



Installation and maintenance of recorders – certification aspects

RMT.0249 (MDM.051) (SECOND NPA STEMMING FROM THIS RMT)

EXECUTIVE SUMMARY

The objective of this 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 the certification specifications (CSs) and acceptable means of compliance (AMC) for the installation of flight recorders on board large aeroplanes and large rotorcraft, and addresses the following subjects:

- Data link recording;
- The serviceability of flight recorders; and
- The quality of recording of cockpit voice recorders.

The NPA also analyses the issue reported after some occurrences (on large aeroplanes) in which the end of the recording was missing from the flight data recorder data due to the loss of normal electrical power. It also considers the option of mandating an alternate power source as a solution. The conclusion recommends no regulatory change.

The proposed changes to CS-25 and CS-29 are expected to increase safety (by addressing some safety recommendations, and overall contributing to facilitating investigations of accidents and incidents), to help operators to ensure the serviceability of recorders, to ease the certification process for recorders for EASA and design organisations, and thereby bring an economic benefit for these stakeholders.

Action area:	Aircraft tracking, rescue operations and accident investigations		
Affected rules:	CS-25, CS-29		
Affected stakeholders:	Design organisations and operators for the aircraft concerned, accident investigation bodies		
Driver:	Safety	Rulemaking group:	No
Impact assessment:	Light	Rulemaking Procedure:	Standard

● EASA rulemaking process milestones



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1. About this NPA

1.1. How this NPA was developed

The European Union Aviation Safety Agency (EASA) developed this NPA in line with Regulation (EU) 2018/1139¹ (hereinafter referred to as the 'Basic Regulation') and the Rulemaking Procedure². This rulemaking activity is included in the European Plan for Aviation Safety (EPAS) [2019-2023](#) under rulemaking task (RMT).0249. The text of this NPA has been developed by EASA, based on the input of the European Flight Recorder Partnership Group. It is hereby submitted to all interested parties³ 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/>⁴.

The deadline for submission of comments is **13 February 2020**.

1.3. The next steps

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

Based on the comments received, EASA will develop a decision that amends CS-25 and CS-29.

The comments received and the EASA responses to them will be reflected in a comment-response document (CRD). The CRD will be published on the EASA website⁵.

¹ Regulation (EU) 2018/1139 of the European Parliament and of the Council of 4 July 2018 on common rules in the field of civil aviation and establishing a European Union Aviation Safety Agency, and amending Regulations (EC) No 2111/2005, (EC) No 1008/2008, (EU) No 996/2010, (EU) No 376/2014 and Directives 2014/30/EU and 2014/53/EU of the European Parliament and of the Council, and repealing Regulations (EC) No 552/2004 and (EC) No 216/2008 of the European Parliament and of the Council and Council Regulation (EEC) No 3922/91 (OJ L 212, 22.8.2018, p. 1) (<https://eur-lex.europa.eu/legal-content/EN/TXT/?qid=1535612134845&uri=CELEX:32018R1139>)

² EASA is bound to follow a structured rulemaking process as required by Article 115(1) of Regulation (EU) 2018/1139. 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 In accordance with Article 115 of Regulation (EU) 2018/1139 and Articles 6(3) and 7 of the Rulemaking Procedure.

⁴ In the case of technical problems, please contact the CRT webmaster (crt@easa.europa.eu).

⁵ <https://www.easa.europa.eu/document-library/comment-response-documents>

2. In summary — why and what

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

The following issues were identified in the Terms of Reference (ToR) and are the subject of this NPA. For more details, please refer to Chapter 4.1.

2.1.1. FDR alternate power source

During some accidents involving large aeroplanes (the CS-25 category), the flight data recorder (FDR) stopped recording before the end of the flight due to the loss of normal electrical power. This led to the data not being recorded during the time when the electrical power was lost.

2.1.2. Data link recording

Annex IV (Part-CAT) to Commission Regulation (EU) No 965/2012 on air operations contains requirements on the recording of data link messages on a flight recorder for aircraft manufactured since April 2014 and under certain conditions (points CAT.IDE.A.195 (aeroplanes) and CAT.IDE.H.195 (helicopters)).

However, there are no corresponding certification specifications for the installation of a data link recording function in CS-25 (large aeroplanes) and CS-29 (large rotorcraft).

As a temporary measure, EASA developed a generic certification review item (CRI) on the subject 'flight recorders and data link recording'. This CRI contains a special condition (SC) and interpretative material (IM).

2.1.3. The serviceability of flight recorders

2.1.3.1 Maintenance instructions

Safety investigation authorities have reported several cases in which the FDR or the cockpit voice recorder (CVR) did not correctly record data due to a malfunction of the unit or of the dedicated equipment (including sensors and transducers). Such failures may remain hidden for a certain amount of time as the serviceability of flight recorders encompasses the quality of the recorded data which cannot currently be automatically assessed.

Part-CAT of Regulation (EU) No 965/2012 on air operations requires (CAT.GEN.MPA.195(b)) aircraft operators to conduct operational checks and evaluations of recordings of flight recorders in order to ensure their 'continued serviceability'. Consistently with the standards in ICAO Annex 6, Part I, Appendix 8, and in ICAO Annex 6, Part III, Appendix 4, AMC1 CAT.GEN.MPA.195(b) recommends several scheduled tasks to comply with this requirement.

In practice, the content and the level of detail of the maintenance instructions for a flight recorder system vary from one installation to another, resulting in inconsistent maintenance practices among aircraft operators.

2.1.3.2 Conversion of FDR raw data into flight parameters expressed in engineering units

Safety investigation authorities also found various cases where the information necessary to convert the FDR raw data into parameters expressed in engineering units, as provided by the type certificate (TC) or supplemental type certificate (STC) holder, was incomplete or inaccurate. As a result, the analysis of the FDR data was significantly delayed. Point (d) of CAT.GEN.MPA.195 requires the

aircraft operator to ‘keep and maintain up-to-date documentation that presents the necessary information to convert FDR raw data into parameters expressed in engineering units’. However, an operator can only do that if the TC or STC holder has provided the corresponding information to the operator.

2.1.4. The quality of recording of cockpit voice recorders

Safety investigation authorities found that some CVR system installations do not provide the quality expected for the cockpit area microphone (CAM) and other audio channels. The issues identified include:

- a) poor quality of the recording on the CAM channel;
- b) saturation of the recording on the CAM channel by very low frequency vibrations;
- c) excessive electrical background noise on a channel;
- d) signals from the channels of flight crew members cancelling each other out;
- e) clipping of the signals on the channels of flight crew members when coming from the oxygen mask microphones;
- f) superimposition of microphone signals by radio reception signals;
- g) inversion of the sign of the signal coming from the CAM channel, resulting in significant attenuation; and
- h) incorrect allocation of the recording capacity to a channel.

These issues seem to be recurrent because of the lack of a framework for demonstrating the audio quality of a CVR system installation. Indeed, many factors potentially affecting the quality of the recorded audio cannot be addressed at the equipment level, such as the effects of components of the audio system (e.g. headsets), the air circulation in the vicinity of microphones (due to air conditioning systems), vibrations during the flight, electromagnetic interference, etc.

As a temporary measure, EASA initially reacted with the publication of Certification Memorandum CM-AS-001 ‘Quality of recording of cockpit voice recorders’, issued in June 2012.

2.2. What we want to achieve — objectives

The overall objectives of the EASA system are defined in Article 1 of the Basic Regulation. This proposal will contribute to the achievement of the overall objectives by addressing the issues outlined in Section 2.1.

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 the safety investigation authorities in the investigation of accidents and incidents. This includes, in particular, the objectives to:

- a) analyse the suitability of requiring the installation of an FDR alternate power source in order for the FDR to continue recording after a loss of normal electrical power;
- b) provide certification specifications to support compliance with the operational rules requiring the recording of data link communications;
- c) improve the serviceability of flight recorders; and



- d) improve the audio quality of CVR recordings.

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

2.3.1. FDR power supply

Requiring an alternate power source (APS) for FDRs on large aeroplanes could be envisaged, in the same way as for CVRs (see NPA 2018-03). An alternate power source is a power source to which the recorder is 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.

However, unlike with CVRs, in order to be able to record data, the APS would have to also power different elements in addition to the FDR itself, to ensure that the data from the various aeroplane systems are provided to the FDR. This, therefore, potentially requires a significant amount of electrical power.

EASA considers that there is not enough safety benefit to be expected from the implementation of an alternate power source for each FDR recording system, which would justify a new requirement mandating it.

Therefore, this NPA does not propose regulatory changes on this topic.

2.3.2. Data link recording

It is proposed to create, in CS-25 and CS-29, new certification specifications and acceptable means of compliance for recorders performing the data link recording function: CS and AMC 25.1460, CS and AMC 29.1460.

2.3.3. The serviceability of flight recorders

It is proposed to introduce, in the various AMCs corresponding to the specifications for recorder installations, new sections explaining the expectations in terms of the instructions for continued airworthiness (ICA) provided by applicants: AMC 25.1457, AMC 25.1459, AMC 25.1460, AMC 29.1457, AMC 29.1459, and AMC 29.1460.

2.3.4. The quality of recording of cockpit voice recorders

It is proposed to introduce, in AMC 25.1457 and AMC 29.1457, a new section explaining how applicants are expected to perform evaluations of CVR recordings.

Amendments to CS 25.1457 and CS 29.1457 are also proposed to allow the use of more than four channels.

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

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

2.4.1. FDR power supply

No regulatory change is proposed on this topic.



2.4.2. Data link recording

The proposed new CS and AMC 25.1460, and the new CS and AMC 29.1460, would bring an economic benefit, and would build on the CRI process to produce an upgraded set of specifications and acceptable means of compliance that would bring benefits to both applicants and EASA. A more robust set of specifications would also bring benefits to accident and incident investigations, thus bringing a safety benefit.

2.4.3. The serviceability of flight recorders

The proposed amendments of the various AMCs, corresponding to the specifications for recorder installations, would create a safety and economic benefit over the current situation in which some accident investigations are hindered.

2.4.4. The quality of recording of cockpit voice recorders

The proposed amendments of AMC 25.1457 and AMC 29.1457 would create a safety and economic benefit over the current situation. It would, overall, ensure that the audio quality of a CVR is thoroughly investigated and reported before it is certified. This will bring benefits to operators, aircraft accident investigation bodies, EASA, and design organisations.



3. Proposed amendments and rationale in detail

3.1. Rationale

3.1.1. Data link recording

It is proposed to create new provisions (CS and AMC 25.1460) to address the installation of data link recorders. The following topics have been reviewed in relation to the content of these new provisions.

Content and sources of the recording:

The messages to record should at least be those which are supported by the data link communication system and related to air traffic service (ATS) communications, as well as messages whereby the flight path of the aircraft is authorised, directed or controlled, and which are relayed over a digital data link rather than by voice communication (refer to CAT.IDE.A.195 and CAT.IDE.H.195).

It should also be possible to correlate the data link recording with associated recordings stored separately from the aircraft in order to accurately reconstruct, in the framework of an accident investigation, the sequence of data link communications between the aircraft and air traffic service units, other aircraft, and other entities. EUROCAE Document ED-93 (dated November 1998), 'Minimum aviation system performance specification for CNS/ATM message recording systems', Sections 2.3.1 and 2.3.2, provide a means of meeting this requirement.

Dedicated sensors: this is not applicable to data link recording.

Power supplies:

EUROCAE Document ED-112A (dated September 2013), 'Minimum operational specification for crash protected airborne recorder systems', paragraph 2-5.3.9 specifies: 'Each recorder, whether containing single or multiple recording functions, shall be connected to a power source providing the most reliable electrical power and which has characteristics ensuring proper and reliable recording in the operational environment.' With regard to the CVR, it is required by CS 25.1457 and CS 29.1457 that '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;' The same requirement applies to the FDR in CS 25.1459 and CS 29.1459.

Means to automatically stop the recorder after a crash impact:

The need for such a means would depend on the duration of the data link recording, which shall be, as a minimum, equal to the duration of the CVR recording. (According to Commission Regulation (EU) No 965/2012 on air operations, the minimum is 25 hours for aeroplanes with MCTOMs of over 27 000 kg and first issued with individual CofAs on or after 1 January 2021, and two hours for all other aeroplanes and helicopters).

However, the data link recording function may be supported by the CVR, where such a means may still be justified (when the CVR recording duration is two hours), or the FDR, which does not need such a means. In addition, given the small volume of data link communication data to be recorded, it is likely that data older than two hours will be retained, and therefore a means to automatically stop

the recording of data link communication messages after a crash impact would probably be superfluous. Therefore, such a means should preferably not be specified in the CS.

Note: unlike audio and flight parameters, the recording of data link communication messages is not continuous: data link communication messages are recorded when they are received, processed or sent by the aircraft. Therefore, for a given memory capacity, the duration of the data link recording may vary, depending on the data link communication traffic.

Means to check the recorder pre-flight for proper operation:

According to ED-112A, paragraph 2-1.4.1, for any recorder installed, 'there shall be aural or visual means for pre-flight checking of the recorder(s) for proper recording of the information in the recording medium'. According to ED-112A paragraph 4-1.2.2, when recording functions are combined, an indication shall be provided of the particular function which has failed.

Location of the recorder container:

The same principles as those applicable to the FDR or the CVR should apply when the recorder is dedicated to data link recording. The choice of location will also depend on whether the recorder is deployable or not.

Means to erase the recording:

ED-112A paragraph IV-2.1.12 prohibits means for erasing the recording of data link communications in the recorder.

Means for facilitating localisation and identification of the recorder after an accident (colour, reflective tapes, ULD, etc.):

The same principles as for the FDR and the CVR should apply.

Synchronisation with other recordings:

This topic encompasses two aspects: synchronisation with ground recordings of data link communication and synchronisation with FDR and CVR recordings. With regard to the first aspect, paragraph CAT.IDE.A.195 requires that the information that is recorded 'enables correlation to any associated records related to data link communications and stored separately from the aeroplane'. On the second aspect, ICAO Annex 6 Part I prescribes that 'Data link recording shall be able to be correlated to the recorded cockpit audio'. CAT.IDE.A.195 contains a slightly different requirement to record 'information on the time and priority of data link communications messages, taking into account the system's architecture'.

Information to convert the recorded data back to the original format of data link communication messages:

In order to enable an aircraft operator to perform an inspection of the data link recording for quality (as recommended by AMC1 CAT.GEN.MPA.195(b)) and the safety investigation authorities to



reconstruct a sequence of events after an accident or a serious incident, sufficient information to convert the recorded data back to the format of the original data link messages is needed. This information should also be sufficient to reconstruct the time sequence of messages with their priorities and correlate this time sequence with the FDR and CVR recordings, as well as with the ground recordings of data link communications.

This information should be clearly organised in documentation that is provided to the aircraft operator, similar to the documentation about the conversion of FDR raw data into flight parameters (refer to 4.1.4).

3.1.2. The serviceability of flight recorders

3.1.2.1 Maintenance instructions

New acceptable means of compliance (AMC) in CS-25 and CS-29 are proposed (in AMC 2X.1457, 2X.1459, 2X.1460) in order to clarify what is expected to be assessed by the applicant and what should be provided in the ICA. The following topics have been reviewed in relation to the content of these new provisions.

The following provisions are relevant to this subject:

- a) ICAO Annex 6, Part I (Eleventh Edition, July 2018) on International Commercial Air Transport - Aeroplanes, Appendix 8 Flight recorders, Section 1 (General requirements) and Section 7 (Inspections of flight recorder systems);
- b) ICAO Annex 6, Part III (Ninth Edition, July 2018) on International Operations - Helicopters, Appendix 4 Flight recorders, Section 1 (General requirements) and Section 6 (Inspections of flight recorder systems); and
- c) EUROCAE Document ED-112A 'Minimum operational performance specification for crash protected airborne recorder systems', dated September 2013, Annex I-C (CVR maintenance practices), Annex II-B (FDR maintenance practices), Annex IV-B (DLR maintenance practices).

Content of the maintenance instructions:

The above-mentioned ICAO Annex 6 standards and the ED-112A standard provide the recommended tasks and intervals which should be addressed by the ICA.

For each task, the analysis should determine, for the specific flight recorder system installed:

- a) whether this task or another equivalent task is needed;
- b) the content of the task;
- c) what should be the recommended periodicity or the trigger to perform the task; and
- d) how, in practice, to perform this task.

As a minimum, the following tasks should be assessed by the flight recorder system installer:

- a) The use of the pre-flight check means for monitoring the proper operation of the flight recorder system;
- b) The inspection of the recording of the flight recorder to ensure that it is complete and of acceptable quality (applicable to the FDR, the CVR and the DLR);



- c) The tasks related to the serviceability of the underwater locating device (for a fixed flight recorder) or of the dedicated emergency locator transmitter (for a deployable flight recorder), including their batteries;
- d) The tasks related to the serviceability of the means for stopping the flight recorder after detection of a crash impact or in case of water immersion, when installed. This should include, if the recorder is deployable, the means to trigger the deployment;
- e) The tasks related to the serviceability of the recorder-independent power supply, when installed, to comply with the requirement for an alternate power source; and
- f) In the case of an FDR, the task of checking that the dedicated flight parameters are recorded within the calibration tolerances, if applicable (e.g. not applicable for a discrete).

3.1.2.2 The conversion of FDR raw data into flight parameters expressed in engineering units

It is proposed to add provisions in AMC 2X.1459 (in CS-25 and CS-29) to include FDR decoding documentation in the list of items to be included in the FDR ICA.

The objective is for FDR decoding documentation to be prepared for every new FDR system installation and updated for every change to an FDR system installation, and that this documentation should be made available to aircraft operators so that they can fulfil their responsibilities with regard to FDR decoding documentation and FDR serviceability. Guidance should also be provided on the content and format of the FDR decoding documentation.

3.1.3. The quality of recording of cockpit voice recorders

The following changes are proposed:

- a) Amend CS 25.1457(c) and CS 29.1457(c) in order to allow the CVR to record on more than four channels, while maintaining the requirement that the signal sources listed in CS 25.1457(c) and CS 29.1457(c) are recorded on separate CVR channels.
- b) Transfer the content of CM-AS-001 (version of 2012) to AMC 25.1457 and AMC 29.1457;
- c) Also add the following in these AMCs:
 - 1) Indicate that the evaluation of the CVR recording should include:
 - i) the tasks described in ED-112A Annex I-A, paragraph I-A.3, and checking that the levels of signals from radio and public address systems are such that these signals are audible and do not mask the signals from the flight crew microphones;
 - ii) checking issues such as described in the BEA documents titled 'Study on Detection of Audio Anomalies on CVR recordings' (published in September 2015) and 'Guidance on CVR recording inspection' (published in October 2018);
 - ii). an assessment of the intelligibility of crew speech on all CVR channels;
 - iv) checking that the CVR begins to operate no later than the start of the pre-flight checklist and continues to operate until the completion of the final post-flight checklist; and
 - v) checking the absence of faults in the BITE memory of the CVR, if applicable.



- 2) Indicate that the evaluation of the CVR recording should involve personnel with adequate knowledge of CVR systems and aircraft operations, and who have appropriate experience of the techniques used to evaluate recordings.
- 3) Add a reference to ED-112A, Annex I-A, with regard to examples of CVR replay and an evaluation report.
- 4) Provide a rating scale for the audio quality of the CVR that may be used by the applicant.
- 5) Specify that only CVR system installations producing recordings with 'good' or 'fair' audio quality for all the signal sources listed in point (c) of CS 25.1457 or required by the applicable operating rules may be considered acceptable.
- 6) Specify that the CVR system installer should provide the CVR evaluation report performed by the replay and evaluation centre as part of the compliance demonstration.
- 7) Specify that the CVR system installer should provide to the operator a summary of the CVR quality report detailing the assessed quality of each of the required signal sources of the approved CVR installation design.

3.2. Draft certification specifications for large aeroplanes (CS-25) (Draft EASA decision)

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 **blue**;
- an ellipsis '[...]' indicates that the rest of the text is unchanged.

3.2.1. Data link recording

Create a new CS 25.1460 as follows:

CS 25.1460 Data link recorders (See AMC 25.1460)

- (a) Each recorder performing the data link recording function required by the operating rules must be approved and must be installed so that it will record the following messages:
 - (1) Data link communication messages related to air traffic services (ATS) communications to and from the aeroplane; and
 - (2) ATS messages whereby the flight path of the aeroplane is authorised, directed or controlled, and which are relayed over a digital data link rather than by voice communication.
- (b) Each data link recorder must be installed so that:
 - (1)(i) it receives its electric power from the bus that provides the maximum reliability for the operation of the recorder without jeopardising service to essential or emergency loads; and



- (ii) it remains powered for as long as possible without jeopardising the emergency operation of the aeroplane;
 - (2) there is an aural or visual means for pre-flight checking of the recorder for the proper recording of data in the storage medium; and
 - (3) if the recorder is deployable, it complies with CS 25.1457(d)(7).
- (c) The container of the recorder must be located and mounted so as to minimise the probability of the recorder container rupturing, the recording medium being destroyed, or the recorder locating device failing as a result of:
- its deployment, if applicable;
 - an impact with the Earth's surface; or
 - the heat damage caused by a post-impact fire.
- (d) The container of the data link recorder must comply with the specifications applicable to the container of the cockpit voice recorder in CS 25.1457(g).

Create a new AMC 25.1460 as follows:

AMC 25.1460

Data link recorders

1. General

In showing compliance with CS 25.1460, the applicant should take into account EUROCAE Document ED-112A, 'Minimum operational performance specification for crash protected airborne recorder systems', dated September 2013, or any later equivalent standard.

The data link recording function may be performed by:

- a. a cockpit voice recorder;
- b. a flight data recorder;
- c. a flight data and cockpit voice combination recorder; or
- d. a dedicated data link recorder.

2. Combination recorders

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 (if any) recording functions (e.g. FDR, CVR, data-link recorder, etc.) have failed.

3. Recorded data

Data link recorded data should be sufficient to allow, in the framework of an accident or incident investigation, to accurately reconstruct the sequence of data link communications between the aircraft and air traffic service units, other aircraft and other entities. For this purpose, the data link recording should comply with:



- a. EUROCAE Document ED-93 (dated November 1998), 'Minimum aviation system performance specification for CNS/ATM message recording systems', Section 2.3.1, Choice of recording points, and Section 2.3.2, Choice of data to be recorded on board the aircraft; and
- b. EUROCAE Document ED-112A (dated September 2013), 'Minimum operational specification for crash protected airborne recorder systems', Part IV, Chapter IV-2, Section IV-2.1.6, Data to be recorded.

3.2.2. The serviceability of flight recorders

Amend AMC 25.1457 as follows:

AMC 25.1457

Cockpit Voice Recorders

(...)

8. Instructions for continued airworthiness (ICA)

The ICA for the cockpit voice recorder, required by CS 25.1529 and Appendix H, should include the following items:

- a. Inspections of in-flight recording, to detect problems with the audio quality of the recording;
- b. Other functional checks needed to ensure that the quality of the recordings is acceptable, when appropriate;
- c. Operational checks of the recorder; and
- d. Tasks to ensure the serviceability of the equipment dedicated to the recorder, which typically include:
 - i. dedicated sensors (e.g. the cockpit area microphone(s));
 - ii. a dedicated power source (e.g. a recorder independent power supply);
 - iii. means to detect a crash impact (e.g. for the purpose of stopping the recording, or for the purpose of deploying the recorder if it is deployable); and
 - iv. means to facilitate finding the recorder after an accident (e.g. an underwater locating device or an emergency locator transmitter attached to the recorder).

Amend AMC 25.1459 as follows:

AMC 25.1459

Flight Data Recorders

(...)

7. Instructions for continued airworthiness (ICA)

The ICA for the flight data recorder, required by CS 25.1529 and Appendix H, should include the following items:



- a. Inspections of in-flight recording, to detect problems with the quality of the recording of flight parameters;
- b. Other functional checks needed to ensure that the quality of the recordings is acceptable, when appropriate;
- c. Operational checks of the recorder;
- d. Calibration checks of flight parameters from sensors dedicated to the flight data recorder;
- e. Tasks to ensure the serviceability of the equipment dedicated to the recorder, which typically include:
 - i. dedicated sensors (e.g. dedicated accelerometers),
 - ii. means to detect a crash impact (e.g. for the purpose of stopping the recording, or for the purpose of deploying the recorder if it is deployable), and
 - iii. means to facilitate finding the recorder after an accident (e.g. an underwater locating device or an emergency locator transmitter attached to the recorder); and
- f. FDR decoding documentation

- i. Definitions

FDR decoding documentation: a document that presents the information necessary to retrieve the raw binary data of an FDR data file and convert it into engineering units and textual interpretations.

Fixed-frame recording format: a recording format organised in frames and subframes of a fixed length and that are recorded chronologically. ARINC Specifications 573 and 717 provide an example of a fixed-frame recording format.

Variable-frame recording format: a recording format based on recording frames which are individually identified and time stamped, so that their order in the recording file is not important. ARINC Specification 767 provides an example of a variable frame recording format.

- ii. The content of the FDR decoding documentation

The FDR decoding documentation should at least contain information on:

- the aircraft make and model;
- the date and time when the document was modified; and
- in the case of a fixed-frame recording format:
 - the sync pattern sequence;
 - the number of bits per word, of words per subframe, and of subframes per frame; and
 - the time duration of a subframe;
- In the case of a variable-frame recording format, the list of frames, and for each frame:
 - its identification;
 - information on whether the frame is scheduled or event-triggered;
 - the recording rate (for a scheduled frame);



- the frame event condition (for an event-triggered frame); and
 - the list of flight parameters, by order of recording;
 - For every FDR parameter:
 - its identification: name (and mnemonic code or other identification if applicable);
 - the sign convention and the units of converted values (if applicable);
 - the location of each parameter component in the data frame;
 - instructions and equations to assemble the parameter components and convert the raw binary values into engineering units (if applicable); and
 - the conversion to text or the discrete decipher logic (if applicable).
- iii. **Format of the FDR decoding documentation**
- The FDR decoding documentation should be provided in an electronic format such that:
- it contains all the information described in paragraph f.ii. above;
 - it is readily displayable (i.e. it can be presented on an output device, like a printer or display screen, using any readily available ASCII text editor); and
 - it allows editing.
- iv. **Electronic documentation format**
- FDR decoding documentation should comply with the standard of ARINC Specification 647A. ARINC Specification 647A provides an electronic documentation format that meets the needs of aircraft operators and of the safety investigation authorities.

The following text is added to the newly created AMC 25.1460 (see above under ‘Specifications for data link recording’) as follows:

AMC 25.1460

Data Link Recorders

(...)

5. Instructions for continued airworthiness (ICA)

The ICA for the data link recorder, required by CS 25.1529 and Appendix H, should include the following items:

- a. Inspections of in-flight recording, to detect problems with the recording of data link messages;
- b. Other functional checks needed to ensure that the quality of the recordings is acceptable, when appropriate;
- c. Operational checks of the recorder;
- d. Tasks to ensure the serviceability of the equipment dedicated to the recorder, which typically include:
 - i. means to detect a crash impact (e.g. for the purpose of stopping the recording, or for the purpose of deploying the recorder if it is deployable), and



- ii. means to facilitate finding the recorder after an accident (e.g. an underwater locating device or an emergency locator transmitter attached to the recorder); and
- e. Documentation to perform the following:
 - i. Convert the recorded data back to the original format of the data link communication messages,
 - ii. Retrieve the time and the priority of each recorded message, and
 - iii. Correlate the recorded messages with the FDR and CVR recordings.

3.2.3. The quality of recording of cockpit voice recorders

Amend CS 25.1457 as follows:

CS 25.1457 Cockpit voice recorders

(See AMC 25.1457)

(...)

(c) Each cockpit voice recorder must be installed so that the part of the communication or audio signals specified in sub-paragraph (a) of this paragraph obtained from ~~each of~~ the following sources is recorded on ~~a~~ **at least four** separate channels:

- (1) ~~For the first channel, f~~From each boom, mask, or hand-held microphone, headset, or speaker used at the first pilot station.
- (2) ~~For the second channel, f~~From each boom, mask, or hand-held microphone, headset, or speaker used at the second pilot station.
- (3) ~~For the third channel, f~~From the cockpit-mounted area microphone.
- (4) ~~For the fourth channel, f~~From:
 - (i) ~~E~~ach boom, mask, or handheld microphone, headset or speaker used at the stations for the third and fourth crew members; or
 - (ii) ~~I~~f the stations specified in sub-paragraph (c)(4)(i) of this paragraph are not required or if the signal at such a station is picked up by another channel, each microphone on the flight deck that is used with the passenger loudspeaker system if its signals are not picked up by another channel.

No channel shall record communication or audio signals from more than one of the following sources: the first pilot station, second pilot station, cockpit-mounted area microphone, or additional crew member stations.

~~(5)~~ As far as is practicable, all sounds received by the microphones listed in subparagraphs (c)(1), (2) and (4) of this paragraph must be recorded without interruption irrespective of the position of the interphone-transmitter key switch. The design must ensure that sidetone for the flight crew is produced only when the interphone, public address system or radio transmitters are in use.

(...)

Amend AMC 25.1457 as follows:

AMC 25.1457



Cockpit Voice Recorders

(...)

9. Evaluation of the CVR recording

The following acceptable means of compliance with CS 25.1457(b) is provided to demonstrate that the performance of the CVR system is acceptable and that the quality of the CVR recording is acceptable.

a. The CVR system should be installed in accordance with the recommendations made in EUROCAE Document ED-112A, in particular:

- Chapter 2-5, Equipment installation and installed performance, and
- Part I, Cockpit Voice Recorder System, Chapter I-6.1.1 Interface design, I-6.1.2 Recorder Operation and I-6.1.3 Bulk Erasure Interlocks.

Particular attention should be given to the location of the cockpit area microphone (CAM). ED-112A, Chapter I-6.2., Equipment location, provides guidance on this topic.

It should be noted that the CVR system may record on more than four channels, and that this may help to avoid superimposition between signal sources recorded on the same CVR channel.

b. To ensure that the CVR system is properly installed, and to verify that the quality of the audio signals recorded from all the audio channels is acceptable, the applicant should conduct a flight test. The recording obtained should be evaluated to confirm that the quality is acceptable during all the normal phases of flight (including taxi-out, take-off, climb, cruise, descent, approach, landing, and taxi-in). ED-112A provides guidance for testing a new CVR installation. (Refer to Chapter I-6.3).

c. The evaluation of the CVR recording should include:

- i. the tasks described in ED-112A, Annex I-A, Chapter I-A.3;
- ii. checking that the vocal signal sources are intelligible and that non-vocal alerts on headsets or speakers can be identified;
- iii. checking that the levels of sidetone signals (e.g. radio) and public address are adjusted so that these signals are audible and do not mask the signals from the flight crew microphones (refer to ED-112A, Part I, Chapter I-6.1.1);
- iv. checking that the CVR begins to operate no later than the start of the pre-flight checklist and continues to operate until the completion of the final post-flight checklist; and
- v. checking for the presence of any fault in the memory of the built-in-test feature of the CVR, if applicable.

d. It is recommended that the evaluation of the CVR recording should be performed by a replay and evaluation centre. An acceptable replay and evaluation centre should fulfil all of the conditions below:

- i. The equipment used for the CVR recording replay should meet the specifications of Chapter I-A.2 of Annex I-A of ED-112A or a higher standard;
- ii. The replay and evaluation of CVR recordings should be performed by personnel who have adequate knowledge of CVR systems and aircraft operations, and who have appropriate experience of the techniques used to evaluate recordings;
- iii. The replay and evaluation centre should document the observations made from the evaluation of the CVR recording in an evaluation report. An example of an evaluation report is provided in ED-112A, Annex I-A; and



iv. The evaluation report should indicate the quality of each signal required by CS 25.1457(c) according to defined criteria. For example, the following criteria may be used:

GOOD:

1. When considering a vocal signal source (crew voice, radio reception, radio sidetone, interphone, public address, synthetic voice in callouts, warnings and alerts) recorded on a channel other than the CAM channel, the signal is intelligible without using any signal post-processing techniques, and no significant issue (e.g. saturation, noise, interference, or inadequate signal level of a source) affects the quality of this signal;
2. When considering non-vocal alerts recorded on a channel other than the CAM channel, the sounds are accurately identifiable in the recording without using any signal post-processing techniques, and no significant issue affects the quality of the sound recording;
3. When considering the CAM, the recording is representative of the actual ambient sound, conversations and alerts as if an observer was listening in the cockpit, and no significant issue affects the quality of the signal; and
4. No 'medium' or 'major' issue is identified on any channel (see Table 1 below for examples).

FAIR: a significant issue affects the signal source being considered. However, the related signal can still be analysed without signal post-processing, or by using signal post-processing techniques provided by standard audio analysis tools (e.g. audio level adjustment, notch filter, etc.). The severity of the identified issues is not rated higher than 'medium' (see Table 1 below for examples).

POOR: the signal source being considered is not intelligible or not identifiable, and this cannot be corrected even with the use of signal post-processing techniques. The severity of the identified issues is not necessarily rated as 'major', and it may also be rated as 'medium' depending on the consequence for the required signal sources (see Table 1 below for examples); and

vii. the audio quality rating of a CVR channel required by CS 25.1457(c) should be the same as the worst audio quality rating among the signal sources to be recorded on this channel.

e. The performance of the CVR system should not be considered acceptable by the applicant if, for any of the signal sources required by CS 25.1457(c) or by the applicable operating rules, the quality of the audio recording was rated as 'poor'.

f. As part of the compliance demonstration, the applicant should provide a statement with regard to the acceptability of the replay and evaluation centre and the CVR evaluation report performed by the replay and evaluation centre. However, the replay and evaluation centre need not be a separate organisation from the applicant's.

Table 1: Examples of issues affecting a signal source and of the associated severity.

Issue severity rating	Examples of issues
<p>MAJOR - leading to a 'POOR' rating for the affected signal</p>	<ul style="list-style-type: none"> — One or more warning or callout is not recorded — Uncommanded interruption of the CAM signal — Unexplained variation of the CAM dynamic range — Hot-microphone function not operative — CVR time code not available

	<ul style="list-style-type: none"> — CAM saturation (due to low frequency vibration) — Radio side tone is missing — One required signal source is missing from the recording (e.g. one microphone signal not recorded) — Bad intelligibility of one microphone source (e.g. speech through oxygen mask mic) — Quasi-permanent physical saturation of a microphone cell — Quasi-permanent electrical saturation of a CVR channel — Mechanical and/or electrical interference providing useful data suppression — Default of CAM sensitivity — Default in the start/stop sequence
<p>MEDIUM –</p> <p>leading to a ‘POOR’ or ‘FAIR’ rating for the affected signals, depending on the duration and the occurrence rate of the issues.</p>	<ul style="list-style-type: none"> — Imbalance of audio events — Audio pollution generated by either the aircraft or the recorder power supply — Low dynamic range of the recording on a CVR channel — Low recording level of alert and or callout — Oversensitivity of the CAM line* to hyper frequency activity (Wi-Fi, GSM, etc.) — Oversensitivity of the CAM line* to electrostatic discharge (ESD) phenomena — Oversensitivity of the CAM to air flow or conditioning noise (bleed air) — Phasing anomaly between CVR tracks — Side tone recorded with low level — Transitional saturation

*CAM line: microphone+control or preamplifier unit+wiring

3.3. Draft certification specifications for large rotorcraft (CS-29) (Draft EASA decision)

3.3.1. Data link recording

Create a new CS 29.1460 as follows:

CS 29.1460 Data link recorders

(See AMC 29.1460)

(a) Each recorder performing the data link recording function required by the operating rules must be approved and must be installed so that it will record the following messages:

- (1) data link communication messages related to air traffic services (ATS) communications to and from the rotorcraft; and
- (2) ATS messages whereby the flight path of the rotorcraft is authorised, directed or controlled, and which are relayed over a digital data link rather than by voice communication.

(b) Each data link recorder must be installed so that:

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



(ii) It remains powered for as long as possible without jeopardising the emergency operation of the aeroplane; and

(2) There is an aural or visual means for pre-flight checking of the recorder for proper recording of data in the storage medium.

(c) The container of the recorder must be located and mounted so as to minimise the probability of the recorder container rupturing, the recording medium being destroyed, or the recorder locating device failing as a result of a crash impact and the consequent heat damage from a post-impact fire.

(d) The container of the data link recorder must comply with the specifications applicable to the container of the cockpit voice recorder in CS 29.1457(g).

Create a new AMC 29.1460 as follows:

AMC 29.1460

Data link recorders

1. General

In showing compliance with CS 29.1460, the applicant should take into account EUROCAE Document ED-112A, 'Minimum operational performance specification for crash protected airborne recorder systems', dated September 2013, or any later equivalent standard.

The data link recording function may be performed by:

- a. a cockpit voice recorder;
- b. a flight data recorder;
- c. a flight data and cockpit voice combination recorder; or
- d. a dedicated data link recorder.

2. Combination recorders

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 (e.g. the FDR, CVR, data-link recording, etc.) have failed.

3. Recorded data

Data link recorded data should be sufficient to allow investigators, in the framework of an accident or incident investigation, to accurately reconstruct the sequence of data link communications between the aircraft and air traffic service units, other aircraft and other entities. For this purpose, the data link recording should comply with:

- a. EUROCAE Document ED-93, 'Minimum aviation system performance specification for CNS/ATM message recording systems', Section 2.3.1, Choice of recording points, and Section 2.3.2, Choice of data to be recorded on board the aircraft; and
- b. EUROCAE Document ED-112A (dated September 2013), Part IV, Chapter IV-2, Section IV-2.1.6, Data to be recorded.

3.3.2. The serviceability of flight recorders

Amend AMC 29.1457 as follows:



AMC 29.1457**Cockpit Voice Recorders**

(...)

6. Instructions for continued airworthiness (ICA)

The ICA for the cockpit voice recorder, required by CS 29.1529 and Appendix A, should include the following items:

- a. Inspections of in-flight recording, to detect problems with the audio quality of the recording;
- b. Other functional checks needed to ensure that the quality of the recordings is acceptable, when appropriate;
- c. Operational checks of the recorder; and
- d. Tasks to ensure the serviceability of equipment dedicated to the recorder, which typically includes:
 - i. dedicated sensors (e.g. the cockpit area microphone(s));
 - ii. a dedicated power source (e.g. a recorder independent power supply);
 - iii. means to detect a crash impact (e.g. for the purpose of stopping the recording, or for the purpose of deploying the recorder if it is deployable); and
 - iv. means to facilitate the localisation of the recorder after an accident (e.g. an underwater locating device or an emergency locator transmitter attached to the recorder).

Amend AMC 29.1459 as follows:

AMC 29.1459**Flight Data Recorders**

(...)

4. Instructions for continued airworthiness (ICA)

The ICA for the flight data recorder, required by CS 29.1529 and Appendix A, should include the following items:

- a. Inspections of in-flight recording, to detect problems with the quality of the recording of flight parameters;
- b. Other functional checks needed to ensure that the quality of the recordings is acceptable, when appropriate;
- c. Operational checks of the recorder;
- d. Calibration checks of flight parameters from sensors dedicated to the flight data recorder; and
- e. Tasks to ensure the serviceability of the equipment dedicated to the recorder, which typically include:
 - i. dedicated sensors (e.g. dedicated accelerometers),
 - ii. means to detect a crash impact (e.g. for the purpose of stopping the recording, or for the purpose of deploying the recorder if it is deployable), and
 - iii. means to facilitate finding the recorder after an accident (e.g. an underwater locating device or an emergency locator transmitter attached to the recorder).



f. FDR decoding documentation

i. Definitions

FDR decoding documentation: a document that presents the information necessary to retrieve the raw binary data of an FDR data file and convert it into engineering units and textual interpretations.

Fixed frame recording format: a recording format organised in frames and subframes of a fixed length and that are recorded chronologically. ARINC specifications 573 and 717 provide an example of a fixed frame recording format.

Variable frame recording format: a recording format based on recording frames which are individually identified and time stamped, so that their order in the recording file is not important. ARINC specification 767 provides an example of variable frame recording format.

ii. Content of the FDR decoding documentation

The FDR decoding documentation should at least contain information on:

- The aircraft make and model;
- The document modification date and time;
- In the case of a fixed-frame recording format:
 - the sync pattern sequence;
 - the number of bits per word, of words per subframe and of subframes per frame; and
 - the time duration of a subframe;
- In the case of a variable frame recording format, the list of frames, and for each frame:
 - its identification;
 - information on whether the frame is scheduled or event-triggered;
 - the recording rate (for a scheduled frame);
 - the frame event condition (for an event-triggered frame); and
 - the list of flight parameters, by order of recording;
- For every FDR parameter:
 - the identification: name (and mnemonic code or other identification if applicable);
 - the sign convention and the units of converted value (if applicable);
 - the location of each parameter component in the data frame;
 - Instructions and equations to assemble the parameter components and convert the raw binary values into engineering units (if applicable); and
 - the conversion to text or the discrete decipher logic (if applicable).

iii. Format of the FDR decoding documentation

The FDR decoding documentation should be provided in an electronic format such that:

- it contains all the information described in paragraph f.ii above;
- it is readily displayable (i.e. it can be presented in an output device, like a printer or display screen, using any readily available ASCII text editor); and
- it allows editing.

iv. Electronic documentation format



The FDR decoding documentation should comply with the standard of ARINC Specification 647A. ARINC Specification 647A provides an electronic documentation format that meets the needs of aircraft operators and of safety investigation authorities.

The following text is added to the newly created AMC 25.1460 (see above under ‘Specifications for data link recording’) as follows:

AMC 29.1460

Data Link Recorders

(...)

5. Instructions for continued airworthiness (ICA)

The ICA for the data link recorder, required by CS 25.1529 and Appendix H, should include the following items:

- a. Inspections of in-flight recording, to detect problems with the recording of data link messages;
- b. Other functional checks needed to ensure that the quality of the recordings is acceptable, when appropriate;
- c. Operational checks of the recorder;
- d. Tasks to ensure the serviceability of equipment dedicated to the recorder, which typically include:
 - i. means to detect a crash impact (e.g. for the purpose of stopping the recording, or for the purpose of deploying the recorder if it is deployable), and
 - ii. means to facilitate the localisation of the recorder after an accident (e.g. an underwater locating device or an emergency locator transmitter attached to the recorder); and
- e. Documentation to perform the following:
 - i. convert the recorded data back to the original format of the data link communication messages,
 - ii. retrieve the time and the priority of each recorded message, and
 - iii. correlate the recorded messages with the FDR and CVR recordings.

3.3.3. The quality of recording of cockpit voice recorders

Amend CS 29.1457 as follows:

CS 29.1457 Cockpit voice recorders

(See AMC 29.1457)

(...)

(c) Each cockpit voice recorder must be installed so that the part of the communication or audio signals specified in sub-paragraph (a) of this paragraph obtained from ~~each of~~ the following sources is recorded on ~~a~~ **at least four** separate channels:

- (1) ~~For the first channel, f~~ From each microphone, headset, or speaker used at the first pilot station.



- (2) ~~For the second channel, f~~From each microphone, headset, or speaker used at the second pilot station.
- (3) ~~For the third channel, f~~From the cockpit-mounted area microphone, or the continually energised or voice-actuated lip microphones at the first and second pilot stations.
- (4) ~~For the fourth channel, f~~From:
- (i) Each microphone, headset, or speaker used at the stations for the third and fourth crew members; or
 - (ii) If the stations specified in sub-paragraph (c)(4)(i) are not required or if the signal at such a station is picked up by another channel, each microphone on the flight deck that is used with the passenger loudspeaker system if its signals are not picked up by another channel.
 - (iii) Each microphone on the flight deck that is used with the rotorcraft's loudspeaker system if its signals are not picked up by another channel.

No channel shall record communication or audio signals from more than one of the following sources: the first pilot station, second pilot station, cockpit-mounted area microphone, and additional crew member stations.

(...)

Amend AMC 29.1457 as follows:

AMC 29.1457

Cockpit Voice Recorders

(...)

7. Evaluation of the CVR recording

The following acceptable means of compliance with CS 29.1457(b) is provided to demonstrate that the performance of the CVR system is acceptable and that the quality of the CVR recording is acceptable.

a. The CVR system should be installed in accordance with the recommendations made in EUROCAE Document ED-112A, in particular:

- Chapter 2-5 Equipment installation and installed performance, and
- Part I Cockpit Voice Recorder System, Chapter I-6.1.1 Interface design, I-6.1.2 Recorder Operation and I-6.1.3 Bulk Erasure Interlocks.

Particular attention should be given to the location of the cockpit area microphone (CAM). ED-112A, Chapter I-6.2. Equipment location, provides guidance on this topic.

It should be noted that the CVR system may record on more than four channels, and that this may help in avoiding superimposition between signal sources recorded on the same CVR channel.

b. To ensure that the CVR system is properly installed, and to verify that the audio signals recorded from all audio channels achieve the acceptable level of quality, the applicant should conduct a flight test. The recording obtained should be evaluated to confirm an acceptable level of quality during all normal phases of flight (including taxi-out, hover, take-off, climb, cruise, descent, approach, landing, taxi-in) and autorotation. ED-112A provides guidance for testing a new CVR installation (refer to Chapter I-6.3).

c. The evaluation of the CVR recording should include:



- i. the tasks described in ED-112A, Annex I-A, Chapter I-A.3;
- ii. checking that the vocal signal sources are intelligible and that non-vocal alerts on headsets or speakers can be identified;
- iii. checking that the levels of sidetone signals (e.g. radio) and public address are adjusted so that these signals are audible and do not mask the signals from the flight crew microphones (refer to ED-112A, Part I, Chapter I-6.1.1);
- iv. checking that the CVR begins to operate no later than the start of the pre-flight checklist and continues to operate until the completion of the final post-flight checklist; and
- v. checking for the presence of any fault in the memory of the built-in-test feature of the CVR, if applicable.

d. It is recommended that the evaluation of the CVR recording should be performed by a replay and evaluation centre. An acceptable replay and evaluation centre should fulfil all of the conditions below:

- i. The equipment used for the CVR recording replay should meet the specifications of Chapter I-A.2 of Annex I-A of ED-112A or a higher standard;
- ii. The replay and evaluation of CVR recordings should be performed by personnel with adequate knowledge of CVR systems and aircraft operations, and who have appropriate experience of the techniques used to evaluate recordings;
- iii. The replay and evaluation centre should document the observations made from the evaluation of the CVR recording in an evaluation report. An example of an evaluation report is provided in ED-112A, Annex I-A; and
- iv. The evaluation report should indicate the quality of each signal required by CS 29.1457(c) according to defined criteria. For example, the following criteria may be used:

GOOD:

1. When considering a vocal signal source (crew voice, radio reception, radio sidetone, interphone, public address, synthetic voice in callouts, warnings and alerts) recorded on a channel other than the CAM channel, the signal is intelligible without using any signal post-processing techniques, and no significant issue (e.g. saturation, noise, interference, or inadequate signal level of a source) affects the quality of this signal;
2. When considering non-vocal alerts recorded on a channel other than the CAM channel, the sounds are accurately identifiable in the recording without using any signal post-processing techniques, and no significant issue affects the quality of the sound recording;
3. When considering the CAM, the recording is representative of the actual ambient sound, conversations and alerts as if an observer was listening in the cockpit, and no significant issue affects the quality of the signal; and
4. No 'medium' or 'major' issue is identified on any channel (see Table 1 below for examples).

FAIR: a significant issue affects the signal source being considered. However, the related signal can still be analysed without signal post-processing, or by using signal post-processing techniques provided by standard audio analysis tools (e.g. audio level adjustment, notch filter, etc.). The severity of the identified issues is not rated higher than 'medium' (see Table 1 below for examples).



POOR: the signal source being considered is not intelligible or not identifiable, and this cannot be corrected even with the use of signal post-processing techniques. The severity of the identified issues is not necessarily rated as ‘major’, and it may also be rated as ‘medium’ depending on the consequence for the required signal sources (see Table 1 below for examples); and

vii. the audio quality rating of a CVR channel required by CS 29.1457(c) should be the same as the worst audio quality rating among the signal sources to be recorded on this channel.

e. The performance of the CVR system should not be considered acceptable by the applicant, for any of the signal sources required by CS 29.1457(c) or by the applicable operating rules, if the audio quality of the recording was rated as ‘poor’.

f. As part of the compliance demonstration, the applicant should provide a statement with regard to the acceptability of the replay and evaluation centre and the CVR evaluation report performed by the replay and evaluation centre. However, the replay and evaluation centre need not be a separate organisation from the applicant’s.

Table 1: Examples of issues affecting a signal source and of the associated severity.

Issue severity rating	Examples of issues
<p>MAJOR – leading to a ‘POOR’ rating for the affected signal</p>	<ul style="list-style-type: none"> – One or more warnings or callouts are not recorded – Uncommanded interruption of the CAM signal – Unexplained variation of the CAM dynamic range – Hot-microphone function not operative – CVR time code not available – CAM saturation (due to low-frequency vibration) – Radio side tone is missing – One required signal source is missing from the recording (e.g. one microphone signal not recorded) – Bad intelligibility of one microphone source (e.g. speech through oxygen mask microphone) – Quasi-permanent physical saturation of a microphone cell – Quasi-permanent electrical saturation of a CVR channel – Mechanical and/or electrical interference providing useful data suppression – Default of CAM sensitivity – Default in the start/stop sequence
<p>MEDIUM – leading to a ‘POOR’ or ‘FAIR’ rating for the affected signals, depending on the duration and the occurrence rate of the issues.</p>	<ul style="list-style-type: none"> – Imbalance of audio events – Audio pollution generated by either the aircraft or the recorder power supply – Low dynamic range of the recording on a CVR channel – Low recording level of alert and or callout – Over sensitivity of the CAM line* to hyper frequency activity (Wi-Fi, GSM, etc.) – Oversensitivity of the CAM line* to electrostatic discharge (ESD) phenomena – Oversensitivity of the CAM to air flow or conditioning noise (bleed air) – Phasing anomaly between CVR tracks – Side tone recorded with low level

	— Transitional saturation
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*CAM line: microphone+control or preamplifier unit+wiring



4. Impact assessment (IA)

4.1. What is the issue

4.1.1. General

In the frame of RMT.0249, NPA 2018-03 addressed a number of issues related to the installation of recorders. As described in the Terms of Reference for RMT.0249, this second NPA follows up on NPA 2018-03 and it will address the following remaining issues.

4.1.2. FDR power supply

During some accidents involving large aeroplanes (CS-25 category), the FDR stopped recording before the end of the flight due to the loss of normal electrical power. This led to the data not being recorded during the time when the electrical power was lost.

CS 25.1459(a)(3) requires that the FDR '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'.

Hence, a loss of power supply to the FDR could typically appear if electrical power from all engines is lost, or if the normal electrical power bus is not available. This may happen under certain circumstances, for instance:

- a) if all engines are lost in flight (e.g. due to fuel starvation/exhaustion, engines damaged by volcanic ash or bird ingestion) and no other backup source is used to provide electrical power (e.g. an auxiliary power unit (APU) or a ram air turbine (RAT));
- b) if all engines are lost, or intentionally shut down, shortly before landing and no other backup source is used (or usable) to provide electrical power (e.g. an APU or a RAT); or
- c) in case of a failure, or an intentional shutdown, of the normal electrical power bus.

In such scenarios, some flight parameters may still be available for recording, such as:

- a) flight parameters produced by systems which are considered as 'essential loads' and are designed to work with an alternate source of power. Typically, the flight parameters from systems supported by the aircraft emergency battery could theoretically be recovered; and
- b) flight parameters from sensors dedicated to the FDR system, if any (typically acceleration parameters).

4.1.3. Data link recording

Part-CAT to Commission Regulation (EU) No 965/2012 on air operations contains requirements on the recording of data link messages on a flight recorder for aircraft manufactured since April 2014 and under certain conditions: refer to points CAT.IDE.A.195 (aeroplanes) and CAT.IDE.H.195 (helicopters). The requirements apply to aircraft first issued with individual certificates of airworthiness (CofAs) on or after 8 April 2014 that have the capability to operate data link communications and are required to be equipped with a CVR.

In addition, the specifications for data link recorders are defined in ETSO-C177/C177a.



However, the existing provisions on the installation of a data link recorder, or of a data link recording function, are very limited in current regulations and guidance.

There are no corresponding certification specifications for the installation of a data link recording function in CS-25 (large aeroplanes) or CS-29 (large rotorcraft).

Applications for new type certificates or for supplemental type certificates are submitted to EASA for aircraft models which are required to record data link messages.

In order to support these applications, EASA developed a generic certification review item (CRI) on the subject 'flight recorders and data link recording'. This CRI contains a special condition (SC) and interpretative material (IM).

4.1.4. The serviceability of flight recorders

4.1.4.1 Maintenance instructions

Safety investigation authorities have reported several cases in which the FDR or the CVR has not correctly recorded data due to a malfunction of the unit or of the dedicated equipment (including sensors and transducers). Such failures may remain hidden for a certain amount of time, as the serviceability of flight recorders encompasses the quality of the recorded data, which to this date cannot be automatically assessed.

Part-CAT of Regulation (EU) No 965/2012 on air operations requires (CAT.GEN.MPA.195(b)) that aircraft operators conduct operational checks and evaluations of recordings of flight recorders in order to ensure their 'continued serviceability'. Consistent with ICAO Annex 6, Part I, Appendix 8, and Part III, Appendix 4, AMC1 CAT.GEN.MPA.195(b) recommends that the following should be performed:

- inspections of the FDR recordings and the CVR recordings every year;
- inspections of the data link recordings every five years;
- using aural or visual means for preflight checking of the flight recorders for proper operation every day; and
- checks every five years, or in accordance with the recommendations of the sensor manufacturer, that the parameters dedicated to the FDR and not monitored by other means are being recorded within the calibration tolerances and that there is no discrepancy in the engineering conversion routines for these parameters.

These scheduled tasks are essential to ensure that, in the event of an accident or a serious incident, the flight recorders provide complete and accurate data.

The certification specifications and guidance material for the Master Minimum Equipment List (CS-MMEL) also contain items addressing inoperative flight recorders. If a flight recorder is identified as unserviceable on board an aircraft where it is required to be carried, then the MMEL would typically require the operator to rapidly replace the recorder in order to avoid operational restrictions.

In order to ensure the serviceability of the flight recorder while avoiding superfluous maintenance tasks and not unnecessarily restricting aircraft operations, it is essential to define maintenance instructions taking into account the specific installation of the flight recorder system. However, the



aircraft operator often does not have in-depth knowledge of the system components and their installations, and therefore cannot define an optimal maintenance programme alone. Only the flight recorder system installer ((supplemental) type certificate holders) has access to the necessary information.

For example, the periodicity of the tasks provisioned in AMC1 CAT.GEN.MPA.195(b) should be assessed by the flight recorder system installer. Other tasks that are not covered by AMC1 CAT.GEN.MPA.195(b), such as the tasks related to checking the underwater locating devices, should also be addressed.

In practice, the content and the level of details of maintenance instructions for a flight recorder system vary from one installation to another, resulting in inconsistent maintenance practices among aircraft operators.

4.1.4.2 Conversion of FDR raw data into flight parameters expressed in engineering units

Safety investigation authorities also found various cases where the information necessary to convert the FDR raw data into parameters expressed in engineering units, as provided by the flight recorder system installer, was incomplete or inaccurate. As a result, the analysis of the FDR data was delayed from a few weeks up to several months.

The following safety recommendations were received by EASA following the investigation of a serious incident to the Cessna 680 Citation Sovereign, registered G-CJCC, on 30 September 2010:

UNKG-2011-027: 'It is recommended that the European Aviation Safety Agency review their certification requirements, guidance and procedures to ensure that controlled documentation, sufficient to satisfy operator flight data recorder documentation requirements, are explicitly part of the type certification and supplemental type certification processes where flight data recorder installations are involved.'

UNKG-2011-029: 'It is recommended that the European Aviation Safety Agency provides guidance detailing the standards for the flight data recorder documentation required for the certification of systems or system changes associated with flight data recorders.'

In such cases, an aircraft operator cannot adequately comply with the rule of Part-CAT of Regulation (EU) No 965/2012, point CAT.GEN.MPA.195(d), which requires operators to 'keep and maintain up-to-date documentation that presents the necessary information to convert FDR raw data into parameters expressed in engineering units'.

Both issues a) and b) were highlighted by EASA in Safety Information Bulletin (SIB) 2009-28 (revision 1 dated 8 January 2015), and recommendations were provided in this document. However, EASA SIBs are for information only, and they are not as visible as the guidance material in the certification specifications.

4.1.5. The quality of recording of cockpit voice recorders

4.1.5.1 General

Safety investigation authorities found that some CVR system installations do not provide the quality expected for the cockpit area microphone (CAM) and other audio channels. The issues identified include:



- a) poor quality of the recording on the CAM channel;
- b) saturation of the recording on the CAM channel by very low frequency vibrations;
- c) excessive electrical background noise on a channel;
- d) signals from the channels of flight crew members cancelling each other out;
- d) clipping of the signals on the channels of flight crew members when coming from the oxygen mask microphones;
- d) superimposition of microphone signals by radio reception signals;
- g) inversion of the sign of the signal coming from the CAM channel, resulting in significant attenuation; and
- h) incorrect allocation of recording capacity to a channel.

These issues may, for example, be attributed to:

- a) the installation of the CVR system or a change to a component of the CVR system;
- b) a change to a component of the audio system (e.g. a new model of headsets);
- c) another aircraft modification affecting the acquisition and/or recording of audio (aircraft engine, air-conditioning, Wi-Fi, etc.); or
- d) the use of portable electronic devices (PEDs) in the cockpit.

These issues seem to be recurrent due to the lack of a framework for demonstrating the audio quality of a CVR system installation. Indeed, the factors listed here above cannot be addressed at the equipment level. Therefore, a revision of ETSO-C123c is not appropriate for solving these issues.

4.1.5.2 EASA Certification Memoranda

EASA initially reacted with the publication of Certification Memorandum CM-AS-001 'Quality of recording of cockpit voice recorders', issued in June 2012, which refers to these issues and provides guidance on how compliance with the CVR recording quality requirements (in the certification specifications) can be demonstrated.

Also, Certification Memorandum CM-ES-003 on 'Guidance to Certify an Aircraft as PED tolerant' includes the CVR in that:

'The applicant should demonstrate that the use of PEDs does not adversely affect the correct operation of equipment and systems that have failure modes that are classified as Major, Hazardous or Catastrophic, as well as the Cockpit Voice Recorder (CVR) and Flight Data Recorder (FDR).'

4.1.5.3 Overview of existing EASA regulations and guidance material

Part-CAT to Commission Regulation (EU) No 965/2012 on air operations, point CAT.GEN.MPA.195(b), states that the aircraft 'operator shall conduct operational checks and evaluations of flight data recorder (FDR) recordings, cockpit voice recorder (CVR) recordings and data link recordings to ensure the continued serviceability of the recorders'. This is essential to ensure that in the event of an accident or a serious incident, the flight recorders provide complete and accurate data.

AMC1 CAT.GEN.MPA.195(b) contains acceptable means of compliance for this requirement, which include an inspection of the recording for quality.



GM1 CAT.GEN.MPA.195(b) provides guidance on the flight recording inspection of the CVR:

‘(b) When performing the CVR recording inspection, (...). The inspection of the CVR recording usually consists of:

- (1) checking that the CVR operates correctly for the nominal duration of the recording;
- (2) examining, where practicable, a sample of in-flight recording of the CVR for evidence that the signal is acceptable on each channel; and
- (3) preparing and retaining an inspection report.’

Note: ICAO Annex 6 Part I (Appendix 8, Section 7) and Part III (Appendix 4, Section 6) also have provisions prescribing that the aircraft operator should perform a number of inspections of the flight recorder systems, including an inspection of the recordings at regular time intervals to check the quality of the recorded audio.

For the certification of the CVR systems of large aeroplanes, CS 25.1457(a) requires aeroplanes equipped with CVRs to record voice communications of flight crew members and audio signals on the flight deck. This paragraph does not contain a specific provision dealing with how to ensure sufficient audio quality when requesting approval of the installation of a CVR system. However, as they are applicable in general terms to all aeroplane systems, CS 25.1301 and 25.1309 require the CVR to perform as expected.

CS 25.1457(b) addresses the need to select the appropriate location for the cockpit area microphone (CAM) and to install pre-amplifiers and filters, when needed, in order to contribute to the intelligibility of the recorded communications at the first and second pilot stations and the voice communications of other crew members on the flight deck when directed to those stations. It also states that ‘Repeated aural or visual playback of the record may be used in evaluating intelligibility’.

AMC 25.1457 - Cockpit Voice Recorders, refers to EUROCAE Document ED-112A ‘Minimum operational performance specification for crash protected airborne recorder systems’, as referred to in ETSO-C123c as guidance in showing compliance with CS 25.1457.

For large rotorcraft, CS 29.1457(a) and (b) provide similar provisions.

It should also be noted that the current wording of CS 25.1457(c) and CS 29.1457(c) is prescriptive with regard to the number of CVR channels and the allocation of signal sources by channels. In particular, it prescribes four CVR channels only, with each channel mixing several signal sources. It is believed that this text is inherited from a time when technology did not permit a large number of CVR channels to be created. On the other hand, with the introduction of digital microphones, voice over Internet protocol (VOIP) etc., it would be easier to allocate a CVR channel per signal source.

ETSO-C123c (Cockpit voice recorder systems) refers to EUROCAE Document ED-112A (dated 2013). However, ETSO-C123c sets the minimum performance standard as follows:

‘Standards set forth in EUROCAE document ED-112A, MOPS for Crash Protected Airborne Recorder Systems, dated September 2013, that pertain to the CVR type, except Chapters I-1 and I-6, and Sections 2-1.1 , 2-1.5 , 2-1.6 , 2-1.11 , 2-1.12 , 2-3.1 , 2-5 , 3-1.1, 3-1.2, 3-1.3, 3-1.4, 3-1.5 , 3-1.7, Annex I-A, Annex I-C, and other ED-112A requirements related to installation, flight testing, aircraft maintenance’

The reason is that an ETSO addresses the performance of the stand-alone equipment, not the performance of the installed equipment.



4.1.5.4 EUROCAE Documents ED-112 and 112A

Section I-6.3 (Flight test procedures) of ED-112 and ED-112A provides ‘guidance for flight testing prototype installations in both aeroplanes and helicopters’.

Sub-section I-6.3.1 states that ‘Each newly installed CVR shall be flight tested and the recording, so obtained, to be evaluated to show adequate recording quality during all normal regimes of flight’. Section I-6.3 also provides guidance on how to perform the flight test procedures, and what to check in each phase of flight.

Annex I-A provides guidance on the post-flight evaluation of CVR recordings. I-A.1.1 states that ‘Following the flight testing of each new CVR installation, the recording so obtained shall be evaluated to confirm adequate quality.’ Annex I-A covers the personnel, the replay equipment, methods to check the proper level of recording (adequate signal to noise ratio, signal levels balanced between channels, etc.), however, not going into much detail. Annex I-A includes an example of a test report.

4.1.5.5 Documents published by BEA France

BEA document titled ‘Study on Detection of Audio Anomalies on CVR recordings’ (published in September 2015) lists a number of audio anomalies which were identified during the evaluation of the quality of CVR channel audio recordings on behalf of French aircraft manufacturers since the 1990s.

BEA document titled ‘Guidance on CVR recording inspection’ (published in October 2018) provides a more detailed description of typical audio anomalies found in the CVR recording and it offers methods to recognise them.

4.1.5.6 Analysis

a) Demonstrating the performance of the CVR

Both EASA CM-AS-001 and FAA AC 20-186 refer to ED-112 (or ED-112A) for demonstrating the installed performance of the CVR and both specifically refer to Chapters 2-5 and I-6 of ED-112 (or ED-112A), which address equipment installation and installed performance.

b) Validating the audio quality

ED-112A paragraph I-3.2.4 specifies that ‘The quality of the recording shall be established and shall not be less than that corresponding to quality values for Speech Transmission Index as stated in Table I-3.1’. ED-112A paragraph I-5.2.4 and Annex I-D describe a method and the formulas to measure the speech transmission index (STI). However the STI is used to check the performance of the CVR ‘in the laboratory’ (prior to installation on the aircraft).

Note:

ED-112A defines the STI as ‘a method of quantifying the intelligibility of speech with respect to the transmission media’. The objective is (refer to Annex I-D) ‘to ensure that a minimum standard of speech intelligibility is achieved by recording systems’.

In addition, ED-112A Chapter I-6, Section I-6.3 specifies that ‘Each newly installed CVR shall be flight tested and the recording, so obtained, to be evaluated to show adequate recording quality during all normal regimes of flight’. Section I-6.3 also provides guidance on how to perform flight test procedures.



ED-112A Annex I-A states that 'Following the flight testing of each new CVR installation, the recording so obtained shall be evaluated to confirm adequate quality.' (refer to I-A.1.1). Annex I-A also provides guidance for the post-flight evaluation of recordings, and, among other items, it specifies the conditions to meet when replaying the CVR recording.

CM-AS-001 refers to Chapter I-6 and Annex I-A of ED-112 (the version from 2003) and it enumerates in its Appendix the material conditions which such a replay centre should meet (the equipment standard, equipment location, access to and protection of recordings, etc.). It also indicates that a 'replay and evaluation report on the CVR replay should be part of the compliance demonstration by the applicant.'

4.1.6. Safety risk assessment

4.1.6.1 General

The four issues discussed in this NPA are related to the availability of data from flight recorders.

Flight recorders are not critical for safe flight and landing, 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.

4.1.6.2 The particular case of the FDR power supply

The following safety recommendations have been addressed to EASA, which recommend requiring an alternate power source for the FDR, in order to prevent an interruption of the FDR recording in case of loss of the normal power source:

- a) After the accident of an A320, registered EY-623 and operated by East Air on 2/2/2014, the Interstate Aviation Committee (Russia) addressed the following safety recommendation to EASA, the FAA and other certification authorities (unofficial translation):

RUSF-2015-001: 'To prevent the loss of recording flight data in case of power supply interruptions from the main bus due to power plant failure or shutdown or other in-flight failure, to consider the usage of uninterruptible power supply systems or units on board that could provide the continuous availability of flight data recorders, flight information acquisition and communication systems with a defined time interval after the failure of power supply from the main bus.'

- b) After the accident of an A320, registered EI-EIB and operated by Alitalia on 29/9/2013, the ANSV (Italy) issued the following safety recommendation (unofficial translation):

ITAL-2016-003: 'ANSV recommends the introduction of a requisite regarding on board recorders such as to guarantee their functioning also in the case of a power failure and, specifically to the A320 family, in case the speed is insufficient for the RAT functioning.'

In both cases, the FDR was not powered during the very last stage of the landing phase.

This issue was analysed by EASA based on an assessment made by the European Flight Recorders Partnership Group (EFRPG), and it was subsequently presented and discussed (in October 2017) within the ICAO Flight Recorder Specific Working Group (FLIRECSWG).

Since 1996, at least the following 9 occurrences have been identified (involving large aeroplanes) where the FDR stopped recording due to the loss of normal electrical power:



Table 1: Occurrences where the FDR stopped recording after loss of normal electrical power

Make and type of aeroplane	Registration and operator	Date of the occurrence	Investigation authority and State
McDonnell Douglas DC-9	N904VJ, ValuJet	11/5/1996	NTSB, USA
Boeing B737	9V-TRF, SilkAir	19/12/1997	NTSC, Indonesia
Airbus A310	D-AHLB, Hapag-Lloyd	12/7/2000	BMVIT, Austria
Boeing B767	SU-GAP, Egyptair	31/10/1999	NTSB, USA
Airbus A330	C-GITS, Air Transat	24/8/2001	GPIAA, Portugal
Bombardier CL-600	N8396A, Pinnacle Airlines	14/10/2004	NTSB, USA
Airbus A320	N409UA, United Airlines	4/4/2011	NTSB, USA
Airbus A320	EY-623, East Air	2/2/2014	MAK, Russia
Airbus A320	EI-EIB, Alitalia	29/9/2013	ANSV, Italy

It can be noted that, except the Bombardier CL-600, all these aeroplanes have maximum certificated take-off masses (MCTOMs) greater than 27 000 kg.

It appears that during these occurrences, the loss of FDR data recording occurred for short time periods (ranging from less than 1 minute to 19 minutes in the serious incident that occurred to the Airbus A330 registered as C-GITS).

Overall, the absence of FDR data for a certain period of time has not prevented the identification of the root causes of these occurrences. Therefore, the impact on safety, i.e. in terms of the lessons learned to avoid a re-occurrence of a similar accident or incident, can be considered low.

In addition, it should be noted that EASA Opinion 02/2019 contains a proposal to require that the CVRs installed on newly manufactured aeroplanes with MCTOMs of over 27 000 kg should be equipped with alternate power sources. This proposal corresponds to a standard in ICAO Annex 6 Part I, which has already been transposed into the U.S air operation regulations. Hence, in the future, accidents and incidents investigations will benefit from the availability of the CVR recording after the loss of the normal electrical power source.

4.1.7. Who is affected

The stakeholders affected by these issues 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; and

- EASA and National aviation authorities (NAAs) of the Member States.

4.1.8. 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.

4.2. What we want to achieve — objectives

The goal of this RMT is to improve the availability of data from flight recorders to better support the investigation of accidents and incidents, and in doing that, to further enhance the level of safety for large aeroplanes and large rotorcraft.

4.3. How it could be achieved — options

4.3.1. FDR power supply

Requiring alternate power sources (APSS) for FDR recording equipment for large aeroplanes could be envisaged, in the same way as for CVRs (see NPA 2018-03). An alternate power source is a power source to which the recorder is 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.

Applicability of the FDR-APS:

Most aeroplanes involved in the occurrences had MCTOMs of over 27 000 kg. Furthermore, the lighter the aeroplane is, the heavier is the impact of an FDR-APS in terms of weight. For these reasons, an APS for the FDR recording system would be mostly justified for aeroplanes with MCTOMs of over 27 000 kg, in particular, if retrospective installations are envisaged.

In order to be able to record data, the APS would have to power various elements in addition to the FDR itself. For instance, among these are flight data acquisition units, which typically have power consumptions higher than those of FDRs, and which vary between 50 W and 120 W. Other elements may need to be powered as well, such as dedicated FDR sensors, analogue/digital converters, data busses, or network switches.

Hence, powering all the components of the FDR recording system would, on current designs, consume more power than current recorder independent power supply (RIPS) designs are capable of delivering (up to 100 W, according to ARINC777) and this would expend a non-negligible proportion of the power delivered by the emergency batteries of the aeroplane (if this solution was retained).

The current situation regarding FDR parameters is as follows:

No FDR parameters are required to be provided by dedicated sensors, and the FDR parameter sources can be very diverse. An FDR parameter source may have a significant power consumption, and an FDR parameter may have to travel on a data bus or a network with significant power consumption before being acquired for recording. In addition, FDR parameters may come from many computers (in a federated architecture), or only a few (in a modular integrated architecture). Data acquisition is dependent on the airborne system architecture and varies from one aeroplane model to another.

Minimum duration of engagement of the FDR-APS:



Similar to the alternate power source of a CVR, the FDR-APS should remain engaged for at least 10 minutes.

Table 2: Selected policy options for ‘FDR power supply’

Option No	Short title	Description
0	No action	No policy change (no change to the rules; risks remain as outlined in the issue analysis)
1	Amend CS-25	Require in CS-25 an alternate power source (APS) for FDR recording systems

4.3.2. Data link recording

A dedicated data link recorder (DLR) is not required by ICAO Standards, EU air operations rules or FAA air operations rules. However, the equipment performing the data link recording function is expected to be a crash-protected flight recorder that complies with EUROCAE ED-112 or ED-112A.

FAA rules FAR 25.1457 and FAR 29.1457 require data link communication messages to be recorded by the CVR under some conditions.

As a principle, the data link recording function is expected to capture the part of communications between the flight crew and the ground which cannot be captured by the CVR, and the handling of data link messages from air navigation service providers (ANSP) by the flight crew. Therefore, the content and the duration of the data link recording should be consistent with the content and duration required for the CVR, which is addressed in the air operations rules. Furthermore, the installation specifications applicable to data link recording should be consistent with the installation specifications applicable to a crash-protected flight recorder (CVR or FDR).

After reviewing the installation specifications provided in CS 25/CS 29.1457 and CS 25/CS 29.1459 and in the EASA generic CRI on data link recording, in conjunction with the air operations requirements and specifications applicable to data link recording in EUROCAE ED-112A and ED-93, EASA should consider creating a new CS 25/CS 29.1460 and the corresponding AMC 25/AMC 29.1460 on data link recorders. The detailed rationale is provided in Chapter 3.

Table 3: Selected policy options for ‘Data link recording’

Option No	Short title	Description
0	No action	No policy change (no change to the rules; risks remain as outlined in the issue analysis)
1	Amend CS-25 and CS-29	Create in CS-25 and CS-29 specifications and acceptable means of compliance for the installation of a data link recording function

4.3.3. The serviceability of flight recorders

4.3.3.1 Maintenance instructions

The current CSs (for aeroplanes and rotorcraft) do not contain specifications and AMC dedicated to maintenance instructions related to the FDR system, the CVR system or the system performing data link recording.

CS 25.1529 and CS 29.1529 specify that instructions for continued airworthiness (ICA) must be prepared. While this provision should be understood as being applicable to any system required to be installed on the aircraft, there is no specific statement in the CS or the AMC and GM that this is also applicable to flight recorders.

By comparison, the following FAA advisory circulars related to CVR and FDR systems contain very explicit statements that the flight recorder system installer must provide ICA, and that these instructions must be provided to the operator:

- FAA AC 20-186 'Airworthiness and Operational Approval of Cockpit Voice Recorder Systems', dated 22 July 2016,
- FAA AC 20-141B 'Airworthiness and Operational Approval of Digital Flight Data Recorder Systems', dated 17 August 2010.

The creation of new acceptable means of compliance (AMC) in CS-25 and CS-29 is therefore considered in order to clarify what is expected to be assessed by the applicant and what should be provided in the ICA. This new AMC material should address flight data recorders, cockpit voice recorders, and data link recorders; it should be part of AMC 2X.1457, AMC 2X.1459, and AMC 2X.1460.

4.3.3.2 Conversion of FDR raw data into flight parameters expressed in engineering units

The CSs do not contain specifications and AMC dealing with FDR documentation presenting the necessary information to convert FDR raw data into parameters expressed in engineering units (hereafter called 'FDR decoding documentation').

The scope of ETSO C124c on Flight Data Recorder Systems does not include requirements related to this documentation, because the acquired flight parameters depend on the aircraft on which the FDR is installed and on other choices regarding the FDR system installation. Hence, the FDR decoding documentation is the responsibility of the FDR system installer, not of the FDR manufacturer.

Also, the existing rules and AMC and GM related to instructions for continued airworthiness (ICA) (in Part-21 and its AMC and GM, and in the CSs) do not mention that FDR documentation should be considered as an ICA item.

The objective is that FDR decoding documentation should be prepared for every new FDR system installation and updated for every change to an FDR system installation, and that this documentation should be made available to aircraft operators so that they can fulfil their responsibilities with regard to FDR decoding documentation and FDR serviceability. Guidance should also be provided on the content and format of the FDR decoding documentation.

It is proposed to follow an approach similar to that of FAA Advisory Circular 20-141B 'Airworthiness and Operational Approval of Digital Flight Data Recorder Systems'. It states in paragraph 2-14 that:



'The installer or applicant must provide ICAs as part of the substantiating data. Under the requirements of 14 CFR parts 23, 25, 27, or § 29.1529, and guidance found in FAA Order 8110.54, Instructions for Continued Airworthiness Responsibilities, Requirements, and Contents, these instructions must include as a minimum and be provided to the operator or maintainer.

a. Data stream. The data stream format and correlation data outlined in appendix 1 or appendix 2 if applicable.'

Therefore, it is proposed to add paragraphs in AMC 2X.1459 (in CS-25 and CS-29) to include FDR decoding documentation in the list of items to be included in the FDR ICA.

Table 4: Selected policy options for 'The serviceability of flight recorders'

Option No	Short title	Description
0	No action	No policy change (no change to the rules; risks remain as outlined in the issue analysis)
1	Amend CS-25 and CS-29	Create new acceptable means of compliance to clarify what is expected to be provided by design organisations to ensure the serviceability of flight recorders as part of the ICA

4.3.4. The quality of recording of cockpit voice recorders

We could envisage amending CS 25.1457 and CS 29.1457 and the corresponding AMCs to better control the quality of CVR recording during the initial and continuing airworthiness of CVR system installations.

This change could make use of the content of CM-AS-001 to be incorporated in AMC 25.1457 and AMC 29.1457. In addition, the AMCs could include the missing elements as described in 4.1 to provide guidance on how the evaluation of the CVR recording should be performed.

Table 5: Selected policy options for 'The quality of recording of cockpit voice recorders'

Option No	Short title	Description
0	No action	No policy change (no change to the rules and no change to CM-AS-001; risks remain as outlined in the issue analysis)
1	Amend CS-25, and CS-29	Amend CS 25.1457 and CS 29.1457 and the related AMC material with provisions specifying how to evaluate the performance of the CVR system and the quality of the CVR recording.

4.4. What are the impacts

4.4.1. Safety impact

4.4.1.1 FDR power supply

Option 0 would leave the current situation unchanged with regard to the identified safety risk from the non-availability of flight data for a period of time following the loss of the normal electrical power to the FDR.

On the other hand, Option 1 would mandate the installation of an APS for the FDR recording system (which includes the powering of data parameters) on new large aeroplane designs such that they would have a means to maintain flight data recording after a loss of normal electrical power. This would bring benefit to accident and incident investigations, as investigation authorities would have a better view of how the occurrence developed and how it was managed by the flight crew. The reported safety issue would therefore disappear from new designs of large aeroplanes.

However, as explained in Section 4.1.6.2, the safety risk at stake is considered low. Therefore, although Option 1 is better, the actual increase in safety benefit compared with Option 0 is very limited.

4.4.1.2 Data link recording

Option 0 and Option 1 do not deal with a specific safety risk. The requirement to record data link communications, useful for investigations of accidents and incidents, already exists in the air operations regulations. The specifications for the installation of the data link recording function help applicants and EASA to agree on how to implement this requirement and ensure that the integrity of the system will be high enough to ensure the availability of data link recording after an accident or incident. This therefore brings a safety benefit by preventing applicants from developing design solutions that are not sufficiently robust.

Option 1 is slightly better than Option 0, as it addresses a few more aspects than the EASA generic CRI.

4.4.1.3 The serviceability of flight recorders

Option 0 would not rectify the reported issues, and therefore the identified safety risk would remain unchanged.

Option 1 would ensure that adequate ICA and FDR decoding documentation is made available to operators. This would mitigate the safety risk posed by missing or unusable recorded data after an accident or incident, thereby providing a safety benefit for products or changes certified in the future.

4.4.1.4 The quality of recording of cockpit voice recorders

Option 0 would rely on EASA CM-AS-001 and the industry voluntarily following the EUROCAE Document ED-112A guidelines to address the issues mentioned. The identified safety risk should decrease over time.

Option 1 would provide additional guidance in the same place (the AMC) and would therefore ensure the best robustness and harmonisation of the CVR recording quality check. This should

improve the recording quality of CVR systems and thereby bring some additional safety benefit in comparison with Option 0.

4.4.2. Environmental impact

4.4.2.1 FDR power supply

An environmental impact is potentially created by a weight impact, which would increase fuel consumption and emissions.

This weight impact would be negligible for the installation of an APS for the FDR, as it would add around one kilogram of weight (corresponding to an additional battery). However, additional design effort is necessary to provide backup power for the flight parameter sources of various aeroplane systems and the corresponding acquisition unit(s) (i.e. beyond the already available essential parameters), which adds a weight penalty. The total weight impact depends on the design of the aeroplane concerned.

Nevertheless, the overall environmental impact is expected to remain either very low or negligible.

4.4.2.2 Data link recording, the serviceability of flight recorders, and the quality of recording of cockpit voice recorders

No impact.

4.4.3. Social impact

An unexplained accident, or an incomplete/unusable set of flight recorder data recordings, 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 issue, this negative impact would remain unchanged with Option 0, while the other options would contribute to mitigating this potential negative social impact.

4.4.4. Economic impact

4.4.4.1 FDR power supply

Option 0 is neutral.

Option 1, applicable to new designs (essentially for new type certification) would involve a low cost impact from the installation of an FDR-APS (non-recurring costs and recurring costs for the aeroplane manufacturers). A more significant cost impact (non-recurring costs and recurring costs for the aeroplane manufacturers) would be generated by the need to also provide backup power for some parameters sources. Although no actual cost is available to EASA, this is considered as a medium cost impact for a new type certification. A low maintenance cost would also be induced for operators to maintain any additional battery.

4.4.4.2 Data link recording

Option 0 means that EASA would continue to use the generic CRI process. Although it allows EASA to deal with applications for certification, this process generates more workload and consumes more time than if specifications and acceptable means of compliance were available in CS-25 and CS-29.

Therefore, Option 1 provides for a more cost-efficient certification path for data link recording functions for both applicants and EASA.

4.4.4.3 The serviceability of flight recorders

Missing or low-quality data from inadequately maintained flight recorders, as well as the lack of adequate FDR decoding documentation, can hinder or delay an investigation after an accident or incident. This has a cost impact on the investigation (an increase in the man hours and the duration of the investigation, putting in place supplementary investigation techniques to compensate, etc.).

In addition, incomplete or inadequate ICA for ensuring the serviceability of flight recorders may have an economic impact on the aircraft operator, because the carriage of an FDR, a CVR, and a DLR is required for large aeroplanes and large rotorcraft. Indeed, this may lead to the flight recorders not being properly maintained, which may disturb the operation of the aircraft (more unscheduled maintenance activities), or it may lead to unnecessary tasks for the operator. The oversight authority may also fine the operator and restrict the operation of the aircraft if they find out that it has been used with unserviceable flight recorders beyond the tolerance provided by the minimum equipment list (MEL).

In the absence of an obligation on the FDR system installer to provide FDR decoding documentation, the operator may receive an aircraft without the FDR decoding documentation. The operator may therefore be unable to perform the regular inspection of the FDR recording (required by ICAO Annex 6). The oversight authority may then fine the operator and restrict the operation of the aircraft if they discover that the operator does not have the FDR decoding documentation. In the worst case, the oversight authority of the operator might require the FDR system installation to be changed because an FDR from which the recorded data cannot be decoded does not meet the requirements of CS 25.1309(a)(1):

‘(a) The aeroplane equipment and systems must be designed and installed so that:

(1) Those required for type certification or by operating rules (...) perform as intended under the aeroplane operating and environmental conditions’

Option 0 would not help to mitigate this impact, as the current situation would remain unchanged.

On the other hand, Option 1 would contribute to decreasing this cost impact by improving the situation on products certified in the future.

Option 1 would also create a low cost impact on design organisations that do not yet properly issue the expected ICA and FDR decoding documentation. This cost impact is nevertheless considered minimal and acceptable, as it mainly consists of additional engineering working hours to meet industry standards.

Overall, the cost benefit for operators and investigation authorities is deemed superior to the cost impact on a few organisations, and a positive economic impact is foreseen.

4.4.4.4 The quality of recording of cockpit voice recorders

EASA has already taken action to ensure that applicants check the audio quality of CVR installations with the publication of the EASA CM. Compared with Option 0, Option 1 adds more guidance on how the audio quality should be checked, rated, and summarised in a report. On one hand, this may create a limited increase in workload for the organisations which do not yet fully follow these



guidelines. On the other hand, the availability of more detailed guidelines will probably save time for the organisation and EASA when reviewing and approving the reports on audio quality checks. In addition to that, a more robust evaluation would ensure that the audio quality of new or modified CVR installations was better overall, thereby benefiting operators (who are required to keep the CVR serviceable, and in particular to perform an inspection of the CVR recording at regular time intervals according to ICAO Annex 6) and accident investigations (saving on investigation costs, and costs induced on accident investigations where the CVR recording is unusable or of poor audio quality). Overall, Option 1 should have a positive economic impact.

4.4.5. ICAO and third-country references relevant to the content of this RMT

References considered for alignment

FDR power supply:

N/a

Data link recording:

ICAO:

- Annex 6, Part I (Eleventh Edition, July 2018 – incorporating Amendments 1 to 43), Chapter 6, 6.3.3 and Appendix 8, Section 5 (Data link recorder (DLR)); and
- Annex 6, Part III (Ninth Edition, July 2018– incorporating Amendments 1 to 22), Section III, Chapter 4, 4.7.3 and Appendix 4, Section 5 (Data link recorder (DLR)).

The FAA: Advisory Circular (AC) 20-160A entitled ‘On-board recording of controller pilot data link communication (CPDLC) in crash survivable memory’

The serviceability of flight recorders:

The FAA:

- FAA AC 20-186 ‘Airworthiness and Operational Approval of Cockpit Voice Recorder Systems’, dated 21 July 2016; and
- FAA AC 20-141B ‘Airworthiness and Operational Approval of Digital Flight Data Recorder Systems’, dated 17 August 2010.

ICAO:

- Annex 6, Part I (Eleventh Edition, July 2018 – incorporating Amendments 1 to 43), Appendix 8, Section 1 (General requirements) and Section 7 (Inspections of flight recorder systems); and
- Annex 6, Part III (Ninth Edition, July 2018– incorporating Amendments 1 to 22), Appendix 4, Section 1 (General requirements) and Section 6 (Inspections of flight recorder systems).

The quality of recording of cockpit voice recorders:

- FAR 25.1457 and FAR 29.1457, like CS 25.1457 and CS 29.1457, do not contain a specific provision on ensuring sufficient audio quality when requesting approval of the installation of a CVR system;



- FAA Advisory Circular (AC) 20-186 ‘Airworthiness and Operational Approval of Cockpit Voice Recorder Systems’ (dated 21 July 2016), Section 2 (Type certification) contains the following provisions:
 - ‘2.3.3 Aircraft Installed Performance. The applicant must install the CVR system per EUROCAE Document ED-112A, ‘Minimum operational performance specification for crash protected airborne recorder systems,’ dated September 2013, Chapters 2-5 and I-6.
 - 2.4 Demonstrate Performance. The applicant must demonstrate the CVR system performs as intended per ED-112A Chapters 2-5 and I-6. Use ED-112A Annex I-A for post flight evaluation of the flight test recordings.
 - Note: Using the flight test data, you must confirm the CVR begins to operate no later than the start of the preflight checklist and continues to operate until completion of the final postflight checklist.’
- Canadian Aviation Regulations (CARs) Part V, Airworthiness Chapter 551 (aircraft equipment and installation) Paragraph 101 (cockpit voice Recorder).

References to differences

N/a

EU requirement not yet having a relevant reference

FDR power supply:

Option 1 would create a difference from the ICAO SARPs and the FAA/TCCA regulations, as they do not have any rules requiring APSs for FDR recording systems.

Data link recording:

Option 1 would create a difference from FAA FAR Part-25 and Part-29 which do not yet include equivalent specifications on data link recording.

The serviceability of flight recorders:

N/a

The quality of recording of cockpit voice recorders:

Option 1 would create a difference from the FAA and TCCA rules on CVR installations (FAR/CAR 25.1457(c) and 29.1457(c)), as it proposes to remove the prescriptive number of recording channels (four).

Also, the proposed AMC 25/29.1457 section on CVR audio quality checks provides more guidelines than those provided in FAA AC 20-186 ‘Airworthiness and Operational Approval of Cockpit Voice Recorder Systems’



4.4.6. General Aviation and proportionality issues

N/a

4.5. Conclusion

4.5.1. Comparison of options

4.5.1.1 FDR power supply

The availability of the flight data recording during time periods where normal electrical power is lost would bring benefit to accident and incident investigations, as investigation authorities would have a better view of how the occurrence developed and how it was managed by the flight crew. However, the CVR is required to have an alternate power source and will provide some information.

Given that the number of occurrences concerned is very small compared with the overall number of accidents and incidents, and that in general, the additional data gained is not critical to identifying the root causes of an occurrence, the actual safety benefit is considered low for option 1.

EASA considers that there is not enough safety benefit to be expected from the implementation of an APS for the FDR recording system to justify the economic impact created by a new rule mandating it.

Option 0 (no action) is therefore the preferred option, and no regulatory change is proposed on this topic.

4.5.1.2 Data link recording

Option 1 (amend CS-25 and CS-29) is the preferred option because it would bring an economic benefit and build on the content of the generic CRI to produce an upgraded set of specifications and acceptable means of compliance that would bring benefit to applicants and EASA. A more robust set of specifications would also bring benefit to accident and incident investigations, thus providing a safety benefit.

4.5.1.3 The serviceability of flight recorders

Option 1 (amend CS-25 and CS-29) is the preferred option, as it would create a safety and economic benefit over Option 0, which would otherwise leave the current situation unchanged, in which some investigations are hindered, thereby having a negative safety and economic impact.

4.5.1.4 The quality of recording of cockpit voice recorders

Option 1 (amend CS-25 and CS-29) is the preferred option, as it would create a safety and economic benefit over Option 0. It would overall ensure that the audio quality of a CVR is thoroughly investigated and reported before the CVR is certified. This will benefit operators, aircraft accident investigation bodies, EASA, and design organisations.

Question to stakeholders:

Stakeholders are invited to provide any other quantitative information they may find necessary to bring to the attention of EASA.

As a result, the relevant parts of the IA might be adjusted.

4.6. Monitoring and evaluation

As this NPA proposes changes to CS-25 and CS-29 that will apply to new aeroplane type designs, the monitoring of the effects created by the new specifications and acceptable means of compliance will consist of:

- a) feedback from future CS-25 and CS-29 type certification projects, and
- b) in the long term, the trend of the issues encountered with flight recorders during investigations of accidents and incidents, as well as other feedback from operators and oversight authorities.

Item 1 depends on the applications received after the amendment of CS-25 and CS-29. A review could not be performed earlier than 5 years after the date of applicability of the CS-25 and CS-29 amendments, and it would require the availability of experience from several certification projects for each type of aircraft.

Item 2 would be available once the new type designs have entered into service and experienced sufficient flight time, which would require several years (at least 5 years to obtain statistically relevant information).

In addition, the changes made to CS-25 and to CS-29 might be subject to interim/on-going/ex-post evaluation that will show the outcome obtained after the application of the new rules, taking into account the earlier predictions made in this impact assessment. The evaluation will provide evidence-based judgement of the extent to which the proposal has been relevant, given the needs and its objectives, effective and efficient, coherent, and has achieved EU added-value. The decision as to whether an evaluation will be necessary will also be taken based on the monitoring results.



5. Proposed actions to support implementation

No action is proposed to support the implementation of the selected options.



6. References

6.1. Affected/Related regulations

N/a

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 »).

6.3. Other reference documents

- ICAO Annex 6, Part I (Eleventh Edition, July 2018 – incorporating Amendments 1 to 43), Appendix 8, Section 1 (General requirements) and Section 7 (Inspections of flight recorder systems);
- ICAO Annex 6, Part III (Ninth Edition, July 2018– incorporating Amendments 1 to 22), Appendix 4, Section 1 (General requirements) and Section 6 (Inspections of flight recorder systems);
- EUROCAE Document ED-93 (dated November 1998), ‘Minimum aviation system performance specification for CNS/ATM message recording systems’;
- EUROCAE Document ED-112A (dated September 2013), ‘Minimum operational specification for crash protected airborne recorder systems’.



7. Appendix

None.



8. Quality of the document

If you are not satisfied with the quality of this document, please indicate the areas which you believe could be improved and provide a short justification/explanation:

- technical **quality** of the draft proposed rules and/or regulations and/or the draft proposed amendments to them
- text clarity and readability
- quality of the impact assessment (IA)
- others (please specify)

Note: Your replies and/or comments to this section shall be considered for internal quality assurance and management purposes only and will not be published in the related CRD.

