in accordance with CS 25.1457, including the 'independent power source': refer to FAR 125.227(h).

4.7.6. General Aviation and proportionality issues

Not applicable. The proposal does not affect General Aviation (GA).

4.7.7. Conclusion

4.7.8. Comparison of options

Option 0 does not meet EASA's objectives. It would not help to prevent future accidents and would have no economic benefits.

On the contrary, the benefits of the selected preferred options (see the green boxes below) are:

— an increase in the level of safety;
— that they address safety recommendations;
— cost savings for search and rescue activities;
— cost savings for certification activities;
— transposition of the ICAO standards and recommendations into the EU rules; and
— greater harmonisation with FAA regulations.

These options have no impact on the environment or on GA and do not create any proportionality issues. Therefore, no drawbacks are expected.

Therefore, the selected preferred options are summarised in the table below (green boxes show the selected options):

<table>
<tr><th></th><th>Option 0
Do nothing</th><th>Option 1
Update CS</th><th>Option 2
Update Part-CAT</th><th>Option 3
Update CS + Part-CAT</th></tr>
<tr><td>A (Resilience to power loss)</td><td rowspan="5">Not selected</td><td colspan="2">Not selected</td><td>preferred</td></tr>
<tr><td>B (Automatic stopping of recording)</td><td rowspan="4">preferred</td><td colspan="2" rowspan="4">Not applicable</td></tr>
<tr><td>C (Combination recorders)</td></tr>
<tr><td>D (Deployable recorders)</td></tr>
<tr><td>E (Performance specifications for flight recorders)</td></tr>
</table>

5. Proposed actions to support implementation

No particular action is expected.

6. References

6.1. Affected regulations

Commission Regulation (EU) No 965/2012 of 5 October 2012 laying down technical requirements and administrative procedures related to air operations

6.2. Affected decisions

— Decision No. 2003/2/RM of the Executive Director of the Agency of 17 October 2003 on certification specifications, including airworthiness codes and acceptable means of compliance, for large aeroplanes (« CS-25 »)

— Decision No. 2003/16/RM of the Executive Director of the Agency of 14 November 2003 on certification specifications for large rotorcraft (« CS-29 »)

— Decision No. 2012/018/R of the Executive Director of the Agency of 24 October 2012 on Acceptable Means of Compliance to Part-CAT

6.3. Other reference documents

— ICAO Annex 6 Operation of Aircraft, Part I International Commercial Air Transport –Aeroplanes, 10th edition, 2017.

— ICAO Annex 6, Operation of Aircraft, Part III International Operations – Helicopters, 8th edition, 2016

7. Appendix

7.1. Annex 1

Table 1: Occurrences of premature ending of CVR recording due to loss of power on all engines (including the APU)

Aircraft Make and Model	Aircraft registration and operator	Date of the occurrence	Investigation authority (Name and State)	Findings made in the investigation report; If any, safety recommendation
DC-9	N904VJ, ValuJet	11/05/1996	NTSB, USA	On May 11, 1996, the crew of ValuJet flight 592, a DC-9-32, reported smoke and fire shortly after departing Miami, Florida. The flight recorders stopped about 40 to 50 seconds before the airplane crashed on its return to the airport, killing all 111 passengers and crew. '1.1 History of flight At 1412:45, the controller transmitted, "Critter five ninety two keep the turnaround heading uh one two zero." There was no response from the flight crew. The last recorded FDR data showed the airplane at 7,200 feet amsl, at a speed of 260 KIAS, and on a heading of 218. (…) The accident occurred at 1413:42.'
B747	N93119, TWA	07/07/1996	NTSB, USA	'The cessation of the CVR recording at 2031:12 was consistent with the loss of electrical power to the recorder.' '1.11.1 Cockpit Voice Recorder The cessation of the CVR recording at 2031:12 was consistent with the loss of electrical power to the recorder.'
B737	9V-TRF, Silk Air	19/12/1997	NTSC, Indonesia	On December 19, 1997, SilkAir flight 185, a Boeing 737, entered a rapid descent from 35 000 ft, which ended with a high speed impact in the Sumatran River near Palembang, Indonesia. There were 104 fatalities. The Indonesian investigation, in which the Safety Board participated, determined that both flight recorders stopped prior to the airplane entering the rapid descent (summary provided by NTSB USA).
MD-11	HB-IWF, Swissair	02/09/1998	TSB, Canada	'2.19 Remaining few minutes following stoppage of recorders The final 5 minutes and 37 seconds of the flight, from when the flight recorders stopped at 01:25:41, were not recorded on the FDR or the CVR. To the extent possible, the events that occurred were reconstructed using information from ground-based primary radar data, full-authority digital electronic control non-volatile memory data, air traffic control (ATC) recordings, witness statements, and wreckage examination.' '4.1.2 Flight Recorder Duration and Power Supply When aircraft power to the SR 111 flight recorders was interrupted at 10 000 feet, the FDR and CVR stopped recording. The aircraft continued to fly for about six minutes with no on-board information being recorded. This lack of recorded information hampered the accident investigation. With maintenance-free independent power sources, it is now feasible to power new-technology CVRs and the cockpit area microphone (CAM) independently of normal aircraft power for a specific period of time in the event that aircraft power sources to the CVR are interrupted or lost. Therefore, to enhance the capture of CVR information needed for accident investigation purposes, the TSB made the following recommendation: As of 01 January 2005, for all aircraft equipped with CVRs having a recording capacity of at least two hours, a dedicated independent power supply be required to be installed

Aircraft Make and Model	Aircraft registration and operator	Date of the occurrence	Investigation authority (Name and State)	Findings made in the investigation report; If any, safety recommendation
				adjacent or integral to the CVR, to power the CVR and the cockpit area microphone for a period of 10 minutes whenever normal aircraft power sources to the CVR are interrupted. A99-03 (issued 9 March 1999) At the time of the occurrence, FDR and CVR installation in MD-11 aircraft were both powered from AC Generator Bus 3. The Smoke/Fumes of Unknown Origin Checklist (…) requires the use of the SMOKE ELEC/AIR selector. This switch is used to cut power to each of the three electrical buses in turn in order to isolate the source of the smoke/fumes. The nature of this troubleshooting procedure requires that the switch remain in each position for an indeterminate amount of time, typically at least a few minutes. When the SMOKE ELEC/AIR selector is in the first (3/1 OFF) position, alternating current (AC) Generator Bus 3 is turned off, thereby simultaneously disabling the FDR and the CVR. With both the CVR and the FDR on the same generator bus, a failure of that bus, or the intentional disabling of the bus (e.g., the result of checklist actions in an emergency), will result in both recorders losing power simultaneously. To enhance the capture of information needed for the identification of safety deficiencies, the TSB made the following recommendation: **Aircraft required to have two flight recorders be required to have those recorders powered from separate generator buses. A99-04 (issued 9 March 1999)'**
B767	SU-GAP, Egyptair	31/10/1999	NTSB, USA	'Review of radar data [...] As previously discussed, these primary radar data (with extrapolated FDR data and simulation results) indicated that after the airplane's FDR and CVR stopped recording, the airplane descended to an altitude of about 16,000 feet amsl, then climbed to about 25,000 feet msl and changed heading from 80º to 140º before it began its second descent, which continued until it impacted the ocean'
A330	C-GITS	24/08/2001	GPIAA, Portugal	'1.11.5 Recorders Power Source Because the recorders are both powered from the same AC2 bus, and did not have an independent power supply, the recorders did not record events after the aircraft electrical system reverted to emergency electrical configuration. Effectively, the last 19 minutes of flight of the engines-out approach and landing were not recorded, a situation that deprived investigators of data and hampered the investigation into this critical portion of the flight.' '2.2.1 Flight recorder power supply The loss of flight recorder information for the last 19 minutes of the engines-out descent and landing on this occurrence did not adversely affect the investigation to this accident for the following reasons: • The crew survived and was able to provide factual information. • ATS recordings provided additional information regarding crew communications and aircraft position data. • There were no safety-significant events during this phase of flight that could have led to the discovery

Aircraft Make and Model	Aircraft registration and operator	Date of the occurrence	Investigation authority (Name and State)	Findings made in the investigation report; If any, safety recommendation
				of underlying factors and the need for safety recommendations. Notwithstanding, had the circumstances been different, the lack of data following the power loss on both engines would have severely affected the ability of the investigation to make findings as to the causes and contributing factors to this occurrence. ' '**Therefore, it is recommended that the European Organization for Civil Aviation Equipment, ICAO, all civil aviation authorities and safety investigation authorities:** **Take into account the circumstances of this particular occurrence in their deliberations on the requirements for independent power supplies for on-board aircraft recordings'**
A320	G-BXKD	15/01/2005	AAIB, UK	'the recorder stopped when the AC power supply was interrupted when the engines were shut off about three seconds after the aircraft touched down at Gatwick Airport. The subsequent landing roll was thus not recorded.' 'The CVR and FDR are both connected to the same AC power source and did not have an independent power supply. The recorders thus ceased to record after the aircraft reverted to the emergency electrical configuration following engines shut-down, and denied accident investigators information that could have been vital had the outcome of the landing been different.' **'Safety Recommendation 2005-074** **For newly manufactured aircraft, the European Aviation Safety Agency should require that no single electrical bus failure terminates the recording on both cockpit voice recorder and flight data recorder.** **Safety Recommendation 2005-075** **For newly manufactured aircraft, the Joint Airworthiness Authorities should require that the cockpit voice recorder and cockpit area microphone are provided with an independent 10 minute back-up power source, to which the cockpit voice recorder and cockpit area microphone are switched automatically, in the event that normal power is interrupted.'**
B737	EI-ENB	21/12/2010	AAIU, Ireland	'1.2 Cockpit Voice Recorder (CVR) The CVR was downloaded and was found to be of good quality, but it was difficult to decipher due to the sound of breathing subsequent to the FO donning his oxygen mask. The CVR confirmed the accuracy of the flight and cabin crew's recollections. However, it terminated while the engines were spooling down and did not record the subsequent evacuation order, PA announcements or the conduct of associated procedures. The CVR electrical power source on this aircraft is from the 115V AC Transfer Bus No. 2. This Bus is de-energised when the engines are shut down unless the Auxiliary Power Unit (APU) is running with its generator on line or external power has been connected; in such cases the CVR will then run for an additional 5 minutes. If neither external nor APU electrical power is available, the CVR ceases recording when the electrical power supply from the engines is lost during shutdown.' '2.2 Evacuation Order When smoke was reported in the cockpit, the aircraft was decelerating and approaching a short taxiway that led to the ramp. CCTV recorded the aircraft coming to a stop on the ramp and later the doors opening and the evacuation commencing. It is unclear at what point the order was made to evacuate the aircraft as the CVR recording stopped during engine shut down.'

Aircraft Make and Model	Aircraft registration and operator	Date of the occurrence	Investigation authority (Name and State)	Findings made in the investigation report; If any, safety recommendation
				'2.4 Cockpit Voice Recorder (CVR) Power supply Because the CVR recording stopped during engine shut down it was not possible to clarify what happened subsequently, as the CVR no longer recorded activities in the cockpit due to the failure of the electrical power supply from the engines.' **'European Aviation Safety Agency (EASA) should introduce a requirement that the CVR should continue to record in the event of power failure. IRLD201203'**

Table 2: Examples of accidents and serious incidents with a long gliding phase

Aircraft Make and Model	**Aircraft registration and operator**	**Date of the occurrence**	**Investigation authority (Name and State)**	**Indications found in the report related to the gliding phase**
A330	C-GITS, Air Transat	24/08/2001	GPIAA, Portugal	'At 06:26, when the aircraft was about 65 nautical miles from the Lajes airport and at an altitude of about FL345, the crew reported that the left engine had also flamed out and that a ditching at sea was possible. Assisted by radar vectors from Lajes air traffic control, the crew carried an engine-out, visual approach, at night and in good visual weather conditions. The aircraft landed on runway 33 at the Lajes airport at 06:45.' 'The CVR recording spanned 28 minutes and 24 seconds of the flight, (…) ending at 06:27:41, shortly after the flameout of the second engine when electrical power was switched to EMERGENCY' **Around 19 minutes of descent with no engine and no CVR recording.**
B737	PK-GWA, Garuda	16/01/2002	NTSC, Indonesia	'On January 16, 2002, (…) a Boeing 737-300, PK-GWA, ditched into the waters of the Bengawan Solo River, Central Java during a forced landing, following loss of power on both engines as the aircraft was descending through 19,000 ft. The dual engine flame out occurred shortly after the aircraft entered severe cumulonimbus cloud formations with turbulence and heavy rain and ice. … The aircraft landed successfully between two iron bridges in the upstream direction, and came to a stop with its nose pointing to the right of the landing path. The aircraft settled down on its belly, with the wings and control surfaces largely intact, and was partially submerged. The evacuation following the landing was successful. Twelve passengers suffered injuries, the flight crew and two flight attendants were uninjured, one flight attendant suffered serious injuries, and another flight attendant was found in the waters of the river and fatally injured.' 'Then at 09.24 UTC the speed increased up to 410 knots, before the SSR target disappeared and faded out. The PSR (Primary Surveillance Radar) showed the target moved fast in an unstable flight path. At 09.32 UTC the PSR target disappeared for few seconds then came back again at 09.33 UTC, which was the last time the PSR target showed. ' 'The stoppage of the recording indicates that the CVR stopped due to loss of AC power. ' **Around 8 minutes of descent with no engine. The CVR stopped with the loss of alternating current power.**

Bombardier CL-600	N8396A, Pinnacle Airlines	14/10/2004	NTSB, USA	'FDR data showed that, about 2152:08, the airplane was in level flight at 41,000 feet … About 2154:57, the FDR recorded the fifth activation of the stick-shaker and the fourth activation of the stick-pusher. Even with the stickpusher's activation, the motion of the airplane continued to increase its AOA to the maximum measurable value of 27º. The pitch angle increased to 29º, and the airplane entered an aerodynamic stall. … About 2155:14, the controller told the pilots to descend and maintain an altitude of 24,000 feet; about 5 seconds later, the captain acknowledged the assigned altitude. About 2155:20, the FDR stopped recording because normal a.c. power to the airplane was lost. (The CVR had a different source of power and continued to record.) The last reliable N2 (core speed) recorded by the FDR before it stopped operating was 46 percent for the No. 1 engine and 51 percent for the No. 2 engine. … The FDR resumed operation about 2159:16.25 FDR data showed that the auxiliary power unit (APU) was supplying electrical power to the airplane, both engines' N1 indications continued to decrease, and both engines' N2 indications were at zero … FDR data showed that, during the next several minutes, four APU-assisted engine restarts were attempted, but the N2 speed for both engines remained at zero throughout the restarts. … About 2215:03, the CVR recorded the captain stating, "we're gonna hit houses," and, about 2 seconds later, the enhanced GPWS alert "pull up." About 2215:06, the CVR recorded a sound similar to an impact and stopped recording about 1 second afterward' **Around 20 minutes of descent with no engines. The CVR was recording until the impact with the ground thanks to 'a different source of power' from alternating current.**

B767	C-FCAG, Air Canada	02/01/2005	TSB, Canada	'On 02 January 2005, a Boeing 767-375 aircraft (registration C-FCAG, serial number 24085) operating as Air Canada Flight 092, was on a scheduled flight from Toronto/Lester B. Pearson International Airport, Ontario, to Santiago/Aeropuerto Comodoro Arturo Merino Benitez, Chile (…) the aircraft was in cruise flight at flight level (FL) 370 approximately 180 nautical miles (nm) north of Santiago, 60 nm prior to the planned start of descent. At that time, the crew received an engine indicating and crew alerting system (EICAS) warning of low fuel pressure output from both boost pumps in the left main fuel tank, and 45 seconds later the left engine (General Electric CF6-80C2B6 turbofan, serial number 690255) flamed out. The crew immediately opened the fuel cross-feed valve, declared a Mayday with Santiago radar and began a drift-down descent. As the aircraft descended through FL330, the auxiliary power unit (APU) was started. At approximately FL230, 18 minutes after the engine flamed out, the crew restarted the left engine. The aircraft continued to Santiago with both engines operating and landed without further incident' **Around 18 minutes of descent with no engines. No indication of a CVR recording in the report.**
ATR72	TS-LBB, Tuninter	06/08/2005	ANSV, Italy	'After gliding for approximately 16 minutes, the aircraft ditched approximately 23 nm northeast from Palermo's airport' 'In case of electrical failure of the two generators, as in case of engine shutdown, the electrical supply is ensured, for the essential users only, by two batteries (main battery at 43 Ah and the emergency battery at 15 Ah)' 'the CVR continued to record until the impact with the water which indicates that the main battery was still working' **Around 16 minutes of descent with no engines. The CVR kept recording because it was on the main battery.**

7.2. Annex 2

Table 1: Investigation reports identifying a trigger of a g-switch as the most probable cause of a premature end of recording

Aircraft Make and Model	**Aircraft registration and operator**	**Date of the occurrence**	**Investigation authority (Name and State)**	**Findings made in the investigation report; If any, safety recommendation**
Sikorsky, S-61N	G-BEWL	25/07/1990	AAIB, UK	The aircraft 'was fitted with a 30 minute duration Fairchild A100A Cockpit Voice Recorder' 'The CVR almost certainly stopped as soon as power to it was interrupted under the influence of the g switch when the initial tail rotor strike was sensed'
Eurocopter, AS332	G-TIGK	19/01/1995	AAIB, UK	'The helicopter was equipped with a combined voice and flight data recorder (CVFDR). It was determined that the recorder had lost its power supply as a result of the operation of the G-switch due to the level of tail rotor vibration induced by the lightning strike' <u>Safety recommendation:</u> 'In order to prevent the premature cessation of electrical power supply to helicopter combined voice/flight data recorders (CVFDR) caused by abnormal excessive vibration effects on associated G-switches, it is recommended that the CAA: 1. Require operators to render inoperative CVFDR G-switches, as an interim measure, and 2. Take action to identify a more suitable method of stopping such flight recorders during crash impact (Safety recommendation 97-32)'
Eurocopter, AS332	G-BWZX	12/12/1997	AAIB, UK	'it was determined that the G-switch, which was fitted in the power supply to the CVFDR in accordance with CAA specification No 11, had operated at the time of the lightning strike. This had prevented the CVFDR from recording aircraft data and audio pertaining to the handling of the damaged aircraft as it returned to the rig.' <u>Safety recommendation:</u> 'For this reason the following Safety Recommendation is made: The CAA reassess the response made to part 1 of Safety Recommendation 97-32 with a view to rendering the CVFDR G-switch inoperative. (Safety Recommendation 99-24).'
Sikorsky, S76	G-BMAL	12/07/2001	AAIB, UK	'The aircraft was fitted with a GEC-Plessey Avionics Combined Voice and Flight Data Recorder(CVFDR)… The CVFDR was fitted with an acceleration cut-off switch, which interrupts electrical power if a local acceleration above 4.5 g at 45 degrees to the longitudinal fuselage datum is exceeded' 'the g switch activated which then precluded the peak normal acceleration being recorded. While not necessary for investigation purposes during this accident, this g switch activation, in other accidents and serious incidents, has resulted in the loss of essential information. In the accident involving G-BMAL, the early activation of the g switch denied knowledge of the peak recorded normal acceleration to enable the operator to gauge and plan the extent of the inspections and repairs necessary.'

Bombardier	VP-CRC	29/01/2008	AAIB, UK	'The CVR was a solid state, 2-hour recorder which captured the last two hours of flight into Luton. [...] The system included an 'impact' or 'g' switch interlock, designed to cut the power to the CVR in the event of a significant crash impact. The switch operates by sensing acceleration and removing the power supply to the CVR in the event of the acceleration exceeding 3g. The switch was mounted in the rear section of the aircraft, at a 45 degree incline to the longitudinal axis. [...] Upon arrival in Luton, the CVR recording ceased just after the nose landing gear touched down. The FDR recording showed a peak normal acceleration at touchdown of 1.2g and longitudinal acceleration peak, just prior to the loss of CVR, of -0.22g. When downloaded, the CVR operated normally and no cut in the aircraft DC essential power supply was reported. Maintenance records did not confirm the operation of the 'g' switch but system troubleshooting suggested that it was the most likely cause of the CVR stopping.' 'As stated in the G-TIGK report, the AAIB was, and continues to be, unaware of any accidents where recorders would have continued to run after the crash impact had no 'g' switch been fitted. However, several accidents were encountered where premature operation of the 'g' switch had impeded the accident investigation.' <u>Safety recommendation:</u> 'It is recommended that the Federal Aviation Administration and the European Aviation Safety Agency review the certification requirements for automatically stopping flight recorders within 10 minutes after a crash impact, with a view to including a specific reference prohibiting the use of `g` switches as a means of compliance as recommended in ED112 issued by EUROCAE Working Group 50.'
Cessna 650	I-FEEV, Air One Executive	07/02/2009	ANSV, Italy	Accident (on-going investigation) The aircraft experienced a deep fall, and the end of FDR recording corresponds to a height above terrain of more than 4 000 ft, while the CVR kept recording until impact. Because of the very high energy, the aircraft was completely destroyed, so that the FDR and the CVR little useful evidence could be recovered on the accident site. The g-switch activation is considered the most likely cause of the premature end of FDR recording.
Sikorsky, S92	C-GZCH	12/03/2009	TSB, Canada	The aircraft 'was equipped with a Penny & Giles multipurpose flight recorder (MPFR)' which records both flight data recorder (FDR) data and cockpit voice recorder (CVR) audio 'The MPFR stopped recording about 44 seconds before impact and then began recording again about 1.7 seconds before the impact. TSB's examination of the MPFR and the components which supply it with data, as well as the associated wiring, determined that there was no indication of a pre-existing condition that would have prevented normal operation.' 'By design, electrical power (power) to the MPFR is routed through a dedicated relay. As long as this relay is not energized, power will be supplied to the MPFR. Once energized, by either the

				omni-directional inertia switch (g-switch) or the water immersion switches, the power to the MPFR will be cut.'
Eurocopter, AS332	G-REDL	01/04/2009	AAIB, UK	'The CVFDR recording ended prematurely and curtailed the only data and audio recording source designed to survive an accident. The outcome of this was a limited amount of data for the remainder of the accident sequence, which relied on information recovered from non-crash-protected components.' 'Loss of power to the CVFDR is likely to have been caused either by a loss of electrical power supply or power interruption by the g-switch. Recorded VHF transmissions, radar data and downloads from the SMD memory and the HUMS data card suggest that electrical power was still available to those systems sharing the same power supply as the CVFDR, after the CVFDR recording ceased.' 'There are currently no programmes to modify in-service systems which were qualified prior to the release of ED112. As such, some existing flight recording systems may suffer a loss of data early in the accident sequence. Simply removing the existing switches means that some systems would no longer be compliant with the requirement to stop the cockpit voice recording within 10 minutes of an accident. One possible solution would be to change the existing mechanical g-switches for a more reliable or improved sensor.' <u>Safety Recommendation:</u> 'It is recommended that the European Aviation Safety Agency require the 'crash sensor' in helicopters, fitted to stop a Cockpit Voice Recorder in the event of an accident, to comply with EUROCAE ED62A.'