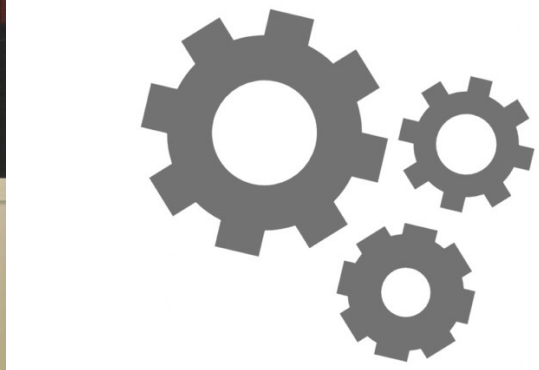

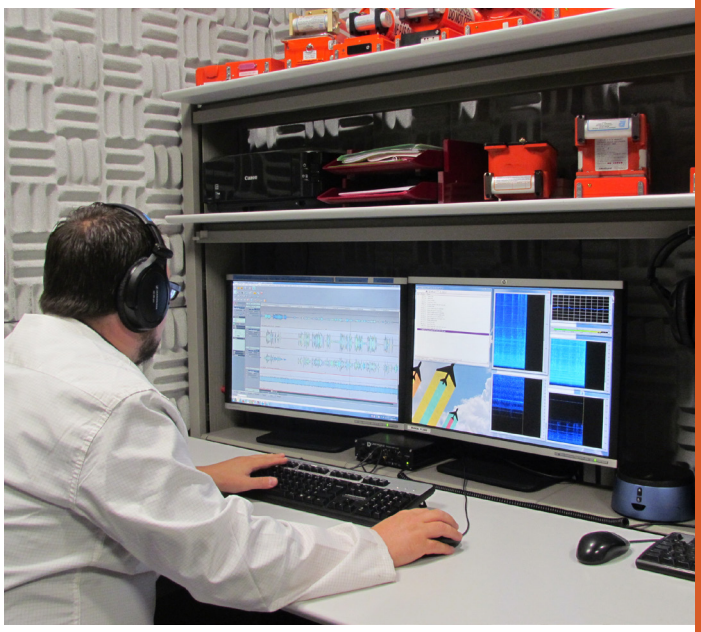

Guidance on CVR recording Inspection

8 October, 2018

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- DGAC France
- European Aviation Safety Agency
- European Cockpit Association
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- UK Civil Aviation Authority
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1 - INTRODUCTION

The purpose of this document is to detail best practices so that the CVR recording inspection is performed in an appropriate manner with methods ensuring the detection of potential defects.

2 - SCOPE AND BACKGROUND

2.1 Issue statement

The issue assessed in this Position is the following:

Define guidance for the CVR recording inspection to ensure that the CVR audio recording is of good quality.

This guidance could also be used by any OEM (original equipment manufacturer) and STC (Supplemental type certificate) holder when the evaluation of the audio quality recording is necessary.

2.2 Definitions

Cockpit Voice Recorder (CVR) system is installed for the purposes of the investigation of an accident or incident. For that purpose, the quality of the recordings should provide for a high level of intelligibility of speech and an accurate reproduction of the sounds and background noise audible in the cockpit.

The CVR system typically includes but is not limited to:

(i) CVR
(ii) Cockpit equipment dedicated to the CVR, including a monitor and failure indication, one or more Cockpit Area Microphones (CAM) and associated pre-amplifiers,
(iii) means of converting the analogue audio signals to a digital format;
(iv) audio interface equipment, including microphone/telephone signal summing amplifiers;
(v) a means of converting a time synchronisation signal to a format which can be recorded; and
(vi) digital data buses and/or networks providing communications between elements of the CVR system.

Note: All microphones at each flight crew position (handset microphone, headset, oxygen mask microphone) are parts of the audio system which significantly contribute to the quality of the CVR recordings; microphones are sensors receiving and converting the sounds into electrical signals which is processed by the audio system and then delivered to the CVR system. For this reason, microphones are to be considered when assessing a CVR recording.

The CVR recording inspection is an inspection of the audio recording files of a CVR in order to verify that all the data required to be recorded by the CVR is recorded and that the audio quality of this data is sufficient for analysis and investigation purposes.

The CVR system installer is the organization applying for the approval of the installation of a cockpit voice recorder system (through a type certification or supplemental type certificate)

Minimum operational performance specifications (MOPS) may be found in EUROCAE documents like ED-112A and ED-56A.

The CVR recording inspection should be performed by an audio specialist hereinafter referred to **analyst**. The basic task of the analyst is to perform the CVR recording inspection checking the recording quality and intelligibility. In case of findings, an audio and CVR system expert, or the operator engineering service would then be responsible to figure out the root cause of the anomaly/ies and fix the corresponding item. This could be done with the potential support of the analyst.

The **inspection report** is a deliverable produced by the analyst and gives the results of the audio evaluation from qualitative and subjective standpoint (refer to chapter 4.4 and Annex 2 for a standard format report).

Waveform : the shape of the graph of a wave or oscillation obtained by plotting the value of some changing quantity against time (source : Collins English Dictionary)

2.3 Background

The CVR recording inspection is performed in order to verify the audio quality of the CVR and to detect the potential defects that have been regularly raised on CVR systems by investigators during incidents and accidents analysis (see appendix 4).

In the EU rules for air operations applicable to commercial air transport (Annex IV to Commission regulation (EU) 965/2012). CAT.GEN.MPA.195 (b) requires that "the 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".

GM2 CAT.GEN.MPA.195(b) clarifies the terms operational check of the flight recorder mentioned in CAT.GEN.MPA.195 : the CVR recording inspection is a dedicated task different from a read out or an operational check.

The CVR recording inspection outcomes will not address exclusively the CVR itself but the CVR system (CVR and CVR dedicated equipment) as mentioned in the Explanatory Note to Decision 2015/021/R. For instance, if a CAM is inoperative, it should be detected through the CVR recording inspection.

Inspection of the CVR recordings should be performed at regular time interval to ensure serviceability of the CVR systems (ref. AMC1 CAT.GEN.MPA.195(b)) and also when the CVR system or the audio system are either modified (headset change for example) or potentially affected by the modification of the aircraft system (Transmiting PED amongst others (refer to EASA certification memorandum CM-ES-003)[1], WIFI installation as an example).

[1] https://www.easa.europa.eu/document-library/product-certification-consultations/easa-cm-001

Discussions with operators have raised concerns regarding the way the CVR recording inspections are conducted: for the same CVR recording, the inspection results showed large variability in the assessment from acceptable (good quality) to unacceptable (very poor quality implying immediate actions for the operator).

The inspection should be performed with efficient and commonly shared methods in order to detect the most significant defects in a timely manner. Harmonization of the methods used might be the ideal objective to help the operators to select the adequate inspection service and help in producing a **more repeatable** and l**ess varied** analysis.

Anomalies could occur only on small portions of the recordings. Therefore, an assessment of the signal quality over the whole recording is generally necessary. However, only some selected portions of recording may require more in-depth analysis including listening (see Chapter 4.)

Furthermore, the recording privacy has to be considered in the framework of the CVR recording inspection. In Europe, the conditions for addressing flight crew privacy are defined in Part CAT, CAT.GEN.MPA.195 subparagraph (f), and in related AMC. IFALPA document 17AAPBL01 further elaborates on this topic.

3 - REGULATION AND GUIDANCE

3.1 Regulations

The current EU requirements and guidance materials for the inspection of the CVR is as follows:

- Annex IV to Commission Regulation (EU) 965/2012 ('Part-CAT'), CAT.GEN.MPA.195(b): "The 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".

AMC1 CAT.GEN.MPA.195(b) indicates the appropriate timeframe between two consecutives checks. It can vary from 3 months to 2 years depending on the recording technology.

The associated GM briefly mentions the expected work to be done : 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.*

In addition, while performing CVR recording inspection, equipment performance compliance may be checked relative to the AMC1 CAT.IDE.A.185 Cockpit voice recorder. AMC1 CAT.IDE.A.185 refers to EUROCAE Documents ED-56[a], ED112 and/or ED-112A for Operational Performance Requirements dedicated to CVR and CVR dedicated equipments. Operational performances of these equipment may have an impact on recording results and have to be considered accordingly.

The conditions for addressing flight crew privacy are defined in Part CAT, CAT.GEN. MPA.195 subparagraph (f), and in related AMC.

EASA Safety Information Bulletin 2009-28R1[(2)] issued on 08 January 2015 entitled Flight Data Recorder and Cockpit Voice Recorder Systems Serviceability mentions that : The quality of the FDR and CVR recordings should be evaluated during the recording inspections and shown to be within acceptable limits. In particular, all required signals recorded by the CVR should meet intelligibility standards(…).

In addition, **the EASA CM-ES-003 Guidance to Certify an Aircraft as PED tolerant** also mentions the inspection of the CVR recording: 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).

[(2)] https://ad.easa.europa.eu/ad/2009-28R1

In **ICAO Annex 6 Part I,** procedures for the inspections of the flight recorder systems are given in Appendix 8 to ensure the Continued serviceability mentioned in 6.3.4.3. In **ICAO Annex 6 Part II**I, procedures for the inspections of the flight recorder systems are given in Appendix 4 to ensure the Continued serviceability mentioned in 4.3.4.3. In addition, ICAO **Flight Recorder System Maintenance Manual (FRSMM)** to be published beginning of 2018 provides complementary information.

3.2 Guidance and Industry standards

ED-112A published in September 2013 contains the following:

- **References to maintenance practices** in Annex I-C to ensure the continued serviceability of the installed CVR system.

''The specified checks need to include verification of system performance, where appropriate. A flight recording should be replayed at specified intervals to reveal defective equipment and to indicate essential maintenance actions. Where a replay evaluation indicates an aircraft system defect, appropriate corrective action shall be initiated.
It mentions in I-C.2 that 'an in-flight recording should be replayed and assessed for quality. ANNEX I-A provides guidance for the evaluation of such recordings. Cockpit Voice recorder systems should be considered unserviceable if the recording duration is less than required, if there is a period of poor quality audio or unintelligible audio/sounds.''

- **Guidance for the evaluation** of the CVR recordings in Annex I-A
- **An example of CVR TEST REPORT** in table I-A.1 usable by the analyst performing inspection of CVR recordings

Examples of CVR audio quality issues and possible causes thereof may be found in the document of the French Bureau d'Enquêtes et d'Analyses, titled 'Study on detection of audio anomalies on CVR recordings' and dated September 2013[3].

IFALPA 17AAPBL01 document[4] addresses the privacy of the flight crew.

These documents can be used as the guidance baseline for the CVR audio recording inspection.

[3] https://www.bea.aero/fileadmin/user_upload/guidance.on.detection.of.audio.anomalies.on.CVR.recordings.pdf

[4] http://www.ifalpa.org/downloads/Level1/Briefing%20Leaflets/AAP/17AAPBL01%20-%20Access%20to%20CVR%20Data%20for%20Maintenance%20Purposes.pdf

4 - CVR RECORDING INSPECTION - BEST PRACTICES

4.1 Organization performing the CVR recording inspections

Recommendations can be found in the ANNEX I-A of EUROCAE ED-112A: ''*the replay and evaluation of recordings shall 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*''.

In addition, the analyst should be familiar with sound/acoustic tools for both usage and analysis.

When selecting the organization performing the CVR recording inspections, the operator shall ensure the privacy of the CVR recording and the CVR recording shall not be disclosed or used for other purposes than ensuring the CVR serviceability. In Europe, the conditions for addressing flight crew privacy are defined in Part CAT, CAT.GEN.MPA.195 subparagraph (f)(1a), and in AMC1 CAT.GEN.MPA.195(f)(1a).

4.2 Overall methodology and selection of analysis tools

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**.

The inspection relies on both quantitative and qualitative evaluation. The quality of the CVR recordings should be within acceptable limits.

Adequate tools should be selected for evaluation and to provide evidence of recording quality while addressing flight crew privacy.

By experience, a complete listening of a recording is not a realistic/efficient method to check that the CVR operates correctly. A better method is to use an enhanced tool to visualize the audio signal over time (waveform) for all CVR audio channels so as to check whether a part of or the whole recording is affected by an audio anomaly.

The analyst should then select the most appropriate sample to be inspected when visualizing the overall waveform: when a portion shows characteristics indicative of a potential anomaly within the recording (i.e. abnormal changes in the waveform like level or frequency changes), the analyst should focus on them. The recording sample to be analysed should not be selected by chance but as the result of this preliminary assessment.

Specific tests are described in chapter 5.

A **CVR sample** in the context of a CVR audio inspection means a portion of the audio signal recording that has been selected based on its audio characteristic. It would vary from few seconds to several minutes.

The example below shows a mechanical interference that occurred over a period of several minutes and disappeared The waveform shows significant fluctuations in the same flight phase. These interferences should be detected and the affected portion of the recording should be analysed.

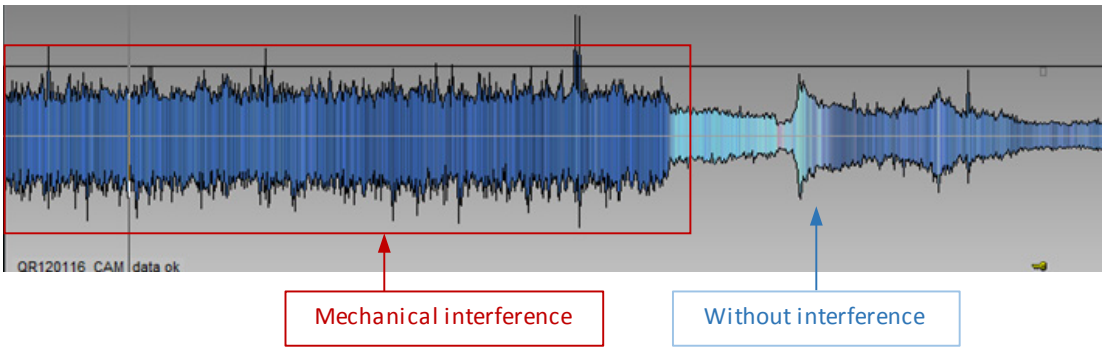


Figure 1: audio level change in cruise flight phase (audio level versus time)

Note: be careful, audio level change can also occur when the aircraft takes off (Air/ground flight phase transition).

Advanced multi-track / multichannel waveform visualizer (such as Audacity, Samplitude, Soundforge, ProTool, WaveLab, etc). makes evaluation easier and more reliable. These make it possible to navigate through the audio file, to view the waveform and thus to quickly identify some anomalies (for example loss of audio signals). They give the capability to focus on selected part of the recording to evaluate intelligibility.

In addition, **spectrogram software** (generally included in the waveform visualizer software) would provide visual representation of the frequency spectrum of the audio signal and could help in identifying a specific anomaly.

For instance, the only way to confirm an electrical interference is to visualize spectra (use the spectrogram view within the software tool).

Note : As per ED-112A, interferences do not necessarily compromise the overall intelligibility. Interferences have to be identified and evaluated.

In the example hereunder, the 400 Hz signal comes from the cabin system during the use of cabin interphone. In ED-112A, paragraph I-A.3 RECORDING EVALUATION, the note 1 indicates that A low level of 400 Hz *interference may be tolerated since it provides a crude but useful time base for accident investigation.*

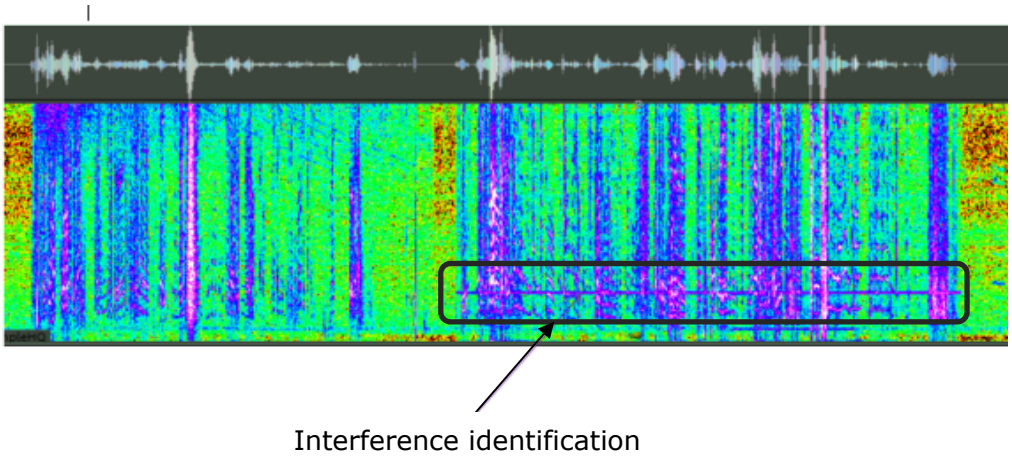


Figure 2 : 400Hz acceptable interference
spectrum analyser view (audio waveform and Frequency data versus time)

By using such advanced visualization tools, most of the inspection can be based on **visual identification** of issues. Listening evaluation is limited to few samples for confirmation. This method alleviates privacy concerns of flight crews.

4.3 Aircraft information

In order to perform the CVR recording inspection, the operator should give to the analyst, when practicable, information on the aircraft, the recorded flight (at least the date of the CVR removal and CVR data download) and the CVR and audio systems configuration (see appendix 1). The associated BITE download if available should also be provided.

An example of inspection request form is given in Annex 1. This document would be filled out by the operator. Some information are necessary to properly identify which criteria should be used during the inspection and identify the corresponding aircraft and the expected CVR quality result. Other could be considered as optionnal and would be helpful in case of detected anomalies to help in identifying the root cause. The analyst is not necessarily in charge of the root cause analysis but could participate to it.

Note:

- *The EU rules applicable to commercial air transport operations are in Annex IV to Commission Regulation (EU) 965/2012 ('Part-CAT'). In particular the EU rules related to carriage of the CVR are in CAT.IDE.A.185 (for aeroplanes) and CAT.IDE.H.185 (for helicopters). In these rules, the requirements on recording duration, information to record, start-and-stop logic depend on the date of first issuance of the individual certificate of airworthiness. In addition, the operational performance requirements specified in the acceptable means of compliance to CAT.IDE.A.185 and CAT.IDE.H.185 also depend on the date of first issuance of the individual certificate of airworthiness.*

- *Hot-mic: The hot-microphone ensures that, in addition to the recording of the radio transmissions to and from the aircraft, all sounds received by the crew's microphones are recorded continuously irrespectively of the position of the audio selector switches. The volume control has no effect on the level of recording of the hot-microphone. Depending on the applicable mandates, not all aircraft are fitted with Hot-mic function. When applicable, this function can be evaluated as per Eurocae MOPS taking into account that specifications are different between ED-56A and ED-112.*
- *The air operation requirements related to the CVR and applicable to non-EU operators may be different (for instance regarding the start-and-stop logic, the recording duration, etc).*
- *In addition to CVR dedicated equipment, headsets (boomsets) may have a significant impact on recording audio quality. A TSO-approved headset does not guarantee good audio quality in the CVR recording. In addition, even if a new headset model is found adequate for operating the aircraft, it might still affect the quality of the CVR audio recording: in other words, good operation of the audio communication system does not mean good quality of the CVR audio recording .*
  - *For example, a new headset might have been installed through STC. This could result in unexpected saturation on the CVR audio recording. The CVR recording inspection could detect and reveal such a mismatch.*

4.4 Inspection report

The analyst should rely on a quality rating scale for assessing all CVR recordings (see Paragraph 6.1 for proposed quality ratings definition). This quality rating scale should be provided for reference in the CVR recording inspection report (see Annex 3).

Appendix 2 – Example of CVR QUALITY ASSESSMENT REPORT presents an example of test results report where dedicated function associated to each channel is evaluated. The number of columns reflects the number of channels (5 columns when there are 5 channels).

For a CVR recording to be considered representative, it should contain at least:

- 1. Taxying (for an aeroplane), and
- 2. Any one of the following:
  - take-off and climb up to cruise altitude, or
  - descent phase from cruise altitude , approach and landing
  - for helicopters, hover and autorisation should be inclused (air particulier for certification process).

Otherwise, the analyst should mention in the report that a complete CVR recording inspection could not be performed. Experience shared by safety investigation authorities showed that the audio quality of a CVR recording may significantly vary depending on whether the aircraft is airborne or not.

5 - CVR RECORDING INSPECTION - TESTS DEFINITION

As mentionned in ED-112A (I-A.3 RECORDING EVALUATION), the following checks should be performed:

- The recording on each channel is checked to confirm that the required input sources are connected to the CVR system, and that recorded levels and signal quality are acceptable.
- Check is made to confirm that adequate signal to noise ratio exists for all significant input signals, and that signal levels are reasonably balanced between the channels. The proper recording level will be confirmed to show that the full recording dynamic range has been achieved without excessive clipping of peak signals.
- Signal quality is checked to ensure that the recording is free from electrical interference and from the effects of vibration.
- The presence of cockpit sounds, crew speech and audible warnings is checked on the area microphone channel.

Note: Vibration means recurrent shocks, or structure resonance; these usually create narrow or wideband noise which could cover voices and/or reduce intelligibility of speeches.

Tests and checks usually performed are described in chapter 5:

- Channel duration
- Data synchronisation
- Signal integrity : no data, poor quality data, signal interruption
- Recorded signals check: passenger address, cockpit area microphone, aural alerts and warnings
- Level balance between tracks
- Interference : mechanical and electrical interferences, hyper frequency burst, audio popping, mechanical interferences
- Signals recording saturation

5.1 Channels synchronization

Once the audio files are opened with the software, it is necessary to ensure that they contain audio data with no audio blanks (see § 5.1). The possibility of viewing the waveform with audio editor software (see figure hereafter) makes this operation easier.

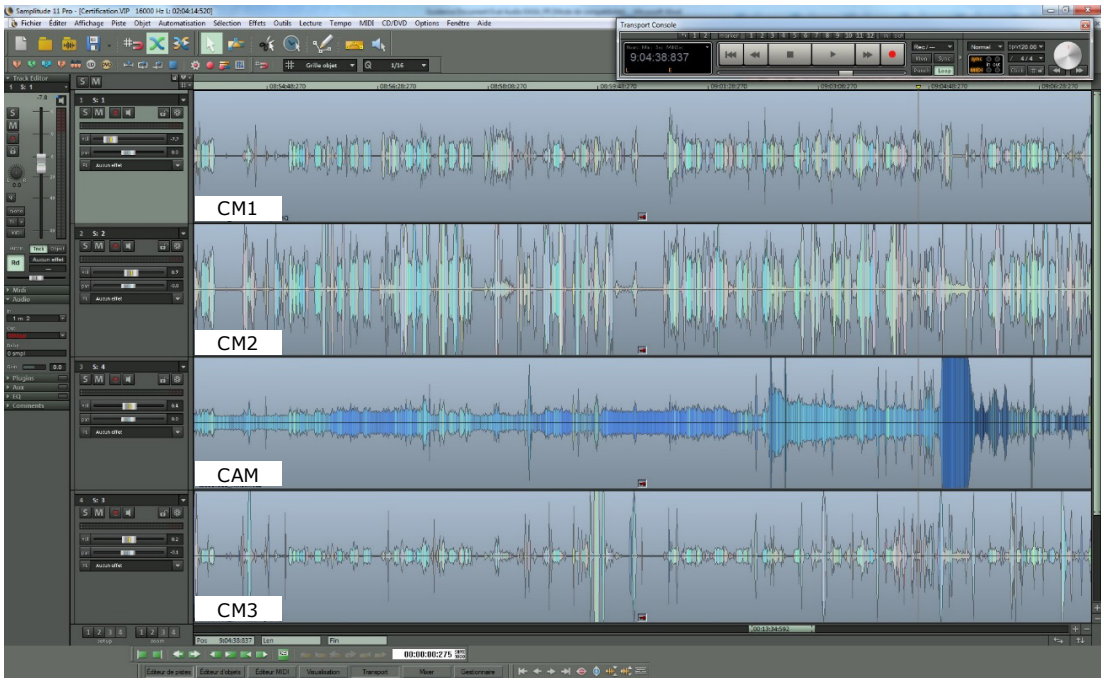


Figure 3: Audio analysis software example (Magix Samplitude®)

It is then necessary to synchronize audio files with each other, which allows them to be replayed together. A quick overview of the signals of the tracks, first individually then simultaneously, makes it possible to quickly identify some anomalies such as full or partial absence of audio data on some tracks.

When the signals do not show obvious anomalies like absence of signal or poor quality of CAM recording, it is acceptable to quickly browse the files, though passing slowly over high noise level areas (for example take-off and landing which are flight phases easily identifiable when looking at the waveform signal) or in low noise level areas to check the presence of audio data.

If anomalies are identified on the recordings, a more thorough and detailed check should be conducted.

5.2 Channel recording duration

During an audio evaluation, it is necessary to work on the data of each track recorded on the CVR (generally from 3 to 6 tracks).

Example of audio files recovered from a CVR download:

- A file with the recording of radio communications and Crew Member 1 (CM1) microphones signal;
- A file with the recording of radio communications and Crew Member 2 (CM2) microphones signal;
- A file with the recording of the interphone call from the cockpit crew to the cabin crew, the third crew member (3rd occupant or observer seat -CM3) microphone signal and its radio communications, the passenger address announce, and the CVR's time code (FSK[5] signal when recorded -see §5.3) ;
- A file with the recording of a mix of the first 3 tracks;
- A file with the recording of the signal from the CAM.

The number of recovered audio files and their recording duration varies depending on either the type of aircraft[6] or the CVR model.

The download of the CVR should generate at least, the number of audio files expected for the recording duration defined by the recorder specification (currently more than 30 minutes or 2 hours).

Duration identification and number of channels

Based on the CVR part number (PN), the expected minimum recording duration recording of the CVR should be checked.

In addition, if information regarding the date of issuance of the individual CofA is provided, it should be checked whether the information to be recorded by the CVR is recorded for at least the duration required by the applicable air operation rules (e.g. Part-CAT, CAT.IDE.A.185 or CAT.IDE.H.185 for EU-based operators).

File size

Audio files should be extracted from native format file to a standard format avoiding any loss of information due to compression (PCM/ADPCM WAV format is adequate for example).

The audio file size can provide hints regarding the recording duration which would be then confirmed.

In case of discrepancy, during the root case investigation, it would then be important to determine whether the issue raised comes from the download process or from the recording.

[5] Frequency Shift Keying / analog burst coding the UTC time generated by the FDAF/U, This burst is emitted every 4s and generally mixed with the 3rd channel audio stream.

[6] Refer to the Aircraft Maintenance Manual (AMM) and the Component Maintenance Manual (CMM) of the recorder, especially the « Description and Operation » part.

5.3 FSK signal

On some aircraft, synchronisation between CVR and FDR can be performed through the CVR audio time code (FSK type). Periodicity could be checked with regard to manufacturer specification at the beginning and at the end of the recording.

It can be noticed that the recording process (failed memory component or CVR internal clock shift) can alter the periodicity of the signal.

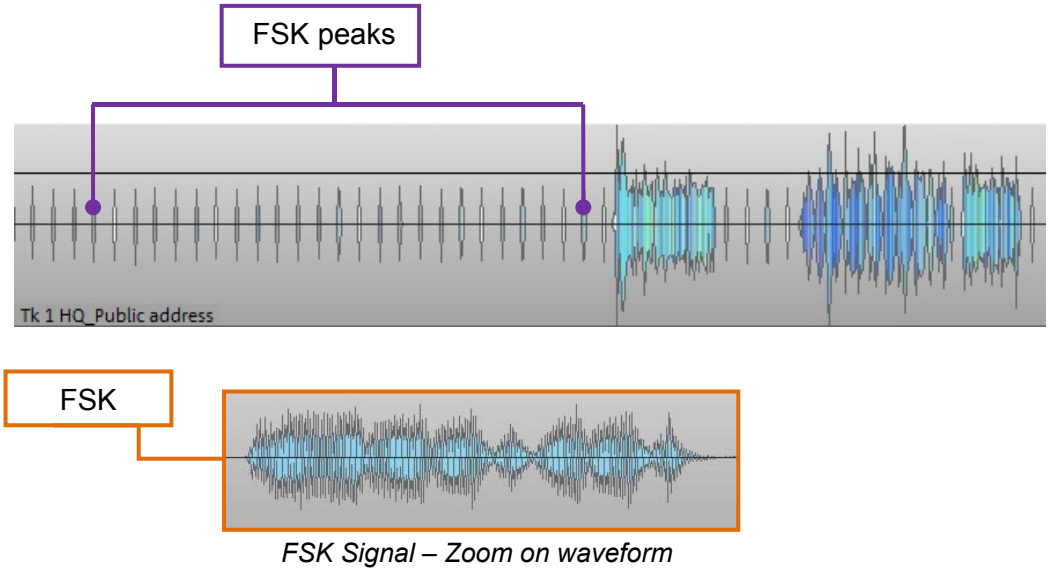


Figure 4: CVR audio time code (FSK type)

The verification of the FSK signal rate is a good and simple way to identify whether the recording synchronisation was correct. The operator should mention whether the airplane is equipped with FSK time code function or not.

5.4 Signal integrity

The overview of the signal should provide immediate clues for the following failures:

5.4.1 Example: No audio data on one or more tracks

This defect is characterized by a lack of useful audio data on one or more tracks on the CVR. It is immediately identifiable when listening and by observing the waveform (see Figure below): only noise associated with aircraft power supply is audible.

This CVR audio anomaly is the most detrimental because it makes a valuable source of information for understanding the event unavailable to the safety investigation.

Reference specifications: ED-56A, §1.4.3.a or ED-112/ED-112A §I-1.3.3.a:

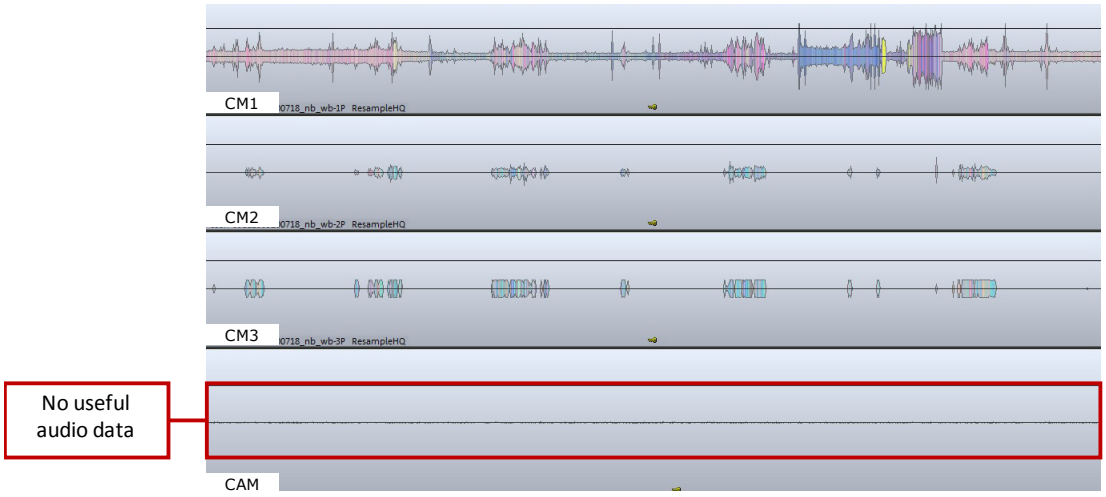


Figure 5: No audio data – Waveform overview

5.4.2 Example: Poor quality of CAM recording

This anomaly can be caused by an intermittent malfunction of the CAM amplification box (Control Unit) or by poor electrical wiring throughout the CAM installation. The overall recording of the CAM signal may be of a very poor quality.

On listening, this defect leads to random variations in signal level: on some portions of the CAM track, the signal may have a very low level, or even be non-existent – thus no audio signal (see Figure below).

This defect results in a loss of useful audio data on the CAM track (warnings, crew exchanges etc.).

Reference specifications: ED-56A, §1.4.3.a and ED-112/ED-112A §I-1.3.3.a.

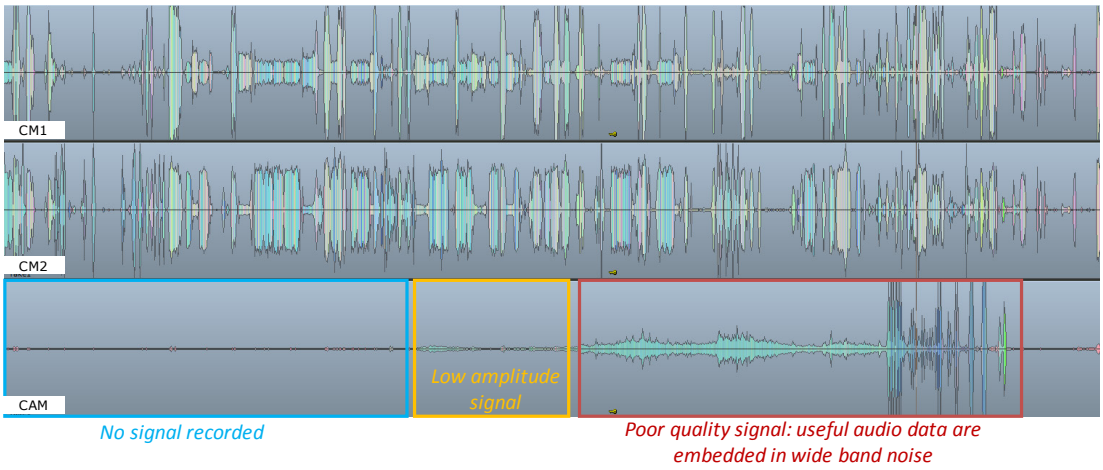


Figure 6: Poor recording quality CAM track – waveform overview

Poor quality of CAM recording
Poor quality of CAM recording
Poor quality of CAM recording
Poor quality of CAM recording

Very good quality of CAM recording

5.4.3 Example: abnormal signal interruption

Audio signal interruption (apart from normal stop of the CVR recording after completion of the flight) should not occur during the recording process on any channel for the recording to be considered satisfactory.

In the example hereafter the CAM signal shows unexpected temporary change of dynamic range associated to some losses of audio signal (see “blank area” in the figure below).

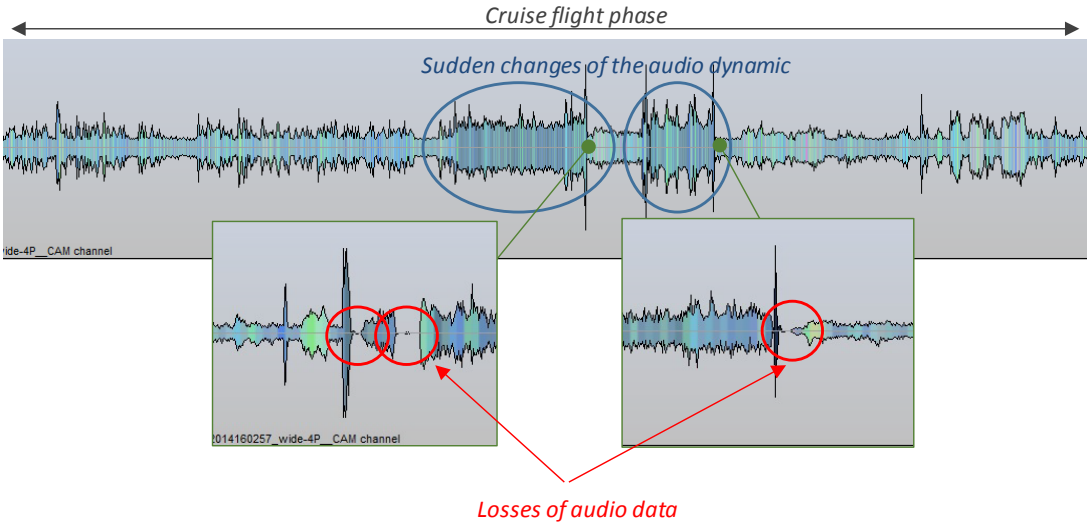


Figure 7: abnormal signal interruption

5.5 Recorded signals

5.5.1 Passenger Address (PA)

PA signal can be recorded on different channels. This signal has to be identified according to aircraft definition and evaluated.

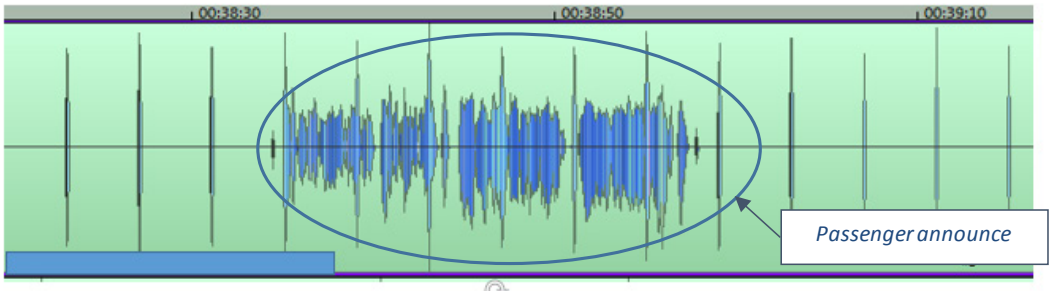


Figure 8: Passenger Address signal

5.5.2 Cockpit Area Microphone

The presence of cockpit crew speech and aural alerts can also be checked on the CAM channel.

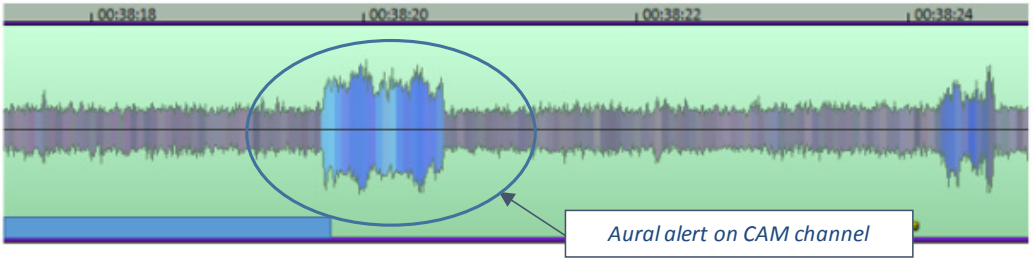


Figure 9: Cockpit Area Microphone

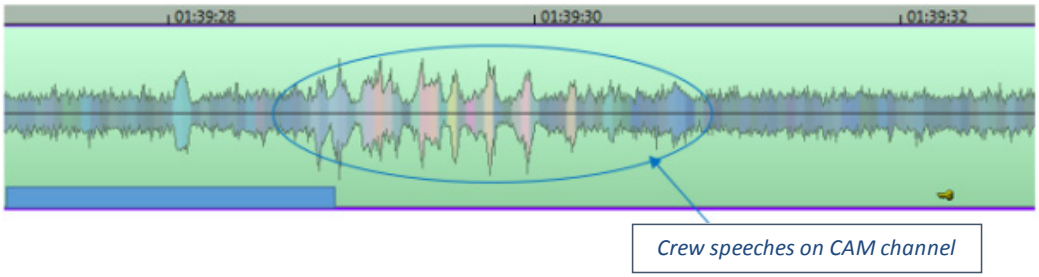


Figure 10: Crew channel

Note: Due to excessive ambient noise inside helicopter cockpits, the example of aural alerts on CAM channel cannot be considered. In this case the presence of aural alerts on the pilot and co-pilot channels should be checked.

5.5.3 Aural alert and warning

Alerts, warnings and audio call-outs should be recorded on the CAM channel.

The check of the audio aural alerts/warning and call-outs on other channels that the CAM should be done for helicopters (see note in 5.4.2).

In review, it might be useful to check normal audio call-outs and aural alerts/warnings are recorded on the other channels in case of a CAM malfunction. In fact, it may support in continued operation of the aircraft if the CAM is inoperative pending the resolution of the issue.

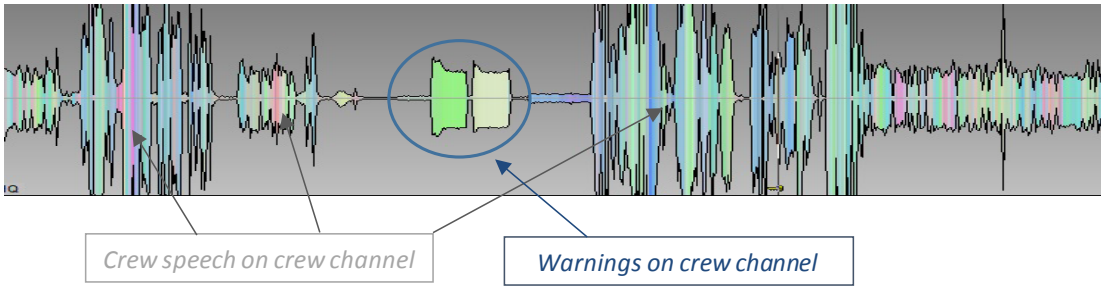


Figure 11: Crew speech and warning on crew channel

5.6 Level balance between tracks

The correct balance between signals should be checked.

The anomaly can be characterized by a level difference between the input signals, particularly with regard to the level of Air Traffic Control (ATC) communications.

In the following example, the ATC message is strongly attenuated on the second track (circled in red), and is almost inaudible.

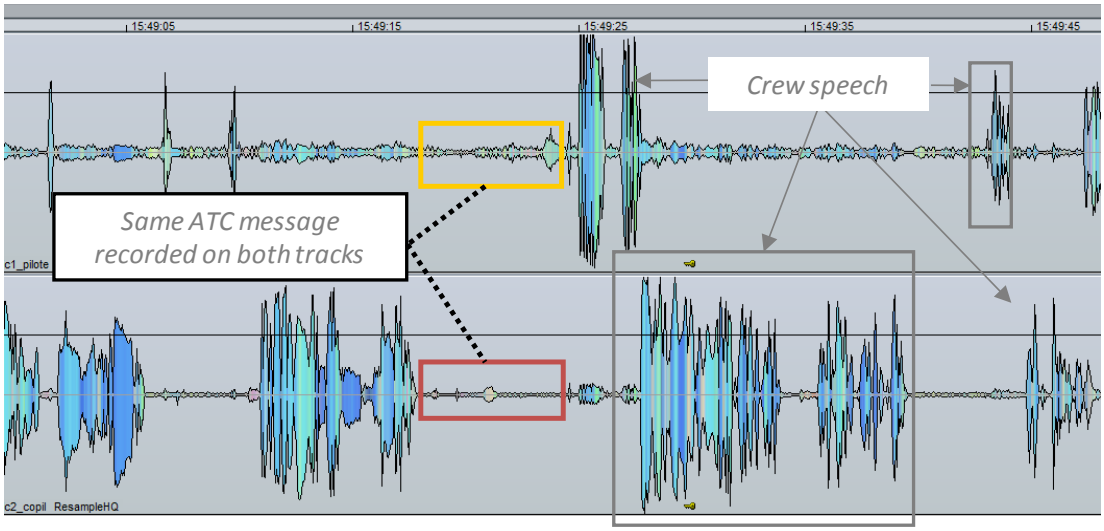


Figure 12: Level imbalance between tracks

Copilot Track__ATC message_Level imbalance

Pilot Track__ATC message_Level imbalance

This defect is detected by observing the waveform of the signal on each track. It can be confirmed by listening to each track separately, the difference in level can then be easily detected.

The example hereafter shows dynamic difference between audio channels: the difference between the sidetone and the reception is very significant (whereas the reception volume control setting is unique for each crew member) and the sidetone is unintelligible on the captain side (which was confirmed by the captain himself during the flight).

Root cause: the headset is not ETSO/TSO'ed and headset interfaces (input and output) are different from MOPS (DO-170 or DO-214).

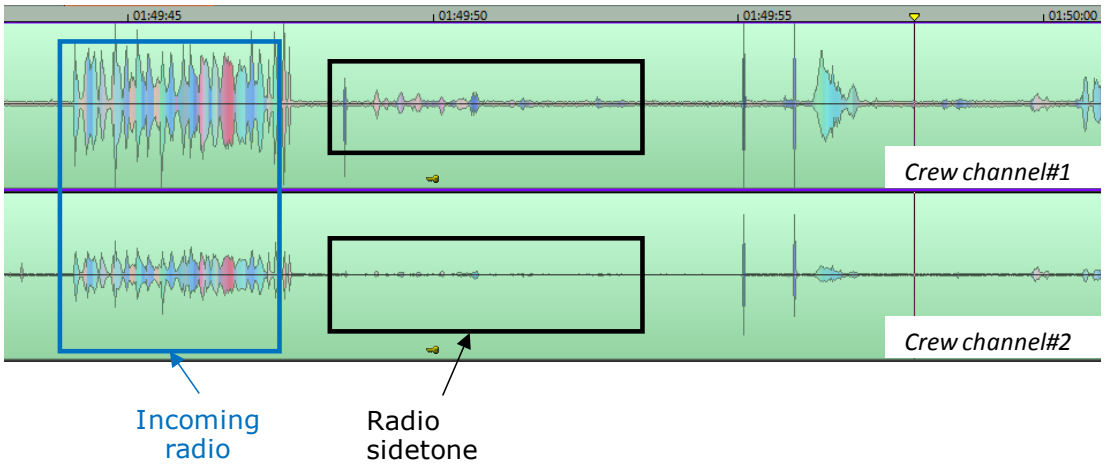


Figure 13: Radio sidetone imbalance

Reference specifications:

- ED-56A - §3.2.5
- ED-112/ED-112A -§ I-3.2.2 (RSL < 3dB).

5.7 Interference

The recorded signal should be inspected to check whether they are free from mechanical and electrical interference. If interference is detected the analyst should determine whether the audio pollution generated by the interference is considered as acceptable.

Hereafter are some examples of interference:

- CVR recording (pilots and/or CAM channels) polluted by aircraft power supply
- CAM recording polluted by the CVR equipment's internal power supply
- CAM recording polluted by hyper frequency pulses(Wi-Fi, GSM, from PED)
- Audio popping events on CAM track

5.7.1 Example : CAM recording pollution by aircraft power supply

This pollution is characterized by the presence of a continuous parasite "sound" on the CVR tracks. The cases studied at the BEA showed that this sound was coming from the aircraft power supply. Listening is then very uncomfortable. This phenomenon appeared mainly on the cockpit area microphone track.

The presence of this anomaly on the recording can be confirmed by spectrum analysis (see Figure 5). This method reveals the presence of a harmonic family with a fundamental frequency moving around 400 Hz (between 340 and 490 Hz – aircraft power supply has a variable frequency for the cases studied). It appears that the greater the harmonic richness (i.e. the energy level of each harmonic frequency), the more severe the pollution will be and render any listening work difficult.

***Note 1**: On some CVRs, the frequency causing of the pollution is stable. It is then tolerated because it provides a useful time frame for the investigation (see ED 56A, §A.1.3.2, NOTE 1 or ED 112/ED-112A, § I-A.3.2.).*

***Note 2**: Audio signal listening and waveform observation make detection of this anomaly possible but are not sufficient to prove its presence (see Figure 4). The use of spectrum viewer is essential to confirm the power supply as the origin of the pollution.*

***Note 3**: It is possible to use signal processing tools to filter this frequency and its harmonics. However, this technique may be difficult to implement because the fundamental frequency of the noise varies during flight. In addition, such filtering should be done with care and precision because if the pollution covers elements of the acoustic signature of the aircraft, removing it entirely (fundamental and each of its harmonics) can lead to the loss of information essential to the investigation.*

This interference causes listening discomfort which decreases the performance of the operator responsible for carrying out the transcription work. In addition, when this pollution is severe, audio data present on the CAM track are hardly usable, especially conversations between crew members.

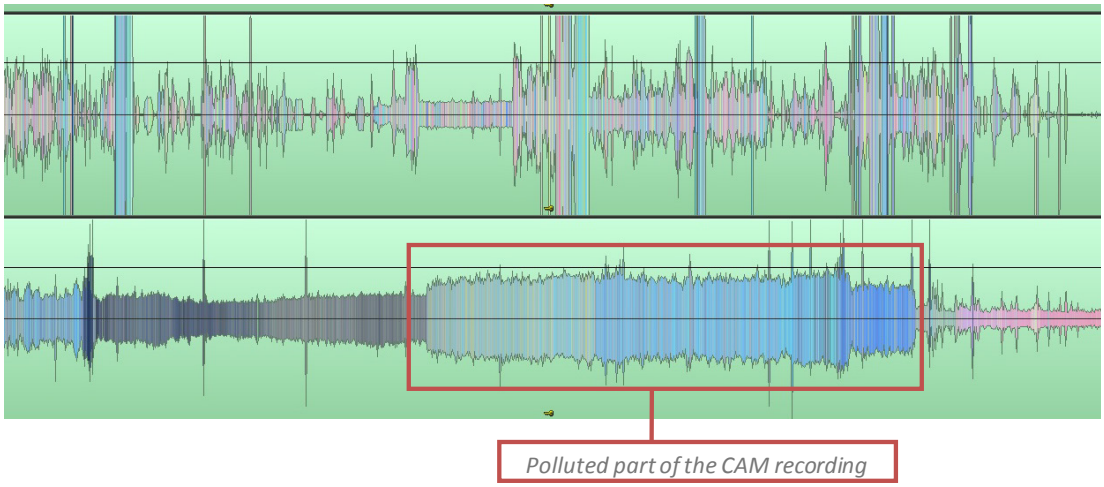


Figure 14: CAM recording pollution

CVR recording pollution by the aircraft power Supply

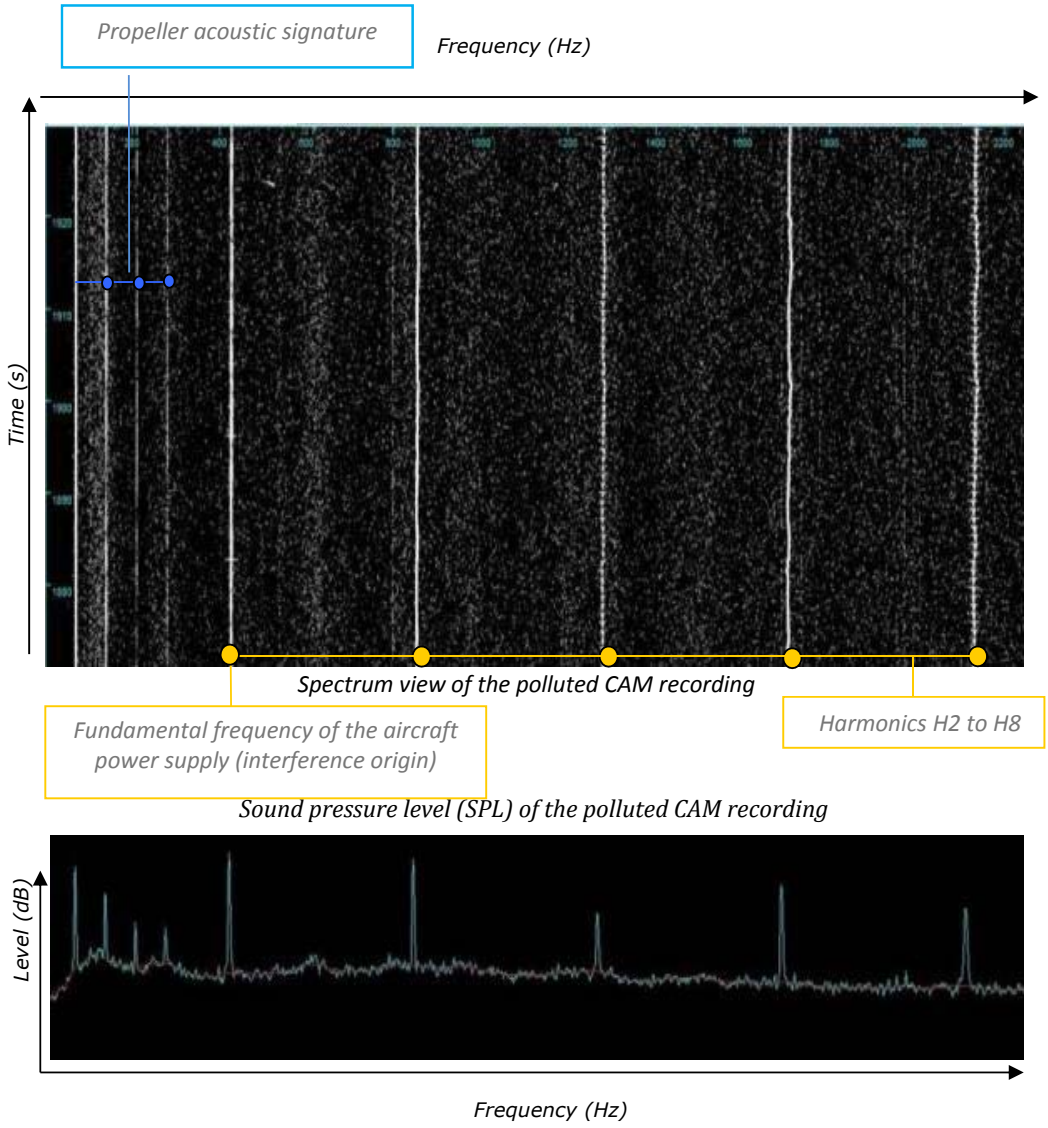


Figure 15: CAM recording pollution – Spectrum view (Spectrum and SPL)

CVR recording pollution by the aircraft power Supply

Another example of CAM defect

On ground, after a particular system activation, the CAM signal is affected by an interference (400 Hz). The noise amplitude increases after a few minutes and lasts during the flight until the engines stopped.

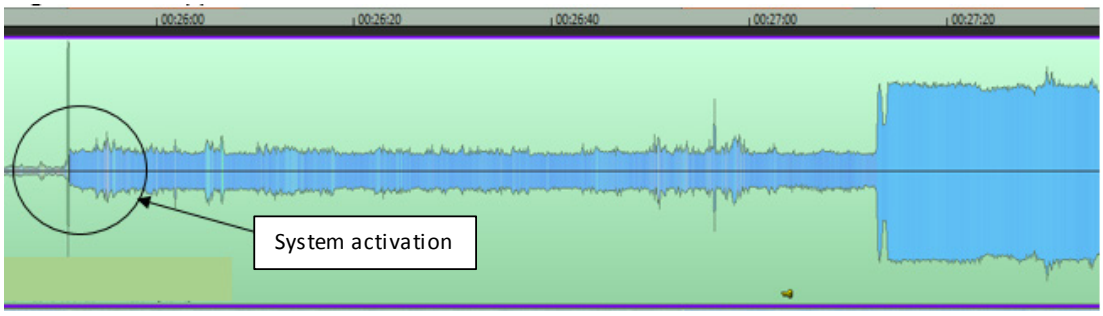


Figure 16: Poor quality CAM after system activation

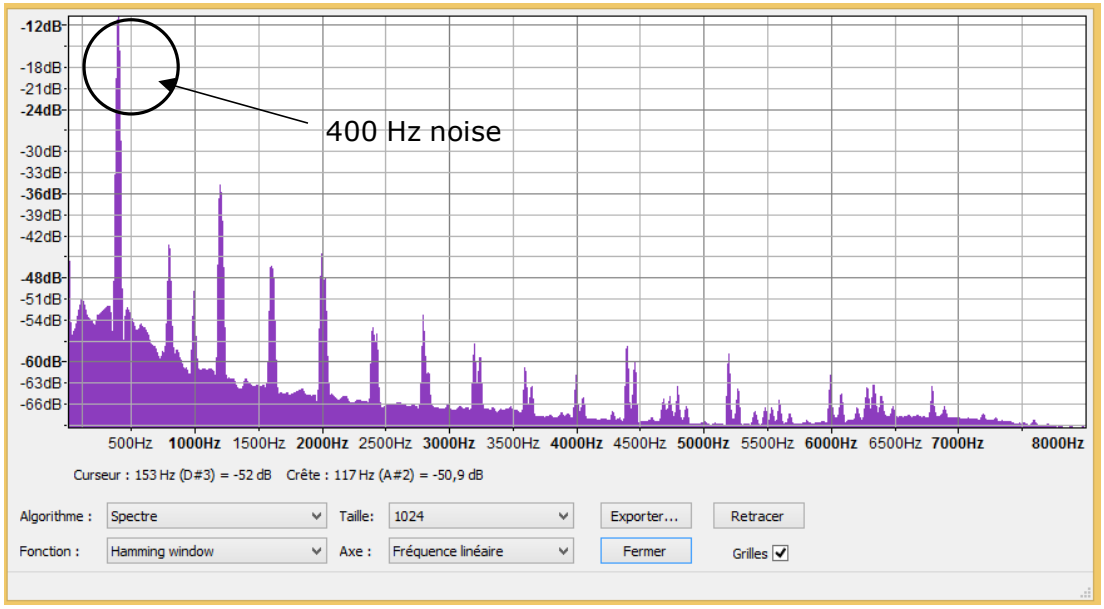


Figure 17: Harmonic family (at a specific time of signal in figure 16)

5.7.2 Example: CAM recording pollution by the CVR equipment internal power supply

This type of pollution can be described as a high level wideband noise (continuous whistle) whose centre frequency fluctuates slightly according to the flight phase. The width of this band is approximately 300Hz. This phenomenon appears when the CVR starts and disappears when the main power supply of the device is cut off (transition to autonomous / alternate power supply) This interference is generated by the internal CVR's electric power supply which also supplies the CAM's preamplification module (Control Unit).

This anomaly is easily detectable because it makes listening work quite uncomfortable. The presence of this type of pollution can be confirmed by a spectrum analysis (see Figure 7).

***Note 1**: Like the previous example, the audio signal listening and the waveform observation make possible a detection of this anomaly but are not sufficient to prove its presence (see Figure 6). The use of spectrum analysis is essential.*
***Note 2**: Depending on the value of the centre frequency, it may be possible to remove this noise by using a notch filter. However, such filtering should be done with care because if the pollution covers over some elements of the aircraft's acoustic signature, removing it can cause a loss of information essential to the investigation.*

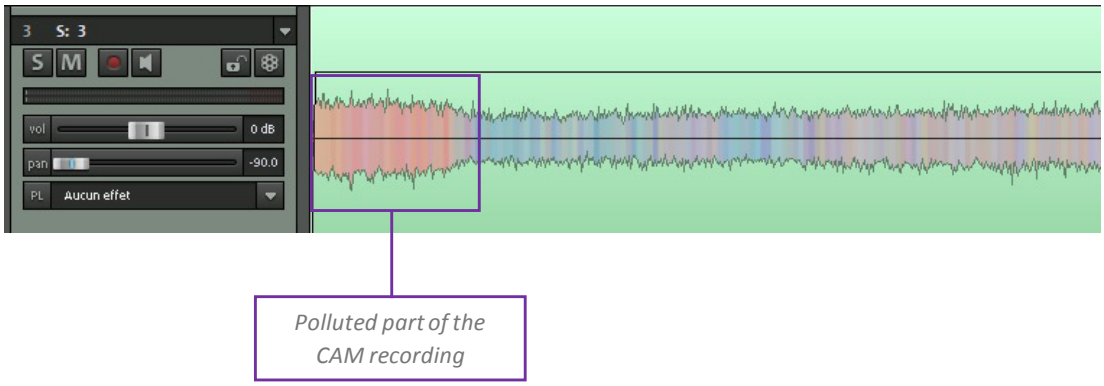


Figure 18: CAM recording pollution – waveform overview

CVR power supply internal interference__in flight
CVR power supply internal interference__on ground

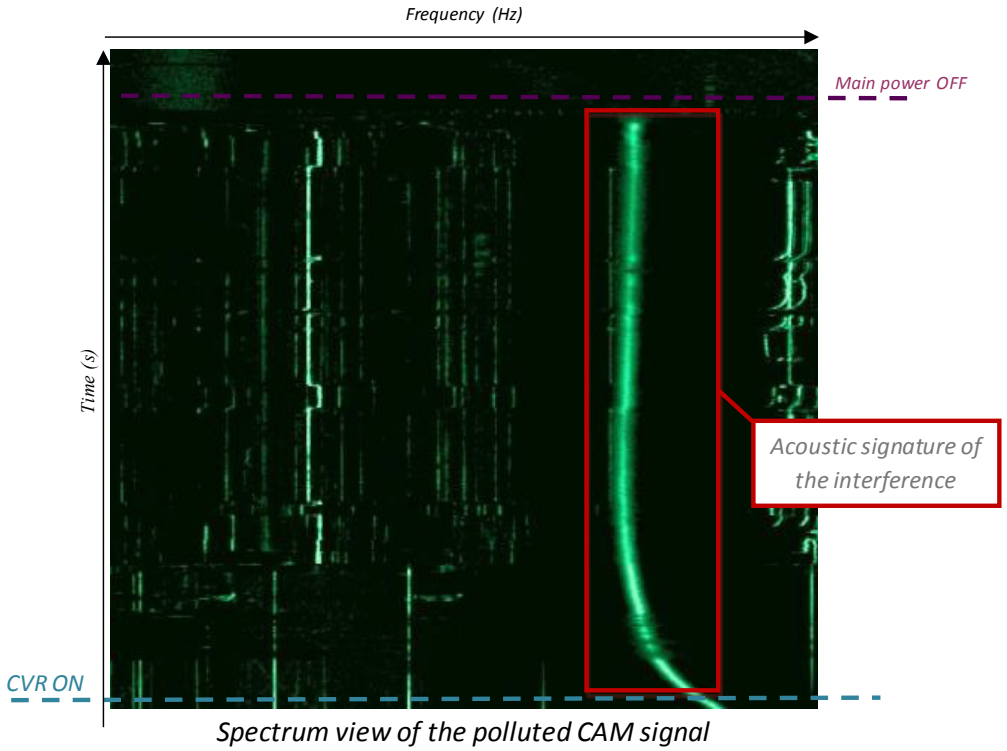


Figure 19: CAM recording pollution – Spectrum view

CVR power supply internal interference__in flight
CVR power supply internal interference__on ground

5.7.3 Example: CAM recording pollution by hyper frequency burst (Wi-Fi and/or GSM pulses)

This anomaly is characterized by the presence of interference on the CAM track. Depending on the level of the transmission, such interference may cause poor perception or even total masking of cockpit conversations. This defect can be detected by listening to the audio recording. A spectrum analysis will confirm its presence (see Figure below).

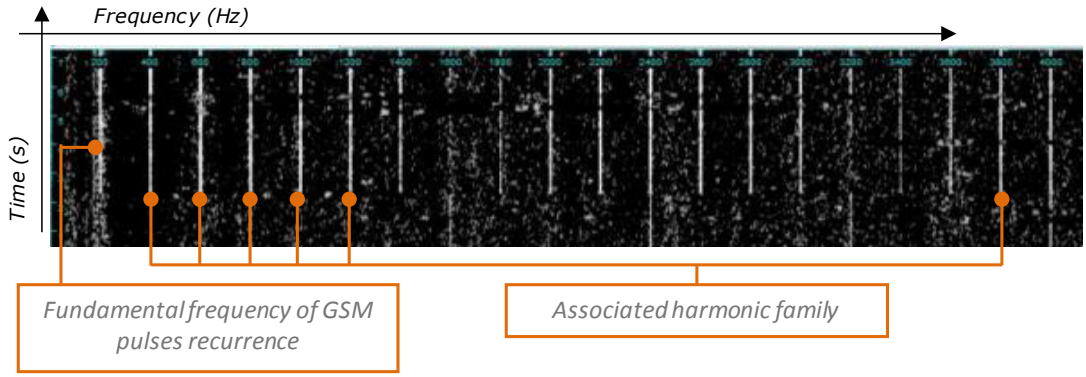


Figure 20: CAM recording pollution by GSM pulses – Spectrum view

GSM interference_CAM

Note: *the interference generated by GSM[7] pulses depends on the frequency used (e.g. 450 MHz, 900 MHz, 1800 MHz, 2.4 GHz). This pulse is transmitted every 4.6 ms. This periodic transmission produces, on the CVR acquisition installation, an audible signal whose fundamental frequency is 217Hz and some harmonics.*

[7]GSM: **G**lobal **S**ystem for **M**obile communication.

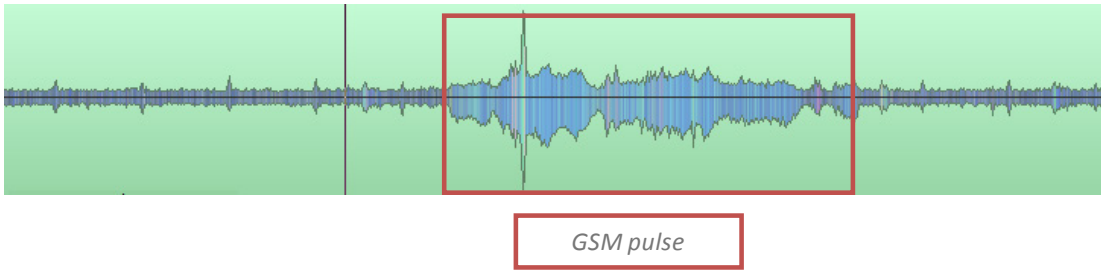


Figure 21: CAM recording pollution by GSM pulses – waveform overview

GSM interference_CAM

Another example is the following spectrum overview where electrical interferences can be identified in flight on channels 1 and 2.

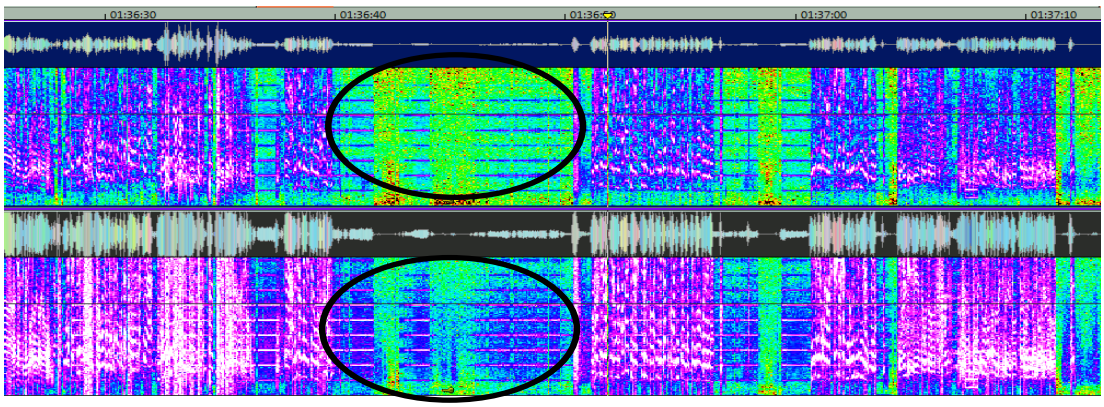


Figure 22: GSM interferences (circled)

GSM interference_CAM

5.7.4 Example: Audio popping on CAM track

This problem appears when listening as a succession of «pops» on the CAM track. It is due to the sensitivity of the CAM line (cockpit area microphone, preamplifier,etc.) to electrostatic discharges at the vicinity of CAM line elements or harness (ESD radiation). This event is predominant and easily identifiable on the waveform (Figure 23). It is similar to a succession of peaks creating clipping on the waveform.

ESD phenomenon are at the origin of these recurrent saturation; it either reach the electric saturation point of the microphone cell itself when the ESD aggression occurred close to the microphone, or reaches the maximum admissible range of the CVR's CAM channel entrance when the ESD aggression applied to preamplifier and/ or harness.

The defect becomes apparent with a spectrum analysis (see Figure 24): it may look like a series of «peaks» with variable levels of energy. The rate of occurrence of these peaks is irregular: they may appear quasi-periodically or completely erratically.

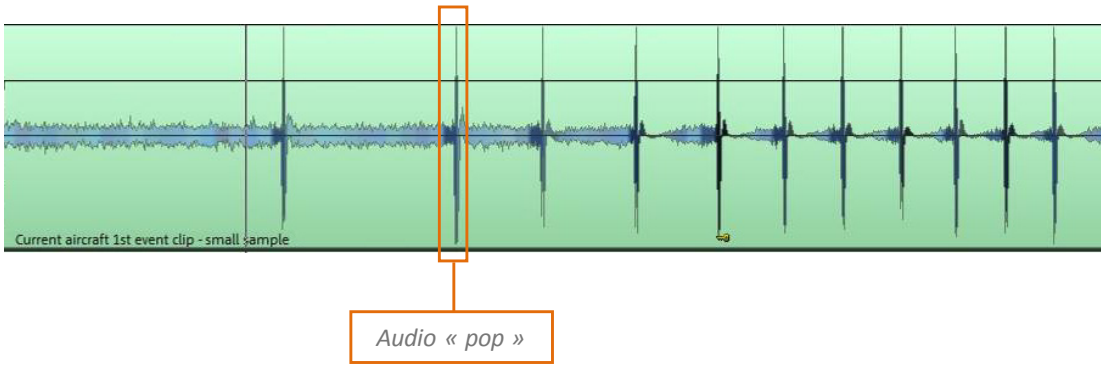


Figure 23: Audio popping on CAM recording – Waveform overview

Erratic popping_CAM
Reccurent popping_CAM
Permanent popping_CAM

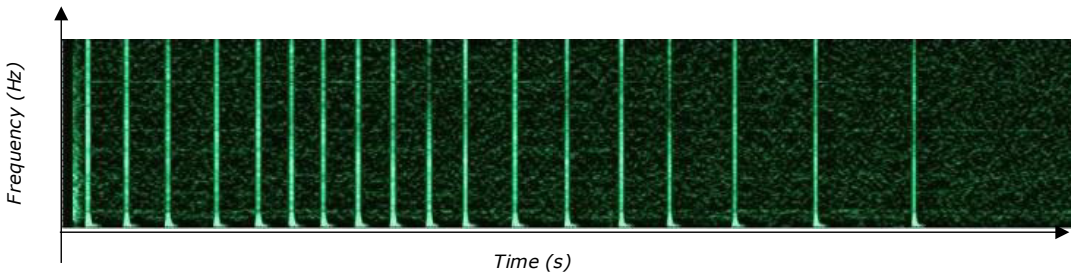


Figure 24: Audio popping on CAM recording – Spectrum view

5.7.5 Example: Mechanical interference

A typical example of mechanical interference is the airflow coming from the air conditioning, mechanical vibration of the CAM housing of the CAM microphone, or vibration of a part of the aircraft. Hereafter, the figure shows severe vibrations of the nose landing gear door that impacted the CVR quality.

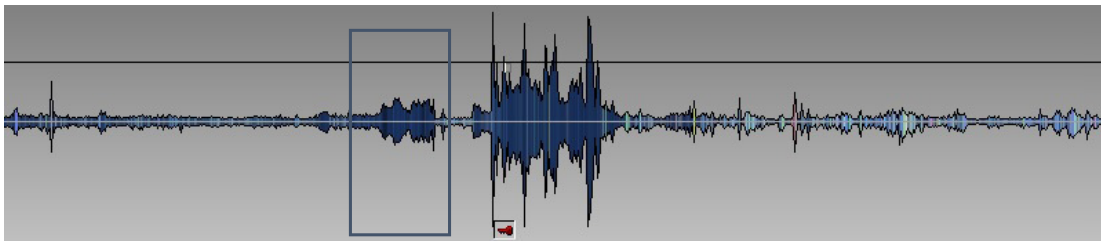


Figure 25: vibration occurrences (highlighted)

Mechanical interference_CAM mic

Vibration phenomenon creates on spectra high energy on a frequency band (narrow or medium band as illustrate below); at a high level of vibration the full audio bandwidth could be saturated, covering all the useful audio signal (speeches, warning,etc.).

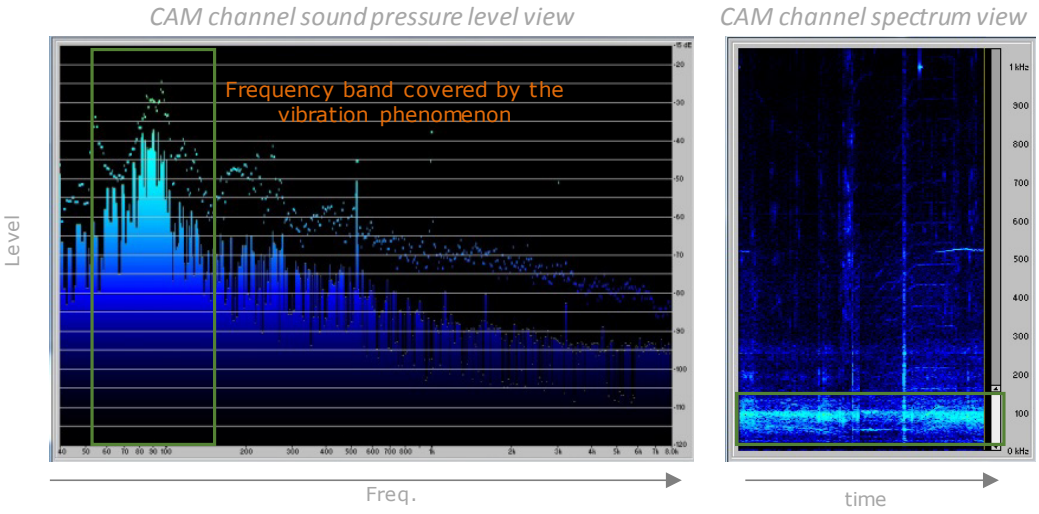


Figure 26: SPL computation at a specific time of signal of figure 25

5.8 Signals recording saturation

5.8.1 Electrical saturation (maximum acceptable entry level of audio chain reached)

Detection of signal saturation (or clipping) can be easily performed by audio analysis tool. It is then necessary to evaluate the detected saturated parts (strength, duration) with regard to intelligibility.

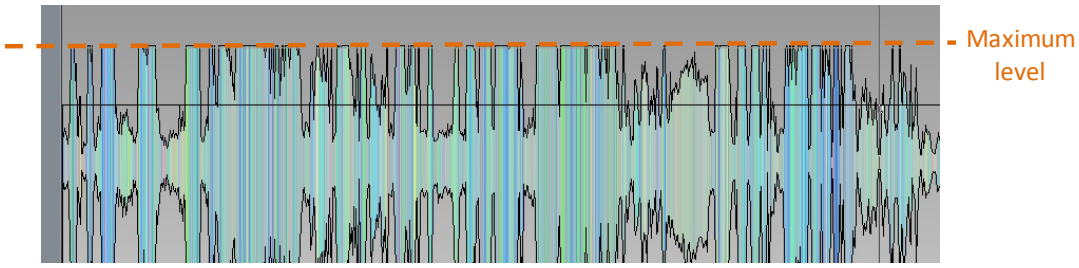


Figure 27: electrical saturation

Electrical saturation_Crew MIC channels

5.8.2 Mechanical saturation

This type of CAM saturation signal is due to an excessive sensitivity of the CAM. This saturation is acoustic, not electrical, because observation of the waveform indicates that the signal does not reach the maximum amplitude allowed by the CAM (no clipping on the waveform) (see Figure below). When listening, the recording is indeed distorted and all relevant audio signals (conversations, warnings, callouts, etc.) are covered by the low frequency noise.

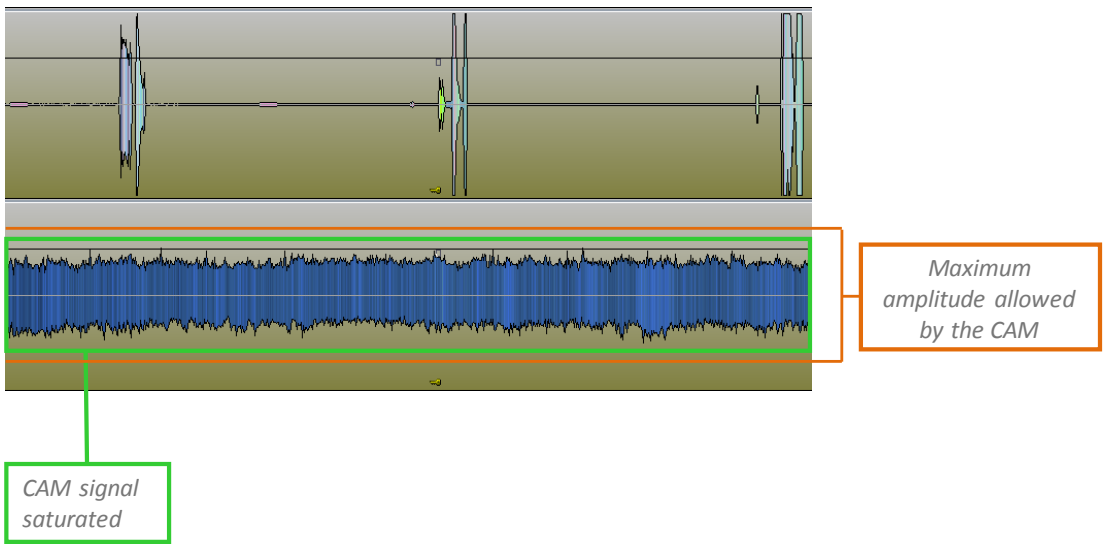


Figure 28: CAM recording saturation – Waveform overview

Mechanical saturation

A spectrum analysis makes it possible to reveal this anomaly. In the example below, a harmonic family with fundamental frequency of 80 Hz (probably the acoustic signature of the aircraft propeller) is present. An SPL shows that this low-frequency harmonic family has a clearly predominant level compared to the general level of the CAM signal. This high level of energy is the cause of the acoustic saturation.

This anomaly causes listening discomfort which lowers the performance of the person responsible for carrying out the transcription work. It can even lead to loss of useful information (communications or alarms/warnings).

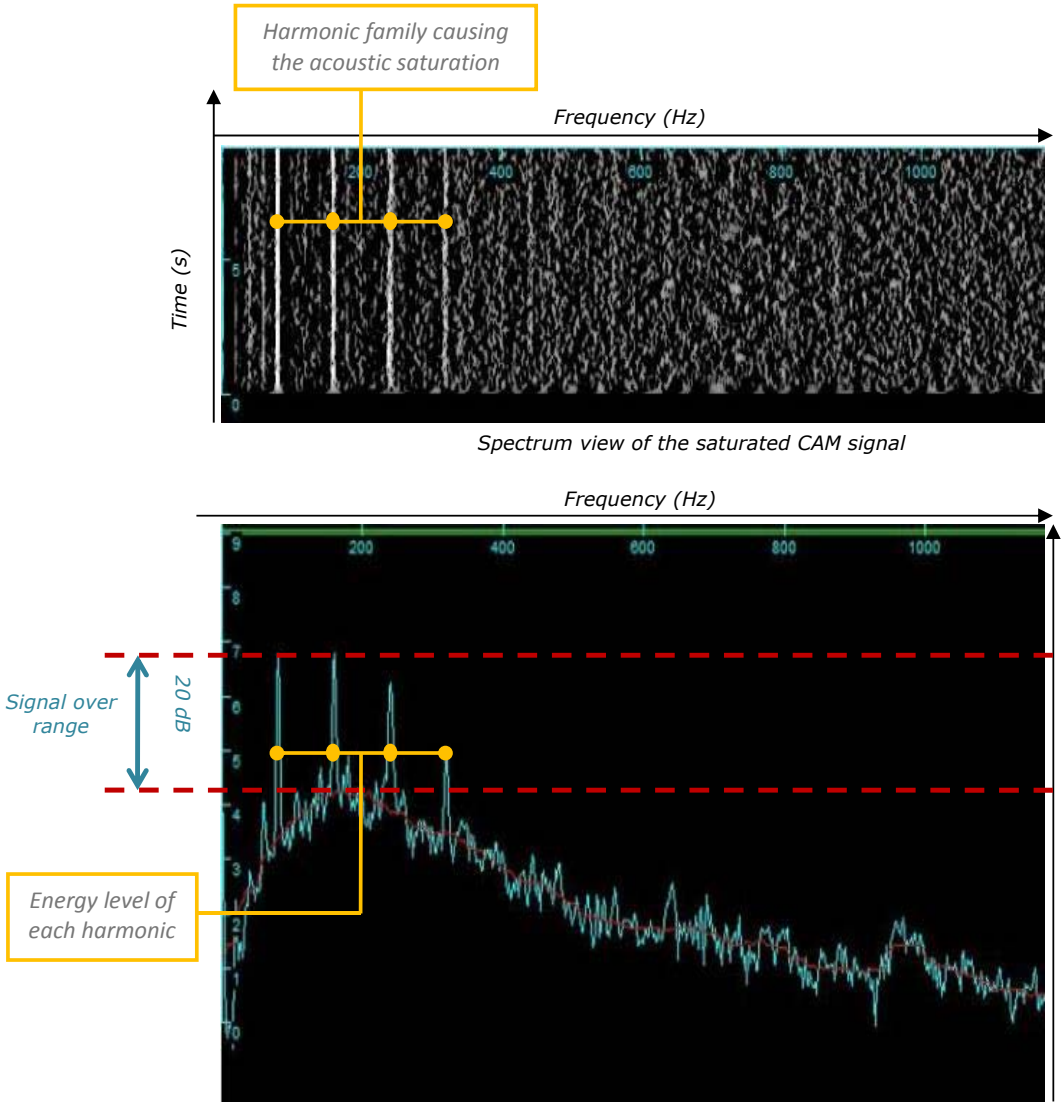


Figure 29: CAM recording saturation – spectrum views

5.9 Additional tests or checks / other miscellaneous anomalies

5.9.1 Start – Stop Function

This test is typically a scheduled Maintenance Planning Data (MPD) task which will be done in accordance with the Aircraft Maintenance Manual (AMM). It could save time if performed at the same time as the CVR recording inspection.

Start / Stop function is easy to identify in the recording as it shows specific signature. Checking the start-stop function makes sure that the recording was not overwritten and the recording under inspection matches the very last flight.

Part-CAT, CAT.IDE.A.185 (f) and **(g)** and **CAT.IDE.H.185 (e)** and **(f)** indicates when the CVR shall start and stop.

In the example hereunder, the spectrogram makes easy to identify the last recording phase (noise level reduction) and actually, the recording stopped 5 minutes after engine stopped.

After the engine stopped, there could be a power interruption (electrical transfer) which can be easily detected through a typical impulsion.

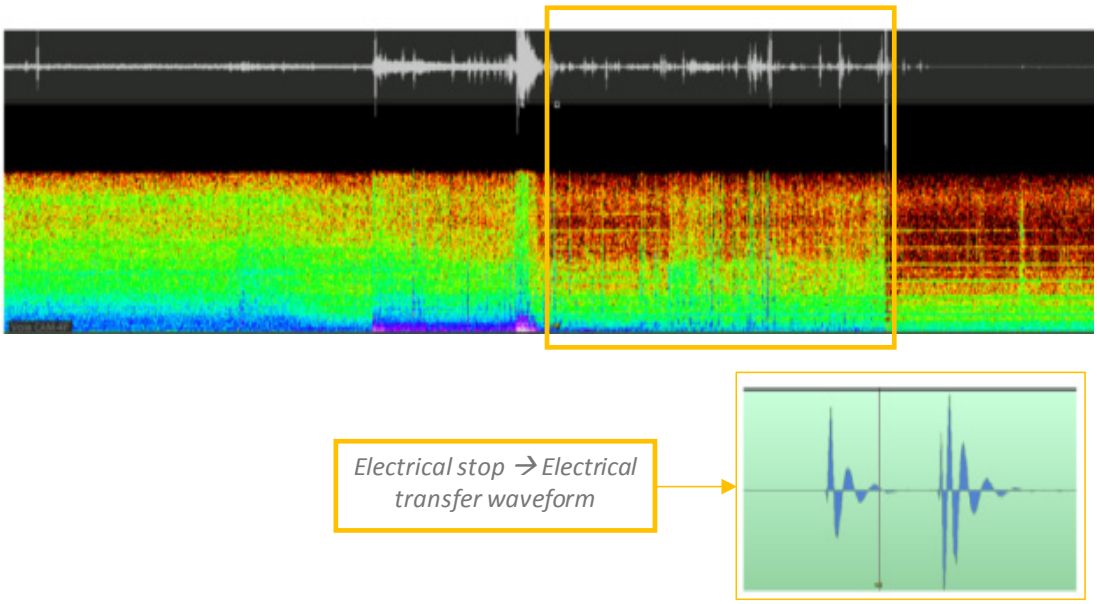


Figure 30: Start – Stop Function

5.9.2 Hot microphone function check

This function should be evaluated with regard to MOPS (ED-56A, ED-112 or ED-112A).

Hot-mic is different from interphone. Even if the CVR has been certified, it does not mean that Hot-mic was fitted on the aircraft at that time.

Furthermore, a new headset with Active Noise Reduction (ANR) can impact the level of Hot-mic and make it inappropriate if the signal is always flooded under the radio reception signals

Hot-mic function is designed within the audio system and not within the CVR even if the signal is added to the CVR data. TSO status (ETSO-C58A FAA TSO-C139a) can give information about the implementation.

The analyst should therefore get the information with the work order if the affected aircraft is equipped with Hot-mic (add to Appendix 1)

If Hot-mic is fitted but not identified during the flight, result summary should mention: “Not identified during the flight. No status” and explain why the Hot-mic has not been detected.

For instance, Hot-mic function was not requested by FAA before April 2010 nor EASA. An aircraft with a CofA anterior to 01 April 2010 which was registered under FAA mandate could be still operated without this function. The example hereunder shows the behaviour of Hot-mic. Crew speech is recorded whereas no PTT was selected.

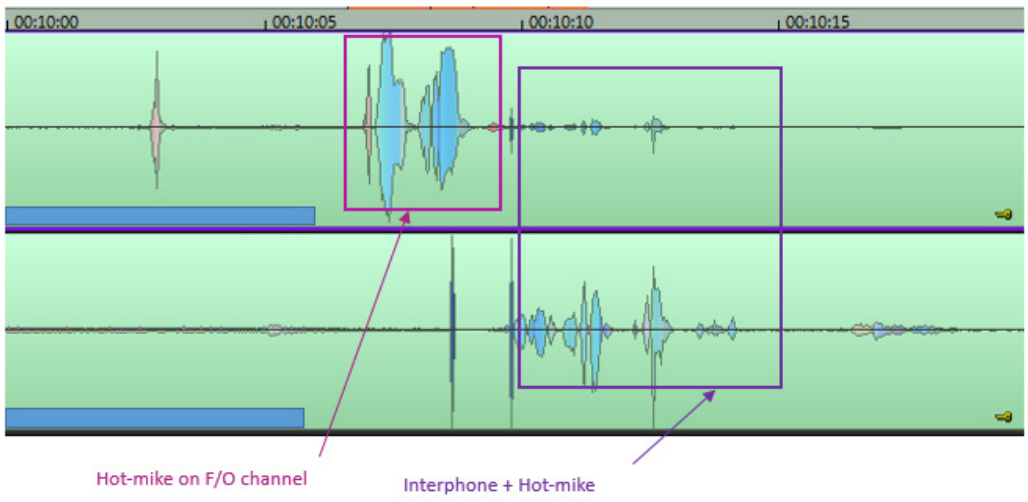


Figure 31: Hot mic function

Hot-Mic default_no corresponding speech on pilot channel
Hot-Mic default_pilot speech on CAM

5.9.3 Phase shift between channels

It sometimes happens that some audio signals (crew conversations, warnings, ATC communications, etc.) are not recorded with the same phase on each track of the CVR. This phase shift is particularly troublesome when it is 180 ° (opposite phase signals).

Phase shift between CVR channels may impact the audio quality when they are mixed. The analyst should take care of this phenomenon when

- several channels are replayed at the same time during evaluation, and
- when the CVR is equipped with a mixed channel that records 2 hours of audio data from the crew channels

In the first case, the analyst may consider that the audio signals are not of adequate quality while the individual replay of each track would show that the audio quality is adequate. This issue can be solved with standard audio analysis tool by modifying the signal phase of tracks.

The second case should be considered a major issue as this anomaly is similar to a loss of audio data and is detrimental to any analytical work on audio recordings, particularly if some of the information useful for the investigation can be found only on the mixed track.

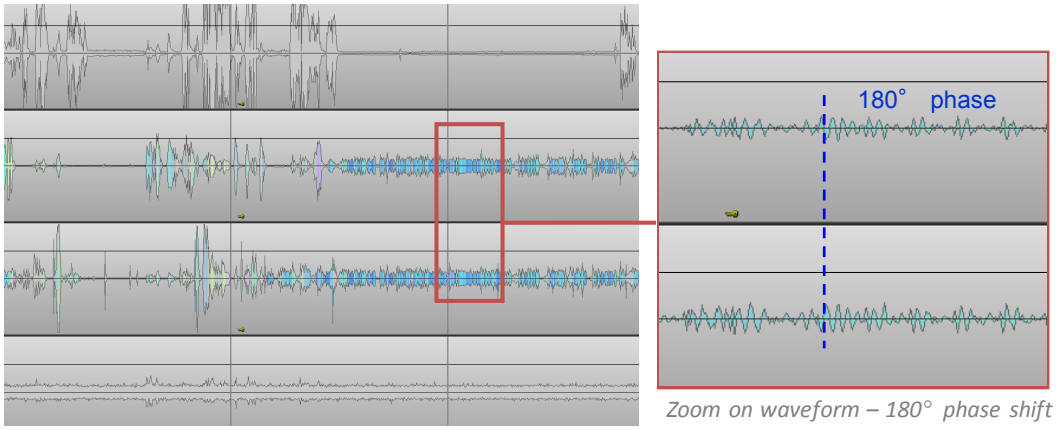
In practice, the same sound event (ATC message, warnings, etc.) will have weakened or even canceled amplitude if it is recorded on a mixed track on the CVR. The effect of this anomaly also appears when the tracks containing phase shifted signals are synchronized and played back simultaneously.

However, as the multiple signals received by the audio management unit have different amplitude, the result of phase shift will mostly be a strong attenuation of the signal.

- This anomaly can be detected if the CVR has a mixed track, observation of the waveform and listening to the audio content on that track will reveal the defect immediately, especially if the other tracks have «normal» waveforms.
- If the CVR does not contain a mixed track, listening simultaneously all the CVR tracks once synchronized will reveal the anomaly: signals present on tracks will have low amplitude. A comparison of each track's waveforms will confirm the «diagnosis». Better detection is possible by enlarging the track waveforms where a noticeable event is recorded (ATC messages, warnings, transient high amplitude signals...). The phase shift will be more visible at this location.

Reference specifications:

- *ED-56A, §1.4.3.a*
- *ED-112/ED-112A, §I-1.3.3.a*



Zoom on waveform – 180° phase shift

Figure 32: Audio signals in opposite phase – Waveform overview

Phase shift__mix of pilot and copilot tracks
Phase shift__one crew member track only

5.9.4 Miscellaneous

Additional items can be considered. Hereafter, some examples of anomalies that were encountered during inspection.

Erroneous memory management

This anomaly is characterized by a distortion of the audio signal. In some parts of the recording, the signal becomes unintelligible and includes electronic noises. It may happen that some parts of the signal have very low amplitude and sometimes a total lack of audio data (audio blanks).

This problem can be quickly identified by observing the waveform of the CVR recording (see Figure below), observation confirmed by listening to the audio data. Generally, the waveform presents «blanks», significant differences in amplitude on the same track (alternation of saturated signal and low amplitude signal). This defect often makes CVR recordings unusable, causing partial or total loss of audio data. In this particular case, the CVR was considered as unserviceable and no further examination of the LRU was performed.

Reference specifications:

- ED-56A, §3.2.1 and §A2.3
- ED-112/ED-112A, §I-2.1.3.

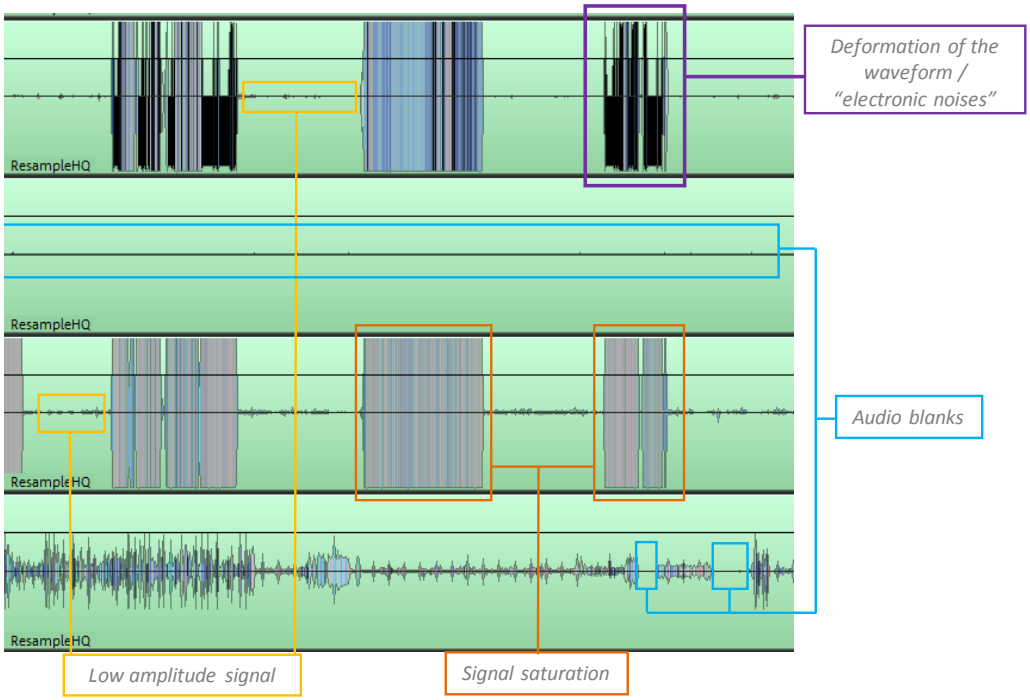


Figure 33: Erroneous memory management – Waveform overview

Erroneous memory management

5.10 Recommendations for capitalization: historical issue

Encountered anomaly logging is recommended for building up a knowledge and experience database.

6 - ASSESSING AND MANAGING THE CVR RECORDING QUALITY

6.1 Quality ratings definition

The audio quality rating of a CVR recording is based on the assessment of the required signal sources: the audio quality rating of a CVR recording cannot be better than the worst audio quality rating among all required signal sources.

In practice, the overall assessment of the CVR recording quality usually relies on the audio quality rating of individual CVR channels. Therefore, the audio quality rating of a CVR channel cannot be better than the worst audio quality rating among all required signal sources considered for this CVR channel.

***Note 1**:*
A 'required signal source' means a signal source which is required to be recorded according to the applicable operating requirements. For example, in the case of an aeroplane used for commercial air transport by an operator subject to EU rules for air operation, the required signal sources are listed in Part-CAT, CAT.IDE.A.185, point (e)[8]. A CVR channel can record only one signal source (e.g. the CAM channel typically only records signals from the CAM) or several signal sources (e.g the captain's channel typically records signals detected by the captain microphone as well as signals transmitted by the captain's headset).

***Note 2**:*
The audio quality of a required signal source needs to be assessed only on one CVR channel, even if it is recorded on several CVR channels. However in that case, the inspection report should clearly indicate on which channel the audio quality of the required signal source was assessed.

Example 1:
On a CVR channel, one of the required signal sources recorded has the audio quality rating 'fair' while all other required signal sources recorded on this CVR channel have the audio quality rating 'good'. Then the quality of this rating channel is 'fair'.

Example 2:
On CVR channel 1, one of the required signal sources recorded has the audio quality rating 'poor' while all other required signal sources recorded on this CVR channel have the audio quality rating 'good'. If the poor signal source is repeated on another CVR channel and its rating is 'fair' or 'good', then the signal source may be disregarded in the audio quality rating of CVR channel 1, and therefore CVR channel 1 could still get a rating quality 'good'.

The evaluation should be done signal source by signal source for each CVR channel (see table in appendix 2 and 3).

[8] '(e) The CVR shall record with reference to a timescale:
(1) voice communications transmitted from or received in the flight crew compartment by radio;
(2) flight crew members' voice communications using the interphone system and the public address system, if installed;
(3) the aural environment of the flight crew compartment, including without interruption:
(i) for aeroplanes first issued with an individual CofA on or after 1 April 1998, the audio signals received from each boom and mask microphone in use;
(ii) for aeroplanes referred to in (a) (2) and first issued with an individual CofA before 1 April 1998, the audio signals received from each boom and mask microphone, where practicable;
(4) voice or audio signals identifying navigation or approach aids introduced into a headset or speaker.'

For each signal source, the following ratings are recommended in the frame of the CVR recording inspection:

- **GOOD**:
  - 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, inadequate signal level of a source) affects the quality of this signal;
  - when considering a non-vocal signal source recorded on a channel other than the CAM channel, the signal is accurately **identifiable in the recording without using any signal post-processing techniques**, and no significant issue affects the quality of this signal;
  - when considering the CAM, the recording is representative of **the actual ambient sound, conversations and warnings as if an observer was listening in the cockpit, and no significant issue affects the quality of the signal**.

The issues associated to 'good' rating shall be not significant, i.e. the issue severity is neither 'medium' nor 'major' (see Table 1 for examples).

- **FAIR**:
  An issue significantly affects the considered signal source. 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 (ex: audio level adjustment, notch filter, etc.).
  The severity of issues associated to 'fair' rating may not be higher than 'medium' (see Table X for examples).

- **POOR**:
  The considered signal source is not intelligible or not identifiable and this issue cannot be corrected even with the use of signal post-processing techniques.
  The severity of the issues associated to 'poor' rating is not necessarily 'major', it could also be 'medium' depending on the consequence for the required signal sources (see Table 1 for examples).

- **N/I**:
  Not identified in the recording. This refers to a required signal source that is not present during the recorded flights (e.g. oxygen mask microphones, warnings). No status.

- **"-"**:
  Not applicable

Note 1:
In the case of the CAM, the evaluation should consider the aircraft type (rotary or fixed wing) and that ambient noise may vary depending on the phase of flight, which may affect the ability to accurately transcribe all crew speech.

Note 2 :
'Intelligible' *means that the audio recording quality is such that it is possible for a speaker familiar with the language spoken to make an accurate transcript of the communications and of synthetic voice in audio callouts, warnings and alerts.*

The inspection report should indicate for each required signal source whether the audio quality is **good**, **fair** or **poor** and it should provide the **quality rating scale** used to assess the audio quality.

Not only the duration of an issue is relevant but also the occurrence rate and the consequences on the intelligibility of the required signal sources should be considered as well. A good example is the so-called “popping audio” mentioned in section 5.7. The phenomenon can be acceptable if it appears once or twice a flight (the audio quality of the affected signal source could be considered ‘fair’). However, if the phenomenon occurs frequently so that it results in unintelligible portions of recordings, the audio quality of the affected signal source should then be considered as ‘poor’.

Based on the investigation authorities’ experience, keeping records of audio quality issues is important for ensuring effective follow-up during subsequent inspections. Indeed, when portions of the CVR recording are affected by an audio quality issue, this may be the precursor of more severe issues affecting the CVR system. Thus, an issue affecting a required signal source on any CVR channel should be mentioned in the inspection report, even if the signal source is repeated and found good on other CVR channels.

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

Issue severity	Examples of issues
MAJOR leading to "poor " rating for the affected signal	❒ One or more warning or callout is not recorded ❒ Uncommanded interruption of the CAM signal ❒ Unexplained variation of the CAM dynamic range ❒ Hot mic function not operative (cf A/C CoFA) ❒ CVR time code not available ❒ CAM saturation (due to LF vibration) ❒ Radio side tone is missing ❒ One required signal source is missing from the recording (ex. one mic signal not recorded) ❒ Bad intelligibility of one mic source (ex. speech through oxygen mask mic) ❒ Quasi permanent physical saturation of a mic 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
MEDIUM leading to "poor" or "fair" rating for the affected signals depending on the duration, and the occurrence rate of the issues.	❒ Imbalance of audio event ❒ Audio pollution generated by either the A/C or the recorder power supply ❒ Low dynamic range of the recording on a CVR channel ❒ Low recording level of warning and or callout ❒ Over sensitivity of the CAM line* to hyper frequency activity (Wifi, GSM, …) ❒ Over sensitivity of the CAM line* to ESD phenomenon ❒ Over sensitivity 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 preamp unit+wiring*

6.2 Managing recording quality issues

CVR audio recording quality should be considered as unacceptable when the information required by regulations to be recorded by the CVR (as indicated by the applicable operating requirements) is missing or unintelligible. For example, if a required source signal on a CVR channel is of poor quality and this required signal source is not recorded by another channel, the CVR audio recording quality should be considered unacceptable.

Thus, troubleshooting should then be performed to identify the appropriate corrective actions. To ensure their effectiveness, a CVR audio quality check should be subsequently performed.

1. In case an equipment error is identified as the root cause of an unacceptable quality malfunction, the affected LRU (e.g. CVR, CAM) should be replaced by applying approved maintenance procedures. According to the definition provided in the Certification Specifications for Master Minimum Equipment Lists (CS-MMEL), paragraph CS-MMEL.105. Inoperative means an item which does not accomplish its intended purpose or is not consistently functioning within its approved operating limits or tolerances.

2. In case the root cause of unacceptable CVR recording quality could not be addressed by a maintenance action, the operator should report the issue to its oversight authority. It is up to the oversight authority to decide whether the operation of the affected aircraft may be continued.

In parallel, the CVR system installer and the competent authority for the CVR installer should be informed (ref. EASA SIB 2009-28R1 - flight data recorder and cockpit voice recorder systems serviceability).

Appendix 1 – Example of the inspection request form

Note: the proposed Inspection Request Form for CVR recording inspection should be adapted based on the applicant and the inspection organization provider.

Applicant

Name :	
Date of the request :	
Reference :	

Aircraft

Type :	
Registration :	
Serial number :	
Date of first ICoA :	
Hot-mic function installed :	
FSK function installed :	

Test

Type of test :	
Date of removal / dump:	
CVR Data download tool:	
Test/download reference	

Recorder and CVR track assignment

Device	Manufacturer	P/N	S/N	Mod Dot(s)
Recorder :				
CVR track assignment :	1 : 4 :	2 : 5 :	3 :	

Complementary information of the onboard audio system

Device	Manufacturer	P/N	EUROCAE compliancy
CAM cockpit Area Microphone:			
C/U or preamplifier:			
Audio Management Unit :			
V/UHF :			
V/UHF if various PN :			
Headset / Boomset :			
Hand microphone:			
Oxygen mask :			
:			
:			
:			

Purpose and condition of the test

Attach If necessary the test program, flight test report, and / or other technical document

Audio system compliancy

EUROCAE reference :	

Inspection report release

Expected date :	

Contact / Person in charge

Name :	
Quality :	
Phone number :	
Email :	

Appendix 2 – Example of CVR QUALITY ASSESSMENT REPORT

References information : table to be built based on the information provided in the inspection request form

Results

Recording Channel	**1**	**2**	**3**	**4**	**5**
Function	**Captain**	**F/O**	**3rd and FSK**	**CAM**	**Mixed**
Microphones					
Hot-mic boom	N/I	N/I	N/I	-	N/I
Hot-mic mask if applicable	N/I	N/I	N/I	-	N/I
Hot-mic level	N/I	N/I	N/I	-	N/I
Telephone / PA					
Radio reception	Fair	Good	N/I	-	Bad
Radio sidetone	Good	Good	N/I	-	Fair
Interphone	Fair	Good	N/I	-	Bad
Public Address	-	-	-	-	-
Warnings *	Good	Good	Fair	-	Good
Signal level	Good	Good	N/I	-	Good
Area mic					
Cockpit sounds	-	-	-	Bad	-
Warnings/Call-Outs	-	-	-	Bad	-
Signal level	-	-	-	Bad	-
Time signal	Good	-	-	-	Good
Start – Stop function if applicable	Good	Good	Good	Good	Good
Channel duration					
RIPS/Alternate power supply if applicable				**Good**	
Additional information					
File name (in native format)	Air Flying -xxx				
File name (.wav)	Air Flying_ch1	Air Flying _ch2	Air Flying _ch3	Air Flying _wb	Air Flying _mb

** may only be recorded on the CAM channel depending on the audio system design*

REMARKS:.....
.....

Certified that the above mentioned recording has been evaluated in accordance with the terms of the contract/order applicable thereto and the requirements of the Certification Authority relating to the evaluation of such recordings.

SIGNED: .....
DATE: .....
for and on behalf of XXX

Appendix 3 – Content of the CVR inspection report

The report on the CVR audio quality check should contain:

- information on the device / equipment and the aircraft configuration as provided in the inspection request form (appendix 1)
- the quality rating scale used in the report
- the Identification of the equipment used to download, replay and analyse the CVR audio files
- the test procedure and results with specific observation if applicable.
- the CVR QUALITY ASSESSMENT REPORT (appendix 2) as a summary of the quality check
- Conclusion

Appendix 4 – Non-exhaustive list of major events where the CVR recording was not of good quality

Major accidents in which the CVR recording could not be analysed due to a failure of the CVR system (providing the miss or of poor quality data):

- Auxiliary Power Unit Battery Fire Japan Airlines Boeing 787-8, JA829J Boston, Massachusetts January 7, 2013: https://www.ntsb.gov/investigations/AccidentReports/Reports/AIR1401.pdf
- Interim report on the accident on June 29, 2009 at sea off the coast of Moroni (Comoros) to the Airbus A310-324 registered 7O-ADJ operated by Yemenia Airways: https://www.bea.aero/en/investigation-reports/notified-events/detail/event/decrochage-lors-dune-approche-interrompue-collision-avec-la-surface-de-leau/
- Investigation Report on the Accident to Ethiopian 409 – Boeing 737-800 Registration ET-ANB at Beirut – Lebanon on 25th January 2010: https://reports.aviation-safety.net/2010/20100125-0_B738_ET-ANB.pdf
- Accident to the McDonnell Douglas DC-9-83 registered EC-LTV on 07/21/2014 near Gossi (Mali) https://www.bea.aero/en/investigation-reports/notified-events/detail/event/accident-to-the-mcdonnell-douglas-dc-9-83-registered-ec-ltv-on-07212014-near-gossi-mali/

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