European Aviation Safety Agency

Notice of Proposed Amendment 2017-03

In-flight recording for light aircraft

RMT.0271 (MDM.073(a)) and RMT.0272 (MDM.073(b))

EXECUTIVE SUMMARY

This Notice of Proposed Amendment (NPA) addresses safety and regulatory harmonisation issues related to the need of in-flight recordings for accident investigation and accident prevention purposes. 12 safety recommendations were addressed to the European Aviation Safety Agency (EASA) by 7 safety investigation authorities, recommending an in-flight recording capability for light aircraft models which are outside the scope of the current flight recorder carriage requirements. In addition, new Standards (recently introduced in ICAO Annex 6) require the carriage of lightweight flight recorders for light aeroplanes and light helicopters.

The specific objectives of this rulemaking task are to:

— enhance the identification of safety issues affecting light aircraft by means of data recorded in flight;

— achieve harmonisation with ICAO Annex 6;

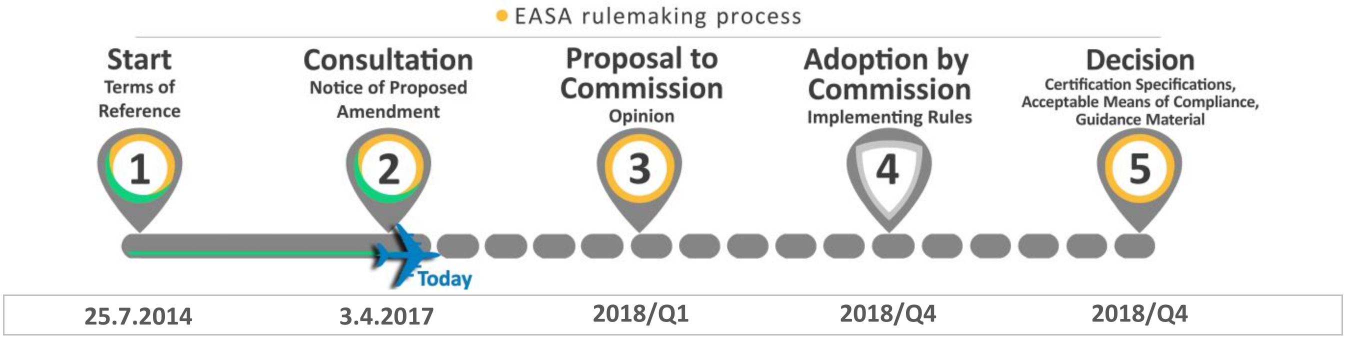
— produce a proportionate regulation which takes into account the General Aviation Road Map; and

— identify avenues other than requiring in-flight recording equipment.

This NPA proposes to mandate the carriage of lightweight flight recorders for some categories of light aeroplanes and light helicopters when they are commercially operated and manufactured 3 years after the date of application of the amending regulation. In addition, this NPA proposes to promote the voluntary installation of in-flight recording equipment for all other light aeroplanes and light helicopters and for all balloons.

The proposed changes are expected to increase safety with limited economic and social impacts.

Action area:	Aircraft tracking, rescue operations, and incident/accident investigations		
Affected rules:	Annex I (Definitions), Annex III (Part-ORO), Annex IV (Part-CAT), and Annex VIII (Part-SPO) to Commission Regulation (EU) No 965/2012 on Air Operations; Decision 2012/015/R; Decision 2014/017/R; Decision 2014/015/R; Decision 2014/018/R		
Affected stakeholders:	Aircraft operators; aircraft manufacturers; aircraft pilots; safety investigation authorities; competent authorities		
Driver:	Safety; safety recommendations; legal obligation (ICAO Standards)	**Rulemaking group:**	Yes
Impact assessment:	Full	**Rulemaking Procedure:**	Standard



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1. About this NPA

1.1. How this NPA was developed

EASA developed this NPA in line with Regulation (EC) No 216/2008[1] (the 'Basic Regulation') and the Rulemaking Procedure[2]. This rulemaking activity is included in the EASA Rulemaking and Safety Promotion Programme for 2017-2021[3] under RMT.0271 (former task number MDM.073(a) & (b)). The text of this NPA has been developed by EASA based on the input of the Rulemaking Group RMT.0271 & RMT.0272. It is hereby submitted to all interested parties[4] 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/**[5].

The deadline for submission of comments is **3 July 2017.**

1.3. The next steps

Following the closing of the public commenting period, EASA will review all comments and decide on the need to set up a review group to assist EASA in providing answers to the comments.

Based on the comments received, EASA will develop an opinion containing the proposed amendments to Regulation (EU) No 965/2012[6] on Air Operations. The opinion will be submitted to the European Commission, which will use it as a technical basis in order to prepare an EU regulation.

Following the adoption of the regulation, EASA will issue a decision containing the related acceptable means of compliance (AMC)/guidance material (GM).

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

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

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

[3] https://www.easa.europa.eu/document-library/rulemaking-programmes/rulemaking-and-safety-promotion-programme-2017-2021

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

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

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

2. In summary — why and what

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

Since 2010, accidents and serious incidents that occur over the territory of an EASA Member State (MS) must be subject to safety investigation. However, almost all categories of light aircraft fall outside the scope of current requirements to carry flight recorders. In the absence of data on the aircraft condition and operation, it can be very difficult to reconstruct the sequence of events that led to an accident or a serious incident; knowing the sequence of events though is essential for defining actions in order to prevent future occurrences.

This is why recent Standards in ICAO Annex 6 prescribe, for some categories of light aeroplanes and helicopters operated for commercial air transport (CAT), the carriage of in-flight recording equipment. In addition, 12 safety recommendations related to in-flight recording for light aeroplanes and helicopters were addressed to EASA by several safety investigation authorities.

Finally, CAT statistics indicate a significantly higher rate of accidents with balloons compared to aeroplanes and helicopters, which raises the question of the need for in-flight recording on-board balloons with a large passenger capacity.

Several studies of safety investigation reports were performed in order to assess the expected benefit of in-flight recording for preventing accidents through facilitation of safety investigations. The conclusion of these studies is that in-flight recording brings moderate benefit, so that requirements applying to all kinds of light aircraft would not be proportionate. Hence, rulemaking should be focused on those light aircraft used for commercial operations and capable of transporting several passengers.

Besides rulemaking, the potential safety benefit of facilitating and promoting voluntary installation of in-flight recording equipment was also identified.

Note: See Chapter 4, Section 4.1, for detailed explanations.

2.2. What we want to achieve — objectives

The overall objectives of the EASA system are defined in Article 2 of the Basic Regulation. This proposal will contribute to the achievement of the overall objectives by addressing the issues outlined in Section 2.1 above and in Chapter 4, Section 4.1.

The specific objectives of this proposal are to:

— enhance the identification and prevention of safety issues affecting light aircraft by means of data recorded in flight;

— achieve harmonisation with ICAO Standards in Annex 6, Parts I, II and III;

— produce a proportionate regulation which takes into account the General Aviation Roadmap; and

— identify avenues other than requirements for in-flight recording equipment.

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

2.3.1. Changes to the Air Operations requirements

Note: The proposed changes to the implementing rules, AMC and GM are presented in detail in Chapter 3.

2.3.1.1. New concepts and definitions

The concept of 'flight recorder' is extended to in-flight recording equipment for light aircraft, which requires limited crash protection. This makes the introduction of definitions for 'flight recorder', 'flight data recorder' (FDR) and 'cockpit voice recorder' (CVR) necessary in Annex I to the Air Operations Regulation.

The new concept of flight recorders now encompasses 'crash-protected' flight recorders and 'lightweight' flight recorders. A crash-protected flight recorder is capable of withstanding very severe crash conditions such as those encountered during some accidents of large aeroplanes and large helicopters (FDRs and CVRs are crash-protected flight recorders). A lightweight flight recorder is designed to meet less demanding crash-protection requirements, and therefore it can be lighter.

2.3.1.2. New recording requirements for commercial operations with light aeroplanes and light helicopters

New rules are created in Annex IV (Part-CAT) and in Annex VIII (Part-SPO) to Regulation (EU) No 965/2012. These rules require that aeroplanes and helicopters which:

— are commercially operated;

— are manufactured on or after [date of application of the amending regulation + 3 years];

— are not specified by the current Part-CAT and Part-SPO requirements on carrying flight data recorders; and

— have an MOPSC of more than 9 (for aeroplanes) or are turbine-engined with an MCTOM of 2 250 kg or more (for aeroplanes and helicopters),

be equipped with a flight recorder which records flight data and/or images that are sufficient to determine the flight path and the aircraft speed (ground speed or indicated airspeed). The flight recorder shall have a minimum recording duration of 10 hours and an automatic start-and-stop logic.

AMC are created in order to provide the operational performance objectives for the new flight recorder carriage requirements. The AMC specify the flight parameters to be recorded and the operational performance target for these flight parameters. The AMC also specify the information to be captured if recording images is preferred to recording flight parameters. Furthermore, the AMC also recommend that the operational performance of the flight recorder meet the specifications laid down in industry standards (EUROCAE Document 155 or EUROCAE 112 or equivalent standards recognised by EASA).

2.3.1.3. Continued serviceability of the flight recorder

Paragraph (b) of CAT.GEN.MPA.195 and related AMC and GM are amended in order to address the serviceability aspects when a flight recorder is installed on a light aeroplane or a light helicopter. In summary, three kinds of checks are expected to be performed on flight recorders:

— inspection of the recording to check the quality and completeness of the recorded data (already applicable to crash-protected flight recorders and required for lightweight flight recorders);

— daily use of the means for preflight check of the flight recorders for proper operation (already applicable to crash-protected flight recorders and required for lightweight flight recorders);

— calibration check of some flight parameters (only applicable to FDRs).

Paragraphs (c) and (d) of CAT.GEN.MPA.195 are amended to take into account the new flight recorder carriage requirements.

The same amendments are made to SPO.GEN.145 and to related AMC.

2.3.1.4. Protection of image recordings

Paragraph (f) of CAT.GEN.MPA.195 is amended in order to address the protection of image recordings:

— reference is added to Regulation (EU) 2016/679 on General Data Protection[7];

— images of the flight crew compartment recorded by a flight recorder may only be used for the following purposes:

- as stipulated in Regulation (EU) No 996/2010;
- to maintain or improve safety (in which case a procedure related to the handling of images and the consent of all crew members is required); or
- to ensure flight recorder serviceability (in which case protecting the privacy of images is required and no other use is allowed except serviceability).

AMC are created to address the use of flight crew compartment images recorded by a flight recorder. These AMC follow the same principles as the already adopted AMC, which address the use of CVR recordings.

2.3.2. Promotion of in-flight recording

The retained options include promoting the benefit of in-flight recording, in particular:

— the recording of flight parameters, images and audio in the flight crew compartment for aeroplanes and helicopters; and

— the recording of trajectory parameters, as well as images of the basket interior for balloons.

While it is not within the scope of this NPA to produce material for such promotion activities, Appendix D presents the potential benefits which could be promoted to industry and identifies factors that may limit the effectiveness of any future promotion activity.

[7] Regulation (EU) 2016/679 of the European Parliament and of the Council of 27 April 2016 on the protection of natural persons with regard to the processing of personal data and on the free movement of such data, and repealing Directive 95/46/EC (General Data Protection Regulation) (OJ L 119, 4.5.2016, p. 1) (http://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32016R0679&qid=1487864197230&from=EN).

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

2.4.1. Summary of the impact assessment (refer to Chapter 4)

With regard to aeroplanes and helicopters, the following options were considered:

— Option A.1: Promote the recording of basic flight parameters, audio and/or a view of the instruments panel for all models of light aeroplanes and light helicopters and for all types of operation (no change to the rules).

— Option A.2: Strictly transpose ICAO Standards in Annex 6 for newly manufactured light turbine-engined aeroplanes and newly manufactured light turbine-engined helicopters operated for CAT.

— Option A.3: Transpose ICAO Standards in Annex 6 with some differences:

- include aeroplanes which have an MOPSC of more than 9;
- include commercial specialised operations (SPO) in addition to CAT; and
- do not require the recording of audio.

— Option A.4: Implement Options A.1 and A.3 together.

With regard to balloons, the following options were considered:

— Option B.1: Promote fitting balloons with means to record trajectory parameters and images from the basket interior (no change to the rules).

— Option B.2: Require newly manufactured balloons used in commercial operations and with an MCTOM of 3 000 kg or more to be fitted with equipment recording the balloon's trajectory parameters and images from the basket interior.

— Option B.3: Implement Options B.1 and B.2 together.

Considering proportionality and cost, it was not found appropriate to develop options for sailplanes.

Regarding aeroplanes and helicopters, Option A.4 is the preferred one because it combines safety promotion (Option A.1) and rulemaking (Option A.3). Option A.4 has a significant positive safety impact while limiting the economic impact and impact on general aviation, and it is proportionate.

Regarding balloons, the rulemaking options (Option B.2 and B.3) have a negative impact on general aviation and proportionality issues, which outweighs the safety benefit. Hence, despite its just slightly positive safety impact, Option B.1 (safety promotion) is the preferred one.

Note: Significant increases, compared to current levels, in the MCTOM and/or passenger capacity of balloons that are commercially operated have the potential to cause a number of fatalities in the aircraft and on the ground comparable to that of large aircraft. Therefore, the trade-off between safety benefit and impact on economic and proportionality issues would need to be assessed again.

2.4.2. Proposal retained for aeroplanes and helicopters

The proposal combines:

— a requirement to record a small set of flight parameters for certain categories of aeroplanes and helicopters; and

— promotion of in-flight recording for all other light aeroplanes and helicopters.

This proposal is expected to have a medium positive to very positive impact on safety (by supporting official safety investigations and operational safety monitoring), a slightly positive impact on rules harmonisation (better alignment with ICAO Annex 6), limited social impact (if a framework is adopted for the protection of images of the flight crew compartment), moderate economic impact (requirement limited to CAT and commercial SPO and to newly manufactured aircraft), and no impact on proportionality issues (requirement limited to turbine-engined aircraft with an MCTOM of 2 250 kg or more and aeroplanes with an MOPSC of more than 9).

2.4.3. Proposal retained for balloons

The proposal is to **promote** fitting balloons with means to record trajectory parameters and images from the basket interior (no change to the rules). No rule change is proposed for balloons.

This proposal is expected to have a slightly positive safety impact and no other type of impact.

Note: For the full impact assessment, please refer to Chapter 4.

3. Proposed amendments and rationale in detail

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

— deleted text is ~~struck through~~;

— new or amended text is highlighted in grey;

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

3.1. Draft Regulation (Draft EASA opinion)

3.1.1. Draft resulting text

3.1.1.1. Annex I (Definitions)

ANNEX I

Definitions for terms used in Annexes II to VIII

(23) 'cockpit voice recorder (CVR)' means a crash-protected flight recorder using a combination of microphones and other audio and digital inputs to collect and record the aural environment of the flight crew compartment and communications to, from and between the flight crew members;

(50) 'Flight data recorder (FDR)' means a crash-protected flight recorder using a combination of data providers to collect and record parameters that reflect the state and performance of the aircraft;

(50a) 'flight recorder' means any type of recorder installed on the aircraft for the purpose of facilitating accident/incident safety investigations.

3.1.1.2. Annex IV (Part-CAT)

ANNEX IV

COMMERCIAL AIR TRANSPORT OPERATIONS [PART-CAT]

SUBPART A

GENERAL REQUIREMENTS

SECTION 1

Motor-powered aircraft

CAT.GEN.MPA.195 Handling of flight recorder recordings: preservation, production, protection and use

[...]

(b) The operator shall conduct operational checks and evaluations of the flight recorders ~~flight data recorder (FDR) recordings, cockpit voice recorder (CVR) recordings and data link recordings~~ to ensure ~~the~~ their continued serviceability ~~of the recorders~~.

(c) The operator shall save the recordings for the period of operating time of the FDR as required by CAT.IDE.A.190~~ or~~, CAT.IDE.A.191, CAT.IDE.H.190 or CAT.IDE.H.191 (as applicable), except that, for the purpose of testing and maintaining the FDR, up to one hour of the oldest recorded material at the time of testing may be erased.

(d) When flight parameters are recorded by a flight recorder, ~~T~~the operator shall keep and maintain up-to-date documentation that presents the necessary information to convert ~~FDR~~ raw data into parameters expressed in engineering units.

[...]

(f) Without prejudice to Regulations (EU) No 996/2010[8] and (EU) 2016/679[9] ~~of the European Parliament and of the Council~~:

[...]

[8] Regulation (EU) No 996/2010 of the European Parliament and of the Council of 20 October 2010 on the investigation and prevention of accidents and incidents in civil aviation and repealing Directive 94/56/EC (OJ L 295, 12.11.2010, p. 35).

[9] Regulation (EU) 2016/679 of the European Parliament and of the Council of 27 April 2016 on the protection of natural persons with regard to the processing of personal data and on the free movement of such data, and repealing Directive 95/46/EC (General Data Protection Regulation) (OJ L 119, 4.5.2016, p. 1).

(2) ~~FDR recordings or data link recordings~~ Flight parameters or data-link messages recorded by a flight recorder shall only be used for purposes other than for the investigation of an accident or an incident which is subject to mandatory reporting, if such records are:

(i) used by the operator for airworthiness or maintenance purposes only; or

(ii) de-identified; or

(iii) disclosed under secure procedures.

(3) Images of the flight crew compartment recorded by a flight recorder shall not be disclosed or used except for ensuring the flight recorder serviceability, or if:

(i) a procedure related to the handling of images is in place;

(ii) all crew members and maintenance personnel concerned have given their prior consent; and

(iii) these images are used only for maintaining or improving safety.

(3a) When images of the flight crew compartment recorded by a flight recorder are inspected for ensuring the serviceability of the flight recorder, then:

(i) these images shall not be disclosed or used for purposes other than for ensuring the flight recorder serviceability; and

(ii) if body parts of crew members are likely to be visible on the images, the operator shall ensure the privacy of these images.

SUBPART D

INSTRUMENTS, DATA, EQUIPMENT

SECTION 1

Aeroplanes

CAT.IDE.A.191 Recording of flight parameters on light aeroplanes

(a) Turbine-engined aeroplanes with an MCTOM of 2 250 kg or more and aeroplanes with an MOPSC of more than 9 shall be equipped with a flight recorder if:

(1) they are not specified in CAT.IDE.A.190, and

(2) they are first issued with an individual CofA on or after [date of application of the amending regulation + 3 years].

(b) The flight recorder referred to in (a) shall record flight data and/or images sufficient to determine the flight path and aircraft speed.

(c) The flight recorder referred to in (a) shall be capable of retaining the flight data or images during at least the preceding 10 hours.

(d) The flight recorder referred to in (a) shall start automatically to record the data prior to the aeroplane being capable of moving under its own power and shall stop automatically after the aeroplane is incapable of moving under its own power.

(e) If the flight recorder referred to in (a) records images of the flight crew compartment, then an erasure function shall be provided which can be operated by the commander and which modifies the recording of these images made before the operation of this function, so that they cannot be retrieved using normal replay or copying techniques.

SECTION 2

Helicopters

CAT.IDE.H.191 Recording of flight parameters on light helicopters

(a) Turbine-engined helicopters with an MCTOM of 2 250 kg or more shall be equipped with a flight recorder if:

(1) they are not specified in CAT.IDE.H.190; and

(2) they are first issued with an individual CofA on or after [date of publication of the Regulation + 3 years].

(b) The flight recorder referred to in (a) shall record flight data and/or images sufficient to determine the flight path and aircraft speed.

(c) The flight recorder referred to in (a) shall be capable of retaining the flight data or images during at least the preceding 10 hours.

(d) The flight recorder referred to in (a) shall start automatically to record the data prior to the helicopter being capable of moving under its own power and shall stop automatically after the helicopter is incapable of moving under its own power.

(e) If the flight recorder referred to in (a) records images of the flight crew compartment, then an erasure function shall be provided which can be operated by the commander and which modifies the recording of these images made before the operation of this function, so that they cannot be retrieved using normal replay or copying techniques.

3.1.1.3. Annex VIII (Part-SPO)

ANNEX VIII

SPECIALISED OPERATIONS
[Part-SPO]

SUBPART A

GENERAL REQUIREMENTS

SPO.GEN.145 Handling of flight recorder recordings: preservation, production, protection and use — operations with complex motor-powered aircraft

[...]

(b) The operator shall conduct operational checks and evaluations of the flight recorders flight data recorder (FDR) recordings, cockpit voice recorder (CVR) recordings and data link recordings to ensure the their continued serviceability of the recorders.

(c) The operator shall save the recordings for the period of operating time of the FDR as required by SPO.IDE.A.145 or, SPO.IDE.A.146, SPO.IDE.H.145 or SPO.IDE.H.146 (as applicable), except that, for the purpose of testing and maintaining the FDR, up to 1 hour of the oldest recorded material at the time of testing may be erased.

(d) When flight parameters are recorded by a flight recorder,Tthe operator shall keep and maintain up-to-date documentation that presents the necessary information to convert FDR raw data into parameters expressed in engineering units.

[...]

(f) Without prejudice to Regulations (EU) No 996/2010 and (EU) 2016/679, and except for ensuring the CVR serviceability,

(1) CVR recordings shall not be disclosed or used unless:

[...]

(g2) FDR recordings or data link recordingsFlight parameters or data-link messages recorded by a flight recorder shall only be used for purposes other than for the investigation of an accident or an incident that is subject to mandatory reporting if such records are:

(1i) used by the operator for airworthiness or maintenance purposes only;

(2ii) de-identified; or

(3iii) disclosed under secure procedures.

(3) Images of the flight crew compartment recorded by a flight recorder shall not be disclosed or used except for ensuring the flight recorder serviceability, or if:

(i) a procedure related to the handling of images is in place;

(ii) all crew members and maintenance personnel concerned have given their prior consent; and

(iii) these images are used only for maintaining or improving safety.

(3a) When images of the flight crew compartment recorded by a flight recorder are inspected for ensuring the serviceability of the flight recorder, then:

(i) these images shall not be disclosed or used for purposes other than ensuring the flight recorder serviceability; and

(ii) if body parts of crew members are likely to be visible on the images, the operator shall ensure the privacy of these images.

SUBPART D
INSTRUMENTS, DATA, EQUIPMENT

SECTION 1
Aeroplanes

SPO.IDE.A.146 Recording of flight parameters on light aeroplanes

(a) Turbine-engined aeroplanes with an MCTOM of 2 250 kg or more and aeroplanes with an MOPSC of more than 9 shall be equipped with a flight recorder if:

(1) they are not specified in SPO.IDE.A.145;

(2) they are commercially operated; and

(2) they are first issued with an individual CofA on or after [date of publication of the Regulation + 3 years].

(b) The flight recorder referred to in (a) shall record flight data and/or images sufficient to determine the flight path and aircraft speed.

(c) The flight recorder referred to in (a) shall be capable of retaining the flight data or images during at least the preceding 10 hours.

(d) The flight recorder referred to in (a) shall start automatically to record the data prior to the aeroplane being capable of moving under its own power and shall stop automatically after the aeroplane is incapable of moving under its own power.

(e) If the flight recorder referred to in (a) records images of the flight crew compartment, then an erasure function shall be provided which can be operated by the pilot-in-command and which modifies the recordings of images in the flight recorder made before the operation of this function, so that they cannot be retrieved using normal replay or copying techniques.

SECTION 2
Helicopters

SPO.IDE.H.146 Recording of flight parameters on light helicopters

(a) Turbine-engined helicopters with an MCTOM of 2 250 kg or more shall be equipped with a flight recorder if:

(1) they are not specified in SPO.IDE.H.145;

(2) they are commercially operated; and

(3) they are first issued with an individual CofA on or after [date of publication of the Regulation + 3 years].

(b) The flight recorder referred to in (a) shall record flight data and/or images sufficient to determine the flight path and aircraft speed.

(c) The flight recorder referred to in (a) shall be capable of retaining the flight data or images during at least the preceding 10 hours.

(d) The flight recorder referred to in (a) shall start automatically to record the data prior to the helicopter being capable of moving under its own power and shall stop automatically after the helicopter is incapable of moving under its own power.

(e) If the flight recorder referred to in (a) records images of the flight crew compartment, then an erasure function shall be provided which can be operated by the pilot-in-command and which modifies the recordings of images made before the operation of this function, so that they cannot be retrieved using normal replay or copying techniques.

3.1.2. Rationale

3.1.2.1. Annex I (Definitions)

While there was no definition of the term 'flight recorder', it was used in the Air Operations rules to designate crash-protected flight recorders required to be carried on-board large aircraft, such as the flight data recorder or the cockpit voice recorder. Crash-protected flight recorders are capable of withstanding very severe crash conditions and they can record a wealth of data from multiple sensors and sources. However, in the recent amendments to ICAO Annex 6, the term 'flight recorder' encompasses lightweight equipment as well, which meets less demanding crash-protection requirements and records only a smaller set of data.

Hence, a definition of 'flight recorder' is introduced for clarification in Annex I to Regulation (EU) No 965/2012. This definition complies with the concept used in ICAO Annex 6. It is also consistent with the definition of a flight recorder in Regulation (EU) No 996/2010[10]. As a consequence, the provisions applicable to the preservation of the recordings after an accident or a serious incident become de facto applicable to the recordings of lightweight flight recorders as well (please refer to AMC2 ORO.MLR.100(q), AMC3 ORO.MLR.100(g), AMC4 ORO.MLR.100(a)(A)(11), CAT.GEN.MPA.105(a)(10), CAT.GEN.MPA.195(a), SPO.GEN.107(a)(9), and SPO.GEN.145(a)).

In addition, definitions of 'flight data recorder' and 'cockpit voice recorder' are introduced in order to provide a clear understanding of these types of flight recorders and avoid confusion with lightweight flight recorders.

3.1.2.2. Annex IV (Part-CAT) and Annex VIII (Part-SPO)

3.1.2.2.1 New recording requirements for commercial operations with light aeroplanes and light helicopters

A new rule CAT.IDE.A.191 is created in Annex IV (Part-CAT) to Commission Regulation (EU) No 965/2012, Subpart D (Instruments, data, equipment), Section 1 (Aeroplanes), which is entitled 'Flight parameters recording on light aeroplanes'.

— In this new rule, it is required that aeroplanes which:

- are manufactured on or after [date of application of the amending regulation + 3 years];

[10] Regulation (EU) No 996/2010 of the European Parliament and of the Council of 20 October 2010 on the investigation and prevention of accidents and incidents in civil aviation and repealing Directive 94/56/EC (OJ L 295, 12.11.2010, p. 35).

- are of a model not specified in CAT.IDE.A.190 (which covers aeroplanes with an MCTOM of over 5 700 kg and multi-engined turbine-powered aeroplanes with an MOPSC of more than 9); and
- have an MOPSC of more than 9 or are turbine-engined with an MCTOM of 2 250 kg or more,

shall be equipped with a flight recorder. This flight recorder may be crash-protected or lightweight (while CAT.IDE.A.190 requires the carriage of a flight data recorder which per definition is crash-protected).

— It is also required that the flight recorder record flight data or images sufficient to determine the flight path and aircraft speed. Indeed, the lightweight flight recorder models available on the market record, as a minimum, images of the aircraft instruments, or 3D-position and acceleration data provided by dedicated GNSS receiver and accelerometric sensors: in both cases, the recorded information is sufficient to determine the flight path and aircraft speed.

— A minimum recording duration of 10 hours is required in order to ensure that the flight recorder is capable of recording a complete flight on the aeroplane models that are within the scope of CAT.IDE.A.191.

— In order to prevent the use of unreliable technologies and facilitate the processing of recorded data in case of an accident investigation, the flight recorder is required to use a digital method of recording and storing the data, such as the one used in all modern models of lightweight flight recorders. This requirement forbids, for example, the use of photographic film to record images.

— The flight recorder is required to have an automatic start-and-stop logic in order to ensure recording as soon as the aeroplane is capable of moving under its own power. In practice, it is sufficient for the flight recorder to be capable of detecting when the aircraft engine delivers power.

— If the flight recorder records images of the flight crew compartment, then:

- an erasure function shall be provided, which can be operated by the commander, in order to modify the recordings of images in the flight recorder so that they cannot be retrieved using normal replay or copying techniques. This is to allow the flight crew to protect their privacy by making the recording of images inaccessible using normal techniques after an uneventful flight. The decision to activate this function is to be made by the commander because they are responsible for the preservation of flight recorder recordings (refer to CAT.GEN.MPA.105). However, this function does not erase recorded data which can still be retrieved using special techniques available to the equipment manufacturer and/or safety investigation authorities. This is consistent with the specifications of ED-155 for the recording of images (refer to ED-155, Part III Airborne Image Recording Systems, paragraph III-2.1.11) and also identified as necessary by the Flight Recorder Specific Working Group (FLIRECSWG) of ICAO.

A new rule CAT.IDE.H.191 is created in Part-CAT, Subpart D, Section 2 (Helicopters), which is entitled 'Flight parameters recording on light helicopters'.

— In this rule, it is required that helicopters which:
  - are manufactured on or after [date of application of the amending regulation + 3 years];
  - are of a model not specified in CAT.IDE.H.190 (which covers helicopters with an MCTOM of over 3 175 kg); and
  - are turbine-engined with an MCTOM of 2 250 kg or more,

  shall be equipped with a flight recorder. This flight recorder may be crash-protected or lightweight.

— This rule also requires that the flight recorder record flight data or images sufficient to determine the flight path and aircraft speed.

— A minimum recording duration of 10 hours is required in order to ensure that the flight recorder is capable of recording a complete flight on most light helicopter models that are within the scope of CAT.IDE.A.191.

— Similar to CAT.IDE.A.191, the flight recorder is required to use a digital method of recording and storing the data.

— Similar to CAT.IDE.A.191, the flight recorder is required to have an automatic start-and-stop logic.

— Similar to CAT.IDE.A.191, if the flight recorder records images, then an erasure function shall be provided.

A new rule SPO.IDE.A.146 is created in Annex VIII (Part-SPO) to Commission Regulation (EU) No 965/2012), Subpart D (Instruments, data, equipment), Section 1 (Aeroplanes), which is entitled 'Flight parameters recording on light aeroplanes'.

— In this rule, it is required that aeroplanes which:
  - are manufactured on or after [date of application of the amending regulation + 3 years];
  - are used for commercial SPO operations;
  - are of a model not specified in SPO.IDE.A.145 (which covers aeroplanes with an MCTOM of more than 5 700 kg); and
  - have an MOPSC of more than 9 or are turbine-engined with an MCTOM of 2 250 kg or more,

  shall be equipped with a flight recorder. This flight recorder may be crash-protected or lightweight.

— This rule also requires that the flight recorder record flight data or images sufficient to determine to flight path and aircraft speed.

— Similar to CAT.IDE.A.191, a minimum recording duration of 10 hours is required.

— Similar to CAT.IDE.A.191, the flight recorder is required to use a digital method of recording and storing the data, and to have an automatic start-and-stop logic.

— Similar to CAT.IDE.A.191, if the flight recorder records images, then an erasure function shall be provided.

A new rule SPO.IDE.H.146 is created in Part-SPO, Subpart D, Section 2 (Helicopters), which is entitled 'Flight parameters recording on light helicopters.

— In this point, it is required that helicopters which:

- are manufactured on or after [date of application of the amending regulation + 3 years];
- are used for commercial SPO operations;
- are of a model not specified in SPO.IDE.H.145 (which covers helicopters with an MCTOM of over 3 175 kg); and
- are turbine-engined with an MCTOM of 2 250 kg or more,

shall be equipped with a flight recorder. This flight recorder may be crash-protected or lightweight.

— This rule also requires that the flight recorder record flight data or images sufficient to determine to flight path and aircraft speed.

— Similar to CAT.IDE.H.191, a minimum recording duration of 10 hours is required.

— Similar to CAT.IDE.H.191, the flight recorder is required to use a digital method of recording and storing the data, and to have an automatic start-and-stop logic.

— Similar to CAT.IDE.A.191, if the flight recorder records images, then an erasure function shall be provided.

3.1.2.2.2 Continued serviceability of the flight recorder

Paragraph (b) of CAT.GEN.MPA.195 is amended to cover the requirements of the new CAT.IDE.A.191 or CAT.IDE.H.191.

Indeed, experience with crash-protected flight recorders installed on large aircraft has shown that without rules the continued serviceability of the flight recorders is not consistently addressed. Flight recorders are considered 'maintenance-significant items' in accordance with the MSG-3 methodology; however, the instructions for continued serviceability vary — in particular, they do not always include checking of the quality of the recorded data (i.e. that the values of flight parameters are reasonable and consistent with each other, and that images are of sufficient quality to be able to read instrument indications). In addition, since a flight recorder failure has no effect on the safe conduct of the flight, repairing it is not considered priority if it is not required by law.

Paragraph (c) of CAT.GEN.MPA.195 is amended to cover the requirements of the new CAT.IDE.A.191 and CAT.IDE.H.191.

Paragraph (d) of CAT.GEN.MPA.195 is amended to include lightweight flight recorders in the requirement to maintain the flight parameters decoding documentation up to date. Up-to-date decoding documentation is essential for investigation purposes and for checking the quality of the recorded flight parameters.

The wording of SPO.GEN.145 is amended in a similar manner to CAT.GEN.MPA.195.

3.1.2.2.3 Protection of image recordings

Since compliance with CAT.IDE.A.191 and CAT.IDE.H.191 may be achieved by recording images of the flight crew compartment, and since the crew members may appear entirely or partly on these images, paragraph (f) of CAT.GEN.MPA.195 has been amended in order to address the protection of such image recordings.

The introduction of a rule to frame the handling of image recordings is necessary in accordance with Standard 6.1 in Appendix 3 of ICAO Annex 19 (Second Edition, applicable on 7 November 2019): 'States shall, through national laws and regulations, provide specific measures of protection regarding the confidentiality and access by the public to ambient workplace recordings.'

In addition, a Standard restricting the use of audio and airborne image recordings was adopted recently[11] for inclusion in Chapter 3 of ICAO Annex 6 Part I (Tenth Edition, Amendment 40-B, applicable on 7 November 2019). The rules proposed in subparagraph (f)(3) and (f)(3a) of CAT.GEN.MPA.195 implement this ICAO Standard for airborne image recordings.

Hence the following principles are proposed:

— If images of the flight crew compartment contain parts of the bodies of crew members, they could be considered personal data. In that case, European operators will have to comply with Regulation (EU) 2016/679 on General Data Protection when it becomes applicable (on 25 May 2018). Therefore, reference to this Regulation is added besides reference to Regulation (EU) No 996/2010, in paragraph (f).

— Similar to the recordings of the cockpit voice recorder, images of the flight crew compartment recorded by a flight recorder may not be used for purposes other than:

- as stipulated in Regulation (EU) No 996/2010;
- maintaining or improving safety; or
- ensuring the flight recorder serviceability.

— Similar to the recordings of the cockpit voice recorder, when images of the flight crew compartment recorded by a flight recorder are used for maintaining of improving safety, then:

- a procedure for the handling of these images shall be in place; and
- all crew members concerned shall have given their prior consent.

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[11] Text of this ICAO Standard:

'3.3.4 States shall not allow the use of recordings or transcripts of CVR, CARS, Class A AIR and Class A AIRS for purposes other than the investigation of an accident or incident as per Annex 13 except where the recordings or transcripts:

a) are related to a safety-related event identified in the context of a safety management system; are restricted to the relevant portions of a de-identified transcript of the recording; and are subject to the protections accorded by Annex 19;

b) are sought for use in criminal proceedings not related to an event involving an accident or incident investigation and are subject to the protections accorded by Annex 19; or

c) are used for inspections of flight recorder systems as provided in Section 7 of Appendix 8.'

— Similar to the recordings of the cockpit voice recorder, when images of the flight crew compartment recorded by a flight recorder are used for ensuring the serviceability of this flight recorder,

- the operator shall ensure the privacy of these images (except if there is no body part of crew members visible on the images) and
- these images shall not be disclosed or used for purposes other than ensuring the flight recorder serviceability.

In that case, it is not practical to request each time the prior consent of the crew. However, if such a recording is inspected for serviceability, it shall not be disclosed or used for other purposes.

Note:

Subparagraphs (f)(3) and (f)(3a) of CAT.GEN.MPA.195 only address images of the flight crew compartment. Hence, images of other parts of the aircraft are not within the scope of these subparagraphs. In addition, images captured 'at the back' of electronic flight instrument displays (reproducing an exact copy of the information presented on the display) are also not within the scope of these subparagraphs.

The new rules CAT.IDE.A.191 and CAT.IDE.H.191 require that if the flight recorder records images of the flight crew compartment, an erasure function be provided. Indeed, the flight crew should be given the technical possibility to erase the recording after an uneventful flight, as a measure to protect their privacy. Modern flight recorders allow the retrieval of data even after activation of the erasure function using special tools, which are usually reserved for the equipment manufacturer and/or safety investigation authorities.

Paragraph (f) of SPO.GEN.145 is amended to address the protection of recorded images of the flight crew compartment.

The new rules SPO.IDE.A.146 and SPO.IDE.H.146 require that if the flight recorder records images of the flight crew compartment, an erasure function be provided (in a manner similar to CAT.IDE.A.191 and CAT.IDE.H.191).

3.2. Draft Acceptable Means of Compliance (AMC) and Guidance Material (GM) (Draft EASA decision)

3.2.1. *Draft resulting text*

3.2.1.1. Draft AMC & GM to Definitions

GM16 Annex I Definitions

FLIGHT RECORDER

A flight recorder may be crash-protected or lightweight. Crash-protected flight recorders are capable of withstanding very severe crash conditions such as those encountered during some accidents of large aeroplanes and large helicopters. Lightweight flight recorders are usually designed to meet less demanding crash-protection requirements, which allows them to be lighter.

3.2.1.2. Draft AMC & GM to Part-ORO (Annex III)

ANNEX III

ORGANISATION REQUIREMENTS FOR AIR OPERATIONS
[PART-ORO]

SUBPART AOC

AIR OPERATOR CERTIFICATION

AMC1 ORO.AOC.130 Flight data monitoring — aeroplanes

[...]

(l) Airborne systems and equipment used to obtain FDM data should range from an already installed full quick access recorder (QAR), in a modern aircraft with digital systems, to a basic crash-protected flight recorder in an older or less sophisticated aircraft.

[...]

AMC3 ORO.MLR.100 Operations manual — general

CONTENTS — CAT OPERATIONS

[...]

11 HANDLING, NOTIFYING AND REPORTING ACCIDENTS, INCIDENTS AND OCCURRENCES AND USING THE CVR RECORDING

[...]

(g) Procedures for the preservation of recordings of the flight recorders following an accident or a serious incident or when so directed by the investigating authority. These procedures should include:

(1) a full quotation of paragraph (a) of CAT.GEN.MPA.195~~(a)~~; and

(2) instructions and means to prevent inadvertent reactivation, repair or reinstallation of the flight recorders by personnel of the operator or of third parties, and to ensure that flight recorder recordings are preserved for the needs of the investigating authority.

3.2.1.3. Draft AMC & GM to Part-CAT (Annex IV)

ANNEX IV

COMMERCIAL AIR TRANSPORT OPERATIONS
[Part-CAT]

SUBPART A

GENERAL REQUIREMENTS

SECTION 1

Motor-powered aircraft

AMC1 CAT.GEN.MPA.195(b) Handling of flight recorder recordings: preservation, production, protection and use

INSPECTIONS AND CHECKS OF RECORDINGS

Whenever a flight recorder is required to be carried:

[...]

(b) when a flight recorder, other than an FDR, is carried on an aircraft in order to ensure compliance with CAT.IDE.A.191 or CAT.IDE.H.191, the operator should perform an inspection of the recording of this flight recorder at time intervals not exceeding 2 years.

(c~~b~~) [...]

(d~~c~~) when installed, the aural or visual means for preflight checking of the flight recorders for proper operation should be used on each day when~~every day~~ the aircraft is used. When no such means is available for a flight recorder, the operator should perform an operational check of this flight recorder at ~~time~~ intervals not exceeding 150 flight hours~~seven calendar days of operation~~.

(e~~d~~) [...]

GM1 CAT.GEN.MPA.195(b) Handling of flight recorder recordings: preservation, production, protection and use

INSPECTION OF THE FLIGHT RECORDERS' RECORDINGS

[...]

(d) The inspection of flight data recorded by a lightweight flight recorder usually consists of the following:

(1) making a copy of the complete recording file;

(2) converting the recording to parameters expressed in engineering units in accordance with the documentation required to be held;

(3) examining a whole flight in engineering units to evaluate the validity of all mandatory parameters. When applicable, each parameter should be expressed in engineering units and checked for different values of its operational range for reasonableness — for this purpose, some parameters may need to be inspected at different flight phases; and

(4) retaining the most recent copy of the complete recording file and the corresponding recording inspection report that includes references to the documentation required to be held.

(e) The inspection of recorded images usually consists of the following:

(1) checking that the flight recorder operates correctly for the nominal duration of the recording;

(2) examining, where practicable and in compliance with paragraph (f) of CAT.GEN.MPA.195, a sample of images recorded in different flight phases for evidence that the images of each camera are of a quality sufficient for reading the instruments' indications; and

(3) preparing and retaining an inspection report.

AMC1 CAT.GEN.MPA.195(f)(1) Handling of flight recorder recordings: preservation, production, protection and use

USE OF CVR RECORDINGS FOR MAINTAINING OR IMPROVING SAFETY

(a) The procedure related to the handling of cockpit voice recorder (CVR) recordings should be ~~written in a document which should be signed~~ documented and signed by all parties (~~airline management~~aircraft operator, crew member representatives nominated either by the union or the crew themselves, maintenance personnel representatives if applicable). This procedure should take into account Regulation (EU) 2016/679[12] and, as a minimum, define:

[...]

AMC1 CAT.GEN.MPA.195(f)(3) Handling of flight recorder recordings: preservation, production, protection and use

USE OF IMAGE RECORDINGS FOR MAINTAINING OR IMPROVING SAFETY

(a) The procedure laid down in point (f)(3)(i) of CAT.GEN.MPA.195 should be documented and signed by all parties involved (aircraft operator, crew member representatives nominated either by the union or the crew themselves, maintenance personnel representatives if applicable). This procedure should take into account Regulation (EU) 2016/679 and, as a minimum, define the following aspects:

[12] Regulation (EU) 2016/679 of the European Parliament and of the Council of 27 April 2016 on the protection of natural persons with regard to the processing of personal data and on the free movement of such data, and repealing Directive 95/46/EC (General Data Protection Regulation) (OJ L 119, 4.5.2016, p. 1).

(1) an access and security policy that restricts access to the image recordings to authorised persons identified by their position;

(2) a retention policy and accountability, including the measures to ensure the security of the image recordings and their protection from misuse;

(3) a description of the uses made of the image recordings;

(4) the participation of flight crew member representatives in the assessment of the image recordings;

(5) the conditions under which advisory briefing or remedial training should take place; this should always be carried out in a constructive and non-punitive manner; and

(6) the conditions under which actions other than advisory briefing or remedial training may be taken for reasons of gross negligence or significant continuing safety concern.

(b) Each time a recording file containing images of the flight crew compartment is read out for purposes other than ensuring the serviceability of the flight recorder, the operator should retain, and when requested, provide the competent authority with:

(1) information on the use made (or the intended use) of the recording file; and

(2) evidence that the crew members concerned consented to the use made (or the intended use) of the flight crew compartment images.

(c) The safety manager or the person identified by the operator to fulfil this role should be responsible for the protection and use of the recordings of flight crew compartment images, as well as the assessment of issues and their transmission to the manager(s) responsible for the process concerned.

(d) In case a third party is involved in the use of recordings of flight crew compartment images, contractual agreements with this third party should, when applicable, cover the aspects enumerated in (a) and (b).

AMC1 CAT.GEN.MPA.195(f)(3a) Handling of flight recorder recordings: preservation, production, protection and use

IMAGE RECORDING INSPECTION FOR ENSURING SERVICEABILITY

(a) When an inspection of recorded images of the flight crew compartment is performed for ensuring the serviceability of the flight recorder and any body part of a crew member is likely to be visible on these images:

(1) the privacy of the image recordings should be ensured (e.g. by locating the replay equipment in a separated area);

(2) access to the replay equipment should be restricted to authorised persons;

(3) provisions should be made for the secure storage of the image recording medium, the image recording files and copies thereof;

(4) the image recording files and copies thereof should be destroyed not earlier than 2 months and not later than 1 year after completion of the image recording inspection; images that do not

contain any body part of a person may be retained for enhancing the image recording inspection (e.g. for comparing image quality); and

(5) only the accountable manager of the operator and, when identified to comply with ORO.GEN.200, the safety manager should be entitled to request a copy of the image recording files.

(b) The conditions enumerated in (a) should also be complied with if the inspection of the image recording is subcontracted to a third party. The contractual agreements with the third party should explicitly cover these aspects.

GM1 CAT.GEN.MPA.195(f) Handling of flight recorder recordings: preservation, production, protection and use

FLIGHT CREW COMPARTMENT

If there are no compartments to physically segregate the flight crew from the passengers during the flight, the 'flight crew compartment' should be understood, in paragraph (f) of CAT.GEN.MPA.195, as the area including:

(a) the flight crew seats;

(b) aircraft and engine controls;

(c) aircraft instruments;

(d) windshield and windows used by the flight crew to get an external view while seated at their duty station; and

(e) circuit breakers accessible by the flight crew while seated at their duty station.

SUBPART D

INSTRUMENTS, DATA, EQUIPMENT

SECTION 1

Aeroplanes

AMC1 CAT.IDE.A.191 Recording of flight parameters on light aeroplanes

OPERATIONAL PERFORMANCE REQUIREMENTS

(a) The flight recorder may record images or flight data, or a combination thereof.

(b) If the flight recorder records flight data, it should record at least the following parameters:

(1) relative time count,

(2) pitch attitude or pitch rate,

(3) roll attitude or roll rate,

(4) heading (magnetic or true) or yaw rate,

(5) latitude,

(6) longitude,

(7) positioning system: estimated error (if available),

(8) pressure altitude or altitude from a positioning system,

(9) time,

(10) ground speed,

(11) positioning system: track (if available),

(12) normal acceleration,

(13) longitudinal acceleration, and

(14) lateral acceleration.

(c) If the flight recorder records images, it should capture views of the main instrument displays at the pilot station, or at both pilot stations when the aeroplane is certified for operation with a minimum crew of two pilots. The recorded image quality should allow reading the following indications during most of the flight:

(1) magnetic heading,

(2) time,

(3) pressure altitude,

(4) indicated airspeed,

(5) vertical speed,

(6) turn and slip,

(7) attitude,

(8) Mach number (if displayed), and

(9) stabilised heading.

(d) If the flight recorder records flight data and images, each flight parameter listed in (b) should be recorded as flight data or by means of images.

(e) The flight parameters listed in (b), which are recorded as flight data, should meet the performance specifications (range, sampling intervals, accuracy limits and resolution in read-out) as defined in the relevant table of EUROCAE Document 112 (Minimum Operational Performance Specification for Crash Protected Airborne Recorder Systems) dated March 2003, or EUROCAE Document ED-155 (Minimum Operational Performance Specification for Lightweight Flight Recording Systems) dated July 2009, or any later equivalent standard accepted by EASA.

(f) The operational performance requirements for the flight recorder should be those laid down in:

(1) EUROCAE Document ED-155 or any later equivalent standard accepted by EASA for lightweight flight recorders; or

(2) EUROCAE Document 112 or any later equivalent standard accepted by EASA for crash-protected flight recorders.

GM1 CAT.IDE.A.191 Recording of flight parameters on light aeroplanes

ADDITIONAL USEFUL INFORMATION

While only flight data or images sufficient to determine the flight path and aircraft speed are required to be recorded, experience has shown that recording information related to the positions of flight controls and an external view is very useful for analysing incidents or accidents.

SECTION 2

Helicopters

AMC1 CAT.IDE.H.191 Recording of flight parameters on light helicopters

OPERATIONAL PERFORMANCE REQUIREMENTS

(a) The flight recorder may record images or flight data, or a combination thereof.

(b) If the flight recorder records flight data, it should record at least the following parameters:

(1) relative time count,

(2) pitch attitude or pitch rate,

(3) roll attitude or roll rate,

(4) heading (magnetic or true) or yaw rate,

(5) latitude,

(6) longitude,

(7) positioning system: estimated error (if available),

(8) pressure altitude or altitude from a positioning system,

(9) time,

(10) ground speed,

(11) positioning system: track (if available),

(12) normal acceleration,

(13) longitudinal acceleration, and

(14) lateral acceleration.

(c) If the flight recorder records images, it should capture views of the main instrument displays at the pilot station, or at both pilot stations when the aeroplane is certified for operation with a minimum crew of two pilots. The recorded image quality should allow reading the following indications during most of the flight:

(1) magnetic or true heading,

(2) time (if presented on the front instrument panel),

(3) pressure altitude,

(4) indicated airspeed,

(5) vertical speed,

(6) slip,

(7) outside air temperature,

(8) attitude (if displayed), and

(9) stabilised heading (if displayed).

(d) If the flight recorder records flight data and images, each flight parameter listed in (b) should be recorded as flight data or by means of images.

(e) The flight parameters listed in (b), which are recorded as flight data, should meet the performance specifications (range, sampling intervals, accuracy limits and resolution in read-out) as defined in the relevant table of EUROCAE Document 112 (Minimum Operational Performance Specification for Crash Protected Airborne Recorder Systems) dated March 2003, or EUROCAE Document ED-155 (Minimum Operational Performance Specification for Lightweight Flight Recording Systems) dated July 2009, or any later equivalent standard accepted by EASA.

(f) The operational performance requirements for the flight recorder should be those laid down in:

(1) EUROCAE Document ED-155 or any later equivalent standard accepted by EASA for lightweight flight recorders; or

(2) EUROCAE Document 112 or any later equivalent standard accepted by EASA for crash-protected flight recorders.

GM1 CAT.IDE.H.191 Recording of flight parameters on light helicopters

ADDITIONAL USEFUL INFORMATION

While only flight data or images sufficient to determine the flight path and aircraft speed are required to be recorded, experience has shown that recording information related to the positions of flight controls and an external view is very useful for analysing incidents and accidents.

3.2.1.4. Draft AMC & GM to Part-SPO (Annex VIII)

ANNEX VIII

SPECIALISED OPERATIONS [PART-SPO]

AMC1 SPO.GEN.145(b) Handling of flight recorder recordings: preservation, production, protection and use

INSPECTIONS AND CHECKS OF RECORDINGS

Whenever a flight recorder is required to be carried:

[...]

(b) When a flight recorder, other than an FDR, is carried on an aircraft in order to ensure compliance with SPO.IDE.A.146 or SPO.IDE.H.146, the operator should perform an inspection of the recording of this flight recorder at time intervals not exceeding 2 years.

(c~~b~~) [...]

(d~~c~~) When installed, the aural or visual means for preflight checking of the flight recorders for proper operation should be used ~~every day~~ on each day the aircraft is used. When no such means is available for a flight recorder, the operator should perform an operational check of this flight recorder at ~~time~~ intervals not exceeding 150 flight hours~~seven calendar days of operation~~.

(e~~d~~) [...]

GM1 SPO.GEN.145(b) Handling of flight recorder recordings: preservation, production, protection and use

INSPECTION OF THE FLIGHT RECORDERS’ RECORDINGS

[...]

(d) The inspection of flight data recorded by a lightweight flight recorder usually consists of the following:

(1) making a copy of the complete recording file;

(2) converting the recording to parameters expressed in engineering units in accordance with the documentation required to be held;

(3) examining a whole flight in engineering units to evaluate the validity of all mandatory parameters; when applicable, each parameter should be expressed in engineering units and checked for different values of its operational range for reasonableness — for this purpose, some parameters may need to be inspected at different flight phases; and

(4) retaining the most recent copy of the complete recording file and the corresponding recording inspection report that includes references to the documentation required to be held.

(e) The inspection of recorded images usually consists of the following:

(1) checking that the flight recorder operates correctly for the nominal duration of the recording;

(2) examining, where practicable and in compliance with paragraph (f) of SPO.GEN.145, a sample of images recorded in different flight phases for evidence that the images of each camera are of a quality sufficient for reading the instruments' indications; and

(3) preparing and retaining an inspection report.

AMC1 CAT.GEN.MPA.195(f) Handling of flight recorder recordings: preservation, production, protection and use

USE OF CVR RECORDINGS FOR MAINTAINING OR IMPROVING SAFETY

(a) The procedure related to the handling of cockpit voice recorder (CVR) recordings should be ~~written in a document which should be~~ documented and signed by all parties (~~airline~~aircraft operator, crew members, maintenance personnel if applicable). This procedure should take into account Regulation (EU) 2016/679 and, as a minimum, define: [...]

AMC1 SPO.GEN.145(f)(3) Handling of flight recorder recordings: preservation, production, protection and use

USE OF IMAGE RECORDINGS FOR MAINTAINING OR IMPROVING SAFETY

(a) The procedure indicated in point (f)(3)(i) of SPO.GEN.145 should be documented and signed by all parties (aircraft operator, crew members, maintenance personnel if applicable). This procedure should take into account Regulation (EU) 2016/679 and, as a minimum, define the following aspects:

(1) an access and security policy that restricts access to the image recordings to authorised persons identified by their position;

(2) a retention policy and accountability, including the measures to ensure the security of the image recordings and their protection from misuse;

(3) a description of the uses made of the image recordings.

(b) Each time a recording file containing images of the flight crew compartment is read out for purposes other than to ensure the serviceability of the flight recorder, the operator should retain and, when requested, provide the competent authority with:

(1) information on the use made (or the intended use) of the recording file; and

(2) evidence that the flight crew members concerned consented to the use made (or the intended use) of the flight crew compartment images.

(c) The safety manager or the person identified by the operator to fulfil this role should be responsible for the protection and use of the recordings of flight crew compartment images, as well as the assessment of issues and their transmission to the manager(s) responsible for the process concerned.

(d) In case a third party is involved in the use of recordings of flight crew compartment images, contractual agreements with this third party should, when applicable, cover the aspects enumerated in (a) and (b).

AMC1 SPO.GEN.145(f)(3a) Handling of flight recorder recordings: preservation, production, protection and use

IMAGE RECORDING INSPECTION FOR ENSURING SERVICEABILITY

(a) When an inspection of recorded images of the flight crew compartment is performed to ensure the serviceability of the flight recorder and any body part of a crew member is likely to be visible on these images:

(1) the privacy of the image recordings should be ensured (e.g. by locating the replay equipment in a separated area);

(2) access to the replay equipment should be restricted to authorised persons;

(3) provisions should be established for the secure storage of the image recording medium, the image recording files and copies thereof;

(4) the image recording files and copies thereof should be destroyed not earlier than 2 months and not later than 1 year after completion of the image recording inspection. Images that do not contain any body part of a person may be retained for enhancing the image recording inspection (e.g. for comparing image quality); and

(5) only the accountable manager of the operator and, when identified to comply with ORO.GEN.200, the safety manager should be entitled to request a copy of the image recording files.

(b) The conditions enumerated in (a) should also be complied with if the inspection of the image recording is subcontracted to a third party. The contractual agreements with the third party should explicitly cover these aspects.

GM1 SPO.GEN.145(f) Handling of flight recorder recordings: preservation, production, protection and use

FLIGHT CREW COMPARTMENT

If there are no compartments to physically segregate the flight crew from the passengers during the flight, the 'flight crew compartment' should be understood in paragraph (f) of SPO.GEN.145 as the area including:

(a) the flight crew seats;

(b) aircraft and engine controls;

(c) aircraft instruments;

(d) windshield and windows used by the flight crew to get an external view while seated at their duty station; and

(e) circuit breakers accessible by the flight crew while seated at their duty station.

SUBPART D

INSTRUMENTS, DATA, EQUIPMENT

SECTION 1
Aeroplanes

AMC1 SPO.IDE.A.146 Recording of flight parameters on light aeroplanes

OPERATIONAL PERFORMANCE REQUIREMENTS

(a) The flight recorder may record images or flight data, or a combination thereof.

(b) If the flight recorder records flight data, it should record at least the following parameters:

(1) relative time count,

(2) pitch attitude or pitch rate,

(3) roll attitude or roll rate,

(4) heading (magnetic or true) or yaw rate,

(5) latitude,

(6) longitude,

(7) positioning system: estimated error (if available),

(8) pressure altitude or altitude from a positioning system,

(9) time,

(10) ground speed,

(11) positioning system: track (if available),

(12) normal acceleration,

(13) longitudinal acceleration,

(14) lateral acceleration.

(c) If the flight recorder records images, it should capture views of the main instrument displays at the pilot station, or at both pilot stations when the aeroplane is certified for operation with a minimum crew of two pilots. The recorded image quality should allow reading the following indications during most of the flight:

(1) magnetic heading,

(2) time,

(3) pressure altitude,

(4) indicated airspeed,

(5) vertical speed,

(6) turn and slip,

(7) attitude,

(8) Mach number (if displayed), and

(9) stabilised heading.

(d) If the flight recorder records flight data and images, each flight parameter listed in (b) should be recorded as flight data or by means of images.

(e) The flight parameters listed in (b), which are recorded as flight data, should meet the performance specifications (range, sampling intervals, accuracy limits and resolution in read-out) as defined in the relevant table of EUROCAE Document 112 (Minimum Operational Performance Specification for Crash Protected Airborne Recorder Systems) dated March 2003, or EUROCAE Document ED-155 (Minimum Operational Performance Specification for Lightweight Flight Recording Systems) dated July 2009, or any later equivalent standard accepted by EASA.

(f) The operational performance requirements for the flight recorder should be those laid down in:

(1) EUROCAE Document ED-155 or any later equivalent standard accepted by EASA for lightweight flight recorders; or

(2) EUROCAE Document 112 or any later equivalent standard accepted by EASA for crash-protected flight recorders.

GM1 SPO.IDE.A.146 Recording of flight parameters on light aeroplanes

ADDITIONAL USEFUL INFORMATION

While only flight data or images sufficient to determine the flight path and aircraft speed are required to be recorded, experience has shown that recording information related to the position of flight controls and an external view is very useful for analysing incidents and accidents.

SECTION 2
Helicopters

AMC1 SPO.IDE.H.146 Recording of flight parameters on light helicopters

OPERATIONAL PERFORMANCE REQUIREMENTS

(a) The flight recorder may record images or flight data, or a combination thereof.

(b) If the flight recorder records flight data, it should record at least the following parameters:

(1) relative time count,

(2) pitch attitude or pitch rate,

(3) roll attitude or roll rate,

(4) heading (magnetic or true) or yaw rate,

(5) latitude,

(6) longitude,

(7) positioning system: estimated error (if available),

(8) pressure altitude or altitude from a positioning system,

(9) time,

(10) ground speed,

(11) positioning system: track (if available),

(12) normal acceleration,

(13) longitudinal acceleration, and

(14) lateral acceleration.

(c) If the flight recorder records images, it should capture views of the main instrument displays at the pilot station, or at both pilot stations when the aeroplane is certified for operation with a minimum crew of two pilots. The recorded image quality should allow reading the following indications during most of the flight:

(1) magnetic or true heading,

(2) time (if presented on the front instrument panel),

(3) pressure altitude,

(4) indicated airspeed,

(5) vertical speed,

(6) slip,

(7) outside air temperature,

(8) attitude (if displayed),

(9) stabilised heading (if displayed).

(d) If the flight recorder records flight data and images, each flight parameter listed in (b) should be recorded as flight data or by means of images.

(e) The flight parameters listed in (b), which are recorded as flight data, should meet the performance specifications (range, sampling intervals, accuracy limits and resolution in read-out) as defined in the relevant table of EUROCAE Document 112 (Minimum Operational Performance Specification for Crash Protected Airborne Recorder Systems) dated March 2003, or EUROCAE Document ED-155 (Minimum Operational Performance Specification for Lightweight Flight Recording Systems) dated July 2009, or any later equivalent standard accepted by EASA.

(f) The operational performance requirements for the flight recorder should be those laid down in:

(1) EUROCAE Document ED-155 or any later equivalent standard accepted by EASA for lightweight flight recorders; or

(2) EUROCAE Document 112 or any later equivalent standard accepted by EASA for crash-protected flight recorders.

GM1 SPO.IDE.H.146 Recording of flight parameters on light helicopters

ADDITIONAL USEFUL INFORMATION

While only flight data or images sufficient to determine the flight path and aircraft speed are required to be recorded, experience has shown that recording information related to the position of flight controls and an external view is very useful for analysing incidents and accidents.

3.2.2. *Rationale*

3.2.2.1. AMC & GM to Definitions

A new GM indicates that a flight recorder can be 'crash-protected' or 'lightweight', and it defines these terms.

3.2.2.2. AMC & GM to Annex III (Part-ORO)

Minor editorial corrections are made to AMC1 ORO.MLR.100 and AMC3 ORO.MLR.100.

3.2.2.3. AMC & GM to Annex IV (Part-CAT) and Annex VIII (Part-SPO)

3.2.2.3.1 AMC & GM to the new recording requirements

AMC1 CAT.IDE.A.191 is created to provide the operational performance requirements of the flight recorder required in CAT.IDE.A.191.

— In the case where the flight recorder records flight data, AMC1 CAT.IDE.A.191(b) specifies what flight parameters should be recorded in order to ensure that sufficient information is recorded to determine the aircraft flight path and speed. The listed flight parameters are already required to be recorded by the FDR, but they can also be obtained by means of dedicated sensors (accelerometric sensors and GNSS receiver), in the case where there is no flight data acquisition unit or if a stand-alone recorder is preferred.

— In the case where the flight recorder records images, AMC1 CAT.IDE.A.191(c) specifies that views of the main instrument displays at the pilot station(s) should be captured, and that the recorded images should allow reading the instruments' indications. In addition, a list of indications to be captured is provided. These indications correspond to instruments required on-board all aeroplanes in accordance with CAT.IDE.A.125 (operations under VFR by day) and CAT.IDE.A.130 (operations under IFR or at night), hence they can be captured by images (refer to Appendix I for more information). When the indication may not be required under some types of operation, then the indication should be recorded 'if displayed'.

— AMC1 CAT.IDE.A.191(a) allows combining the recording of images and flight data, at the operator's convenience. However, the flight parameters recommended in

AMC1 CAT.IDE.A.191(b) do not contain the same information as the indications recommended to be recorded by means of images in AMC1 CAT.IDE.A.191(c). To resolve this discrepancy and ensure that a minimum data subset is recorded whatever the elected solution is, AMC1 CAT.IDE.A.191(d) recommends that when both flight data and images are recorded, each flight parameter listed in AMC1 CAT.IDE.A.191(b) is recorded as flight data or by means of images.

— AMC1 CAT.IDE.A.191(e) clarifies the applicable flight parameter performance when flight data is recorded, taking into account that the operator may choose to record the data on a crash-protected FDR or on a lightweight aircraft data recording system (ADRS). The performance of flight parameters should then meet the applicable performance specifications (i.e. range, sampling intervals, accuracy limits and resolution in read-out) either given by Table II-A.1 of EUROCAE Document 112 (ED-112) dated 2003, or by Table II-B.1 of EUROCAE Document 155 (ED-155) dated 2009. This is consistent with the flight parameter performance prescribed in ICAO Annex 6 Part I. It should be noted that although ED-112 was superseded by ED-112A in 2013, compliance with ED-112 is still considered acceptable: this is because the flight parameters performance provided by ED-112 is considered sufficient for investigation purposes in the case of a light aircraft.

— AMC1 CAT.IDE.A.191(f) recommends that the operational performance of the flight recorder should in any case meet the specifications of either ED-155 or ED-112. This is consistent with the operational performance prescribed for flight recorders in ICAO Annex 6 Part I, which refers to ED-112 and ED-155. In addition, EUROCAE standards are the reference industry standards in the Air Operations rules applicable to crash-protected flight recorders (see for instance AMC1 CAT.IDE.A.190), as well as in the CS-ETSO addressing flight data recorders (ETSO-C124b), airborne image recorders (ETSO-C176) and lightweight flight recorders (ETSO-2C197).

AMC1 CAT.IDE.H.191 is created to provide the operational performance requirements of the flight recorder required in CAT.IDE.H.191.

— Similar to AMC1 CAT.IDE.A.191, AMC1 CAT.IDE.H.191 specifies what flight parameters should be recorded when flight data is recorded and what instrument indications should be captured if images are recorded (based on the indications required to be displayed in accordance with CAT.IDE.H.125 and CAT.IDE.H.130 (refer to Appendix I for more information).

— Similar to AMC1 CAT.IDE.A.191, AMC1 CAT.IDE.H.191 allows combining the recording of images and flight data; however, in that case, each flight parameter listed in AMC1 CAT.IDE.H.191(b) is recorded as flight data or by means of images.

— Similar to AMC1 CAT.IDE.A.191, AMC1 CAT.IDE.H.191 refers to ED-112 and ED-155 with regard to the performance of the flight parameters and the operational performance of the flight recorder.

AMC1 SPO.IDE.A.146 is created to provide the operational performance requirements of the flight recorder required in SPO.IDE.A.146. AMC1 SPO.IDE.A.146 has the same content as AMC1 CAT.IDE.A.191.

AMC1 SPO.IDE.H.146 is created to provide the operational performance requirements of the flight recorder required in SPO.IDE.A.146. AMC1 SPO.IDE.H.146 has the same content as AMC1 CAT.IDE.H.191.

GM1 CAT.IDE.A.191 is created to encourage operators to record more data than what is strictly related to flight path and aircraft speed. In particular, the operator may also want to consider recording the position of the flight controls and an external view. This would make the recordings more complete and, therefore, more useful for an operator which would like to use them to analyse its incidents. GM1 CAT.IDE.H.191, GM1 CAT.IDE.A.146 and GM1 CAT.IDE.H.146 are created for the same purpose.

3.2.2.3.2 Continued serviceability of the flight recorder

The wording of AMC1 CAT.GEN.MPA.195(b) and GM1 CAT.GEN.MPA.195(b) is amended in order to address the flight recorder's serviceability when a flight recorder is installed in order to comply with CAT.IDE.A.191 or CAT.IDE.H.191.

— Indeed, experience with crash-protected flight recorders (FDRs and CVRs) has shown that in industry there is widespread over-reliance on the built-in test feature of flight recorders: such a feature can detect internal failures of the equipment, but not problems with the quality of recorded data (e.g. it will not tell if the values of a recorded flight parameter are realistic or if recorded audio is intelligible). As a result, safety investigation authorities have repeatedly pointed at recordings of bad quality and other issues (refer to Notice of Proposed Amendment 2013-26 'Amendment of requirements for flight recorders and underwater locating devices'[13] and to EASA Safety Information Bulletin 2009-28R1 'Flight Data Recorder and Cockpit Voice Recorder Systems Serviceability'[14]).

— ICAO Annex 6 Part I prescribes in its Appendix 8 three kinds of checks to be performed by the operator:

- inspection of the recording at time intervals of 1 or 2 years for the FDR and the CVR (5 years for data-link recording);
- daily use of the means for preflight checking of the flight recorders for proper operation;
- calibration check of some flight parameters recorded by the FDR.

— These ICAO Standards were transposed in AMC1 CAT.GEN.MPA.195(b) for crash-protected flight recorders and they are also considered regarding the serviceability of lightweight flight recorders.

— However, since the cost impact of maintenance tasks should remain proportionate for light aircraft, a less constraining framework is proposed for a flight recorder installed in order to comply with CAT.IDE.A.191 or CAT.IDE.H.191, when it is not a FDR:

- Recording inspection at time intervals of 2 years (paragraph (a) of AMC1 CAT.GEN.MPA.195(b)).

[13] https://www.easa.europa.eu/document-library/notices-of-proposed-amendments/npa-2013-26
[14] http://ad.easa.europa.eu/ad/2009-28R1

- Given that just a dozen of flight parameters are required to be recorded, this inspection is expected to be completed much faster than for a FDR where up to 80 flight parameters are required to be recorded, depending on the aircraft model and the date of manufacture.
- In addition, paragraph (d) of GM1 CAT.GEN.MPA.195(b) only recommends a reasonableness check of the flight parameters, as this check is qualitative and therefore less complex and time-consuming than a correlation test.
- The new paragraph (e) of GM1 CAT.GEN.MPA.195(b) is created to address the inspection of recorded images. In that case, given the potential privacy aspect of images, it is not recommended to make a copy of the recording file or to retain the recorded images. In the case of images, the primary purpose is to verify that the images are of a quality sufficient for reading the instruments' indications, and this in various flight phases.

- Daily use of the means for preflight checking of the flight recorder for proper operation (paragraph (c) of AMC1 CAT.GEN.MPA.195(b)). This operational check may be performed by the flight crew within a few seconds at the first flight of the day.
  - If, however, no means for preflight checking of the flight recorder is available, an operational check should be performed at time intervals not exceeding 150 flight hours, instead of previously '7 calendar days of operation'. Indeed 'days of operation' is not commonly used metrics. 150 flight hours correspond to more than 7 days of operation, assuming that the aircraft is operated 21 hours per day (case of large aeroplanes which are flying most of the time). For a light aircraft which is usually less used, the operational check can be performed at longer time intervals.

When the operator installs an FDR in order to comply with CAT.IDE.A.191 or CAT.IDE.H.191, it is recommended to perform the same operational checks and evaluations as for an FDR installed on a large aeroplane or a large helicopter.

The wording of AMC1 SPO.GEN.145(b) and GM1 SPO.GEN.145(b) is amended similarly to AMC1 CAT.GEN.MPA.195(b) and GM1 CAT.GEN.MPA.195(b).

3.2.2.3.3 Protection of audio and image recordings

AMC1 CAT.GEN.MPA.195(f)(1), which addresses the use of CVR recordings for maintaining or improving safety, is amended to recommend that account is taken of Regulation (EU) 2016/679 in the procedure related to the handling of CVR recordings, in the case where the CVR is used for maintaining or improving safety. This reference to Regulation (EU) 2016/679 is made so that the operator ensures that the procedure is consistent with this Regulation.

AMC1 CAT.GEN.MPA.195(f)(3) is created to address the use of flight crew compartment images recorded by a flight recorder for maintaining or improving safety. The provisions of this AMC are similar to those of AMC1 CAT.GEN.MPA.195(f)(1).

— Paragraph (a) of AMC1 CAT.GEN.MPA.195(f)(3) recommends that the procedure related to the handling of recordings of flight crew compartment images be documented and signed by all parties, so that it can be checked that all internal stakeholders are aware of this procedure. Subparagraph (a) also recommends that Regulation (EU) 2016/679 should be considered when drafting this procedure. This is for the operator to ensure that the procedure is consistent with this Regulation.

— In addition:

- Subparagraph (a)(1) of AMC1 CAT.GEN.MPA.195(f)(3) limits the access to recorded images to specifically authorised persons.
- Subparagraph (a)(2) recommends that retention of recorded images be addressed by a policy and accountability, which specifically includes measures to ensure the protection of recordings.
- In order to facilitate oversight of the appropriate use of recorded images, subparagraph (a)(3) recommends that the aircraft operator explain in the procedure what use is intended to be made of the images.
- In order to promote fair assessment of recorded images in case of safety concern, three subparagraphs are created, which are consistent with the existing provisions applicable to flight data monitoring (FDM) programmes in AMC1 ORO.AOC.130(k).
- Subparagraph (a)(4) recommends that the procedure specify how flight crew member representatives will be involved in the assessment of recorded images. Indeed, it is a good practice to request the participation of a flight crew member in the analysis of images.
- Subparagraphs (a)(5) and (a)(6) recommend that the procedure detail, in the case where a safety issue is confirmed, the conditions for determining a corrective action. Such a framework provides for more transparency and trust within the aircraft operator, and it can be checked by the competent authority.

— The objective of paragraph (b) of AMC1 CAT.GEN.MPA.195(f)(3) is to ensure that, in the case where a recording file containing images of body parts is read out, the competent authority may check the use of this recording file.

— Paragraph (c) recommends that the safety manager or the person identified by the operator to fulfil this role be responsible for the protection and use of flight crew compartment images, as well as the assessment and transmission of issues. This is consistent with the fact that the use of recorded images is allowed only for safety purposes or to ensure the flight recorder serviceability except when Regulation (EU) No 996/2010 applies (refer to CAT.GEN.MPA.195(f)(3)).

— Paragraph (d) of AMC1 CAT.GEN.MPA.195(f)(3) recommends that when a third party is involved in the use of recorded images, contractual agreements with this third party should, when applicable, cover the aspects enumerated in paragraphs (a) and (b). This is to ensure that even if part of the handling of recorded images is subcontracted, the necessary precautions for the protection of data privacy will be taken by the third party.

AMC1 CAT.GEN.MPA.195(f)(3a) is created to address the use of flight crew compartment images recorded by a flight recorder for ensuring serviceability. It follows principles similar to those of AMC1 CAT.GEN.MPA.195(f)(1a), which addresses the recording inspection of the CVR for ensuring serviceability. However, the conditions enumerated in paragraph (a) of AMC1 CAT.GEN.MPA.195(f)(3a) are only applicable when a body part of a crew member is visible on the images, otherwise the recorded images have no privacy content and can be handled in a manner similar to FDR data.

— Subparagraph (a)(1) of AMC1 CAT.GEN.MPA.195(f)(3a) recommends that replays are conducted under conditions that ensure the privacy of recordings required by CAT.GEN.MPA.195(f)(3a).

— Subparagraph (a)(2) recommends to restrict access to the replay equipment in order to ensure that the use of this equipment is controlled.

— Subparagraphs (a)(3) and (a)(4) are related to the protection of the recording medium and the recording files read out from this recording medium. They recommend secure storage of the recording medium and the recording files, as well as destruction of the recording files in a given timeframe, except for images retained for the purpose of enhancing the recording inspection. The recording files should not be destroyed immediately in order to permit an independent check of the quality of the recorded images, if necessary. However, a maximum retention time of the recording files is also recommended, as they contain sensitive information.

— Subparagraph (a)(5) designates the accountable manager and the safety manager of the operator as the only persons entitled to request a copy of a recording file. This is meant to ensure control of the recorded images and it is consistent with AMC1 CAT.GEN.MPA.195(f)(3). Except for ensuring serviceability, the only permitted use during day-to-day operations is for maintaining and improving safety, and in that case, in accordance with AMC1 CAT.GEN.MPA.195(f)(3), the safety manager should be responsible for the use and protection of the CVR recordings.

— Paragraph (b) covers the cases where the CVR recording inspection is subcontracted to a third party.

GM1 CAT.GEN.MPA.195(f) is created to provide for a common understanding of images of the 'flight crew compartment', when there are no compartments segregating the flight crew from the passengers.

4. Impact assessment (IA)

Note:

In this chapter, the following terms are used:

— 'Crash-protected flight recorder' means any type of recorder installed in the aircraft and recording in a crash-survivable recording medium for the purpose of facilitating accident/incident safety investigations. Crash-protected flight recorders comprise one or more of the following systems: a flight data recorder (FDR), a cockpit voice recorder (CVR), an airborne image recorder (AIR), and/or a data-link recorder (DLR).

— 'Lightweight flight recorder' means a system installed in the aircraft and recording in a robust recording medium primarily for the purpose of facilitating accident/incident safety investigations. Lightweight flight recorders comprise one or more of the following systems: an aircraft data recording system (ADRS), a cockpit audio recording system (CARS), an airborne image recording system (AIRS), and/or a data-link recording system (DLRS).

— 'In-flight recording' means recording by an airborne system of data that can be easily used to reconstruct the history of the flight for the purpose of a safety investigation. In-flight recording solutions include but are not limited to crash-protected flight recorders and lightweight flight recorders, and they do not necessarily rely on dedicated equipment.

— 'Light aeroplane' means an aeroplane of a maximum certified take-off mass (MCTOM) of 5 700 kg or less.

— 'Light helicopter' means a helicopter of an MCTOM of 3 175 kg or less.

— 'Large aeroplane' means an aeroplane of an MCTOM of more than 5 700 kg.

— 'Large helicopter' means a helicopter of an MCTOM of more than 3 175 kg.

— 'Complex aeroplane' means an aeroplane:

- with an MCTOM of more than 5 700 kg; or
- certificated for a maximum passenger seating configuration of more than 19; or
- certificated for operation with a minimum crew of at least two pilots; or
- equipped with one or more turbojet engines or two or more turboprop engines.

— 'Complex helicopter' means a helicopter certificated:

- for a maximum take-off mass of more than 3 175 kg; or
- for a maximum passenger seating configuration of more than nine or
- for operation with a minimum crew of at least two pilots.

4.1. What is the issue

4.1.1. Definition of the issue

4.1.1.1. The need for investigation

In the absence of recording of the aircraft condition and operation, it can be very difficult to reconstruct the sequence of events that led to an accident or a serious incident. Moreover, this sequence of events is essential for defining actions in order to prevent future occurrences. Many investigations of aircraft accidents and serious incidents are hindered by the absence of accurate data on what happened.

The analysis of other types of evidence (witness statements, accident site examination, etc.) is usually time-consuming and does not provide such complete and accurate data as in-flight recording does.

Since 2010, almost all accidents and serious incidents that occur over the territory of an EASA MS must be subject to safety investigation[15]. However, many aircraft categories and types of operation fall outside the scope of current requirements to carry a crash-protected flight recorder. Those are for instance:

— aeroplanes with an MCTOM of 5 700 kg or less (hereinafter called 'light aeroplanes');

— helicopters with an MCTOM of 3 175 kg or less (hereinafter called 'light helicopters');

— balloons; and

— sailplanes.

In effect, more than 80 % of the occurrences requiring a safety investigation and that happened in 2012, 2013 or 2014 with aircraft registered in an EASA MS involved a light aeroplane, a light helicopter, a sailplane or a balloon (please refer to Appendix B, which presents statistics of accidents and serious incidents of aircraft registered in EASA MSs between 2012 and 2014).

4.1.1.2. The drivers

Note: This section presents the developments which triggered the initial decision of EASA to assess the need for extending in-flight recording requirements to lighter aircraft. Hence, 'drivers' should not be understood as the rationale for the proposals contained in Chapter 3 of this NPA — they are rather the facts that triggered the programming of RMT.0271.

4.1.1.2.1 ICAO Standards

The Standards recently introduced in ICAO Annex 6, Part I and Part III, prescribe that future light turbine-engined aeroplanes and helicopters operated for CAT shall be equipped with a means to record flight data and, under certain conditions, a means to record cockpit audio. Hence, current EU rules are not fully in line with the ICAO Standards applicable to in-flight recording. Appendix A provides a comparison of ICAO Standards and EU Air Operations rules related to in-flight recording.

[15] Refer to Articles 3 and 5 of Regulation (EU) No 996/2010 of the European Parliament of the Council of 20 October 2010 on the investigation and prevention of accidents and incidents in civil aviation and repealing Directive 94/56/EC (OJ L 295, 12.11.2010, p. 35).

4.1.1.2.2 Safety recommendations

12 safety recommendations addressed to EASA recommend the introduction of in-flight recording for light aeroplanes and helicopters and these safety recommendations are within the scope of RMT.0271. These safety recommendations were issued in the framework of official safety investigations of 10 accidents. Below is the list of safety recommendations with reference information on the accidents:

— Safety Recommendation FINL-2014-001 (Cessna 206 registered OH-AAA, 8.11.2012);

— Safety Recommendation FRAN-2009-008 (Beech C90 registered F-GVPD, 18.10.2006);

— Safety Recommendation FRAN-2013-012 (Cessna 208 registered F-OIXZ, 5.9.2010);

— Safety Recommendation HUNG-2008-002 (Eurocopter EC135 registered HA-ECE, 31.7.2008);

— Safety Recommendation NETH-2012-001 (Pilatus PC12 registered PH-RUL, 16.10.2009);

— Safety Recommendation NORW-2012-010 (Aerospatiale AS350 registered LN-OXC, 4.7.2011);

— Safety Recommendation SPAN-2012-011 (Swearingen SA226 registered EC-GDG, 18.2.1998);

— Safety Recommendation UNKG-2005-101 (Bell 206 registered G-BXLI, 22.1.2005);

— Safety Recommendation BELG-2015-001 (Pilatus PC6 registered OO-NAC, 19.10.2013);

— Safety Recommendation UNKG-2015-035 (Eurocopter EC135 registered G-SPAO, 29.11.2013);

— Safety Recommendation FRAN-2016-045 (TBM700 registered N129AG, .6.8.2014);

— Safety Recommendation FRAN-2016-046 (TBM700 registered N129AG, 6.8.2014).

In addition, 16 safety recommendations related to in-flight recording for light aeroplanes and light helicopters were issued by safety investigation authorities of the EASA MSs to authorities other than EASA.

With regard to the 12 safety recommendations addressed to EASA, it should be noted that:

— 7 out of the 12 safety recommendations concern CAT operations or parachuting activities, while 5 safety recommendations do not specify the type of operation;

— 7 out of 11 accidents involved aeroplanes and 4 involved helicopters;

— 10 out of 11 accidents involved a turbine-engined aircraft; and

— 9 out of 11 accidents involved a light aeroplane or a light helicopter with an MCTOM of 2 250 kg or more.

With regard to the 16 safety recommendations addressed to the EASA MSs:

— 13 out of the 16 safety recommendations concern CAT operations, aerial work, police or parachuting activities, while 3 safety recommendations do not specify the type of operation;

— 7 out of 16 safety recommendations were issued after an accident or a serious incident which involved an aeroplane, and 9 safety recommendations after an accident or a serious incident which involved a helicopter;

— 15 out of 16 safety recommendations were issued after an accident or a serious incident involving a turbine-engined aircraft; and

— 13 out of 16 safety recommendations were issued after an accident or a serious incident involving a light aeroplane or a light helicopter with an MCTOM of 2 250 kg or more.

Hence, the focus of European safety investigation authorities seems to be rather on light aeroplanes and light helicopters equipped with turbine engines, used for CAT or SPO operations, and have an MCTOM of 2 250 kg or more.

Appendix C presents safety recommendations that have been issued by European safety investigation authorities since 2000 and relate to in-flight recording for light aircraft. Most of these safety recommendations address CAT operations with light aeroplanes and light helicopters.

4.1.1.2.3 Commercial operations with balloons

When considering CAT operations, lighter-than-air aircraft are involved in a number of accidents of the same order of magnitude as aeroplanes and helicopters[16]. The accumulated time of CAT operations with balloons registered in EASA MSs — being much less than the accumulated time of CAT operations with aeroplanes and helicopters — leads to conclude that there is a much higher rate of accidents per flight hour for balloons than for aeroplanes and helicopters. This is also consistent with the figures presented in Appendix 2 of the EASA Opinion No 01/2016[17]: the accident rate per flight is found to be around 6×10^{-5} for balloons, while for aeroplanes it is around 4×10^{-6}. Furthermore, almost all CAT operations with balloons are actually commercial passenger transport operations, and some balloon models are certified to carry more than 9 passengers.

This shifts the focus on balloons with large passenger capacity, since there are aeroplane models and helicopter models with comparable or smaller passenger capacity that are required to carry crash-protected flight recorders (FDRs and CVRs) in accordance with Regulation (EU) No 965/2012 on Air Operations. For example:

— all models of multi-engined turbine-powered aeroplanes with an MOPSC of 9;

— all helicopter models with an MCTOM close to 3 175 kg, which typically have an MOPSC of 7 to 10.

Note: International operations with balloons are not covered by the ICAO Annexes.

4.1.1.3. Scope of the issue

The need for in-flight recording is assessed for aircraft categories which are within the scope of the European Air Operations rules, namely: aeroplanes, helicopters, sailplanes and balloons. Aircraft which belong to a category listed in Annex II of Regulation (EC) No 216/2008[18] (the Basic Regulation) are not

[16] In accordance with the statistics of Appendix B, when considering aircraft operated for commercial air transport and registered in the EASA MSs, there were 30 accidents with balloons operated between 2012 and 2014, which corresponds to about 10 accidents per year. Meanwhile, there were 25 accidents with aeroplanes and 13 accidents with helicopters in average per year over the decade 2002–2011.

[17] EASA Opinion No 01/2016 ‘Revision of the European operational rules for balloons’ proposes a simpler and more proportionate air operations regulatory framework for balloons. For this purpose, this Opinion proposes the extraction of the operational rules for balloons from Regulation (EU) No 965/2012, except for the authority requirements specified in Annex II (Part-ARO), and the issue of a new regulation on operational rules for balloons.

[18] The aircraft categories enumerated in Annex II of Regulation (EC) No 216/2008 are historic aircraft, experimental aircraft, amateur-built aircraft, aircraft that have been in the service of a military force, very light aeroplanes and helicopters, powered parachutes, gyroplanes, very light sailplanes, and unmanned aerial vehicles.

within the scope of the European Air Operations rules. In addition, aeroplanes and helicopters of models already subject to crash-protected flight recorder carriage requirements in accordance with Regulation (EU) No 965/2012 on Air Operations are outside the scope of RMT.0271 & RMT.0272[19].

Table 1 presents a summary of the aircraft categories that are within the scope of RMT.0271 & RMT.0272 and of the safety drivers.

19 For example, the extension of the requirement for an FDR to be carried on helicopters with an MCTOM of over 3 175 kg and first issued with an individual CofA before 1 August 1999 is outside the scope of RMT.0271 & RMT.0272.

Table 1: Scope of RMT.0271 & RMT.0272

Aircraft category	**Applicable Part of the Air OPS rules**	**Aircraft within the scope of RMT.0271 & RMT.0272**	**Drivers for change**
Aeroplanes not designated by Annex II of the Basic Regulation	Annex IV (Part-CAT)	Light aeroplanes with an MOPSC of less than 9 or not multi-engined turbine-powered	— ICAO Standard for the recording of basic flight parameters — ICAO Standard for the recording of audio — Safety recommendations addressed to EASA and to EASA MSs recommending in-flight recording for CAT operations
	Annex VI (Part-NCC)	— Light aeroplanes — Aeroplanes with an MCTOM of less than 27 000 kg for the recording of audio	— ICAO Recommended Practice for light turbine-engined aeroplanes
	Annex VIII (Part-SPO)	— Light aeroplanes (either complex or non-complex and used for commercial SPO) — Aeroplanes with an MCTOM of less than 27 000 kg for the recording of audio	— ICAO Recommended Practice for light turbine-engined aeroplanes — Safety recommendations addressed to EASA and to EASA MSs recommending in-flight recording for SPO
	Annex VII (Part-NCO)	All aeroplanes	— ICAO Recommended practice for light turbine-engined aeroplanes
Helicopters not designated by Annex II of the Basic Regulation	Annex IV (Part-CAT)	Light helicopters	— ICAO Standard for the recording of basic flight parameters — Safety recommendations addressed to EASA and to EASA MSs recommending in-flight recording for CAT operations
	Annex VI (Part-NCC)	— Light helicopters — Helicopters with an MCTOM of up to 7 000 kg for the recording of audio	— No driver identified
	Annex VIII (Part-SPO)	— Light helicopters (either complex or non-complex and used for commercial operations) — Helicopters with an MCTOM of less than 7 000 kg for the recording of audio	— Safety recommendations addressed to EASA MSs recommending in-flight recording for SPO
	Annex VII (Part-NCO)	All helicopters	— No driver identified
Balloons and hot-air airships not designated by	Basic requirements (BAS)	All balloons	— No driver identified

Aircraft category	**Applicable Part of the Air OPS rules**	**Aircraft within the scope of RMT.0271 & RMT.0272**	**Drivers for change**
Annex II of the Basic Regulation	Additional requirements for commercial operations (ADD)	All balloons	— Significantly higher accident rate for passenger air transport operations than for aeroplanes and helicopters — Aeroplanes and helicopters with a passenger capacity of 10 or more and performing CAT operations are required to carry an FDR and a CVR
Sailplanes and powered sailplanes not designated by Annex II of the Basic Regulation	Annex IV (Part-CAT)	All sailplanes	— No driver identified
	Annex VIII (Part-SPO)	All sailplanes	— No driver identified
	Annex VII (Part-NCO)	All sailplanes	— No driver identified

4.1.2. Safety risk assessment

4.1.2.1. Principles of assessing the safety risk

Benefits for accident prevention

The need for in-flight recording for investigation purposes should be assessed in light of its ultimate objective which is to improve aviation safety in the long term, i.e. decrease in the number of accidents. Therefore, when assessing the need for in-flight recording, the key criterion is the extent to which in-flight recording may contribute to accident prevention by providing information otherwise difficult to obtain.

However, when the accident causes are already known, accident prevention might be better served by measures other than recording data in flight.

Possible uses for other than safety investigation

Beyond the use by safety investigation authorities, in-flight recording may contribute to accident prevention through:

— operational safety monitoring (e.g. flight data monitoring);

— better data for the continuing airworthiness of products;

— engine or gearbox health monitoring; and

— dissuading against unnecessary risk-taking by pilots (because pilot actions are recorded).

Possible uses other than directly serving safety investigation are presented in detail in Appendix D.

The proposed approach to assess safety risks

One common method to assess safety risks is to apply a conventional method of risk assessment, such as the one reflected, for instance, in CS 23.1309 ‘Equipment, systems and installations’. In simple terms, this approach is based on a two-dimensional risk assessment, where one dimension is related to the frequency of a failure (from ‘frequent’ to ‘extremely improbable’) and the other dimension reflects the potential severity of a failure (from ‘no effect’ to ‘catastrophic’).

In-flight recording is not meant for the safe conduct of the flight, and recording failure or absence of recorded data has no effect on the safe continuation of a flight. The conventional method of risk assessment is simply not appropriate because its focus is limited on the safe completion of one individual flight following a system failure. It excludes a macroscopic approach to safety which consists in taking safety-effective actions based on data collected from day-to-day operations or from serious incidents and accidents.

In the case of in-flight recording equipment, the safety risk to be assessed is related to the non-realised safety benefit for an operator (when recorded data could be used for FDM or safety management) or for authorities (when recorded data would be useful to investigate a safety occurrence). In the absence of recorded data, it would be difficult to timely identify some of the hazards and, subsequently, to help preventing future accidents where these hazards will occur again.

No one-size-fits-all safety risk assessment

The safety risk assessment should take into account the category of aircraft and the type of operation considered because, for instance:

a) the acceptable level of safety risk is not the same when considering CAT operations and general aviation (refer to Appendix H for the principles of safety risk assessment);

b) the potential severity of an accident varies depending on aircraft passenger capacity (number of fatalities on board) or the aircraft mass (number of ground fatalities and level of damage on the ground).

Therefore, even when considering only the safety aspects, the risk assessment cannot be the same for all categories of aircraft and for all types of operation considered.

4.1.2.2. *Principle of proportionality*

In the case of light aircraft, the general principle of proportionality is of utmost importance. Requirements should be commensurate with the capability of those to which they apply. In particular, the principles of the General Aviation Road Map[20] should be observed to ensure that any proposed requirement will be manageable in the context of non-commercial operations.

In practice, this means for in-flight recording the following:

— When considering non-commercial operations, it is essential to have requirements that are easy to understand and implement, with an acceptable economic impact. The economic impact is not limited to purchase and certification costs, but also encompasses operational procedures and maintenance aspects. In addition, a possible new requirement on safety equipment should not be considered in isolation but together with all other requirements already applicable. This is because requirements are competing for limited human and financial resources.

— Also, the recording of data with potential privacy content involves appropriate protection of the recordings, which translates into additional constraints in use (protection and retention of data, access policy, etc.). These constraints might be difficult to manage in the context of recreational activities and private flights.

— When considering the carriage of equipment on light aircraft, the mass of the equipment, its power consumption and size are critical aspects to be considered. For these aspects, not only the recording equipment per se, but also the dedicated sensors and controls and the installation kit should be considered.

4.1.2.3. *Preliminary safety targets*

Due to the diversity of aircraft categories and types of operation considered in the framework of RMT.0271 & RMT.0272, a unique level of in-flight recording equipment cannot be considered for all possible cases. It is, therefore, proposed to define four levels of equipment for in-flight recording, independently of the considerations about the best way to reach this level of equipment (through rulemaking, safety promotion, or both):

[20] Refer to http://easa.europa.eu/easa-and-you/general-aviation/general-aviation-road-map.

1. **High:** the data collected should be exhaustive and allow getting a good picture of the sequence of events that occurred in the flight crew compartment. At least flight parameters related to the engines, to flight controls and to all essential aircraft systems should be recorded, including audio (and data-link communications, when applicable). The operational performance specifications of the dedicated in-flight recording equipment should be based on highly demanding industry standards (e.g. EUROCAE Documents ED-112 or ED-112A).
2. **Medium:** the data collected should help reconstruct the sequence of events that occurred in the flight deck and they should be collected by dedicated in-flight recording equipment; however, it is acceptable that only a reduced set of flight parameters is recorded or that audio is not recorded. Basic flight parameters related to aircraft attitude and trajectory and/or audio should be collected. Other means of collecting data, such as by means of image recording of the instruments, could be acceptable. The in-flight recording equipment may also fulfil other functions than recording data for investigation purposes; however, its operational performance specifications should be based on recognised industry standards (e.g. EUROCAE Document ED-155, ED-112 or ED-112A).
3. **Low:** the data collected should provide useful information for reconstructing a reliable history of the flight, which is the first step of a safety investigation. Typically, data computed by a GNSS receiver (aircraft position, ground speed, track and altitude) would serve this purpose, but alternative solutions could be acceptable. The collection of data would not need to be performed by dedicated equipment, and the data could also be transmitted to the ground in lieu of being recorded on board, or the aircraft could be tracked from the ground. The solution would, however, need to meet some minimum operational performance specifications.
4. **None:** not enough justification to require or promote in-flight recording.

When applying the principle of proportionality across categories of aircraft and types of operations, the following approach is proposed:

— The target level of equipment should be higher for commercial operations and lower for non-commercial operations; and

— The target level of equipment should be the highest for large aeroplanes (above 5 700 kg MCTOM) and large helicopters (above 3 175 kg MCTOM), followed by light complex aeroplanes and helicopters, followed by non-complex aircraft (light non-complex aeroplanes and light non-complex helicopters, as well as balloons and sailplanes).

Based on this principle and the drivers identified in Section 4.1.1 (see Table 1), a preliminary mapping of target levels of equipment is presented in Tables 2A, 2B and 2C.

Note: As regards balloons, EASA Opinion No 01/2016 proposes to move all provisions related to balloons from Regulation (EU) No 965/2012 to a new regulation. Unlike for other categories of aircraft, the balloons provisions would be organised into two subparts under Part-BOP (Balloon Operations): Subpart BAS (Basic Requirements) and Subpart ADD (Additional Requirements for Commercial Operations).

Table 2A: Preliminary target levels of in-flight recording equipment for aeroplanes and helicopters

Target level of equipment (applicable Part of Air OPS rules)	**Large aeroplanes and large helicopters**	**Light aeroplanes and light helicopters**
CAT operations (Part-CAT)	'High' (already covered by the Air OPS rules).	High for multi-engined turbine-powered aeroplanes with MOPSC > 9 (already covered by the Air OPS rules). 'None' to 'high' for other aircraft categories depending on aircraft complexity and passenger capacity (e.g. 'none' for a small piston-engined aircraft capable of carrying just one passenger, may be 'high' if the aircraft is complex and/or carries a large number of passengers).
Commercial SPO (Part-SPO)	'High' for aeroplanes with an MCTOM exceeding 27 000 kg and helicopters with an MCTOM exceeding 7 000 kg (already covered by the Air OPS rules). 'Medium' for aeroplanes with an MCTOM between 5 700 and 27 000 kg and helicopters with an MCTOM between 3 175 and 7 000 kg (already covered by the Air OPS rules).	'None' to 'medium' depending on aircraft complexity and passenger capacity.
Non-commercial operations (Part-NCC or Part-NCO)	'High' for aeroplanes with an MCTOM exceeding 27 000 kg and helicopters with an MCTOM exceeding 7 000 kg (already covered by the Air OPS rules). 'Medium' for aeroplanes with an MCTOM between 5 700 and 27 000 kg and helicopters between 3 175 and 7 000 kg (already covered by the Air OPS rules).	'None' to 'medium' depending on aircraft complexity and passenger capacity.

Table 2B: Preliminary target levels of in-flight recording equipment for sailplanes

Target level of equipment (applicable Part of the Air OPS rules)	Sailplanes
CAT operations (Part-CAT)	'None' to 'low' (e.g. 'none' if just one passenger can be carried, and could be 'low' if several passengers can be carried)
Commercial SPO (Part-SPO)	'None' to 'low'
Non-commercial operations (Part-NCO)	'None' to 'low'

Table 2C: Preliminary target levels of in-flight recording equipment for balloons

Target aircraft	Balloons
Basic requirements (Part-BOP, Subpart BAS)	'None' to 'low' (non-commercial operations with balloons).
Additional requirements for commercial operations (Part-BOP, Subpart ADD)	'None' to 'medium' depending on passenger capacity (e.g. 'none' for a balloon capable of carrying a small number of passengers, and may be 'medium' for balloons which transport a large number of passengers).

4.1.2.4. Assessing the safety risk

Limitations of an assessment based on safety recommendations

While the several safety recommendations related to in-flight recording should be carefully considered, basing the safety risk assessment only on their review is not sufficient for the following reasons:

— Such safety recommendations were mainly triggered by the lack of data to analyse and explain the accidents, while the need for in-flight recording should be assessed against the ultimate objective of a safety investigation, which is to improve aviation safety. It is not obvious that if data had been available to facilitate those accident investigations (for which safety recommendations related to in-flight recording were issued and contributory factors could have been subsequently better identified), this would have resulted in corrective actions to prevent future accidents.

— There are many more cases where the absence of reliable data has hindered the investigation than those which have triggered a safety recommendation. It is not common practice among safety investigation authorities to issue a safety recommendation each time they are missing important data (except in the case of accidents with the largest category of aircraft).

— The majority of the safety recommendations were issued before Regulation (EU) No 996/2010 made the investigation of all accidents and serious incidents occurring over the territory of a MS mandatory (except for Annex II aircraft). In the past, some safety investigation authorities chose to investigate only occurrences that happened during CAT operations or only when the aircraft MCTOM or occupancy was above a given threshold.

— The majority of the safety recommendations were issued at a time when there was no industry standard for lightweight flight recorders, and very few such systems were offered on the market. The only available concept was that of conventional, ED-112-compliant, crash-protected flight recorders, which are relatively heavy and expensive and not designed for light aircraft. Therefore, it was not felt justified by investigators to issue safety recommendations for aircraft other than aeroplanes and helicopters operated for CAT. Almost half of the safety recommendations presented in Appendix C had been issued before ED-155 was published in 2009.

— Most of the safety recommendations are rather generic in their nature, i.e. they do not target a specific category of aircraft nor do they specify what information should be recorded.

Studying safety investigation reports

In order to better assess the safety risks caused by the absence of in-flight recording, and not just rely on safety recommendations, it was decided to systematically study investigation reports. The studies were performed by EASA in coordination with the RMT.0271 & RMT.0272 Rulemaking Group.

The objective of these studies was to collect evidence of the actual contribution brought by recorded data for the identification and resolution of safety issues. Two approaches were combined in these studies: the first approach was focused on hindrance to investigations due to the absence of reliable data (assessment by the negative), while the second aimed to assess the benefits brought by in-flight recording and tentatively determined to what extent these benefits could be transposed to a dedicated in-flight recording function (assessment by the positive).

In total, four studies were performed. For each study, a study set of investigation reports corresponding to a given period of time was extracted and systematically reviewed using a grid of predefined questions (i.e. no cherry-pick selection of the study case).

Study 1 aimed to assess to what extent facts can be established, causes determined, and safety issues identified during safety investigations of accidents involving light aeroplanes, light helicopters, balloons or sailplanes. This included questions on:

— the establishment of the final trajectory of the aircraft;

— the identification of the sequence of aviation occurrences;

— the need for test and research activities, and whether they could have been rendered unnecessary by in-flight recording; and

— the mention by the investigation that causes could not be established due to the lack of data.

For this study, a sample of 81 safety investigation reports of accidents which occurred between 2009 and 2012 was analysed.

Study 2 aimed to infer what factual data could be obtained from in-flight recording equipment based on positive evidence. Therefore, all accident reports selected for Study 2 mentioned recordings which were retrieved and analysed (the 'recordings' were performed by equipment installed on the aircraft, devices brought by persons on board, as well as recordings made outside the aircraft).

Study 2 included questions such as:

— whether the recording helped to establish a more reliable sequence of the events that led to the accident;

— whether the recording helped to identify the contributory factors;

— whether the recording was eventually useful to identify corrective actions (i.e. safety recommendations or actions performed by stakeholders to address a safety issue identified by the investigation); and

— what kind of recording (flight parameters, audio, image, etc.) would have provided equivalent information.

For this study, a sample of 48 safety investigation reports of accidents that occurred between 2010 and 2012 was analysed.

Study 3 aimed to assess whether the CVR carriage requirements should be as stringent in Part-NCC and Part-SPO as they are in Part-CAT. In practice, Study 3 was restricted to studying the benefit of CVR recording for helicopters with an MCTOM between 3 175 and 7 000 kg (subject to carry a CVR when operated under Part-CAT, but not under Part-SPO or Part-NCC), since it was found that for aeroplanes, aligning the CVR carriage requirements across the Parts would, in practice, mean equipping very few aircraft and therefore bring little safety benefit.

Study 3 included questions such as:

— whether the CVR recording helped to establish a more reliable sequence of events that led to the accident;

— whether the CVR recording helped to identify the contributory factors; and

— whether the CVR recording was eventually useful to identify corrective actions.

For this study, a sample of 5 safety investigation reports of helicopter accidents that occurred between 2007 and 2011 was analysed.

Study 4 aimed to assess what factual data could be obtained from image recordings based on positive evidence. Therefore, all accident reports analysed in the context of this study mentioned image recordings taken from inside the aircraft, which were retrieved and analysed. Study 4 was an extension of Study 2, because the latter did not cover enough cases of image recordings and therefore it was felt that a dedicated study was needed.

Study 4 included questions such as:

— whether the image recording helped to establish a more reliable sequence of events that led to the accident;

— whether the image recording helped to identify the causes;

— what kind of information was obtained thanks to the image recording (indications of instruments, non-verbal communication, meteorological conditions, etc.); and

— whether the image recording was eventually useful to identify corrective actions.

For this study, a sample of 20 safety investigation reports of accidents that occurred between 2011 and 2014 was analysed.

Details on each of these studies are presented in Appendix E.

Results of the studies

The following general results could be obtained from Studies 1, 2, 3 and 4:

1. When considering light aeroplanes, light helicopters, sailplanes and balloons:

   — Trajectory reconstruction is attempted in most investigations, but only a third get sufficient data to establish a complete final trajectory. The best sources for trajectory data seem to be GNSS receivers (widely used on sailplanes) and radar tracks (often recorded in the case of aeroplanes and helicopters).

   — A third of investigations perform test and research activities. These activities aim to obtain information that usually cannot be obtained with just a trajectory. Only an extensive set of flight parameters (such as those recorded by an FDR) could deliver the data that would allow saving on test and research activities in most cases. A reduced set of flight parameters (such as the ones recorded by an ADRS) would have been helpful in half of the cases.

   — In accordance with Study 2, for half of the analysed recordings, the extracted data could have been provided by flight parameters, except for balloons, where images seem to be more relevant.

   — For the majority of investigations where an image recording is retrieved and analysed (15 out of 20 in accordance with Study 4), the recording helps to determine significant events or significant contributory factors by providing information:

     - on what was displayed by the aircraft instruments; and
     - on the aircraft location and its environment.

   — Most investigation reports establish some causes and contributory factors; however, a quarter of the reports do not establish a complete sequence of aviation occurrence, irrespective of the availability of a recording.

   — Less than half of the investigation reports mention a corrective action (safety recommendation or other kind of corrective action taken by any of the involved parties): 18 out of 48 reports for Study 2, and 4 out of 20 reports for Study 4. In the case of sailplanes, it is even less than a quarter.

   — The recording was actually found to be useful for identifying corrective actions in only a small proportion of investigations (actions taken by stakeholders or recommended by safety investigation authorities): 6 out of 48 reports for Study 2, and 1 out of 20 reports for Study 4. In most investigation reports, no explicit link was made between the information obtained from the recording and the corrective actions.

2. When considering CVRs installed on helicopters with an MCTOM between 3 175 and 7 000 kg (Study 3):

— For all investigation reports analysed, the CVR was instrumental in determining some significant events or significant contributory factors, in particular:

- information on chronology and timeline;
- information on communication and CRM;
- information on the application of procedures and checklists; and
- information on alarms and technical failures.

— However, a link to corrective actions (safety recommendations or other) was not clearly demonstrated.

In conclusion, while recordings indisputably provide useful data for reconstructing trajectories and flight instrument indications, as well as determining some significant events or significant contributory factors, their potential benefits for accident prevention seems moderate because they do not significantly influence the number of corrective actions. The reasons for this can be, among other things:

— The fact that corrective actions generally address safety findings which are established on the analysis of several sources of data. It is then difficult to assess a posteriori the contribution of a given source (here, in-flight recording) to the identification of corrective actions.

— The fact that (when considering general aviation with light aircraft) most accident causes are recurrent, well-known, and often related to errors made by the pilot-in-command (inadequate flight preparation, fuel mismanagement, non-compliance with the Rules of the Air, excessive risk-taking, etc.). In this context, there is often no scope to make specific safety recommendations.

Quantifying the safety risk

Two dimensions are considered for assessing the safety risk associated with the absence of in-flight recording:

— **severity,** i.e. how many lives could be saved in the best case by timely identifying a hazard thanks to recorded data; and

— **frequency,** i.e. how often after an accident or a serious incident an in-flight recording would provide data in order to understand the causes that would otherwise be difficult to identify and that can be addressed by corrective actions before they cause a fatal accident.

Severity

When considering light aviation where the number of potential fatalities caused by an accident is limited, the severity of an accident would not exceed '**hazardous**' (i.e. a limited number of serious or fatal injuries; refer to Appendix H, Table H.2). Therefore, the corresponding severity is also considered to be limited to 'hazardous' because the number of lives saved and of serious injuries prevented will be limited.

Frequency

The frequency is proposed to be assessed on the basis of the number of fatal accidents prevented thanks to data provided by an in-flight recording in a previous accident or serious incident.

Therefore, one needs first to assess the proportion of accidents and serious incidents bearing a contributory factor that could only be identified with the help of in-flight recording. In addition, this contributory factor should be useful for identifying corrective actions. Based on the results of the studies of investigation reports (in particular Study 2 and Study 4), it is estimated that for less than 10 % of the accidents and serious incidents involving a light aircraft, a corrective action is identified.

P is the proportion of accidents and serious incidents for which a corrective action is identified, and it is assumed that P = 10 %.

It is assumed that a proportion C of the corrective actions identified during the investigation of an accident or a serious incident that occurred in year (N) prevents future accidents from occurring in year (N + 1). The value of C is arbitrarily set at 20 %.

Statistics presented in Appendix B also show that around 10 % of the accidents occurring with light aeroplanes, light helicopters, balloons and sailplanes are fatal.

With these assumptions, the number of fatal accidents prevented in year (N + 1), assuming that I(N) investigations are performed in year (N), is:

$F = I(N) \times P \times C \times 0.1$

Assuming that:

— 100 000 light aircraft are fitted with in-flight recording equipment (roughly the size of the European fleet: see Table 4);

— 1 % of these light aircraft were involved in accidents or serious incidents in year N, which were investigated, i.e. I(N) = 100 000 × 0.01 = 1 000 (roughly the number of accidents per year with light aeroplanes, light helicopters, balloons and sailplanes: see Appendix B);

— In P = 10 % of the investigations, a corrective action was identified;

— C = 20 % (i.e. 20 % of the corrective actions identified in year (N) prevent an accident in year (N + 1));

— 10 % of the prevented accidents in year (N + 1) would have been fatal,

then the number of fatal accidents prevented in the following year is:

F = 1 000 × 0.1 × 0.2 × 0.1 = 2 fatal accidents prevented in year (N + 1) from 1 000 investigations in year N, for which in all cases in-flight recording was available. Therefore, the proposed safety benefit frequency is considered equivalent to a risk frequency level which is qualified as '**remote**' (refer to Table H.1 of Appendix H).

Also, the annual number of fatal accidents for the years 2012, 2013 and 2014 was in average more than 80 when considering all light aeroplanes, light helicopters, balloons and sailplanes. This is 20 times more than the theoretical number of accidents prevented per year in the example above. This shows that equipping all light aircraft registered in Europe and within the scope of RMT.0271 & RMT.0271 with in-flight recording equipment would actually result in just a moderate reduction of the number of fatal accidents per year.

Safety risk level

Based on the above, the safety risk caused by the absence of in-flight recording on-board light aircraft has a 'remote' frequency level and a 'hazardous' severity level. The level of safety risk associated with the absence of in-flight recording on-board light aircraft, based on Table H.3 of Appendix H, is considered '**medium**'.

4.1.2.5. Consolidated safety targets

Knowing that the safety risk level associated with the absence of in-flight recording on board light aircraft is not higher than medium, the preliminary target levels of equipment presented in Tables 2A, 2B and 2C can be refined. Tables 3A, 3B and 3C present consolidated target levels of equipment.

Table 3A: Consolidated mapping of target levels of equipment for in-flight recording for aeroplanes and helicopters

Target level of equipment (applicable Annex of Regulation (EU) No 965/2012 on Air Operations)	**Large aeroplanes and large helicopters**	**Light aeroplanes and light helicopters**
Annex IV (Part-CAT)	'High' (already covered by the Air OPS rules)	'High' for multi-engined turbine-powered aeroplanes with an MOPSC of more than 9 (already covered by the Air OPS rules). 'Medium' for turbine-engined aeroplanes with an MCTOM equal to or greater than 2 250 kg, and for aeroplanes with an MOPSC of more than 9. 'Medium' for turbine-engined helicopters with an MCTOM equal to or greater than 2 250 kg. 'None' to 'low' for other light aeroplanes and light helicopters.
Annex VIII (Part-SPO)	'High' for aeroplanes with an MCTOM exceeding 27 000 kg and helicopters with an MCTOM exceeding 7 000 kg (already covered by the Air OPS rules). Medium for aeroplanes with an MCTOM between 5 700 and 27 000 kg and helicopters between 3 175 and 7 000 kg (already covered by the Air OPS rules).	'Medium' for turbine-engined aeroplanes with an MCTOM equal to or greater than 2 250 kg, and for aeroplanes with an MOPSC of more than 9. 'Medium' for turbine-engined helicopters with an MCTOM equal to or greater than 2 250 kg. 'None' to 'low' for other light aeroplanes and light helicopters.

Annex VI (Part-NCC) or Annex VII (Part-NCO)	'High' for aeroplanes with an MCTOM exceeding 27 000 kg and helicopters with an MCTOM exceeding 7 000 kg (already covered by the Air OPS rules). 'Medium' for aeroplanes with an MCTOM between 5 700 and 27 000 kg and helicopters between 3 175 and 7 000 kg (already covered by the Air OPS rules).	'None' to 'low' for other light aeroplanes and light helicopters.

Table 3B: Consolidated mapping of target levels of equipment for in-flight recording for sailplanes

Target level of equipment (applicable Annex of the Air OPS rules)	Sailplanes
Annex IV (Part-CAT)	'None'
Annex VIII (Part-SPO)	'None'
Annex VI (Part-NCC) and Annex VII (Part-NCO)	'None'

Table 3C: Consolidated mapping of target levels of equipment for in-flight recording for balloons

Target aircraft	Balloons
Basic requirements (Part-BOP, Subpart BAS)	'None'
Additional requirements for commercial operations (Part-BOP, Subpart ADD)	'Low' if MCTOM is equal to or greater than 3 000 kg (corresponds to a passenger capacity of more than 13). 'None' to 'low' otherwise.

4.1.3. Who is affected

4.1.3.1. Stakeholders

The stakeholders affected by this issue are:

— manufacturers of light aeroplanes, light helicopters, sailplanes or balloons;

— commercial operators of light aeroplanes, light helicopters, sailplanes or balloons;

— non-commercial operators of light aeroplanes, light helicopters, sailplanes or balloons;

— private pilots and aircraft owners;

— safety investigation authorities of EASA MSs; and

— EASA and competent authorities of MSs (regulators).

4.1.3.2. Affected fleet

To date, there is unfortunately no common standard agreed between the EASA MSs for fleet data collection; every EASA MS uses different rules for collecting and categorising data on light aircraft under their registry. As a result, assessing total numbers of light aircraft registered in the EASA MSs is almost impossible.

A tentative assessment made for three MSs (France, Germany and the United Kingdom) gave the results presented in Table 4. Given that light aircraft registered in these three MSs account for around half of the accidents that occurred with light aircraft registered in the EASA MSs, one may assume that doubling the fleet numbers gives a rough estimate of the number of aircraft potentially impacted by RMT.0271 & RMT.0272.

Note: For balloons, the fleet data provided in Opinion No 01/2016 was used.

Table 4: Fleet numbers — light aircraft

Aircraft category	Total number in year 2013 for France, Germany and the United Kingdom (rounded to the nearest hundred)	Roughly estimated number in year 2013 for all EASA MSs
Light aeroplanes (MCTOM ≤ 5 700 kg)	23 200	46 400 (double)
Light helicopters (MCTOM ≤ 3 175 kg)	2 700	5 400 (double)
Sailplanes	15 800	31 600 (double)
Balloons	2 800	6 000 (Opinion No 01/2016)
Total	44 500	89 400

4.1.4. How could the issue/problem evolve

If the requirements for flight recorder carriage are not changed for commercial operations, the gap in the understanding of large aircraft and light aircraft accident causes and in the identification of relevant safety actions will grow. Indeed, more and more data are collected and analysed by operators of large aeroplanes and large helicopters on a day-to-day basis (for flight data monitoring, condition monitoring, continuing airworthiness). In addition, the capabilities of flight recorders required to be installed on large aircraft are being enhanced (e.g. with data-link recording, the advent of very long recording duration CVRs). Consequently, the gap in knowledge is expected to grow between large aircraft and light aircraft.

Because of this, while one can expect that the level of safety will further increase for commercial operators of large aircraft thanks to the increase of recorded data, it may still remain at a lower level for commercial operators of light aircraft (operated under Part-CAT or Part-SPO) in spite of the demanding requirements they have to comply with anyway in terms of equipment, procedures, and training. Also, side safety benefits of continuously recording data (such as dissuasion against risk-taking by pilots, favouring retrospective occurrence reporting or earlier detection of performance issues with engines or systems) will not be reaped. These diverging trends are problematic when considering in particular the transportation of fare-paying passengers, as the general public may rightfully expect an equivalent level of safety when they are travelling, whatever the aircraft used.

One should also not rely on coincidental recordings from portable electronic devices (portable GNSS receiver, action camera, smartphone) to replace dedicated in-flight recording, because the data formats used by these devices are proprietary and data is encrypted; this makes retrieval of any useful data very challenging when the device is damaged (often the case after an accident). Also retrieving data from these devices on a day-to-day basis for operational purposes is difficult for technical and privacy reasons. The manufacturers of these electronic devices usually provide little assistance to the investigation authorities.

When considering non-commercial operations with light aircraft (covered by Part-NCC and Part-NCO), the absence of dedicated in-flight recording equipment will probably not make any significant difference safety-wise. Since the regulatory framework set by Regulation (EU) No 965/2012 on Air Operations (Part-SPO, Part-NCC and Part-NCO) is much less stringent for light aircraft, a higher level of risk-taking is considered acceptable. Also refer to Appendix H for considerations related to general aviation.

It is also not expected that in-flight recording data would make a significant difference for accident prevention, because most causes of accidents affecting light aircraft used for general aviation are often recurrent and well-known. In that case, accident prevention might be better served by other measures than recording flight data (for instance, enhancing the design of aircraft control or instruments, improving procedures, specific training, etc.).

In addition, non-commercial operators and private owners usually have limited financial capacity. In this case, in-flight recording equipment may bring limited side benefits for the cost of fitting and maintaining it serviceable. Please refer also to the principle of proportionality presented in Section 4.1.2.

Finally, it should be noted that Regulation (EU) 2016/1185[21] introduced a new requirement for all pilots of aircraft carrying a serviceable transponder to 'operate the transponder at all times during flight, regardless of whether the aircraft is within or outside airspace where SSR is used for ATS purposes' (refer to Appendix F). Since most light aeroplanes and helicopters operated under Part-NCO are fitted with a transponder in order to be able to fly through airspace where it is required, one may expect that in the future a radar track will almost always be available after an accident of such aircraft, hence facilitating the reconstruction of the flight's history.

4.2. What we want to achieve — objectives

The operational objectives of this proposal are to:

— enhance the identification and prevention of safety issues affecting light aircraft by means of data recorded in flight;

— achieve harmonisation with ICAO Standards in Annex 6 Parts I, II and II;

[21] Commission Implementing Regulation (EU) 2016/1185 of 20 July 2016 amending Implementing Regulation (EU) No 923/2012 as regards the update and completion of the common rules of the air and operational provisions regarding services and procedures in air navigation (SERA Part C) and repealing Regulation (EC) No 730/2006 (OJ L 196, 21.7.2016, p. 3).

— produce a proportionate regulation which takes into account the General Aviation Roadmap; and

— identify avenues other than requirements for in-flight recording equipment.

4.3. How it could be achieved — options

4.3.1. Requiring, facilitating or promoting

When a target level of equipment cannot be achieved by introducing a new requirement due to cost impact and proportionality considerations despite the recognised safety benefit, then other ways to achieve it may facilitate or promote the installation of equipment.

In this context, 'facilitate' means modifying the regulatory framework so that in-flight recording equipment can be installed following a faster and cheaper approval process. 'Promote' means communicating the benefits of installing in-flight recording equipment in order to get buy-in from the industry and pilots.

4.3.1.1. Facilitating the installation of in-flight recording equipment

Voluntary installation of equipment recording data, audio or images can be facilitated by allowing it to be performed under a standard change, such as the one defined by the Certification Specifications for Standard Changes and Standard Repairs (CS-STAN). An installation performed under CS-STAN does not require an approval process if it is validated by an aircraft certificate of release to service (in accordance with Part-M, M.A.801) issued by the appropriate certifying staff.

The equipment for which the installation could be facilitated includes:

— video cameras;

— GNSS receivers;

— in-flight recording system when it relies on dedicated sensors (camera, GNSS receiver, accelerometer, etc.);

— transponder (because it allows the recording of a radar track on the ground).

The objective of RMT.0690 (NPA 2016-17 'Regular update of certification specifications for standard changes & standard repairs (CS-STAN)'[22], published on 7 December 2016) is to update CS-STAN. The tasks under RMT.0690 include the introduction in Subpart B of the CS-STAN (standard changes) of items addressing the installation of video camera mountings, of a GNSS receiver and of a transponder. They also include the creation of a new item addressing the installation of an in-flight recording system.

The update of CS-STAN is outside the scope of this rulemaking task.

4.3.1.2. Promoting in-flight recording equipment

In order for the promotion of in-flight recording equipment to be successful, benefits other than facilitating official safety investigations should be put forward. Indeed, from the perspective of small operators, pilots and aircraft owners, the probability of an accident is very remote; consequently, they

[22] Available at https://www.easa.europa.eu/document-library/notices-of-proposed-amendment/npa-2016-17.

are more inclined to invest in equipment that has a more direct impact on safety (e.g. an anti-collision system) than in in-flight recording equipment. Among other things, the benefits of in-flight recording equipment could be promoted among operators, flight schools and aero clubs in order to monitor the safe and cost-effective use of aircraft, prevent excessive risk-taking, and support training.

More details on the potential benefits of in-flight recording and the stakeholders which could be receptive to promotion of in-flight recording are presented in Appendix D.

4.3.2. The options

Due to the fact that the context and the drivers are very different when considering aeroplanes, helicopters, sailplanes and balloons, different sets of policy options were established depending on the aircraft category. Table 5A and Table 5B present these options.

Table 5A: Selected policy options for light aeroplanes and light helicopters

Option No	*Short title*	**Description**
A.0	Do nothing	Baseline option (no change to the rules and no promotion); risks remain as outlined in the issue analysis.
A.1	Safety promotion	Promote the recording of basic flight parameters, audio and/or a view of the instruments panel for all models of light aeroplanes and light helicopters and for all types of operations (no change to the rules).
A.2	ICAO Annex 6	Strictly transpose ICAO Standards in Annex 6 for newly manufactured light turbine-engined aeroplanes and newly manufactured light turbine-engined helicopters operated for CAT.
A.3	ICAO Annex 6 with differences	Transpose ICAO Standards in Annex 6 with the following differences: — With regard to aeroplanes, the applicability set is newly manufactured aeroplanes which have an MOPSC of more than 9 or which are turbine-engined and have an MCTOM of 2 250 kg or more; — The requirement to record basic flight parameters on board aeroplanes and helicopters is also applicable to commercial SPO; — Recording of audio is not required.
A.4	Combined solution	Option A.1 + Option A.3

Option A.0 means no change to the current rules and no promotion action.

Option A.1 means promoting the benefits of recording flight parameters, interactions between the pilots and the aircraft by means of a camera, as well as audio in the flight crew compartment. Promotion could take, for example, the form of a leaflet or of information on the EASA website.

Option A.2 means strictly transposing the Standards of ICAO Annex 6 Parts I and III for lightweight flight recorders into Regulation (EU) No 965/2012 on Air Operations. This means:

— newly manufactured turbine-engined light aeroplanes operated for CAT are required to record basic flight parameters by means of an FDR, an ADRS, a Class C airborne image recorder (AIR) or a Class C airborne image recording system (AIRS) (ICAO Standard 6.3.1.2.1 of Annex 6 Part I);

— newly manufactured turbine-engined light aeroplanes operated for CAT,

- which have an MCTOM of more than 2 250 kg; and
- which are certified for operation with a minimum crew of at least two pilots,

are required to record audio by means of a CVR or a CARS (ICAO Standard 6.3.2.1.1 of Annex 6 Part I); and

— newly manufactured turbine-engined light helicopters operated for CAT, which have an MCTOM of more than 2 250 kg, are required to record basic flight parameters by means of an FDR, an ADRS, a Class C AIR or a Class C AIRS (ICAO Standard 4.3.1.2.4 of Annex 6 Part III, Section II).

Option A.3 means transposing the Standards in ICAO Annex 6 Parts I and III and adapting them to capture aeroplanes with an MOPSC exceeding 9 and turbine-engined aeroplanes with an MCTOM of 2 250 kg or more, and to capture commercial SPO. In addition, the ICAO Standard prescribing the recording of audio for light aeroplanes is not transposed. This means:

— newly manufactured light aeroplanes operated for CAT or commercial SPO, which in addition:
  - have an MOPSC of more than 9; or
  - are turbine-engined and have an MCTOM of 2 250 kg or more,

are required to record basic flight parameters (by means of an FDR, an ADRS, a Class C AIR or a Class C AIRS);

— newly manufactured turbine-engined light helicopters operated for CAT or commercial SPO, which have an MCTOM of 2 250 kg or more, are required to record basic flight parameters (by means of an FDR, an ADRS, a Class C AIR or a Class C AIRS).

Option A.4 means implementing Options A.1 and A.3 together.

Table 5B: Selected policy options for balloons

Option No	*Short title*	**Description**
B.0	Do nothing	Baseline option (no change to the rules and no promotion); risks remain as outlined in the issue analysis.
B.1	Safety promotion	Promote the fitment of balloons with means to record trajectory parameters and images from the basket interior (no change to the rules).
B.2	Record position and images	Require newly manufactured balloons used in commercial operations and with an MCTOM of 3 000 kg or more to be fitted with equipment recording the balloon’s trajectory parameters and images from the basket interior.
B.3	Combined solution	Option B.1 + Option B.2.

Option B.0 means no change to the current rules and no promotion action.

Option B.1 means promoting the benefits of recording trajectory parameters (i.e. three-dimensional position and, when available, speed and track), as well as images of the basket interior (capturing a view of the normal position of the pilot and the passengers in the balloon). This may be performed by dedicated in-flight recording equipment or by equipment with another purpose: GNSS receiver with a recording function, flight tracking system, etc. Promotion could take, for example, the form of a leaflet or of information on the EASA website.

Option B.2 means that all newly manufactured balloons used in commercial operations and with an MCTOM of 3 000 kg or more (corresponding to a passenger capacity of more than 13 on most balloon models) are required to record, in the balloon or on the ground, trajectory parameters (i.e. three-dimensional position and, when available, speed and track) and images of the basket interior (capturing a view of the normal position of the pilot and the passengers in the balloon). This may be performed by dedicated in-flight recording equipment, or by equipment with another purpose. The requirement proposed by Option B.2 is performance-based (not prescriptive) and allows, for instance, that the data is recorded on the ground.

However, two conditions are defined for a solution to be considered acceptable (see also Appendix F):

a) If data is recorded on board, a non-volatile memory medium is used; and

b) Information sufficient to recover and decode the recorded data files is provided to safety investigation authorities, also in the case where chip-level recovery is needed (equipment is damaged in the accident).

Option B.3 means implementing options B.1 and B.2 together.

Tables 6A and 6B show how the options address the consolidated target level of equipment presented in Tables 3A and 3C.

Table 6A: Target levels of equipment and identified options for aeroplanes and helicopters

Target level of equipment (applicable Annex of Regulation (EU) No 965/2012 on Air Operations)	**Light aeroplanes and light helicopters**	**Options**
Annex IV (Part-CAT)	'High' for multi-engined turbine-powered aeroplanes with an MOPSC of more than 9 (already covered by the AirOPS rules).	(Already covered by the Air OPS rules)
	'Medium' for turbine-engined aeroplanes with an MCTOM equal to or greater than 2 250 kg, as well as for aeroplanes with an MOPSC of more than 9.	Option A.2 or Option A.3
	'Medium' for turbine-engined helicopters with an MCTOM equal to or greater than 2 250 kg.	Option A.2 or Option A.3
	'None' to 'low' for other light aeroplanes and light helicopters.	Option A.1
Annex VIII (Part-SPO)	'Medium' for turbine-engined aeroplanes with an MCTOM equal to or greater than 2 250 kg, as well as for aeroplanes with an MOPSC of more than 9.	Option A.3
	'Medium' for turbine-engined helicopters with an MCTOM equal to or greater than 2 250 kg.	Option A.3
	'None' to 'low' for other light aeroplanes and light helicopters.	Option A.1
Annex VI (Part-NCC) or Annex VII (Part-NCO)	'None' to 'low' for other light aeroplanes and light helicopters.	Option A.1

Table 6B: Target levels of equipment and identified options for balloons

Target aircraft	Balloons	Options
Basic requirements (Part-BOP, Subpart BAS)	'None'	Option B.0
Additional requirements for commercial operations (Part-BOP, Subpart ADD)	'Low' if MCTOM is 3 000 kg or more (corresponds to a passenger capacity of more than 13). 'None' to 'low' otherwise.	Option B.2 Option B.1

4.4. Methodology and data

4.4.1. Methodology applied

The methodology applied for this IA is the multi-criteria analysis (MCA) which allows comparing all options by scoring them against a set of criteria.

MCA covers a wide range of techniques that aim to combine a range of positive and negative impacts into a single framework to allow easier comparison of scenarios. Essentially, it applies cost-benefit thinking to cases where there is a need to present impacts that are a mixture of qualitative, quantitative, and monetary data, and where there are varying degrees of certainty. The MCA key steps generally include:

— establishing the criteria to be used to compare the options (these criteria should be measurable, at least in qualitative terms);

— attributing weight to each criterion to reflect its relative importance to the decision to be taken;

— scoring how well each option meets the criteria (the scoring needs to be relative to the baseline scenario);

— ranking the options by combining their respective weights and scores; and

— performing sensitivity analysis on the scoring to test the robustness of the ranking.

The criteria used to compare the options were derived from the Basic Regulation and the IA guidelines developed by EASA and in line with the principles of better regulation issued by the European Commission. The principal objective of EASA is to 'establish and maintain a high uniform level of safety' (Article 2(1) of the Basic Regulation). As additional objectives, the Basic Regulation identifies environmental, economic, proportionality, and harmonisation aspects, which are reflected below.

For the scoring of the impacts, a simple scale ranging from – 5 (very negative) to + 5 (very positive) is used to indicate the positive and negative impacts. The intermediate impact values are:

— – 3 (medium negative),

— – 1 (slightly negative),

— 0 (neutral),

— + 1 (slightly positive), and

— + 3 (medium positive).

This was found to be a simple way to assess the impacts. In addition, each criterion (safety, economic, environmental, etc.) was attributed an equal weight.

4.4.2. Data collection

EASA's accident databases have been used to collect statistics on accidents and serious incidents with light aircraft, as well as safety recommendations related to in-flight recording.

In addition, four studies were performed by EASA in order to assess the potential safety benefits of in-flight recording for light aircraft. The results of these four studies are summarised in Section 4.1.2. The detailed results of these studies are presented in Appendix E.

With regard to the cost, operational impact and benefits of in-flight recording systems, EASA launched a survey from 7 May to 9 June 2015. The survey was focused on aircraft systems which are permanently installed on light aeroplanes and light helicopters, and whose primary function is to record data, audio or images for later analysis or investigation. The survey was addressed to the EASA advisory bodies and to equipment manufacturers. 12 organisations responded (8 aircraft manufacturers, 6 equipment manufacturers, and 1 aircraft owner). The results of this survey are presented in Appendix G.

4.5. What are the impacts

4.5.1. Safety impact

Option A.0: Do nothing

The safety impact of Option A.0 is expected to be negative for commercial operations and neutral for non-commercial operations (refer to Section 4.1.4). However, only a small proportion of light aeroplanes and light helicopters are used for commercial operations.

Hence, the overall impact of Option A.0 is considered **slightly negative (– 1)**.

Option A.1: Safety promotion

When considering Option A.1, the arguments for promoting the recording of basic flight parameters are the ones presented in Table D.1 of Appendix D. The arguments for promoting the recording of cockpit audio are presented in Table D.2 of Appendix D. The arguments for promoting the recording of images are presented in Table D.3 of Appendix D. Table D.4 of Appendix D presents the potential incentives for the various categories of stakeholders.

However, a number of factors may limit the effectiveness of promoting in-flight recording:

1) While organisations (aircraft operators, aero clubs, training organisations) may see benefits of equipping their aircraft with in-flight recording equipment, this may not be the case for individual aircraft owners if there is no return on investment.

2) Another possible hindrance is the protection of in-flight recordings, in particular audio and image recordings, because of their intrinsic privacy content. While a minimum level of protection should be required to avoid misuse, this could in turn make in-flight recording less interesting for day-to-day use, and therefore difficult to promote.

3) Given the limited financial capacity of the target audience and the small size of the aircraft, promotion of in-flight recording is more likely to be convincing if the advocated concept is less prescriptive and can be implemented with equipment primarily designed for other purposes (such as navigation equipment). On the other hand, this would have to be balanced with safety

investigation needs (e.g. the memory should not be volatile, the data should not be encrypted, decoding documentation should be available, etc.). Reconciling these two objectives could be challenging.

4) The operational constraints and maintenance cost of installed equipment should be as low as possible. A fit-and-forget approach should be made possible. The equipment should also not be required to be maintained serviceable when it is installed on a voluntary basis, as this would work against promotion. This in return may affect the availability and consequently the safety benefits of the equipment.

It should be noted that CS-STAN could be amended to allow recording equipment to be installed under a standard change (refer to NPA 2016-17, published on 7 December 2016). Indeed, the cost of certifying the installation of such equipment is a major cost contributor. Given the limited financial capacity of operators and owners of light aeroplanes and helicopters, this change in the CS-STAN is important for the effective promotion of recording equipment. On the other hand, if a supplemental type certificate (STC) is required to install the in-flight recording equipment, most likely the certification cost will discourage voluntary installation. When a new part or appliance is installed on an aircraft, except when it is ELA1 or ELA2 aircraft, this requires an authorised release certificate (EASA Form 1) that only a production organisation approval (POA) holder is entitled to issue (refer to Part-21, points 21.A.163 and 21.A.307), unless an equivalent form recognised by bilateral agreements[23] is used. In practice, this means that aeroplanes with an MCTOM above 2 000 kg and helicopters with an MCTOM above 600 kg or turbine-engined, or more than 2 occupants, require an EASA Form 1 when a new part or appliance is installed. However, EASA RMT.0018 & RMT.0571 'Installation of parts and appliances that are released without an EASA Form 1 or equivalent'[24] should relax the conditions to allow aircraft release after installation of new parts and appliances without an EASA Form 1. This would make it possible for more categories of light aeroplanes and helicopters to benefit from the exemption of EASA Form 1.

In addition, while promotion activities might create an incentive for aircraft operators as well as flight schools and aero clubs to install dedicated in-flight recording equipment, the incentive for individual aircraft owners and private pilots is not strong. Therefore, the safety impact of Option A.1 is expected to be overall medium positive (+ 3) if rules are amended to allow installation of in-flight recording equipment under a standard change and without an EASA Form 1, slightly positive (+ 1) if installation of in-flight recording equipment is possible by means of a minor change, and neutral (0) if the installation requires an STC. **For the purpose of scoring, a middle score is retained (+ 1) corresponding to a slightly positive impact.**

[23] For example, FAA Form 8130-3 or TCCA Form 24-0078.

[24] http://www.easa.europa.eu/document-library/rulemaking-subjects/installation-parts-and-appliances-are-released-without-easa

Option A.2: ICAO Annex 6

Option A.2 would affect newly manufactured turbine-engined light aeroplanes and newly manufactured turbine-engined light helicopters operated for CAT.

— When considering the transposition of ICAO Standard 6.3.1.2.1 of Annex 6 Part I:

In accordance with Table B.2 of Appendix B, between 2012 and 2014 there were 134 accidents with aeroplanes registered in the EASA MSs, with an MCTOM of less than 5 700 kg and used for commercial operations (CAT or aerial work). In 5 out of these 134 accidents, the aeroplane was operated for CAT and of a model subject to FDR carriage in accordance with Part-CAT, CAT.IDE.A.190 (multi-engined turbine-powered and MOPSC of more than 9). In the same period, there were 12 accidents of a model subject to recording flight parameters in accordance with Standard 6.3.1.2.1 of Annex 6 Part I. Hence, the safety benefit of transposing Standard 6.3.1.2.1 is considered **slightly positive**: (12 – 5) = 7 additional accidents are captured (5 %) out of 134.

— When considering the transposition of ICAO Standard 6.3.2.1.1 of Annex 6 Part I:

For aeroplanes, transposing this Standard would in practice mean equipping few aircraft and therefore that would bring very little safety benefit. Indeed, transposing ICAO Standard 6.3.2.1.1 would mean adding a requirement for those aeroplanes which are:

- single-engined turbine-powered, with an MCTOM between 2 250 and 5 700 kg and certified for operation with a minimum crew of at least two pilots: no aircraft model in this category is known; and
- multi-engined turbine-powered, with an MOPSC of 9 or less, with an MCTOM between 2 250 and 5 700 kg and certified for operation with a minimum crew of at least two pilots. Few aircraft models belong to this category (Beech 90, Raytheon 390, Piper PA42, Cessna Citation I). Between 2006 and 2014, there were only 4 accidents involving aircraft of such models registered in an EASA MS and operated for CAT out of 377 accidents with light aeroplanes used for commercial operations (1 %), with 12 fatalities in total.

Hence, the safety benefit of transposing Standard 6.3.2.1.1 is considered **negligible**.

Refer to Table 7 for the comparison between current CVR requirements and ICAO Standard 6.3.2.1.1.

— When considering the transposition of ICAO Standard 4.3.1.2.4 of Annex 6 Part III, Section II:

In accordance with Table B.3 of Appendix B, between 2012 and 2014 there were 58 accidents with helicopters operated commercially, with an MCTOM of less than 3 175 kg. None of these helicopters were required to carry a crash-protected flight recorder or any kind of in-flight recording system in accordance with the current Air Operations rules. In the same period, there were 5 accidents with helicopters operated for CAT and of a model within the scope of Standard 6.3.1.2.1 of Annex 6 Part I (turbine-engined helicopters with an MCTOM of over 2 250 kg and operated for CAT). Hence, the safety benefit of transposing Standard 6.3.1.2.1 is considered **slightly positive**: 5 additional accidents are captured (8 %) out of 58.

Table 7: Comparison between ICAO Annex 6 Part I and Regulation (EU) No 965/2012 on Air Operations with regard to recording audio on aeroplanes with an MCTOM of less than 5 700 kg and operated for CAT

Reference regulation	CVR/CARS carriage requirement for aeroplanes with an MCTOM of 5 700 kg or less
Regulation (EU) No 965/2012 Part-CAT, CAT.IDE.A.185	CVR required if: — multi-engined turbine-powered aeroplanes, — MOPSC > 9, and — first issued with an individual CofA on or after 1 January 1990.
ICAO Annex 6 Part I Standard 6.3.2.1.1	CVR or CARS prescribed if: — turbine-engined aeroplanes, — MCTOM > 2 250 kg, — certified for operation with a minimum crew of at least two pilots, and — application for type certificate on or after 1 January 2016.

In conclusion, the safety impact of Option A.2 is considered overall **slightly positive (+ 1).**

Option A.3: ICAO Annex 6 with differences

— When considering aeroplanes:

In accordance with to Table B.2 of Appendix B, between 2012 and 2014 there were 27 accidents with aeroplanes used for commercial operations, and which either were turbine-engined with an MCTOM of 2 250 kg or more or had an MOPSC of more than 9. Hence, the safety impact for aeroplanes is considered **slightly to medium positive**: (27 – 5) = 22 accidents are captured (16 %) out of 134.

— When considering helicopters:

In accordance with Table B.3 of Appendix B, there were 14 accidents with turbine-engined helicopters with an MCTOM of 2 250 kg or more and used for commercial operations. Hence, the safety impact for helicopters is considered **medium positive**: 14 accidents are captured (24 %) out of 58.

Hence, compared to Option A.2, Option A.3 captures 3 times more historical accidents with aeroplanes (22 instead of 7) and 3 times more accidents with helicopters (14 instead of 5).

In conclusion, the safety impact of Option A.3 is considered **medium positive (+ 3).**

Option A.4: Combined solution

Option A.4 combines Option A.1 and Option A.3, i.e. promotion and requirement for an extended set of aircraft models compared to Option A.2. Therefore, the safety impact of Option A.4 is expected to be overall very positive (+ 5) if the rules are amended to allow for the installation of in-flight recording equipment under a standard change and without an EASA Form 1, and medium positive (+ 3) otherwise. **For the purpose of scoring, a middle score of + 4 is retained (corresponding to medium positive to very positive impact).**

4.5.1.1. Safety impact for balloons

Option B.0

The safety impact of Option B.0 is expected to be negative for commercial operations and neutral for non-commercial operations (refer to Section 4.1.4). However, only a small proportion of balloons are used for commercial operations.

Hence, the overall impact of Option B.0 is considered **slightly negative (– 1)**.

Option B.1: Safety promotion

Similar to Option A.1, promoting the recording of trajectory parameters and images has some limitations. When considering Option B.1, the arguments for promoting the recording of trajectory parameters are the ones presented in Table D.1 of Appendix D. The arguments for promoting the recording of images of the basket interior are presented in Table D.3 of Appendix D. Table D.4 presents the potential incentives for the various categories of stakeholders.

It should be noted that CS-STAN could be amended to allow video cameras and GNSS receivers to be installed under a standard change. This would reduce the cost of certifying the installation of such equipment. In addition, all balloons are ELA1 or ELA2 aircraft, therefore the installation of new parts and appliances may be done without the issue of an EASA Form 1 if the conditions described in Part-21, 21.A.307(c)[25], are fulfilled.

In summary, promotion is expected to create an incentive for some balloon operators, as well as balloon clubs, to install dedicated in-flight recording equipment because it would allow better monitoring of compliance with procedures and of the airworthiness of the aircraft, and would dissuade pilots from taking excessive risks. However, the incentive for individual balloon owners is not considered strong. Therefore, the safety impact of Option B.1 is expected to be overall **slightly positive**.

Option B.2: Record position and images

In accordance with Table B.4 of Appendix B, there were 32 accidents and serious incidents with balloons registered in the EASA MSs and operated for commercial operations between 2012 and 2014. 4 of them involved a balloon with an MCTOM of 3 000 kg or more. Therefore, the safety impact of Option B.2 is expected to be **slightly positive (+ 1)**: 4 accidents are captured (12 %) out of 32.

Option B.3: Combined solution

Option B.3 combines Option B.1 and Option B.2, i.e. promotion and requirement. The cumulated safety impact is considered **medium positive (+ 3)**.

[25] These conditions are:
‘1. not life-limited, nor part of the primary structure, nor part of the flight controls;
2. manufactured in conformity to applicable design;
3. marked in accordance with Subpart Q;
4. identified for installation in the specific aircraft;
5. to be installed in an aircraft for which the owner has verified compliance with the conditions 1 through 4 and has accepted responsibility for this compliance.’

4.5.1.2. Summary of safety impact

Table 8A: Comparative safety impact for aeroplanes and helicopters

	Option A.0	*Option A.1*	*Option A.2*	*Option A.3*	*Option A.4*
Safety impact	**– 1** Negative impact on commercial operations, and no impact on non-commercial operations	**+ 1** — negligible effect if the installation requires an STC; — slightly positive if installation can be made under a minor change approval; — medium positive if the installation can be made by means of a standard change and without an EASA Form 1	**+ 1** Strictly transposing the ICAO Standards would result in a small proportion of accidents covered by in-flight recording	**+ 3** Larger proportion of accidents covered than with Option A.2	**+ 4** Combines the safety benefits of A.1 and A.3: — medium positive if the installation requires an STC; — very positive if the installation can be made under a minor change approval or by means of a standard change

Table 8B: Comparative safety impact for balloons

	Option B.0	*Option B.1*	*Option B.2*	*Option B.3*
Safety impact	**– 1** Negative impact on commercial operations, and no impact on non-commercial operations	**+ 1**	**+ 1** Small proportion of accidents and serious incidents covered by in-flight recording	**+ 3** Combines the safety benefits of B.1 and B.2

4.5.2. Environmental impact

Whichever the option, it has no foreseeable environmental impact: the environmental impact is considered **neutral (0)**.

4.5.3. Social impact

Option A.0

The social impact of Option A.0 is expected to be **neutral (0)**.

Option A.1

Fitting a light aeroplane or a light helicopter with equipment capable of recording audio or images may raise questions related to the protection of pilot privacy. The current Air Operations rules only address the protection of the FDR recording and the CVR recording (refer to Appendix D).

However, with Option A.1, every aircraft operator and aircraft owner remains free to install or not such equipment.

Therefore, the social impact of Option A.1 is considered **neutral (0)**.

Option A.2

Fitting a light aeroplane or a light helicopter with equipment capable of recording audio or images may raise questions related to the protection of pilot privacy. The current Air Operations rules only address the protection of the FDR recording and the CVR recording (refer to Appendix D).

In order to mitigate this issue, it is proposed that:

— images of the flight crew compartment recorded by a flight recorder (crash-protected or lightweight) cannot be used for purposes other than maintaining or improving safety, or ensuring the flight recorder serviceability;

— if such images are disclosed or used for maintaining or improving safety, then:
  - the flight crew shall give their prior consent, and
  - a procedure related to the handling of images shall be in place;

— when such images are inspected for ensuring the serviceability of the flight recorder:
  - these images shall not be disclosed or used for purposes other than for ensuring the flight recorder serviceability, and
  - if body parts of flight crew members may appear on the images, the operator shall ensure the privacy of these images.

Assuming that such principles are transcribed into rules, the social impact is considered **slightly negative (– 1)**.

Option A.3

Assuming that principles such as those proposed in Option A.2 are transcribed into rules, the social impact is considered **slightly negative (– 1)**.

Option A.4

Assuming that principles such as those proposed in Option A.2 are transcribed into rules, the social impact is considered **slightly negative (– 1)**.

4.5.3.1. Social impact for balloons

Option B.0

The social impact of Option B.0 is expected to be **neutral (0)**.

Option B.1

Fitting balloons with equipment capable of recording images of the occupants inside the basket may raise questions related to the protection of privacy. The current Air Operations rules only address the protection of the FDR recording and the CVR recording (refer to Appendix D).

However, with Option B.1, balloon operators or balloon owners remain free to install or not such equipment, and it is assumed that they will make their decision also taking into account the social impact at their level.

Therefore, the social impact of Option B.1 is considered **neutral (0)**.

Option B.2

Fitting balloons with equipment capable of recording images of the occupants inside the basket may raise questions related to the protection of privacy. The current Air Operations rules only address the protection of the FDR recording and the CVR recording when installed on an aeroplane or a helicopter (refer to Appendix D).

In order to mitigate this issue:

— images of the basket cannot be used for purposes other than maintaining or improving safety, or ensuring equipment serviceability;

— if such images are disclosed or used for maintaining or improving safety, then the flight crew and the passengers shall give their prior consent; and

— when such images are inspected for ensuring the serviceability of the equipment:

  - these images shall not be disclosed or used for purposes other than ensuring the equipment serviceability, and
  - if parts of the bodies of flight crew members or of passengers might appear on the images, the operator shall ensure the privacy of these images.

Assuming that such principles are transcribed into rules, the social impact is considered **slightly negative (– 1)**.

Option B.3

Assuming that principles such as those proposed in Option B.2 are transcribed into rules, the social impact is considered **slightly negative (– 1)**.

4.5.3.2. Summary of the social impact

Table 9A: Comparative social impact for aeroplanes and helicopters

	Option A.0	**Option A.1**	**Option A.2**	**Option A.3**	**Option A.4**
Social impact	**0**	**0** Aircraft operators and aircraft owners are free to make decisions with no social impact	**– 1** Limited impact if audio and image recordings are protected by rules	**– 1** Same as Option A.2 for images No social impact if only flight data are recorded	**– 1** Combines the social impact of A.1 and A.3

Table 9B: Comparative social impact for balloons

	Option B.0	**Option B.1**	**Option B.2**	**Option B.3**
Social impact	**0**	**0** Balloon operators and balloon owners are free to make decisions with no social impact	**– 1** Limited impact if image recordings are protected by rules	**– 1** Combines the social impact of B.1 and B.2

4.5.4. Economic impact

Note: For the purpose of the economic impact assessment, 'recurring cost' means cost occurring once for each individual aircraft concerned.

Option A.0

The economic impact of Option A.0 is expected to be **neutral (0)**.

Option A.1

Option A.1 would result in a number of stakeholders voluntarily installing some kind of in-flight recording equipment when it is economically reasonable. There is no direct economic benefit from installing an in-flight recording system (refer to Appendix D for the identified benefits). On the other hand, since each aircraft owner or aircraft operator may choose or not to install such equipment in accordance with to Option A.1, it is expected that they will perform such installation only when this is economical for them. For these reasons, the economic impact of Option A.1 is considered **neutral (0)**.

From the safety investigation authorities' perspective, Option A.1 would result in more investigations where an in-flight recording of the sequence of events is available. This would accelerate the investigations, in particular by saving on test and research (refer to Study 1, presented in Appendix E). Study 1 also showed that test and research are performed in about a quarter of the investigations of light aircraft accidents, and in only half of the cases where test and research were performed would a limited set of flight parameters (such as those recorded by a lightweight flight recorder) be sufficient to avoid performing test and research.

Hence, the overall economic impact of Option A.1 for safety investigation authorities is expected to be **slightly positive (+ 1)**.

Option A.2

In accordance with the survey on cost, operational impact and benefits of in-flight recording systems (refer to Appendix G), implementing Option A.2 for the aeroplanes and helicopters involved would result in the cost presented in Table 10A.

These results consider the cost of an STC and the cost of a minor change. If the equipment could be installed under a standard change not requiring approval (performed in accordance with CS-STAN) and not requiring the issue of an EASA Form 1, then the non-recurring cost would be significantly reduced.

Table 10B presents a summary of the fees levied for a standard STC and for a minor change, for light aeroplanes and light helicopters, as set by Regulation (EU) No 319/2014[26]. Table 10B shows that for the categories of aeroplanes and helicopters considered, the fees for an STC may be up to EUR 5 000. In addition, an STC usually requires an in-depth demonstration by the applicant, which adds costs. Based on the results of the survey presented in Appendix G, it is assumed that the cost for design, testing and certification ranges between EUR 100 000 and 300 000 in the case where an STC is required.

If the installation of in-flight recording equipment could be performed under a minor change (hence not requiring an STC), the certification fees would be below EUR 1 000. In addition, the other cost for the certification demonstration could be reduced by several tens of thousands of euros (given that the certification efforts would be much less). It is assumed that the cost for design, testing and certification ranges between EUR 10 000 and 50 000 in the case where a minor change approval is required. Further to that, a minor change is a change that has no appreciable effect 'on the mass, balance, structural strength, reliability, operational characteristics, noise, fuel venting, exhaust emission, or other characteristics affecting the airworthiness of the product' (refer to Part-21, point 21.A.91). Hence, the installation of equipment performed under a minor change is expected to be simple and therefore to require limited efforts in terms of design and testing. Consequently, design and test costs are also expected to be reduced compared to the installation of equipment that requires an STC.

If a standard installation of the in-flight recording equipment (under CS-STAN) was made possible, then there would be no cost for installation certification.

Given that Option A.2 is only applicable to aeroplanes and helicopters manufactured after a given date in the future, it is assumed that in practice this option will be implemented by aircraft manufacturers which will offer it as an option upon aircraft delivery (as it is already the case for some aircraft models). One may assume that a manufacturer is best positioned to play on scales in order to get a low unit purchase price and to distribute the installation design, test and certification costs over a large number of individual aircraft. In addition, for forward-fit, there is no additional cost generated by aircraft downtime, and the number of hours needed to install the equipment is reduced compared to a

[26] Commission Regulation (EU) No 319/2014 of 27 March 2014 on the fees and charges levied by the European Aviation Safety Agency, and repealing Regulation (EC) No 593/2007 (OJ L 93, 28.3.2014, p. 58).

retrofit. For example, assuming that the equipment interacts with some aircraft systems in order to retrieve data, so that its installation is considered complex and requires three 8-hour days at 100 EUR/working hour, then the corresponding cost is EUR 2 400. If, on the other hand, the equipment does not interact with the aircraft systems, then one 8-hour day could be assumed, which corresponds to EUR 800 of installation cost. It is assumed that the installation cost ranges between EUR 500 and 3 000.

Table 10A: Main cost items of installing a lightweight flight recorder compliant with EUROCAE Document 155 (in accordance with the survey) during production (no retrofit) — (year 2016)

Cost item	Range of cost in EUR	Recurring or non-recurring cost	Comment
Unit purchase price	from 4 000 to 8 000	Recurring	Unit price depends on equipment model and effect scale
Installation design, installation test and installation certification (assuming that the installation requires an STC)	From 100 000 to 300 000 when installed on newly manufactured aircraft	Non-recurring	This cost depends on the complexity of the installation
Installation design, installation test and installation certification (assuming that the installation requires a minor change approval)	10 000 to 50 000	Non-recurring	Example of cost for a minor change
Equipment installation	500 to 3 000	Recurring	The equipment is forward-fitted during the aircraft production by the aircraft manufacturer: no aircraft downtime and reduced number of man-hours compared to a retrofit

Table 10B: Fees levied by EASA for various categories of light aeroplanes and light helicopters (year 2016)

Aircraft category	Type of certification approval	Fee levied by EASA (in EUR)
Aeroplane with an MCTOM of less than 5 700 kg and considered a high-performance aircraft	Standard STC	5 140
	Minor change	890
Aeroplane with an MCTOM over 2 000 kg and up to 5 700 kg and not considered a high-performance aircraft	Standard STC	2 030
	Minor change	290
Aeroplane with an MCTOM up to 2 000 kg and not considered a high-performance aircraft	Standard STC	1 160
	Minor change	290
Rotorcraft, medium	Standard STC	4 640
	Minor change	460
Rotorcraft, small	Standard STC	3 480
	Minor change	460

Table 11 shows that the range of cost per individual aircraft is high, between less than EUR 5 000 and more than EUR 20 000. Table 11 also shows that the type of approval required makes a significant difference: if an STC is required, then the total cost per individual aircraft can vary from a factor of one to three or more depending on whether a large series of aircraft is produced. On the other hand, if only a minor change is required or if the equipment can be installed under a standard change, the cost per individual aircraft remains below EUR 10 000 and the influence of scale effect is much less.

Hence, the economic impact is considered medium negative (– 3) if an STC is required, and slightly negative (– 1) if it is not. **A middle score of – 2 (medium to slightly negative) is retained.**

Table 11: Example of cost computation of installing a lightweight flight recorder compliant with EUROCAE Document 155 based on different scenarios (year 2016 price)

Conditions	Total cost per individual aircraft	Comment
Cost for installation design, test and certification is EUR 300 000 (STC required) Small series (20 aircraft) Unit price is EUR 6 000 Installation cost is EUR 3 000 (complex installation)	Cost = 6 000 + 300 000 / 20 + 3 000 = EUR 24 000	STC with high cost, small series
Cost for installation design, test and certification is EUR 200 000 (STC required) Large aircraft series (200 aircraft) Unit price is EUR 4 000 Installation cost is EUR 3 000 (complex installation)	Cost = 4 000 + 200 000 / 200 +3 000 = EUR 8 000	STC with median cost, large series
Cost for installation design, test and certification is EUR 20 000 (minor change) Small series (20 aircraft) Unit price is EUR 6 000 Installation cost is EUR 500 (non-complex installation)	Cost = 4 000 + 20 000 / 20 + 500 = EUR 5 500	Minor change with higher cost, small series
Cost for installation design, test and certification is EUR 20 000 (minor change) Large aircraft series (200 aircraft) Unit price is EUR 4 000 Installation cost is EUR 500 (non-complex installation)	Cost = 4 000 + 20 000 / 200 + 500 = EUR 4 600	Minor change with lower cost, large series
No cost for installation design and test (standard installation under CS-STAN) Small series (20 aircraft) Unit price is EUR 6 000 Installation cost is EUR 500 (non-complex installation)	Cost = 6 000 + 500 = EUR 6 500	Standard change (no certification cost, very reduced design and test cost), small series
No cost for installation design and	Cost = 4 000 + 500	Standard change (no certification

test (standard installation under CS-STAN) Large series (200 aircraft) Unit price is EUR 4 000 Installation cost is EUR 500 (non-complex installation)	= EUR 4 500	cost, very reduced design and test cost), large series

With regard to safety investigation authorities, the economic impact is considered **slightly positive (+ 1)**, similar to Option A.1.

Option A.3

The categories of aircraft considered are slightly different from those considered for Option A.2, but this difference is not expected to have any influence. Hence the economic impact for the industry is also considered medium negative (– 3) if an STC is required, and slightly negative (– 1) if it is not. **A middle score of – 2 (medium to slightly negative) is retained.**

With regard to safety investigation authorities, the economic impact is considered **slightly positive (+ 1)**, similar to Option A.1.

Option A.4

The economic impact of Option A.4 for industry, being a combination of Option A.1 (no economic impact) and Option A.3 (economic impact medium negative), is expected to be medium negative (– 3) if an STC is required and slightly negative (– 1) if it is not. **A middle score of – 2 (medium to slightly negative) is retained.**

With regard to safety investigation authorities, the economic impact is considered **medium positive (+ 3)**, since this Option combines Option A.1 and Option A.3, and it is expected that more aircraft will be equipped with in-flight recording equipment than in any of the other options considered.

4.5.4.1. Economic impact for balloons

Option B.0

The economic impact of Option B.0 is expected to be **neutral (0)**.

Option B.1

Option B.1 would result in some stakeholders voluntarily installing video cameras and equipment capable of recording or transmitting the balloon's 3-D position, when this is economically reasonable. There are no direct economic benefits from installing such equipment (refer to Appendix D for the identified benefits). On the other hand, since each balloon owner or balloon operator may choose either to install such equipment or not, it is expected that they will perform such installation when this is economical for them. For these reasons, **the economic impact of Option B.1 is considered neutral (0).**

Option B.2

Option B.2 implies the mandatory installation of a camera and of a means to record or transmit the trajectory of large balloons which are operated commercially. In addition, for the recordings to be useful in case of an accident or a serious incident, the equipment should meet at least the following two conditions (see also Section 4.3.2):

(a) if data is recorded on board, a non-volatile memory medium is used; and

(b) information sufficient to recover and decode the recorded data files is provided to safety investigation authorities.

Many video camera or GNSS receiver models already fulfil condition (a), and fulfilling condition (b) means that the equipment manufacturer should provide the investigation authorities with information sufficient to allow them retrieving the files. Hence, Option B.2 would not require the development of new equipment. In addition, the equipment needed for Option B.2 can be stand-alone, compact, and it is not expected to interact with other balloon equipment.

It is planned to include in CS-STAN items allowing the installation of camera mountings and of a GNSS receiver under a standard change.

If, however, a minor change approval is required:

— the certification fees for a minor change is EUR 300 (see Table 12B);

— similar to aeroplanes and helicopters, it is assumed that the cost for design, testing and certification varies between EUR 10 000 and 50 000.

Given that Option B.2 is only applicable to balloons manufactured after a given date in the future, it is assumed that, in practice, this option will be implemented by balloon manufacturers which will offer it as a standard option. Hence, the equipment installation cost will be reduced. EUR 500 is assumed for the installation itself (installation is non-complex).

On the other hand, large balloons are sold in small series, so that the installation design and test cost cannot be distributed over a large number of models.

Table 12A presents examples of costs. Assuming a series of 10 balloons and that the cost for design, test and certification is EUR 20 000 (minor change), the individual cost per balloon of Option B.2 would then be 2 000 + 20 000 / 10 + 500 = EUR 4 500. Assuming that the installation can be performed as a standard change, then whatever the size of the balloon series, the individual cost of Option B.2 would then be 2 000 + 500 = EUR 2 500.

Therefore, the economic impact is considered **slightly negative (– 1)**.

Note: When compared with the balloon purchase price and the revenue brought in per flight, the cost figures mentioned above are still significant. This aspect is taken into account in the impact on proportionality issues (see Section 4.4.5).

Table 12A: Example of main cost items of installing means, during balloon production, to record images of the basket and balloon position (no retrofit)

Cost item	Range of cost	Recurring or non-recurring cost	Comment
Unit purchase price of equipment recording images of the basket interior and trajectory data	EUR 2 000	Recurring	Equipment relies on standard and small components (camera + GNSS receiver or flight tracker)
Installation design, test and certification	EUR 10 000 to 50 000 if the installation is made under a minor change approval EUR 0 if the installation is made under a standard change	Non-recurring	Equipment does not interact with balloon equipment: no STC is required
Installation of the equipment on the aircraft	EUR 500	Recurring	The equipment is forward-fitted during the aircraft production by the aircraft manufacturer: no aircraft downtime and reduced number of man-hours compared to a retrofit

Table 12B: Fees levied by EASA for balloons

Aircraft category	Type of certification approval	Fee levied by EASA (in EUR)
Balloons	Standard STC	460
	Minor change	290

Option B.3

As Option B.3 is a combination of Option B.1 (no economic impact) and Option B.2 (economic impact medium negative), the economic impact of Option B.3 is expected to be **slightly negative (– 1)**.

4.5.4.2. Summary of economic impact

Table 13A: Comparative economic impact for aeroplanes and helicopters

	Option A.0	Option A.1	Option A.2	Option A.3	Option A.4
Economic impact	**0**	**0 for industry** Aircraft operators and aircraft owners are free to make decisions with no economic impact **+1 for authorities** In-flight recording equipment accelerates investigation	**– 2 for industry** Impact is medium negative if STC is required, slightly negative otherwise **+1 for authorities** In-flight recording equipment accelerates investigation	**– 2 for industry** Impact is medium negative if STC is required, slightly negative otherwise **+1 for authorities** In-flight recording equipment accelerates investigation	**– 2 for industry** Combines the economic impact of A.1 and A.3 **+1 for authorities** In-flight recording equipment accelerates investigation

Table 13B: Comparative economic impact for balloons

	Option B.0	Option B.1	Option B.2	Option B.3
Economic impact	**0**	**0** Balloon operators and balloon owners are free to make decisions with no economic impact	**– 1** No STC, can rely on cheap equipment already used for recreational activities	**– 1** Combines the economic impact of B.1 and B.2

4.5.5. General aviation and proportionality issues

4.5.5.1. Impact of the options for aeroplanes and helicopters

Option A.0

The impact of Option A.0 is expected to be **neutral (0)**.

Option A.1

Option A.1 is about promoting (not requiring) the installation of in-flight recording systems on aeroplanes and helicopters. In accordance with Option A.1, aircraft manufacturers, aircraft operators and aircraft owners remain free to install or not such systems. Hence, the impact of Option A.1 is **neutral (0)**.

Option A.2

Option A.2 affects turbine-engined light aeroplanes and turbine-engined light helicopters with unit price typically ranging from EUR 1 500 000 to 5 000 000, and Option A.2 is applicable to CAT operations only.

Option A.2 includes a requirement to record basic flight parameters (by means of an FDR, ADRS or Class C AIR or AIRS) on board turbine-engined aeroplanes operated for CAT without any MCTOM or MOPSC threshold. Hence, potentially turboprop aeroplane models with an MCTOM of less than 2 250 kg (such as Pilatus PC6, Cessna 206, Piper PA46 and PA34) could be subject to such a requirement if they were operated for CAT. While the cost of installing the equipment (between EUR 4 000 and 25 000; see Section 4.4.4) is low when compared to the purchase price of such aircraft models, their limited passenger capacity (e.g. only 5 passengers for the Cessna 206 or the Piper PA46) results in limited revenue per flight.

Therefore, the overall impact of Option A.2 is considered **slightly negative (– 1)**.

Option A.3

Option A.3 only includes turbine-engined aeroplanes and helicopters with an MCTOM of more than 2 250 kg and aeroplanes with an MOPSC of more than 9. Hence, Option A.3 does not affect those aeroplane and helicopter models which are usually operated for recreational activities, or whose passenger capacity is very small.

Unlike Option A.2, Option A.3 encompass, in addition to CAT operations, commercial SPO, i.e. aerial work activities which are remunerated and are either available to the public or performed under a contract between the aircraft operator and a customer that has no control over the operator. In summary, the stakeholders affected by Option A.3 are commercial operators selling passenger tickets or services related to aerial work activities.

Hence, the overall impact of Option A.3 is considered **neutral (0)**.

Option A.4

The impact of Option A.4, being a combination of Option A.1 (no impact) and Option A.3 (neutral), is expected to be **neutral (0)**.

4.5.5.2. Impact of the options for balloons

Option B.0

The impact of Option B.0 is expected to be **neutral (0)**.

Option B.1

Option B.1 is about promoting (not requiring) the recording of the balloon position and of images of the basket interior. In accordance with Option B.1, balloon manufacturers and balloon operators remain free to install equipment to record this data. Hence, the impact of Option B.1 is considered **neutral (0)**.

Option B.2

Option B.2 only covers commercial operators of large balloons (MCTOM of 3 000 kg corresponding to an envelope volume of 10 000 cubic meters or more) typically capable of transporting more than 13 passengers. Option B.2 is limited to newly manufactured balloons (no retrofit).

The individual purchase price of a balloon with an MCTOM of 3 000 kg typically varies from EUR 100 000 to 200 000. Hence, the impact on proportionality is considered medium because of the cost of installing the equipment (between EUR 2 000 and 4 000; see Section 4.4.4), while low in the absolute, is still high when compared to the purchase price of the balloon.

With regard to practical implementation, the equipment would probably have to rely on a stand-alone battery since there is no source of power on a conventional balloon. Such battery might have to be recharged or replaced often mainly because of the power consumption of a camera. However, given that typically several hours elapse between two successive flights with a balloon, this is not considered adding an operational constraint. Hence, the operational impact of Option B.2 is expected to be **negligible**.

For these reasons, the overall impact of Option B.2 is considered overall **medium negative (– 3**).

Option B.3

As Option B.3 is a combination of Option B.1 (no impact) and Option B.2 (impact medium negative), its impact is expected to be **medium negative (– 3)**.

4.5.5.3. Summary of impact on general aviation and proportionality issues

Table 14A: Impact for aeroplanes and helicopters

	Option A.0	**Option A.1**	**Option A.2**	**Option A.3**	**Option A.4**
Impact on general aviation and proportionality issues	0	0 Aircraft operators and aircraft owners are free to make decisions with no impact	– 1 Impact on very light turboprop aeroplanes	0 Does not impact turboprop aeroplanes of less than 2 250 kg	0 Combines the impacts of A.1 and A.3 on general aviation and proportionality issues

Table 14B: Comparative impact for balloons

	Option B.0	**Option B.1**	**Option B.2**	**Option B.3**
Impact on general aviation and proportionality issues	0	0 Balloon operators and balloon owners are free to make decisions with no impact	– 3 Captures only large balloons operated commercially; however, the cost is still significant when compared with balloon purchase price and revenue from flights	– 3 Combines the economic impact of B.1 and B.2

4.5.6. Impact on better regulation and harmonisation

4.5.6.1. Impact of the options for aeroplanes and helicopters

Option A.0

The impact of Option A.0 is expected to be **neutral (0)**.

Option A.1

Option A.1 is about promoting (not requiring) the installation of in-flight recording systems on aeroplanes and helicopters. Hence, the impact of Option A.1 on rules harmonisation and better regulation is considered **neutral (0)**.

Option A.2

Option A.2 is about fully transposing ICAO Standards of Annex 6 Part I and III related to lightweight flight recorders. Hence, it would improve the harmonisation of Regulation (EU) No 965/2012 on Air Operations with ICAO Standards.

Option A.2 would not simplify the existing Air Operations rules. It would actually make the rules applicable to aeroplanes with an MCTOM between 2 250 and 5 700 kg more complex, with multiple cases depending on the type and the number of engines, the number of passengers, and the number of pilots required (see Table 15A).

Option A.2 would not make the rules applicable to helicopters more complex (see Table 15B).

Option A.2 would not contradict the General Aviation Safety Strategy and Roadmap since only aircraft used for CAT operation are within the scope of this Option.

Hence, the overall impact of Option A.2 on rules harmonisation and better regulation is considered **slightly positive (+ 1)**.

Table 15A: Summary of in-flight recording requirements applicable to newly manufactured aeroplanes operated for CAT, if Option A.2 is elected (the new requirements appear in bold)

	MCTOM < 2 250 kg	**2 250 ≤ MCTOM ≤ 5 700 kg**	**MCTOM > 5 700 kg**
Not turbine-engined	NIL	— NIL	FDR and CVR required in all cases
Turbine-engined	**Record basic flight parameters (by means of an FDR or an ADRS or a Class C AIR or AIRS)**	— If multi-engined turbine-powered and MOPSC of more than 9: FDR and CVR required — **If turbine-engined and certified for operation with two or more pilots: record basic flight parameters by means of an FDR or an ADRS or a Class C AIR or AIRS) and record audio (by means of a CVR or CARS)** — **In all other cases: record basic flight parameters only (by means of an FDR or an ADRS or a Class C AIR or AIRS)**	FDR and CVR required in all cases

Table 15B: Summary of in-flight recording requirements applicable to newly manufactured helicopters operated for CAT, if Option A.2 is elected (the new requirements appear in bold)

	MCTOM < 2 250 kg	**2 250 ≤ MCTOM ≤ 3 175 kg**	**MCTOM > 3 175 kg**
Not turbine-engined	NIL	NIL	FDR and CVR required in all cases
Turbine-engined	NIL	**Record basic flight parameters (by means of an FDR or an ADRS or a Class C AIR or AIRS)**	FDR and CVR required in all cases

Option A.3

Option A.3 is about introducing requirements which are not fully transposing ICAO Standards in Annex 6 Part I and III related to lightweight flight recorders. Hence, the harmonisation of the Air Operations rules with the ICAO Standards would be less improved with Option A.3 than with Option A.2.

On the other hand, compared to Option A.2, Option A.3 introduces less complexity into the Air Operations rules applicable to aeroplanes with an MCTOM between 2 250 and 5 700 kg.

With regard to helicopters, there is no difference between Option A.2 and Option A.3.

Option A.3 would not contradict the General Aviation Safety Strategy and Roadmap since only commercial operations and aircraft models which are not commonly used for recreational activities are within the scope of this Option.

Therefore, the impact of Option A.3 is considered **slightly positive (+ 1).**

Table 16A: Summary of in-flight recording requirements applicable to aeroplanes if Option A.3 is selected (the new requirements appear in bold)

<table>
<tr><th></th><th>MCTOM < 2 250 kg</th><th>MCTOM between 2 250 and 5 700 kg</th><th>MCTOM > 5 700 kg</th></tr>
<tr><td>No turbine engine</td><td rowspan="2">If MOPSC > 9 PAX: Record basic flight parameters
(by means of an FDR or an ADRS or a Class C AIR or AIRS)</td><td>If MOPSC > 9 PAX: Record basic flight parameters (by means of an FDR or an ADRS or a Class C AIR or AIRS)</td><td rowspan="3">FDR and CVR required in all cases</td></tr>
<tr><td>One turbine engine</td><td>Record basic flight parameters
(by means of an FDR or an ADRS or a Class C AIR or AIRS)</td></tr>
<tr><td>Multiple turbine engines</td><td colspan="2">If MOPSC > 9: FDR and CVR required</td></tr>
</table>

Option A.4

As Option A.4 is a combination of Option A.1 (no impact) and Option A.3 (impact slightly positive), its impact is expected to be **slightly positive (+ 1)**.

4.5.6.2. Impact of the options for balloons

Option B.0

The impact of Option B.0 is expected to be **neutral (0)**.

Option B.1

Option B.1 is about promoting (not requiring) the installation of in-flight recording systems on aeroplanes and helicopters. Hence, the impact of Option B.1 on rules harmonisation and better regulation is considered **neutral (0)**.

Option B.2

Option B.2 would not improve the harmonisation with the ICAO Standards since these do not address international operations with balloons.

With regard to compliance, Option B.2 requires specifying a few conditions to increase the likelihood that the recorded data will be retrieved in case of an accident (see Section 4.3.2). This could be done by means of an acceptable means of compliance (AMC).

Overall, Option B.2 would make the balloon rules slightly more complex, while efforts have been made recently to simplify as much as possible the balloon rules (refer to EASA Opinion No 01/2016).

Hence, the impact of Option B.2 on rules harmonisation and better regulation is considered **slightly negative (– 1)**.

Option B.3

As Option B.3 is a combination of Option B.1 (no impact) and Option B.2 (slightly negative), its impact is expected to be **slightly negative (– 1)**.

4.5.6.3. Summary of impact on better regulation and harmonisation

Table 17A: Impact for aeroplanes and helicopters

	Option A.0	Option A.1	Option A.2	Option A.3	Option A.4
Impact on better regulation and harmonisation	**0**	**0** Promotion, no impact on regulations	**+ 1** Fully transposes ICAO Standards; however, makes the rules slightly more complex with multiple conditions	**+ 1** Partially transposes the ICAO Standards	**+ 1** Combines the impact of A.1 and A.3 on better regulation and harmonisation

Table 17B: Comparative impact for balloons

	Option B.0	Option B.1	Option B.2	Option B.3
Impact on better regulation and harmonisation	**0**	**0** Promotion, no impact on regulations	**– 1** Does not improve rule harmonisation and does not follow the intent of Opinion No 01/2016 to simplify the rules for balloons	**– 1** Combines the impacts of B.1 and B.2 on better regulation and harmonisation

4.6. Conclusion

4.6.1. Comparison of options

The strengths and weaknesses of each option are presented in Table 18A (for aeroplanes and helicopters) and Table 18B (for balloons).

In conclusion, when considering aeroplanes and helicopters, Option A.2 (strictly transpose ICAO Standards into requirements) would result in limited safety benefits, which would not outweigh the economic impact and the impact on proportionality issues. Option A.3 (transpose ICAO Standards with some differences) would result in somewhat greater safety benefits for a similar economic impact and impact on proportionality issues than Option A.2 would. Option A.1 (promote the recording of basic flight parameters, audio and/or a view of the instruments panel) would bring limited safety benefits, and would have no other kind of impact. Hence, Option A.4 (which is a combination of Option A.1 and Option A.3) seems to be the best option. It should also be noted that the overall score of any option may vary depending on whether the in-flight recording system installation would require an STC approval, a minor change approval or if the installation could be performed under CS-STAN.

With regard to balloons, Option B.1 (promote the installation of means to record the trajectory and images from the basket interior) would bring limited safety benefits, and would have no other kind of impact. Option B.2 (mandate means to record trajectory parameters and images from the basket interior for balloons with an MCTOM of 3 000 kg or more) would result in limited safety benefits, which would not outweigh the economic impact and the impact on proportionality issues. In addition, it would introduce more requirements while the intent of EASA Opinion No 01/2016 is to simplify the requirements for balloon operations. Option B.3, which combines Option B.1 and Option B.2, would overall bring slightly more safety benefits than Option B.2 would — however, still not outweighing the negative economic impact nor the negative impact on proportionality issues and rules complexity. Therefore, B.1 seems to be the only appropriate option at this stage.

Table 18A: Detailed comparison of impacts between the various options for aeroplanes and helicopters

Option	**Option A.0**	**Option A.1**	**Option A.2**	**Option A.3**	**Option A.4**
Option description	Baseline option (no change to the rules and no promotion); risks remain as outlined in the issue analysis	Promote the recording of basic flight parameters, audio and/or a view of the instruments panel for all models of light aeroplanes and light helicopters and for all types of operation (no change to the rules).	Strictly transpose ICAO Standards in Annex 6 for newly manufactured light turbine-engined aeroplanes and newly manufactured light turbine-engined helicopters operated for CAT.	Transpose ICAO Standards in Annex 6 with the following differences: — With regard to aeroplanes, the applicability set is newly manufactured aeroplanes which have an MOPSC of more than 9 or which are turbine-engined and have an MCTOM of 2 250 kg or more. — The requirement to record basic flight parameters on board aeroplanes and helicopters is also applicable to commercial SPO. — Recording of audio is not required.	Option A.1 + Option A.3
Safety impact	**– 1** Negative impact on commercial	**+ 1** — No effect if the installation	**+ 1** Strictly transposing the ICAO Standards	**+ 3** Larger proportion of accidents covered	**+ 4** Combines the safety benefits of A.1 and

Option	Option A.0	Option A.1	Option A.2	Option A.3	Option A.4
	operations, no impact on non-commercial operations	requires an STC; — Slightly effective if installation can be performed under a minor change approval; — Medium effective if the installation can be performed by means of a standard change and without an EASA Form 1	would result in a small proportion of accidents covered by in-flight recording	than in Option A.2	A.3: medium effective if the installation requires an STC; very effective if the installation can be performed under a minor change approval or by means of a standard change
Environmental impact	**0**	**0** No impact on environment	**0** No impact on environment	**0** No impact on environment	**0** No impact on environment
Social impact	**0**	**0** Aircraft operators and aircraft owners are free to make decisions with no social impact	**– 1** Reduced social impact, assuming that some requirements are introduced to protect audio and image recordings	**– 1** Same as for Option A.2 for images No social impact if only flight data is recorded	**– 1** Combines the social impact of A.1 and A.3
Economic impact	**0**	**0 for industry** Aircraft operators and aircraft owners are free to make decisions with no economic	**– 2 for industry** Impact is medium negative if STC is required, slightly negative otherwise	**– 2 for industry** Impact is medium negative if STC is required, slightly negative otherwise	**– 2 for industry** Combines the economic impact of A.1 and A.3

Option	Option A.0	Option A.1	Option A.2	Option A.3	Option A.4
		impact **+ 1 for authorities** In-flight recording equipment accelerates investigation	**+ 1 for authorities** In-flight recording equipment accelerates investigation	**+ 1 for authorities** In-flight recording equipment accelerates investigation	**+ 3 for authorities** In-flight recording equipment accelerates investigation
Impact on general aviation and proportionality issues	**0**	**0** Aircraft operators and aircraft owners are free to make decisions with no impact	**– 1** Impact on turboprop below 2 250 kg	**0** Does not impact on turboprop aeroplanes below 2 250 kg	**0** Combines the impacts on general aviation and proportionality of A.1 and A.3
Impact on better regulation and harmonisation	**0**	**0** Promotion, no impact on regulations	**+ 1** Fully transposes the ICAO Standards; however, it makes the rules complex with multiple conditions	**+ 1** Partially transposes the ICAO Standards	**+ 1** Combines the impacts on general aviation and proportionality of A.1 and A.3
Total score (assuming all impact dimensions have a weight of 1)	**– 1**	**+ 1**	**– 2**	**+ 1**	**+ 2**

Table 18B: Detailed comparison of impacts between the various options for balloons

Option	Option B.0	Option B.1	Option B.2	Option B.3
Option description	Baseline option (no change to the rules and no promotion); risks remain as outlined in the issue analysis	Promotes the fitment of balloons with means to record trajectory parameters and images from the basket interior (no change to the rules).	Requires newly manufactured balloons operated for commercial operations and with an MCTOM of 3 000 kg or more to be fitted with equipment recording the balloon trajectory parameters and images from the basket interior.	Option B.1 + Option B.2
Safety impact	– 1 Negative impact on commercial operations, no impact on non-commercial operations	+ 1	+ 1 Small proportion of accidents and serious incidents covered by in-flight recording	+ 3 Combines the safety benefits of B.1 and B.2
Environmental impact	0	0 No impact on environment	0 No impact on environment	0 No impact on environment
Social impact	0	0 Balloon operators and balloon owners are free to make decisions with no social impact	– 1 Limited social impact if image recordings are protected	– 1 Combines the social impact of B.1 and B.2
Economic impact	0	0 Balloon operators and balloon owners are free to make decisions with no economic	– 1 No STC, can rely on cheap equipment already used for recreational activities	– 1 Combines the economic impact of B.1 and B.2

Option	Option B.0	Option B.1	Option B.2	Option B.3
		impact		
Impact on general aviation and proportionality issues	0	0 Balloon operators and balloon owners are free to make decisions with no impact	– 3 Captures only large balloons operated commercially; however, the cost is still high when compared with balloon purchase price and revenue from flights	– 3 Combines the economic impact of B.1 and B.2
Impact on better regulation and harmonisation	0	0 Promotion, no impact on regulations	– 1 Does not improve rule harmonisation and does not follow the intent of Opinion No 01/2016 to simplify the rules for balloons	– 1 Combines the economic impact of B.1 and B.2
Total weight (assuming all impact dimensions have a weight of 1)	– 1	+ 1	– 5	– 3

4.7. Monitoring and evaluation

Monitoring and evaluation is a continuous and systematic process of data collection and analysis about the implementation and effectiveness of a rule or activity. It generates factual information for future evaluations and impact assessments and helps to identify implementation problems.

The options retained by this IA are basically the following two categories:

1) Safety promotion: promoting the voluntary installation of in-flight recording equipment (Option A.1 for aeroplanes and helicopters, and Option B.1 for balloons); and

2) Equipment requirements: mandating the carriage of lightweight flight recorders (Option A.3, only applicable to aeroplanes and helicopters).

4.7.1. Monitoring implementation

With regard to the first category of options (safety promotion), it is proposed to monitor their impact by means of a survey conducted 1 year after initiating safety promotion in order to check:

— how many stakeholders have been reached by the safety promotion activities;

— what are the most and the least convincing arguments of the safety promotion material; and

— how many stakeholders have decided to install in-flight recording equipment as a consequence of the safety promotion activities.

With regard to the second category of options (equipment requirements), no monitoring is considered necessary because Option A.3 is about mandating the installation of equipment which is already commercially available on newly manufactured, light aeroplanes and helicopters. Hence, no technical implementation issue is expected.

4.7.2. Evaluating the effectiveness of options (after implementation)

All retained options serve the common objective of increasing the overall ratio of light aeroplanes, light helicopters and balloons which are fitted with in-flight recording equipment. The evaluation should consist in assessing whether the increase of the level of equipage has contributed to enhancing safety for light aircraft, either directly (by making the use of light aircraft safer and better monitored by operators, flight schools, aero clubs, etc.) or indirectly (by facilitating more in-depth investigations and the identification of more effective corrective actions).

The evaluation of the effectiveness could be done by category of aircraft (aeroplanes, helicopters, balloons) because of the fundamental differences in the way of piloting, the operational context and the stakeholders involved.

Hence, it is proposed to check, for each category of light aircraft (light aeroplanes, light helicopters, and balloons):

— whether the carriage of in-flight recording equipment makes the day-to-day use of the aircraft safer; and

— whether the investigations of accidents and serious incidents involving light aircraft can identify causes (otherwise unknown or not well understood) thanks to in-flight recording equipment, and determine corrective actions with more significant influence on the prevention of future accidents.

5. Proposed actions to support implementation

EASA is committed to providing support for the implementation of the new rules. The range of activities developed in this regard will vary depending on the complexity of the rules, the affected stakeholders, as well as on the amount and type of resources allocated by stakeholders to ensure compliance with the new rules.

The feedback from stakeholders is crucial in determining the type of activities that will be developed. In this respect, any constructive feedback provided via different communication channels (e.g. regular meetings with the EASA advisory bodies, development of frequently asked questions published on the EASA website, or a combination of the above) will be taken into consideration once the new rules are applicable.

6. References

6.1. Affected regulation

— Commission Regulation (EU) No 965/2012 of 5 October 2012 laying down technical requirements and administrative procedures related to air operations pursuant to Regulation (EC) No 216/2008 of the European Parliament and of the Council (OJ L 296, 25.10.2012, p. 1), as last amended

6.2. Affected decisions

— Decision N° 2012/015/Directorate R of the Executive Director of the Agency of 24th October 2012 on Acceptable Means of Compliance and Guidance Material to Commission Regulation (EU) No 965/2012 of 5 October 2012 laying down technical requirements and administrative procedures related to air operations pursuant to Regulation (EC) No 216/2008 of the European Parliament and of the Council (Guidance Material to Annex I — Definitions)

— Decision 2014/017/R of the Executive Director of the Agency of 24 April 2014 adopting Acceptable Means of Compliance and Guidance Material to Part-ORO of Regulation (EU) No 965/2012 and repealing Decision 2012/017/R of 24 October 2012 'AMC and GM to Part-ORO — Issue 2'

— Decision 2014/015/R of the Executive Director of the Agency of 24 April 2014 adopting Acceptable Means of Compliance and Guidance Material to Part-CAT of Regulation (EU) No 965/2012 and repealing Decision 2012/018/R of the Executive Director of the Agency of 24 October 2012 ('AMC and GM to Part-CAT — Issue 2')

— Decision 2014/018/R of the Executive Director of the Agency of 24 April 2014 adopting Acceptable Means of Compliance and Guidance Material to Part-SPO of Regulation (EU) No 965/2012 ('AMC and GM to Part-SPO')

6.3. Other reference documents

— ICAO Annex 6, Part I (Amendment 38)

— ICAO Annex 6, Part II (Amendment 33)

— ICAO Annex 6, Part III (Amendment 19)

— EASA Research Project 'Investigation of the technical feasibility and safety benefit of a light aeroplane operational Flight Data Monitoring (FDM) system', dated 16 December 2008

— European General Aviation Strategy, dated 30 August 2012

— EASA Management Board meeting 04/2012 of 11 December 2012, working paper 9a: Roadmap for Regulation of GA.

7. Appendices

7.1. Appendix A: Comparison of European Air Operations rules and provisions of ICAO Annex 6

Table A.1 presents a comparative of Regulation (EU) No 965/2012 on Air Operations and the provisions of ICAO Annex 6 related to in-flight recording capability for CAT with aeroplanes.

Table A.2 presents a comparative of Regulation (EU) No 965/2012 on Air Operations and the provisions of ICAO Annex 6 related to in-flight recording capability for CAT with helicopters.

Table A.3 presents a comparative of Regulation (EU) No 965/2012 on Air Operations and the provisions of ICAO Annex 6 related to in-flight recording capability for aeroplanes used for types of operation other than CAT.

Table A.4 presents a comparative of Regulation (EU) No 965/2012 on Air Operations and the provisions of ICAO Annex 6 related to in-flight recording capability for helicopters used for types of operation other than CAT.

Note: In ICAO Annex 6 Part III, the MCTOM break for crash-protected flight recorder carriage requirements is set at 3 180 kg, while in Regulation (EU) No 965/2012 on Air Operations it is set at 3 175 kg.

Table A.1: CAT aeroplanes

Aeroplanes operated for CAT

Function	**Reference text**	**MCTOM over 5 700 kg**	**MCTOM up to 5 700 kg**
Flight parameters	Regulation (EU) No 965/2012 Part-CAT	FDR required if: — first issued with an individual CofA on or after 1 June 1990, or — turbine-engined.	FDR required if: — multi-engined turbine-powered, and — MOPSC of more than 9, and — first issued with an individual CofA on or after 1 April 1998.
	ICAO Annex 6 Part I Standards	FDR required if: — first issued with an individual CofA on or after 1 January 1989, or — turbine-engined.	FDR or ADRS or Class C AIR required if: — turbine-engined, and — application for TC submitted on or after 1 January 2016.
	ICAO Annex 6 Part I Recommended Practices	(No Recommended Practice on carriage of recording equipment)	FDR required if: — multi-engined turbine-powered, and — first issued with an individual CofA on or after 1 January 1990. FDR or ADRS or Class C AIR required if: — turbine-engined, and — first issued with an individual CofA on or after 1 January 2016.
Audio	Regulation (EU) No 965/2012 Part-CAT	CVR required	CVR required if: — multi-engined turbine-powered, and — MOPSC of more than 9, and — first issued with an individual CofA on or after 1 January 1990.

Aeroplanes operated for CAT

Function	**Reference text**	**MCTOM over 5 700 kg**	**MCTOM up to 5 700 kg**
	ICAO Annex 6 Part I Standards	CVR required if: — turbine-engined and MCTOM of over 27 000 kg and prototype was certified after 30 September 1969, or — first issued with an individual CofA on or after 1 January 1987.	CVR or CARS required if: — turbine-engined, and — MCTOM of over 2 250 kg, and — required to be operated by more than one pilot, and — application for TC submitted on or after 1 January 2016.
	ICAO Annex 6 Part I Recommended Practices	CVR required if turbine-engined and prototype was certified after 30 September 1969.	CVR or CARS required if: — turbine-engined, and — MCTOM of over 2 250 kg, and — required to be operated by more than one pilot, and — first issued with an individual CofA on or after 1 January 2016.
Data-link messages	Regulation (EU) No 965/2012 Part-CAT	Recording required if: — CVR is required, and — capable to operate data-link messages, and — first issued with an individual CofA on or after 8 April 2014.	Recording required if: — CVR is required, and — capable to operate data-link messages, and — first issued with an individual CofA on or after 8 April 2014.
	ICAO Annex 6 Part I Standards	Recording required if: — CVR is required, and — aircraft utilise any of the data-link communication applications listed, and — first issued with an individual CofA on or after 1 January 2016. + Recording required if:	Recording required if: — CVR is required, and — aircraft utilise any of the data-link communication applications listed, and — first issued with an individual CofA on or after 1 January 2016. + Recording required if:

Aeroplanes operated for CAT

Function	Reference text	MCTOM over 5 700 kg	MCTOM up to 5 700 kg
		— CVR is required, and — aircraft modified on or after 1 January 2016 for the installation and utilisation of any of the data-link communication applications listed.	— CVR is required, and — aircraft modified on or after 1 January 2016 for the installation and utilisation of any of the data-link communication applications listed.
	ICAO Annex 6 Part I Recommended Practices	(No Recommended Practice on carriage of recording equipment)	(No Recommended Practice on carriage of recording equipment)

Table A.2: CAT helicopters

Helicopters operated for CAT

Function	Reference text	**MCTOM over 3 175 kg**	**MCTOM up to 3 175 kg**
Flight parameters	Regulation (EU) No 965/2012 Part-CAT	FDR required if: — MCTOM of over 3 175 kg and first issued with an individual CofA on or after 1 August 1999, or — MCTOM of over 7 000 kg or MOPSC of more than 9, and first issued with an individual CofA on or after 1 January 1989.	No carriage requirement.
	ICAO Annex 6 Part III Standards	FDR required if: — first issued with an individual CofA on or after 1 January 2016, or — MCTOM of over 7 000 kg or passenger seating configuration of more than 19 and first issued with an individual CofA on or after 1 January 1989.	FDR or ADRS or Class C AIR required if: — turbine-engined, and — MCTOM of over 2 250 kg, and — application for TC submitted on or after 1 January 2018.
	ICAO Annex 6 Part III Recommended Practices	FDR required if first issued with an individual CofA on or after 1 January 1989.	FDR or ADRS or Class C AIR required if first issued with an individual CofA on or after 1 January 2018.
Audio	Regulation (EU) No 965/2012 Part-CAT	CVR required if: — MCTOM of over 7 000 kg, or — MCTOM of over 3 175 kg and first issued with an individual CofA on or after 1 January 1987.	No carriage requirement.
	ICAO Annex 6 Part III Standards	CVR required if MCTOM over 7 000 kg.	(No Standard on carriage)
	ICAO Annex 6 Part III Recommended Practices	CVR required if first issued with an individual CofA on or after 1 January 1987.	(No Recommended Practice on carriage)

Helicopters operated for CAT

Function	Reference text	**MCTOM over 3 175 kg**	**MCTOM up to 3 175 kg**
Data-link messages	Regulation (EU) No 965/2012 Part-CAT	Recording required if: — CVR is required, and — capable to operate data-link messages, and — first issued with an individual CofA on or after 8 April 2014.	Recording required if: — CVR is required, and — capable to operate data-link messages, and — first issued with an individual CofA on or after 8 April 2014.
	ICAO Annex 6 Part III Standards	Recording required if: — CVR is required, and — aircraft utilise any of the data-link communication applications listed, and — first issued with an individual CofA on or after 1 January 2016. + Recording required if: — CVR is required, and — aircraft modified on or after 1 January 2016 for the installation and utilisation of any of the data-link communication applications listed.	Recording required if: — CVR is required, and — aircraft utilise any of the data-link communication applications listed, and — first issued with an individual CofA on or after 1 January 2016. + Recording if: — CVR is required, and — aircraft modified on or after 1 January 2016 for the installation and utilisation of any of the data-link communication applications listed.
	ICAO Annex 6 Part III Recommended Practices	(No Recommended Practice on carriage)	(No Recommended Practice on carriage)

Table A.3: Aeroplanes operated for non-commercial or SPO operations

Aeroplanes operated for non-commercial or SPO operations

Function	Reference text	**MCTOM over 5 700 kg**	**MCTOM up to 5 700 kg**
Flight parameters	Regulation (EU) No 965/2012 Part-NCC, Part-NCO and Part-SPO	FDR required if first issued with an individual CofA on or after 1 January 2016.	(No carriage requirement)
	ICAO Annex 6 Part II Standards	FDR required if first issued with an individual CofA on or after 1 January 2005.	(No Standard on carriage)
	ICAO Annex 6 Part II Recommended Practices	(No Recommended Practice on carriage)	FDR or ADRS or Class C AIR required if: — turbine-engined, and — first issued with an individual CofA on or after 1 January 2016, and — (*proposed by ICAO State Letter AN 11/6.3.27-14/10*) more than 5 passenger seats.
Audio	Regulation (EU) No 965/2012 Part-NCC, Part-NCO and Part-SPO	CVR required if MCTOM is over 27 000 kg and first issued with an individual CofA on or after 1 January 2016.	CVR required if: — MCTOM of over 2 250 kg, and — certified for operation with at least two pilots, and — one turbojet engine or more than one turboprop engine, and — TC first issued on or after 1 January 2016.
	ICAO Annex 6 Part II Standards	CVR required if: — MCTOM over 27 000 kg and first issued with an individual CofA on or after 1 January 1987, or — turbine-engined aeroplane required to be operated by more than one pilot and application for TC submitted on or after 1 January 2016.	(No Standard on carriage)

Aeroplanes operated for non-commercial or SPO operations

Function	Reference text	**MCTOM over 5 700 kg**	**MCTOM up to 5 700 kg**
	ICAO Annex 6 Part II Recommended Practices	CVR required if aeroplanes are required to be operated by more than one pilot and first issued with an individual CofA on or after 1 January 1987.	CVR or CARS required if: — turbine-engined, and — required to be operated by more than one pilot, and — first issued with an individual CofA on or after 1 January 2016, and — (*proposed by ICAO State Letter AN 11/6.3.27-14/10*) more than 5 passenger seats.
Data-link messages	Regulation (EU) No 965/2012 Part-NCC, Part-NCO and Part-SPO	Recording required if: — CVR is required, and — capable to operate data-link messages, and — first issued with an individual CofA on or after 1 January 2016.	Recording required if: — CVR is required, and — capable to operate data-link messages, and — first issued with individual CofA on or after 1 January 2016.
	ICAO Annex 6 Part II Standards	Recording required if: — CVR is required, and — aircraft utilise any of the data-link communication applications listed, and — first issued with an individual CofA on or after 1 January 2016. + Recording required if: — CVR is required, and — aircraft modified on or after 1 January 2016 for the installation and utilisation of any of the data-link communication applications listed.	Recording required if: — CVR is required, and — aircraft utilise any of the data-link communication applications listed, and — first issued with an individual CofA on or after 1 January 2016. + Recording required if: — CVR is required, and — aircraft modified on or after 1 January 2016 for the installation and utilisation of any of the data-link communication applications listed.
	ICAO Annex 6 Part II Recommended Practices	(No Recommended Practice on carriage)	(No Recommended Practice on carriage)

Table A.4: Helicopters operated for non-commercial or SPO operations

Helicopters operated for non-commercial or SPO operations

Function	Reference text	**MCTOM over 3 175 kg**	**MCTOM up to 3 175 kg**
Flight parameters	Regulation (EU) No 965/2012 Part-NCC, Part-NCO and Part-SPO	FDR required if MCTOM of over 3 175 kg and first issued with an individual CofA on or after 1 January 2016.	No carriage requirement.
	ICAO Annex 6 Part III Standards	FDR required if: — first issued with an individual CofA on or after 1 January 2016, or — MCTOM of over 7 000 kg or passenger seating configuration of more than 19 and first issued with an individual CofA on or after 1 January 1989.	(No Standard on carriage)
	ICAO Annex 6 Part III Recommended Practices	FDR required if first issued with an individual CofA on or after 1 January 1989.	(No Recommended Practice on carriage)
Audio	Regulation (EU) No 965/2012 Part-NCC, Part-NCO and Part-SPO	CVR required if MCTOM of over 7 000 kg and first issued with an individual CofA on or after 1 January 2016.	No carriage requirement.
	ICAO Annex 6 Part III Standards	CVR required if MCTOM over 7 000 kg.	(No Standard on carriage)
	ICAO Annex 6 Part III Recommended Practices	CVR required if first issued with an individual CofA on or after 1 January 1987.	(No Recommended Practice on carriage)

Helicopters operated for non-commercial or SPO operations

Function	Reference text	**MCTOM over 3 175 kg**	**MCTOM up to 3 175 kg**
Data-link messages	Regulation (EU) No 965/2012 Part-NCC, Part-NCO and Part-SPO	Recording required if: — CVR is required, and — capable to operate data-link messages, and — first issued with an individual CofA on or after 8 April 2014.	Recording required if: — CVR is required, and — capable to operate data-link messages, and — first issued with an individual CofA on or after 8 April 2014.
	ICAO Annex 6 Part III Standards	Recording required if: — CVR is required, and — aircraft utilise any of the data-link communication applications listed, and — first issued with an individual CofA on or after 1 January 2016. + Recording required if: — CVR is required, and — aircraft modified on or after 1 January 2016 for the installation and utilisation of any of the data-link communication applications listed.	Recording required if: — CVR is required, and — aircraft utilise any of the data-link communication applications listed, and — first issued with an individual CofA on or after 1 January 2016. + Recording if: — CVR is required, and — aircraft modified on or after 1 January 2016 for the installation and utilisation of any of the data-link communication applications listed.
	ICAO Annex 6 Part III Recommended Practices	(No Recommended Practice on carriage)	(No Recommended Practice on carriage)

7.2. Appendix B: Statistics of accidents and serious incidents

Table B.1 presents statistics of accidents and serious incidents with aircraft registered in any of the EASA MSs for the years 2012, 2013 and 2014. These statistics were prepared using the EASA database of accidents and serious incidents.

Note 1: The figures do not always add up in Table B.1. This is because some fields in the extracted records are empty (e.g. type of operation missing for a given record, or MCTOM missing).

Note 2: In all tables of this Appendix, the following acronyms are used:

CAT = commercial air transport

AW = aerial work (SPO activities as per Regulation (EU) No 965/2012)

GA = general aviation

Table B.1: Accidents and serious incidents with aircraft registered in an EASA MS (*Source:* EASA database — figures based on a query performed on 12.2.2016)

Category	Number of accidents and serious incidents in 2012	Number of fatal accidents in 2012	Number of accidents and serious incidents in 2013	Number of fatal accidents in 2013	Number of accidents and serious incidents in 2014	Number of fatal accidents in 2014
All aircraft	1 333	153	1 196	139	1 186	131
Aeroplanes, helicopters, balloons and sailplanes	1 005	105	884	83	919	92
All aeroplanes	**652**	**58**	**543**	**44**	**617**	**62**
Aeroplanes operated for CAT with MCTOM > 5 700 kg	126	1	106	0	103	2
Aeroplanes operated for GA with MCTOM > 5 700 kg	9	1	4	0	7	0
Aeroplanes operated for AW with MCTOM > 5 700 kg	1	0	0	0	2	1
Aeroplanes operated for CAT with MCTOM < 5 700 kg	9	3	9	0	11	2
Aeroplanes operated for GA with MCTOM < 5 700 kg	443	42	381	35	433	46
Aeroplanes operated for AW with MCTOM < 5 700 kg	34	7	37	6	34	7
All helicopters	**108**	**12**	**96**	**13**	**79**	**10**
Helicopters operated for CAT with MCTOM > 3 175 kg	6	0	3	1	3	0
Helicopters operated for GA with MCTOM > 3 175 kg	4	0	3	0	2	1
Helicopters operated for AW with MCTOM > 3 175 kg	3	1	0	0	0	0
Helicopters operated for CAT with 2 250 kg ≤ MCTOM ≤ 3 175 kg	2	0	1	0	1	1
Helicopters operated for GA with 2 250 kg ≤ MCTOM ≤ 3 175 kg	6	0	9	0	5	0
Helicopters operated for AW with	4	0	4	1	2	0

Category	Number of accidents and serious incidents in 2012	Number of fatal accidents in 2012	Number of accidents and serious incidents in 2013	Number of fatal accidents in 2013	Number of accidents and serious incidents in 2014	Number of fatal accidents in 2014
2 250 kg ≤ MCTOM ≤ 3 175 kg						
Helicopters operated for CAT with MCTOM < 2 250 kg	6	0	6	0	2	0
Helicopters operated for GA with MCTOM < 2 250 kg	34	5	41	7	40	5
Helicopters operated for AW with MCTOM < 2 250 kg	14	4	9	0	7	0
All balloons	**26**	**3**	**30**	**2**	**17**	**1**
Balloons operated for CAT	14	2	8	1	8	1
Balloons operated for GA	9	1	17	1	7	0
Balloons operated for AW	1	0	1	0	2	0
All sailplanes	**233**	**28**	**217**	**18**	**206**	**19**
Sailplanes operated for CAT	13	0	2	0	1	0
Sailplanes operated for GA	217	28	209	18	178	16
Sailplanes operated for AW	1	0	0	0	23	3

Table B.2: Accidents and serious incidents with light aeroplanes registered in an EASA MS (*Source:* EASA database — figures based on a query performed on 12.2.2016)

Category	Number of accidents and serious incidents in 2012	Number of accidents and serious incidents in 2013	Number of accidents and serious incidents in 2014
Aeroplanes operated for GA with MCTOM < 5 700 kg	443	381	433
Aeroplanes operated for AW with MCTOM < 5 700 kg	34	37	34
Aeroplanes operated for CAT with MCTOM < 5 700 kg	9	9	11
Aeroplanes operated for CAT with MCTOM < 5 700 kg and multi-engined turbine-powered and with an MOPSC of more than 9	0	1	4
Aeroplanes operated for CAT with MCTOM < 5 700 kg and engine turbine-powered	3	3	4
Aeroplanes operated for CAT with MCTOM < 5700 kg and which are: — engine turbine-powered and with an MCTOM of 2 250 kg or more, or — with an MOPSC of more than 9.	3	5	4
Aeroplanes operated for AW with MCTOM < 5 700 kg and which are: — engine turbine-powered and with an MCTOM of 2 250 kg or more, or — with an MOPSC of more than 9.	5	6	4

Table B.3: Accidents and serious incidents with light helicopters registered in an EASA MS (*Source:* EASA database – figures based on a query performed on 12.2.2016)

Category	**Number of accidents and serious incidents in 2012**	**Number of accidents and serious incidents in 2013**	**Number of accidents and serious incidents in 2014**
Helicopters operated for GA with MCTOM < 3 175 kg	40	50	45
Helicopters operated for AW with MCTOM < 3 175 kg	18	13	9
Helicopters operated for CAT with MCTOM < 3 175 kg	8	7	3
Turbine-engined helicopters operated for CAT with 2 250 kg ≤ MCTOM < 3 175 kg	3	1	1
Turbine-engined helicopters operated for AW with 2 250 kg ≤ MCTOM < 3 175 kg	3	4	2

Table B.4: Accidents and serious incidents with balloons registered in an EASA MS (*Source:* EASA database — figures based on a query performed on 12.2.2016)

Category	**Number of accidents and serious incidents in 2012**	**Number of accidents and serious incidents in 2013**	**Number of accidents and serious incidents in 2014**
All balloons	27	32	17
Balloons operated for CAT with MCTOM of 2 250 kg or more	2	0	2
Balloons used for non-commercial operations with MCTOM of 2 250 kg or more	0	0	0
Balloons operated for aerial work with MCTOM of 2 250 kg or more	0	0	0
Balloons operated for CAT with MCTOM of less than 3 000 kg	13	9	6
Balloons used for non-commercial operations or aerial work with MCTOM of less than 3 000 kg	10	21	9
Balloons for which either the MCTOM or the type of operation is unknown	2	2	0

7.3. Appendix C: Safety recommendations related to in-flight recording for light aircraft

Tables C.1 and C.2 present an inventory of safety recommendations related to in-flight recording for light aircraft, and issued by safety investigation authorities of EASA MSs since 2000.

Table C.1 presents the reference information and the full text of the safety recommendations[27].

Table C.2 presents the application domain of these safety recommendations, as well as the characteristics of the aircraft actually involved in the investigated accidents and serious incidents that triggered safety recommendations.

[27] For convenience, some safety recommendations were translated into English. As accurate as the translation may be, the original text of the safety recommendation should be consulted when in doubt.

Table C.1: Reference and text of safety recommendations related to in-flight recording, and issued by safety investigation authorities of the EASA MSs since 2000

Safety recommendation						Investigation	
EASA recommendation number	Addressed to EASA?	EASA status on 2.12.2016	Included in the terms of reference of RMT.0271?	Date of issue or receipt	Safety recommendation text	Date of occurrence	State of the safety investigation authority
UNKG-2001-001	No	N/A	No	08/01/2001	It is recommended that the CAA should: a. Encourage the development of a suitable lightweight and low-cost Voice, Data and Combined recorder and the installation of such equipment by operators. b. Consider whether such flight recorders should be introduced for operations such as dedicated police and HEMS operations involving as they do, the exposure of third parties to risk not present in normal Public Transport operations.	26/07/1998	UK
UNKG-2001-038	No	N/A	No	31/07/2001	The CAA should take forward to the JAA a proposal to re-examine the criteria for the carriage of flight recorders by mult-piston engine aircraft, which have in force a certificate of airworthiness in the Transport Category (Passenger) and are certified to carry more than 9 passengers with a view to requiring all aircraft, whether piston or turbine powered, to carry at least a Cockpit Voice Recorder.	03/09/1999	UK
FRAN-2001-038	No	N/A	No	01/07/2001	Consequently, the BEA recommends that: • the DGAC and the JAA make mandatory the installation of at least one flight recorder on board public transport aircraft authorized to carry more than nine passengers and whose maximum certified take-off weight is less than or equal to 5,700 kg, whatever the date of certification may be.	24/03/2001	France
GREC-2002-027	No	N/A	No	12/04/2005	At national level, the HCAA should take care of equip the helicopters in subject with CVR, regardless to the provisions in ANNEX 6, part III, referring to helicopters operating in special conditions as the HELITALIA’s helicopters do.	14/01/2001	Greece

Safety recommendation						Investigation	
EASA recommendation number	Addressed to EASA?	EASA status on 2.12.2016	Included in the terms of reference of RMT.0271?	Date of issue or receipt	Safety recommendation text	Date of occurrence	State of the safety investigation authority
FRAN-2003-012	No	N/A	No	21/08/2003	Consequently, the BEA recommends that: • the DGAC and the J.A.A. urgently take into account, for safety reasons, the need for flight recorders for the rapid determination of the causes and circumstances of accidents which occur in public air transport and that, to this end, these organizations: - impose as soon as possible, without any possible exemptions, the carriage of at least one flight recorder on aircraft operating for public transport with a maximum certificated takeoff weight lesser than 5,700 kg and whose maximum approved passenger seating configuration is ten seats or more, whatever the date of certification may be; - extend these provisions to airplanes of the same type transporting cargo; - study the extension of these provisions to helicopters operated for public transport.	24/03/2001	France
GREC-2003-029	No	N/A	No	12/04/2005	CVR Despite ICAO restrictions as mentioned in ANNEX 6, Part III, referring to CVR installation, all Public Transport helicopters on a national level should be equipped with said equipment. The AAIASB after the helicopter accident on January 14, 2001, issued ist ASA 2002/2, dated 3-7-2002 and insists in the implementation of the aforementioned ASA once again.	16/06/2002	Greece
GREC-2004-020	No	N/A	No	12/04/2005	All h/c for public transportation should be equipped with CVR, FDR, ELT and ULT devices.	11/02/2003	Greece
UNKG-2004-084	No	N/A	No	19/11/2004	The Department for Transport should urge the International Civil Aviation Organisation (ICAO) to promote the safety benefits of fitting, as a minimum, cockpit voice recording equipment to all aircraft operating with a Certificate of Airworthiness in the Commercial Air Transport category, regardless of weight or age.	19/07/2003	UK
UNKG-2004-085	No	N/A	No	19/11/2004	The Department for Transport should urge the International Civil Aviation Organisation (ICAO) to promote research into the design and development of inexpensive, lightweight, airborne flight data and voice recording equipment.	20/07/2003	UK
N/A	No	N/A	No	27/05/2005	It is recommended to assess the opportunity to make mandatory the installation of a CVR and an FDR on all helicopters operating for HEMS and SAR.	13/08/2003	Italy

Safety recommendation						Investigation	
EASA recommendation number	Addressed to EASA?	EASA status on 2.12.2016	Included in the terms of reference of RMT.0271?	Date of issue or receipt	Safety recommendation text	Date of occurrence	State of the safety investigation authority
UNKG-2005-062	Yes	Closed	No, it was addressed by creation of TSO 2C-197 on information collection and monitoring systems	24/06/2005	It is recommended that the European Aviation Safety Agency develop standards for appropriate recording equipment that can be practically implemented on small aircraft.	27/06/2004	UK
UNKG-2005-100	Yes	Closed	No, it was addressed by EASA Research Project EASA.2007.OP.18	04/05/2006	The EASA should promote research into the design and development of inexpensive, lightweight, airborne flight data and voice recording equipment.	22/01/2005	UK
UNKG-2005-101	Yes	Closed	Yes	04/05/2006	The EASA should promote the safety benefits of fitting, as a minimum, CVR equipment to all aircraft operated for the purpose of commercial air transport, regardless of weight or age.	22/01/2005	UK
DENM-2006-002	No	N/A	No	01/01/2006	The Danish Civil Aviation Administration should consider whether a Flight Recorder should be required for all commercial aviation in order to improve the operator's opportunities for supervision. The data recorded for small aircraft should at least include time, position and flying altitude.	06/08/2004	Denmark
IRLD-2008-014	Yes	Closed	No, it was addressed by EASA Research Project EASA.2007.OP.18	01/07/2008	EASA should initiate a study of the necessity for aerial work aircraft in the General Aviation category to have installed a simple on-board device to record basic flight parameters.	25/05/2006	Ireland
HUNG-2008-002	Yes	Closed	Yes	03/11/2009	The IC recommends the EASA to promote the safety benefits of fitting, as a minimum, of an aircraft data recording system (ADRS) and a cockpit audio recording system (CARS) to all twin-engine helicopters flying Category A missions.	31/07/2008	Hungary

Safety recommendation						Investigation	
EASA recommendation number	Addressed to EASA?	EASA status on 2.12.2016	Included in the terms of reference of RMT.0271?	Date of issue or receipt	Safety recommendation text	Date of occurrence	State of the safety investigation authority
FRAN-2009-008	Yes	Closed	Yes	27/05/2009	[Unofficial English Translation: The BEA recommends that EASA expands the conditions of carriage obligation of flight recorders for public transport.]	18/10/2006	France
N/A	No	N/A	No	N/A	It is recommended that the International Civil Aviation Organisation establish as an essential requirement for skydiving operations that the aircraft utilized for this activity have onboard a flight data recorder capable of logging at least the basic parameters of the operation.	30/05/2008	Spain
FRAN-2009-010	No	N/A	No	13/11/2009	En conséquence, le BEA recommande que l' OACI étende les conditions d'obligation d'emport d'enregistreurs de vol à tous les avions effectuant du transport public. As a consequence, the BEA recommends that ICO extend the conditions for mandating the carriage of flight recorders to all aeroplanes thet perform public transport.	28/06/2008	France
UNKG-2010-016	No	N/A	No	16/04/2010	It is recommended that the International Civil Aviation Organisation adopt the proposals of its Flight Recorder Panel for the requirement to install flight recorders on turbine-engine-powered aeroplanes of a maximum certified takeoff mass of 5,700 kg or less.	30/03/2008	UK
SPAN-2012-011	Yes	Closed	Yes	06/07/2012	It is recommended that the European Aviation Safety Agency (EASA) study the viability of introducing a requirement into the operational regulations that cockpit voice and flight data recorders of given specifications be installed on turboprop aircraft authorized for IFR flights and used for the public transport or passengers or cargo, regardless of their weight or maximum number of seats.	18/02/1998	Spain
NORW-2012-010	Yes	Closed	Yes	01/11/2012	The Accident Investigation Board Norway (AIBN) recommends that EASA considers introducing requirements regarding flight recorders on more aircraft than are covered by the current regulations.	04/07/2011	Norway
NETH-2012-001	Yes	Closed	Yes	21/12/2011	It is recommended to EASA to make flight recorder equipment mandatory for High Performance Aircraft, designed for carrying persons and/or cargo for the purpose of accident investigation.	16/10/2009	Netherlands
FRAN-2013-012	Yes	Closed	Yes	23/05/2013	The BEA recommends that EASA extend the obligation to carry at least one flight recorder on board any aircraft operated for public transport.	05/09/2010	France

Safety recommendation						Investigation	
EASA recommendation number	Addressed to EASA?	EASA status on 2.12.2016	Included in the terms of reference of RMT.0271?	Date of issue or receipt	Safety recommendation text	Date of occurrence	State of the safety investigation authority
FINL-2014-001	Yes	Closed	Yes	23/01/2014	SIAF recommends that the EASA study the possibility of drawing up a proposal for a standard which would suggest that all GPS devices intended for use in aviation have a function that records the parameters of the route flown. Moreover, the memory of such devices should not require a power source to retain the stored data. A similar safety recommendation was already issued in 2009, in conjunction with Investigation Report B3/2008L.	08/11/2012	Finland
BELG-2015-001	Yes	Open	Yes	09/07/2015	It is recommended that EASA mandates the installation of a lightweight recording system in aircraft used for parachuting activities	19/10/2013	Belgium
UNKG-2015-032	No	N/A	No	16/10/2015	It is recommended that the Civil Aviation Authority requires all helicopters operating under a Police Air Operators Certificate, and first issued with an individual Certificate of Airworthiness before 1 January 2018, to be equipped with a recording capability that captures data, audio and images in crash-survivable memory. They should, as far as reasonably practicable, record at least the parameters specified in The Air Navigation Order, Schedule 4, Scale SS(1) or SS(3) as appropriate. They should be capable of recording at least the last two hours of (a) communications by the crew, including Police Observers carried in support of the helicopter's operation, and (b) images of the cockpit environment. The image recordings should have sufficient coverage, quality and frame rate characteristics to include actions by the crew, control selections and instrument displays that are not captured by the data recorder. The audio and image recorders should be capable of operating for at least 10 minutes after the loss of the normal electrical supply.	29/11/2013	UK

Safety recommendation						Investigation	
EASA recommendation number	**Addressed to EASA?**	**EASA status on 2.12.2016**	**Included in the terms of reference of RMT.0271?**	**Date of issue or receipt**	**Safety recommendation text**	**Date of occurrence**	**State of the safety investigation authority**
UNKG-2015-033	No	N/A	No	16/10/2015	It is recommended that the Civil Aviation Authority requires all helicopters operating under a Police Air Operators Certificate, and first issued with an individual Certificate of Airworthiness on or after 1 January 2018, to be fitted with flight recorders that record data, audio and images in crash-survivable memory. These should record at least the parameters specified in The Air Navigation Order, Schedule 4, Scale SS(1) or SS(3), as appropriate. They should be capable of recording at least the last two hours of (a) communications by the crew, including Police Observers carried in support of the helicopter's operation, and (b) cockpit image recordings. The image recordings should have sufficient coverage, quality and frame rate characteristics to include control selections and instrument displays that are not captured by the other data recorders. The audio and image recorders should be capable of operating for at least 10 minutes after the loss of the normal electrical supply.	29/11/2013	UK
UNKG-2015-035	Yes	Open	Yes	16/10/2015	It is recommended that the European Aviation Safety Agency mandate the ICAO Annex 6 flight recorder requirements for all helicopter emergency medical service operations, regardless of aircraft weight. The last two hours of flight crew communications and cockpit area audio should be recorded. The cockpit area audio recording should continue for 10 minutes after the loss of normal electrical power.	29/11/2013	UK
FRAN-2016-045	Yes	Open	Yes	02/12/2016	Consequently the BEA recommends that: EASA add this accident to the TBM700 registered N129AG on 6 August 2014 at Saint-Jean-les-Deux-Jumeaux in the terms of reference for regulatory task RMT.0271.	06/08/2014	France
FRAN-2016-046	Yes	Open	Yes	02/12/2016	Consequently the BEA recommends that: EASA require or promote the installation of on-board recorders on aeroplanes categorised as high performance aircraft (HPA), depending on the type of operation of the aircraft.	06/08/2014	France

Table C.2: Scope of safety recommendations related to in-flight recording, and issued by safety investigation authorities of the EASA MSs since 2000

EASA recommendation number	Accident aircraft							Application domain of the safety recommendation						
	Aircraft registration	Aircraft make and model	Type of operation	Fixed wing or rotary wing	Turbine or piston (number)	MCTOM (kg)	Passenger capacity or payload	Type of operation	Fixed wing or rotary wing	Turbine or piston (and number of engines)	Forward-fit or retrofit	MCTOM (kg)	Passenger capacity	Recording function
UNKG-2001-001	G-MASK	Aerospatiale AS355 F1 Ecureuil II	CAT (Emergency medical services)	RW	Turbine (2)	2400	6 PAX	CAT (Emergency medical services)	RW	Not specified	Not specified	Not specified	Not specified	Not specified
UNKG-2001-038	G-ILGW	Cessna 404 Titan	CAT (Passengers)	FW	Turbine (2)	3810	10 PAX	CAT (Passengers)	Not specified	Multi-engined	Not specified	All	More than 9 pax	CVR
FRAN-2001-038	F-OGES	De Havilland DHC6-300	CAT (Passengers)	FW	Turbine (2)	5670	20 PAX	CAT	Both	All	Retro fit	< 5 700 kg	More than 9 pax	FDR or CVR
GREC-2002-027	SX-HDT	Agusta AW 109	CAT (Emergency medical services)	RW	Turbine (2)	3000	7 PAX	Not specified	Not specified	Not specified	Not specified	Not specified	Not specified	CVR
FRAN-2003-012	F-OGES	De Havilland DHC6-300	CAT (Passengers)	FW	Turbine (2)	5670	20 PAX	CAT	Both	All	Retro fit	< 5 700 kg	More than 9 pax	FDR or CVR
GREC-2003-029	SX-HDR	Agusta AW 109	CAT (EMS)	RW	Turbine (2)	3000	7 PAX	CAT	RW	All	All	All	All	CVR
GREC-2004-020	SX-HDV	Agusta AW 109	CAT (EMS)	RW	Turbine (2)	3000	7 PAX	CAT	RW	All	Retro fit	All	All	FDR + CVR
UNKG-2004-084	G-CSPJ	Hughes 369HS	GA (Private)	RW	Turbine (1)	1157	4 PAX	CAT	Both	All	Retro fit	All	Not specified	CVR
UNKG-2004-085	G-CSPJ	Hughes 369HS	GA (Private)	RW	Turbine (1)	1157	4 PAX	Not specified	Not specified	Not specified	Not specified	Not specified	Not specified	Not specified
N/A	I-SEIQ	Agusta Bell 412 SP	SAR	RW	Turbine (2)	5400	13 PAX	CAT + AW	RW	All	Not specified	All	All	FDR + CVR
UNKG-2005-062	G-BGED	Cessna U206F Stationair	AW	FW	Piston (1)	1630	6 PAX	Not specified	Not specified	Not specified	Not specified	Not specified	Not specified	Not specified

EASA recommendation number	Accident aircraft							Application domain of the safety recommendation						
	Aircraft registration	Aircraft make and model	Type of operation	Fixed wing or rotary wing	Turbine or piston (number)	MCTOM (kg)	Passenger capacity or payload	Type of operation	Fixed wing or rotary wing	Turbine or piston (and number of engines)	Forward-fit or retrofit	MCTOM (kg)	Passenger capacity	Recording function
UNKG-2005-100	G-BXLI	Bell 206B	GA (Private)	RW	Turbine (1)	1450	4 PAX	Not specified	Not specified	Not specified	Not specified	Not specified	Not specified	FDR + CVR
UNKG-2005-101	G-BXLI	Bell 206B	GA (Private)	RW	Turbine (1)	1 450	4 PAX	CAT	Both	All	Retro fit	All	All	CVR
DENM-2006-002	OY-CAK	SOCATA TB-10	CAT	FW	Piston (1)	1 150	5 PAX	CAT	Both	All	Not specified	All	All	FDR
IRLD-2008-014	EI-CHM	Cessna 150M	AW (Training flight)	FW	Piston (1)	730	1 PAX (+2 Children)	AW	Not specified	Not specified	Not specified	Not specified	Not specified	FDR
HUNG-2008-002	HA-ECE	Eurocopter EC135 T2	CAT (Emergency medical services)	RW	Turbine (2)	2 835	2 pilots + 2 patients	CAT	RW	Multi-engined	Not specified	All	All	FDR+CVR
FRAN-2009-008	F-GVPD	Beech 90 KING AIR	CAT	FW	Turbine (2)	4 851	7 PAX	CAT	Not specified	Not specified	Not specified	Not specified	Not specified	FDR+CVR
N/A	EC-JXH	Pilatus PC6-B2H4	AW (parachute dropping)	FW	Turbine (1)	2 800	10 PAX	Skydiving	Not specified	Not specified	Not specified	Not specified	Not specified	FDR
FRAN-2009-010	V2-LFL	De Havilland DHC6	CAT	FW	Turbine (2)	5 670	20 PAX	CAT	FW	All	Not specified	All	All	Not specified
UNKG-2010-016	VP-BGE	Cessna Citation I (500)	CAT (Passengers)	FW	Turbine (2)	5 375	6 PAX	Not specified	FW	Turbine	Not specified	All	All	Not specified
SPAN-2012-011	EC-GDG	Fairchild SA-226-TC	CAT (Cargo)	FW	Turbine (2)	5 665	19 PAX	CAT	FW	Turbine	Not specified	All	All	FDR+CVR
NORW-2012-010	LN-OXC	Eurocopter AS 350 B3	CAT (Passengers)	RW	Turbine (1)	2 250	5 PAX	Not specified	Not specified	Not specified	Not specified	Not specified	Not specified	Not specified
NETH-2012-001	PH-RUL	Pilatus PC-12/47E	GA (Business flight)	FW	Turbine (1)	4 740	6 PAX (business config.)	Not specified	Both	All	Not specified	All	All	Not specified
FRAN-2013-012	F-OIXZ	Cessna 208B	CAT	FW	Turbine (1)	3 630	9 PAX	CAT	Both	All	Not specified	All	All	FDR or CVR

EASA recommendation number	Accident aircraft							Application domain of the safety recommendation						
	Aircraft registration	Aircraft make and model	Type of operation	Fixed wing or rotary wing	Turbine or piston (number)	MCTOM (kg)	Passenger capacity or payload	Type of operation	Fixed wing or rotary wing	Turbine or piston (and number of engines)	Forward-fit or retrofit	MCTOM (kg)	Passenger capacity	Recording function
FINL-2014-001	OH-AAA	Cessna 206	GA (Private)	FW	Piston (1)	1 720	5 PAX	Not specified	Both	All	Not specified	All	All	GPS
BELG-2015-001	OO-NAC	Pilatus PC6	AW (parachute dropping)	FW	Turbine (1)	2 800	10 PAX	Parachute dropping	Both	All	Retrofit	All	All	Not specified
UNKG-2015-032	G-SPAO	Eurocopter EC135 T2+	State flight (police)	RW	Turbine (2)	2 835	2 pilots + 2 patients	Police	RW	All	Retrofit	All	All	FDR + CVR + Image
UNKG-2015-033	G-SPAO	Eurocopter EC135 T2+	State flight (police)	RW	Turbine (2)	2 835	2 pilots + 2 patients	Police	RW	All	Forward-fit	All	All	FDR + CVR + Image
UNKG-2015-035	G-SPAO	Eurocopter EC135 T2+	State flight (police)	RW	Turbine (2)	2 835	2 pilots + 2 patients	CAT (Emergency medical services)	RW	All	Not specified	All	All	FDR + CVR
FRAN-2016-045	N129AG	Socata TBM700	GA (Private)	FW	Turbine (1)	2 984	5 PAX	Not specified	FW	Turbine	Not specified	Not specified	Not specified	Not specified
FRAN-2016-046	N129AG	Socata TBM700	GA (Private)	FW	Turbine (1)	2 984	5 PAX	Not specified	FW	All	Not specified	Not specified	Not specified	Not specified

7.4. Appendix D: Promoting the benefits of in-flight recording for light aircraft

7.4.1. Potential benefits of in-flight recording for stakeholders

Tables D.1, D.2 and D.3 present the benefits (for safety, cost, liability, etc.) of installing in-flight recording equipment that may be promoted to aviation stakeholders. Table D.1 addresses the flight parameters recording function of such in-flight recording equipment, Table D.2 addresses the audio recording function, and Table D.3 addresses the image recording function.

Table D.4 presents the potential incentives for each category of stakeholder using light aircraft.

Table D.1: Potential benefits of recording the aircraft flight parameters

Type of benefit	Applicable categories of light aircraft	Nature of the benefits	Limitations
Safety/economic	Light aeroplanes and light helicopters	Flight parameters can be used for operational safety monitoring (such as performed as part of flight data monitoring (FDM)), analysis of incidents, educating on hazards (training). These processes can support with operational data the safety management system (SMS) of an aircraft operator[28]. In addition, an evidence-based operational safety monitoring might justify reduced insurance premiums. This has been the case for FDM when implemented by aircraft operators.	Making this safety benefit real would not only require airborne equipment, but also ground infrastructure, human resources and procedures to process and analyse the data at regular time intervals. Therefore, this is not relevant for private owners. Many other factors than the availability of recorded data are taken into account by an insurer for determining an insurance premium. There is no automatic reduction of insurance premium granted for installing an in-flight recording system.
Safety	Light aeroplanes, light helicopters, sailplanes	Getting more reliable data on the circumstances of incidents and accidents in order to better understand safety issues and to avoid that an aviation authority enacts conservative operational restrictions.	Applicable mainly to aircraft manufacturers, aircraft operators, and aircraft owner associations. Not relevant when considering an individual aircraft owner.
Safety/economic /corporate image	Light aeroplanes, light helicopters, sailplanes	Getting clear answers to questions related to the airworthiness of a product and being able to determine quick corrective actions.	Applicable to aircraft and engine manufacturers. Not relevant when considering an individual aircraft owner.
Safety/economic /aircraft availability	Light aeroplanes and light helicopters	Engine and systems health monitoring in order to get a better insight into the circumstances of engines failure and systems failure, detect or confirm exceedance of limitations, and assess reliability or monitor trends[29].	Assumes that more advanced flight parameters are recorded, not just basic trajectory parameters (hence implying that these advanced flight parameters are produced in the aircraft).
Safety/liability	Light aeroplanes, light helicopters, sailplanes, balloons	Monitor the compliance with airspace restrictions, airfield procedures and noise-abatement procedures by pilots. Aircraft users will take more care of the rules and procedures because the aircraft owner can check their flight afterwards.	

[28] Example for helicopters: Helicopter flight data monitoring toolkit produced by the IHST (http://www.ihst.org/portals/54/hfdm.pdf).

[29] Note: Usage monitoring systems are already required for helicopters without an assured safe forced landing capability during the take-off and landing phases, in accordance with CAT.POL.H.305.

Type of benefit	Applicable categories of light aircraft	Nature of the benefits	Limitations
		In addition, in case of complaints of airfield neighbours or dispute with the local ATC, recorded data provide evidence of the actual trajectories flown by the aircraft. For this, only trajectory flight parameters are needed.	
Economic	Light aeroplanes and light helicopters	Accurate fuel and usage cost billing, based on actual flight time.	For this purpose, a Hobbs meter is sufficient.
Warranty and liability claims	Light aeroplanes and light helicopters	Flight parameters can be used to set a datum for measurement of performance guaranteed by the aircraft manufacturer or an aircraft equipment manufacturer. If it can be shown with data that the actual performance is not at the specified levels then the aircraft owner/operator is in a position to claim compensation under the terms of the warranty.	This is assuming that a more extensive set of flight parameters than just trajectory parameters is recorded. In addition, this could work for an aircraft operator or a pilot association, but a single private aircraft owner would probably not have sufficient resources nor enough weight to make a successful claim. In addition, for demonstrating performance issues, accurate knowledge of the conditions are needed (atmospheric conditions, loading, etc.). This is difficult to achieve for an individual owner or pilot.
Validation of skills	Light aeroplanes, light helicopters, sailplanes, balloons	Trajectory flight parameters of a trustable source (which cannot be altered) can be used for validating success in a test or a competition. Example: the standard developed by IGC for 'IGC-approved flight recorders' used for badges.	

Table D.2: Potential benefits of recording audio

Type of benefit	Applicable categories of light aircraft	Nature of the benefits	Limitations
Safety	Light aeroplanes, light helicopters, sailplanes, balloons	Getting more reliable data on the circumstances of incidents and accidents in order to detect and address earlier a safety issue and to avoid that an aviation authority enacts operational restrictions.	Applicable mainly to aircraft manufacturers and aircraft operators, not relevant when considering aircraft owners.
Safety	Light aeroplanes and light helicopters	Engine/gearbox health monitoring. The audio recording may capture information on the speed, vibrations and transition modes of rotating parts, which are difficult to record with flight parameters (no sensor installed or too low sampling rate).	Mainly of interest for helicopters. Data privacy may limit the possible access to the recordings by maintenance staff, especially when considering image and audio recording.

Table D.3: Potential benefits of recording images

Type of benefit	Applicable categories of light aircraft	Nature of the benefits	Limitations
Safety	Light aeroplanes, light helicopters, sailplanes, balloons	Getting more reliable and complete data on the circumstances of incidents and accidents in order to detect and address earlier a safety issue and to avoid that an aviation authority enacts operational restrictions. Information not recorded by audio or flight parameters includes: — crew actions on flight controls, engine control, selectors and switches; — non-verbal communication (for aircraft certified for operation with a minimum flight crew of at least two pilots); — flight parameters indicated by aircraft instruments (when it is too difficult to collect them from the aircraft sensors); — displayed pictures (e.g. by a moving map, a TAWS, etc.) for glass cockpits; — display settings; — weather conditions.	Applicable mainly to aircraft manufacturers and aircraft operators, not relevant when considering aircraft owners. Capturing usable pictures of instruments and displays require good picture resolution, capability to cope with various lighting conditions and vibration-proofed installation. This could significantly drive the cost up.
Safety	Light aeroplanes, light helicopters, sailplanes, balloons	Operational safety monitoring, analysis of incidents, educating on hazards (training). These processes can support with operational data the safety management system (SMS) of an aircraft operator.	Making this safety benefit real would not only require airborne equipment, but also ground infrastructure, human resources and procedures to process and analyse the data at regular time intervals. Therefore, this is not relevant for private owners. Because of the privacy content, there are limitations to the use of image recording by the aircraft operator; however, they are less problematic if the view is limited to the instruments panel.
Safety	Light aeroplanes,	Pilot knows that they are recorded and	Experience has shown that some

Type of benefit	**Applicable categories of light aircraft**	**Nature of the benefits**	**Limitations**
	light helicopters, sailplanes, balloons	this is dissuading them from taking unnecessary risk (flying low, risky manoeuvres).	pilots bring a camera in the flight crew compartment in order to share a recording of their feats afterwards, and this tends to favour risk-taking. However, when the camera is installed by the aircraft owner or operator, then it is assumed that it can help in preventing reckless behaviour. Because of the privacy content, there are limitations to the use of image recording by the aircraft owner.
Safety	Light aeroplanes, light helicopters, sailplanes, balloons	Video can be a good media for sharing lessons learnt among private pilots (social media).	Video can also be wrongly used to encourage excessive risk-taking by displaying unsafe manoeuvres. For video to be used in a positive way, there probably is a need for control of the information. For example, this could work if an association of private pilots is administering the social medium.

Table D.4: Potential incentives for in-flight recording per category of stakeholder

Category of stakeholder	Potential incentives
Commercial aircraft operators	— Better data-driven operational safety monitoring, including better understanding of incidents. — Smarter maintenance through engine and systems health monitoring and quantitative data on limitation exceedance. — Reduced operation cost through better monitoring of the management of fuel and of the aircraft. — Encourage better adherence to SOPs because pilots know they are monitored. — Trustable source of data if an issue is raised by ATC/airport operator/airport neighbours. — Might justify lower insurance premiums.
Flying/piloting schools	— Validation of test. — Capturing events that can affect aircraft airworthiness (e.g. hard landings, abrupt manoeuvres) yet get sometimes unnoticed/unreported. — Replay of actual flights for training purposes. — More data-driven training programmes.
Aero clubs	— Monitoring of compliance with airspace restrictions, airfield procedures and noise-abatement procedures by their members. — Monitor the use of their aircraft if they are leased to people outside the club (safe operation and, for example, usage of engines). — Dissuade members from taking excessive risk. — Capturing events that can affect aircraft airworthiness (e.g. hard landings, abrupt manoeuvres) yet get sometimes unnoticed/unreported. — Trustable source of data if an issue is raised by airfield operator/airfield neighbours.
Associations of aircraft owners and pilots	— A larger proportion of light aircraft accidents being fully explained, allowing: • more focused safety communication towards their members; • self-explanatory examples of what-to-do and what-not-to-do in the case where video recordings can be collected and shared; • more commensurate and focused corrective actions by aviation authorities. — Provided recorded data can be collected from association members and analysed, evidence of an issue with a given aircraft model, a given airfield, a requirement, etc.
Private pilots	— Monitor the usage of their aircraft when they are leased; — Might justify lower insurance premiums.

7.4.2. The privacy issue

7.4.2.1. Flight parameters

Using recorded flight parameters for sanctioning a professional pilot or publishing identified flight data can have significant consequences on their career and it has been considered detrimental to the safety of commercial operations in the long term.

This is why, when considering the flight data recorder (FDR) mandated on board large aeroplanes and large helicopters, subparagraph (f)(2) of CAT.GEN.MPA.195 requires the following:

'FDR recordings or data-link recordings shall only be used for purposes other than for the investigation of an accident or an incident which is subject to mandatory reporting, if such records are:

(i) used by the operator for airworthiness or maintenance purposes only; or

(ii) de-identified; or

(iii) disclosed under secure procedures.'

A similar provision can be found in Part-NCC and Part-SPO.

However, care should be taken to not apply the same level of protection when considering light aircraft used for non-professional activities because this could significantly reduce the possible use of this equipment and therefore work against promotion of recording.

Note: The FDR may be used for a flight data monitoring (FDM) programme. However, accessing the FDR to download the data is on most installations not convenient (because it is not easily accessible and because the FDR is an MEL item). Furthermore, the FDR has usually a limited recording duration (because its memory must be crash-protected and fulfil a number of constraining specifications), so most operators use quick-access recorders (QARs) with easily removable memory media instead, or even wireless transmission of the FDM data file when the aircraft arrives at its gate. However, an FDM programme is also required to be 'non-punitive' and to have 'appropriate safeguards' in place to protect the data.

7.4.2.2. Audio and images

Audio recordings and image recordings have an intrinsic privacy content (information that is private and unrelated to the accident might be recorded, and the human voice itself or images of body parts can be considered a privacy element). Therefore, the recording of the cockpit voice recorder (CVR) mandated for large aircraft is considered sensitive, and its use is more restricted than it is for the FDR recording.

Paragraph (f) of CAT.GEN.MPA.195 requires the following:

'(f) Without prejudice to Regulation (EU) No 996/2010 of the European Parliament and of the Council:

(1) Except for ensuring the CVR serviceability, CVR recordings shall not be disclosed or used unless:

(i) a procedure related to the handling of CVR recordings and of their transcript is in place;

(ii) all crew members and maintenance personnel concerned have given their prior consent; and

(iii) they are used only for maintaining or improving safety.

(1a) When a CVR recording is inspected for ensuring the CVR serviceability, 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.'

Some level of protection would probably be justified for in-flight equipment recording audio or images on board a light aircraft. This could restrict the possible use of this equipment, making its promotion challenging.

One technical solution to partially mitigate this issue is to require that the pilot is made aware of the recording of audio in the aircraft, and that a means is installed to erase the audio or image recording after completion of the flight (recommended in France by Commission Nationale de l'Informatique et des Libertés[30]). In addition, the aircraft owner should not be allowed to disclose the recordings without the consent of the pilot(s).

Some dedicated in-flight recording systems only record a certain level of ambient noise. IGC specifications for the equipment designated by the IGC as 'IGC-approved flight recorders'[31] also specify that just a certain level of ambient noise needs to be recorded. This solution resolves the privacy issue; however, the information content of ambient noise is much less, and it is not sufficient for engine/gearbox health monitoring.

30 See http://www.cnil.fr/english/.

31 GNSS receivers which fulfil specifications set by the IGC.

7.5. Appendix E: Systematic studies of investigation reports

Four systematic studies of investigation reports were conducted in order to better assess the potential safety benefits of in-flight recording for light aircraft. Their scope and results are presented below.

7.5.1. General principles applied for conducting the studies

For all four studies, the following principles were applied:

— For each study, the study set was defined based on homogeneous and transparent criteria (no cherry-pick selection of study cases). The reports were analysed factually, without any interpretation.

— The scope of the study was determined in order to account for a large enough sample for each aircraft category, mass group and type of aircraft which are within the scope of RMT.0271 & RMT.0272. 'Sufficient' in this context means enough to get a rough picture of the investigation needs, and not necessarily to establish accurate statistics.

— Many investigation reports pertaining to light aircraft accidents are not translated into English, partially due to the fact that they do not contain a safety recommendation addressed to an international organisation. This means that only investigation reports in the language(s) mastered by the analysts could be reviewed.

— Due to the limited range of light aircraft, most accidents and serious incidents that occurred in the territory of an EASA MS involved aircraft which was (were) also registered in an EASA MS, and conversely most accidents and serious incidents with aircraft registered in an EASA MS occurred in the territory of an EASA MS. This means that the study focused on aircraft registered in an EASA MS.

— Only investigation reports pertaining to accidents were analysed because a more severe outcome usually justifies a more extensive safety investigation. Also, when considering that accidents with light aeroplanes, light helicopters and sailplanes are numerous, the study set was further reduced to fatal accidents which are often subject to even more investigation efforts. However, when considering large aircraft and balloons, since the number of fatal accidents is small, it is advisable to include all accidents.

— Only final investigation reports (containing the most complete information gathered and the final conclusions of the investigation) were retained for the study. The life cycle of a safety investigation is usually of a at least several months and up to several years. Therefore, the studies focused on occurrences that were 1 year old or more the date on which the study was conducted.

— In accordance with Regulation (EU) No 996/2010, which entered into force in December 2010, all accidents of aircraft within the scope of RMT.0271 & RMT.0272 and occurring in Europe shall be investigated, except for accidents involving Annex II aircraft. Before this time, national rules applied and the scope of activity of some safety investigation authorities was limited. Therefore, the studies focused on accidents which occurred after December 2010. In addition, because accidents with Annex II aircraft are not required to be investigated and the regulation of operation of Annex II aircraft is outside the remit of EASA, related investigation reports were not retained for the studies.

7.5.2. Study 1

7.5.2.1. Scope and study set

Study 1 aimed to assess to what extent facts can be established, causes determined, and safety issues identified during light-aircraft accident investigations. Study 1 consisted in assessing whether the investigations were hindered or significantly delayed due to the lack of factual data that could have been recorded on board. It is based on three variant approaches which focus on:

— the difficulties in establishing the sequence of occurrences and events, and the factors;

— test and research activities performed in the absence of a recording; and

— the need to establish the final trajectory.

In order to assess to what extend the investigations could determine facts and safety issues after an accident, a sample of safety investigations was analysed. Each safety investigation report was reviewed and a set of questions defined for the study was answered given the information in the report. The scope of the study and the questions are presented in Table E.1.

Table E.1: Scope of Study 1

Study 1	**Criteria applied to determine the study set and study questions**
Aircraft groups considered	1. Aeroplanes with MCTOM less than 5 700 kg 2. Helicopters with MCTOM less than 3 175 kg 3. Sailplanes 4. Balloons and hot-air airships
Study period	Between XX/XX/XXXX and 31/12/2012
Occurrence class	Accidents
Aircraft registration	Aircraft registered in one of the EASA MSs
Severity	— Fatal accidents (at least one fatality) for aircraft groups 1 to 3. — Fatal and non-fatal accidents for aircraft group 4 (balloons and hot-air airships).
Investigation reports	Only final reports
Number of investigation reports reviewed for each aircraft group	At least 20 for each aircraft category. The final reports corresponding to the 20 most recent accidents in the study period were selected for the study. The selection of investigation reports starts with those final reports corresponding to the most recent accidents in the study period and then it goes backwards into time until a sufficient number of reports is obtained for the study.
Questions to answer for each report reviewed	— What is the category of aircraft (aeroplane, helicopter, balloon, sailplane)? — What is the aircraft maximum occupancy provided in the type certificate datasheet? (Or, if not available for balloons, the difference between maximum take-off mass and minimum landing mass provided in the type certificate datasheet.) — For aeroplanes, helicopters and sailplanes: what is the aircraft MTOM provided in the type certificate datasheet? — What is the number of engines? — What is the type of the engine (reciprocating, turboprop, turbojet)? — For aeroplanes and helicopters: was the aircraft certified for operation with a minimum crew of at least two pilots? — State of the investigation authority. — Provide the sequence of aviation occurrences identified in the report, or the category of the last occurrence (RE, CFIT, LOC-I, etc.). — What would be the applicable Part of the Air OPS rules (CAT, SPO, NCC, NCO)? — Did the investigation report establish the final trajectory of the aircraft (from 5 minutes before the accident until the accident): (yes; no; partially; not necessary; or not addressed):

Study 1	Criteria applied to determine the study set and study questions
	• Final trajectory: which were the source(s) of data (FDR or ADRS; GNSS receiver or navigation equipment; other airborne system; radar track; video from ground; eyewitness; other; unknown)? — Test and research activities: were there any test and research activities conducted during the investigation? — What was the essential information looked at? — What kind of examinations were performed? If applicable: • Which flight parameters could have provided this essential information? • Would these flight parameters be recorded by an FDR? An ADRS? A GNSS receiver? • Which one of these flight parameters are among the parameters required to be measured and displayed for this aircraft category and this type of operation, or which one of these flight parameters can be calculated from the parameters required to be measured and displayed for this aircraft category of and this type of operation? — Was there a portable or installed equipment using a GNSS function? — Were useful trajectory GNSS data retrieved? — If not, why? (no track; damaged GNSS; loss of data due to volatile memory; data impossible to decode; no data of the event flight recorded (recording not activated, full memory, rewriting); sampling too low; 2D recording) — Does the report explicitly mention that some causes and/or contributory factors could not be established with certainty or were unknown? (yes; no, the causes/factors are clearly established; not addressed) • If 'yes' and 'no', please provide paragraph references. — Does the investigation report explicitly point at the need for and/or the benefit of in-flight recording? (yes; no; not addressed) • If 'yes', please provide paragraph references.

A sample of 81 final safety investigation reports of light-aircraft accidents that occurred from 2009 to 2012 was analysed for Study 1. The reference information on these accidents is presented in Table E.2.

Table E.2: Accidents whose investigation reports were analysed for Study 1

Date of the accident	State of registry	Aircraft registration	Aircraft category
13/11/2012	Latvia	YL-SVN	aeroplane
11/11/2012	Ireland	EI-AST	aeroplane
10/10/2012	France	F-GBXQ	aeroplane
16/08/2012	Austria	OE-DII	aeroplane
16/08/2012	UK	G-BODP	aeroplane
10/08/2012	Germany	D-EIYL	aeroplane
19/05/2012	France	F-KGDE	aeroplane
05/05/2012	France	F-GXES	aeroplane
28/04/2012	Switzerland	HB-PGA	aeroplane
18/01/2012	UK	G-BWHF	aeroplane
08/01/2012	France	F-GLPO	aeroplane
12/11/2011	UK	G-BXRG	aeroplane
16/10/2011	Belgium	OO-KKK	aeroplane
14/10/2011	UK	G-BBEF	aeroplane
14/10/2011	Spain	EC-KDS	aeroplane
02/09/2011	France	F-BRTE	aeroplane
02/09/2011	Germany	D-EGFU	aeroplane
29/07/2011	UK	G-RVRF	aeroplane
17/07/2011	France	F-GNJU	aeroplane
04/07/2011	France	F-GBCZ	aeroplane
05/12/2012	Norway	LN-OMY	helicopter
18/09/2012	Switzerland	HB-ZJO	helicopter
11/01/2012	Sweden	SE-JPZ	helicopter
12/11/2012	UK	G-WOOW	helicopter
18/10/2011	Belgium	OO-HCI	helicopter
14/09/2011	France	F-HFBI	helicopter
24/07/2011	UK	G-ROTG	helicopter
09/07/2011	Belgium	OO-HNE	helicopter
04/07/2011	Norway	LN-OXC	helicopter
19/03/2011	Spain	EC-KTA	helicopter
08/03/2011	Hungary	HA-LFB	helicopter
09/12/2010	UK	G-CBVL	helicopter
04/08/2010	France	F-OIEL	helicopter
31/07/2010	France	F-GKBF	helicopter
25/07/2010	France	F-GJGQ	helicopter
27/06/2010	Netherlands	PH-ECJ	helicopter
31/05/2010	France	F-ORGB	helicopter
15/11/2009	UK	G-RIDL	helicopter
09/10/2009	France	F-GKRL	helicopter
22/09/2009	UK	G-LINX	helicopter
23/08/2012	Slovenia	S5-OLO	balloon
19/08/2012	France	F-HDJH	balloon
31/07/2012	UK	G-VBFH	balloon
26/07/2012	France	F-GOXA	balloon
25/05/2012	Netherlands	PH-ZOZ	balloon
23/05/2012	UK	G-VBFA	balloon
14/05/2012	France	F-GXFX	balloon
13/05/2012	France	F-HTML	balloon
25/03/2012	UK	G-BEEI	balloon
30/09/2011	UK	G-VBFV	balloon
22/09/2011	UK	G-LRGE	balloon
24/08/2011	UK	G-CBZZ	balloon
02/07/2011	Portugal	CS-BAS	balloon
12/06/2011	UK	G-TLEL	balloon
21/05/2011	France	F-GSUI	balloon

22/04/2011	Belgium	OO-BHA	balloon
05/03/2011	UK	G-VBFG	balloon
07/01/2011	France	F-GXEB	balloon
01/01/2011	UK	G-BVXF	balloon
12/09/2010	Germany	D-OBBU	balloon
13/10/2012	Germany	D-7565	sailplane
08/09/2012	Germany	D-KPIW	sailplane
04/09/2012	UK	G-EENN	sailplane
04/08/2012	France	F-CEVU	sailplane
04/08/2012	UK	G-DDFN	sailplane
30/07/2012	Switzerland	HB-1585	sailplane
18/09/2012	Germany	D-KBEM	sailplane
14/06/2012	France	F-CHFM	sailplane
03/05/2012	France	F-CGVV	sailplane
05/10/2011	France	F-CGZM	sailplane
13/09/2011	Czech Republic	OK-A630	sailplane
30/06/2011	Germany	D-KKYB	sailplane
12/06/2011	Finland	OH-920	sailplane
18/05/2011	France	F-CHIT	sailplane
13/04/2011	Germany	D-2428	sailplane
27/09/2010	France	F-CGZL	sailplane
13/08/2010	Belgium	OO-ZGJ	sailplane
08/08/2010	UK	G-DBZZ	sailplane
01/08/2010	France	F-CBLB	sailplane
07/07/2010	Germany	D-KANR	sailplane
12/06/2010	Belgium	OO-YEB	sailplane

7.5.2.2. Conclusions

In general, the investigations determined causes and factors. The proportion of reports which mention that some causes and/or contributory factors could not be established is smaller for balloons and higher for aeroplanes and sailplanes.

For at least a quarter of the study set, the investigations did not establish the complete sequence of occurrences, which is an indication that even a high-level scenario of the accident is missing. This is seldom the case when investigating an accident of a large aircraft that carries crash-protected flight recorders. However, since this analysis did not go to a deeper level of analysis and assess to what extent the sequence of events and descriptive factors identified by the investigation are complete, it is not possible to draw any additional conclusions with regard to the capability of the investigation to identify all causes and contributory factors in this study.

Also, a third of the investigations established the complete final trajectory, while trajectory reconstruction was attempted in most cases. The proportion of investigations establishing a partial or complete final trajectory is higher for aeroplanes and helicopters than it is for balloons and sailplanes. This can be explained by the fact that a radar track is seldom available in the case of balloons and sailplanes (because few are equipped with an SSR transponder) whereas it is one of the main sources for helicopters and aeroplanes. However, the proportion of investigations establishing the complete final trajectory is higher for sailplanes than it is for the other aircraft categories. A high proportion of sailplanes have equipment using a GNSS function in comparison to other aircraft categories. Eyewitness was one of the primary sources of trajectory data for all aircraft categories.

The investigation is more likely to reconstruct the complete final trajectory of the aircraft if the recording of a GNSS receiver or of a radar track is available. However, the study does not show that the investigation is more likely to establish causes and contributory factors when a GNSS receiver recording or a radar track can be retrieved or when tests and research activities are conducted.

A third of the investigations included tests and research activities. In most cases, one or several flight parameters were identified that could have provided (alone or in combination) the desired information. This means that a third of the investigations could be facilitated if flight parameters were recorded. However, trajectory flight parameters would not be sufficient in most cases, and ADRS flight parameters would be helpful only in half of the cases. Only a complete set of flight parameters such as those required to be recorded by an FDR would cover the need for information in most cases. In general, there are more tests and research activities conducted for aeroplane and helicopter investigations than for balloon or sailplane investigations.

Only 3 reports out of 81 in the study set explicitly point at the need for and/or the benefit of in-flight recording. Since the primary purpose of an accident report is not to express investigation needs, no factual conclusion as regards the need for in-flight recording for the investigation can be drawn from this figure alone.

7.5.3. Study 2

7.5.3.1. Scope and study set

The objective of Study 2 was to assess what factual data could be obtained from in-flight recording and the benefit of that information for identifying and resolving safety issues. It was based on positive evidence as it focused on the contribution of data coincidentally recorded on board.

In this study, recordings from equipment installed on aircraft and from devices brought by persons on board as well as recordings made outside the aircraft were considered. For example, a recording from a camera, a smartphone, a GNSS receiver, an avionics system, an engine control system, etc.

A sample of safety investigation reports was analysed. The scope of the study and the questions are presented in Table E.3.

Table E.3: Scope of Study 2

Study 2	Criteria applied to determine the study set and study questions
Aircraft groups considered	1. Aeroplanes with MCTOM less than 5 700 kg 2. Helicopters with MCTOM less than 3 175 kg 3. Sailplanes 4. Balloons and hot-air airships
Study period	Between XX/XX/XXXX and 31/12/2012
Occurrence class	Accidents
Aircraft registration	Aircraft registered in one of the EASA MSs
Severity	— Fatal accidents (at least one fatality) for aircraft groups 1 to 3. — Fatal and non-fatal accidents for aircraft group 4 (balloons and hot-air airships).
Investigation reports	Only final reports
Recording	Only reports of accidents with light aircraft where a useful in-flight recording was retrieved and analysed.
Number of investigation reports reviewed for each aircraft group	At least 20 for each aircraft category The final reports corresponding to the 20 most recent accidents in the study period were selected for the study.
Questions to answer for each report reviewed	— What is the category of aircraft (aeroplane, helicopter, balloon, sailplane)? — What was the aircraft maximum occupancy provided in the type certificate datasheet? (Or, if not available for balloons, the difference between maximum take-off mass and minimum landing mass provided in the type certificate datasheet.) — For aeroplanes, helicopter and sailplanes: what is the aircraft MTOM provided in the type certificate datasheet? — What is the number of engines? — What is the type of the engine (reciprocating, turboprop, turbojet)? — For aeroplanes and helicopters: was the aircraft certified for operation with a minimum crew of at least two pilots? — State of the investigation authority. — Provide the sequence of aviation occurrences identified in the report, or the category of the last occurrence (RE, CFIT, LOC-I, etc.). — What would be the applicable Part of the AirOPS rules (CAT, SPO, NCC, NCO)? — Was there any corrective action following the accident? — For each recording retrieved, did the recording help in determining significant events and/or significant causal/contributory factors? If yes: • What was the nature of the recording(s) retrieved (data from an instrument or navigation equipment, from engine controls, from pictures or video, etc.)? • List the main events and contributory/causal factors that were established thanks to the recording and provide paragraph references. • Indicate which in-flight recording function(s) (flight parameters, audio, image, data link) could have provided equivalent information. • Was the information extracted from the recording useful to identify and recommend corrective actions? (yes/no; what were the recommended corrective actions; why was the recording useful; paragraph reference).

A sample of 48 final safety investigation reports of light-aircraft accidents occurred over from 2009 to 2012 was analysed for Study 2. The reference information on these accidents is presented in Table E.4.

Table E.4: Accidents whose investigation reports were analysed for Study 2

Date of the accident	State of registry	Aircraft registration	Aircraft category
13/11/2012	Latvia	YL-SVN	aeroplane
16/08/2012	Austria	OE-DII	aeroplane
16/08/2012	UK	G-BODP	aeroplane
10/08/2012	Germany	D-EIYL	aeroplane
28/04/2012	Switzerland	HB-PGA	aeroplane
18/01/2012	UK	G-BWHF	aeroplane
08/01/2012	France	F-GLPO	aeroplane
12/11/2011	UK	G-BXRG	aeroplane
14/10/2011	UK	G-BBEF	aeroplane
02/09/2011	Germany	D-EGFU	aeroplane
29/07/2011	UK	G-RVRF	aeroplane
05/12/2012	Norway	LN-OMY	helicopter
11/01/2012	Sweden	SE-JPZ	helicopter
12/11/2012	UK	G-WOOW	helicopter
18/10/2011	Belgium	OO-HCI	helicopter
14/09/2011	France	F-HFBI	helicopter
24/07/2011	UK	G-ROTG	helicopter
04/07/2011	Norway	LN-OXC	helicopter
19/03/2011	Spain	EC-KTA	helicopter
08/03/2011	Hungary	HA-LFB	helicopter
09/12/2010	UK	G-CBVL	helicopter
04/08/2010	France	F-OIEL	helicopter
27/06/2010	Netherlands	PH-ECJ	helicopter
23/08/2012	Slovenia	S5-OLO	balloon
19/08/2012	France	F-HDJH	balloon
13/05/2012	France	F-HTML	balloon
12/06/2011	UK	G-TLEL	balloon
22/04/2011	Belgium	OO-BHA	balloon
05/03/2011	UK	G-VBFG	balloon
01/01/2011	UK	G-BVXF	balloon
12/09/2010	Germany	D-OBBU	balloon
28/08/2010	UK	G-CBZU	balloon
11/01/2010	France	F-GOBI	balloon
04/09/2012	UK	G-EENN	sailplane
04/08/2012	France	F-CEVU	sailplane
04/08/2012	UK	G-DDFN	sailplane
30/07/2012	Switzerland	HB-1585	sailplane
18/06/2012	Germany	D-KBEM	sailplane
14/06/2012	France	F-CHFM	sailplane
03/05/2012	France	F-CGVV	sailplane
05/10/2011	France	F-CGZM	sailplane
13/09/2011	Czech Republic	OK-A630	sailplane
30/06/2011	Germany	D-KKYB	sailplane
18/05/2011	France	F-CHIT	sailplane
13/04/2011	Germany	D-2428	sailplane
27/09/2010	France	F-CGZL	sailplane
01/08/2010	France	F-CBLB	sailplane
07/07/2010	Germany	D-KANR	sailplane

7.5.3.2. Conclusions

From the results it can be concluded that at least for a quarter of the investigations the complete sequence of occurrences could not be established. This is a result similar to that of Study 1, therefore it cannot be concluded that data from a recording can facilitate the determination of the sequence of occurrences.

> *Note:*
>
> Establishing the correct sequence of occurrences depends on many factors: from the availability of factual data (of which recorded data are just a category) to support the investigation efforts to the capability to encode an accident or serious incident. For example, it is sometimes difficult to code balloon accidents with the CICTT occurrence taxonomy because this code was primarily designed for aeroplanes or helicopters.

For the majority of safety investigations, the recordings retrieved helped in determining significant events and/or significant contributory factors. Also, all categories of recordings helped in determining significant events and factors. In the case of aeroplanes, helicopters and sailplanes, the most useful recording function that could have provided equivalent information is flight parameters, followed by image recordings. When considering balloons, image recordings would have been the most useful: indeed, no flight parameter can provide sufficient information on the position of passengers during landing or on the wind and weather conditions, which appear to be essential information for a balloon accident investigation.

The proportion of radar track data retrieved is higher for aeroplanes than it is for the other aircraft categories, and the proportion of sailplanes fitted with equipment using a GNSS function is higher when considering other aircraft categories. Pictures and videos considered together represent a third of the recordings retrieved for aeroplanes and helicopters, but they represent half of the recordings for balloons, and they represent only a small proportion of the recordings for sailplanes.

Only 18 out of 48 safety investigation reports identified a corrective action of any kind (safety recommendation or mention of any other kind of corrective action taken by the parties involved). This proportion is even smaller in the particular case of sailplanes, where only one quarter of the investigation reports identified a corrective action.

Considering the investigation reports identifying corrective actions, in only 6 cases out of 18 was an explicit link made between the information obtained from the recording and the corrective actions. In particular for helicopters, no investigation report established a link between the findings from a recording and the corrective actions.

Note: There is no obligation (or even guidance) to specify, when writing an investigation report, whether the information obtained from a recording was useful to establish a given corrective action. In addition, corrective actions generally relate to several significant events and factors that are established based on the analysis of several sources of data. It is then difficult to assess a posteriori the contribution of a given recording to the identification of corrective actions.

7.5.4. Study 3

7.5.4.1. Scope and study set

The aim of Study 3 was to assess the potential contribution of the CVR to the investigation of an accident. Indeed, all models of aeroplanes with an MCTOM of over 27 000 kg and all models of helicopters with an MCTOM of over 7 000 kg are subject to carry a CVR. However, for lighter models of aeroplanes and helicopters, the eligibility criteria are different when considering CAT and when considering other types of operations. This is why the initial scope of Study 3 was limited to:

— aeroplanes with an MCTOM of less than 27 000 kg required to carry a CVR in accordance with Part-CAT, but not in accordance with Part-NCC/-SPO; and

— helicopters with an MCTOM between 3 175 and 7 000 kg (required to carry a CVR in accordance with Part-CAT, but not in accordance with Part-NCC/-SPO).

Table E.5: CVR carriage requirements for aeroplanes, depending on the type of operation

Applicable Part of the Air Operations rules	**CVR carriage required if:**
Part-CAT	— MCTOM > 5 700 kg, or — multi-engined turbine-powered aeroplanes with MOPSC > 9 and first issued with an individual CofA on or after 1 January 1990.
Part-NCC and Part-SPO	— MCTOM > 27 000 kg and first issued with an individual CofA on or after 1 January 2016, or — MCTOM > 2 250 kg and certified for operation with a minimum crew of at least two pilots and equipped with turbojet engine(s) or more than one turboprop engine and type certificate is first issued on or after 1 January 2016.

Table E.6: CVR carriage requirements for helicopters, depending on the type of operation

Applicable Part of the Air Operations rules	**CVR carriage required if:**
Part-CAT	— MCTOM > 7 000 kg, or — MCTOM > 3 175 kg and first issued with an individual CofA on or after 1 January 1987.
Part-NCC and Part-SPO	— MCTOM > 7 000 kg and first issued with an individual CofA on or after 1 January 2016.

However, the EASA accident and incident database was queried in order to evaluate the number of aeroplane and helicopter accidents that would fall within the scope of Study 3. It was found that:

— 451 non-Annex II aeroplanes registered in an EU MS were involved in accidents or incidents in 2012, and whose MCTOM < 27 000 kg. For 9 out of 451 of them, the aeroplane was of a model subject to the CVR carriage requirement if operated for CAT, while it was operated for general aviation or aerial work. This represents less than 2 % of the EU non-Annex II aeroplanes involved in accidents or incidents in 2012.

— 178 non-Annex II helicopters registered in an EU MS were involved in accidents or incidents between 2007 and 2012, and whose MCTOM < 7 000 kg. For 37 out of 178 of them, the helicopter was of a model subject to the CVR carriage requirement if operated for CAT, while it was operated for general aviation or aerial work. This represents 22 % of the EU non-Annex II helicopters involved in accidents or incidents in 2012.

Hence, the potential safety benefits of extending CVR carriage requirements currently applicable to CAT to NCC/SPO appear to be very limited when considering aeroplanes. On the contrary, a significant proportion of safety investigations involving helicopters operated under Part-NCC or Part-SPO may potentially benefit from the carriage of a CVR. For this reason, it was decided to keep only helicopters in the scope of Study 3.

A sample of safety investigation reports was analysed. The scope of the study and the questions are presented in Table E.7.

Table E.7: Scope of Study 3

Study 3	**Criteria applied to determine the study set and study questions**
Aircraft groups considered	CAT helicopters with an MCTOM between 3 175 and 7 000 kg and required to carry a CVR in accordance with the OPS/CAT rules.
Study period	Between XX/XX/XXXX and 31/12/2012
Occurrence class	Accidents
Aircraft registration	Aircraft registered in one of the EASA MSs
Severity	Fatal and non-fatal accidents
Investigation reports	Only final reports
Recording	At least 5 (if possible, 10 or more) for helicopters. The final reports corresponding to the most recent accidents (minimum 5, if possible 10 or more) in the study period were selected for the study.
Number of investigation reports reviewed for each aircraft group	CAT helicopters with an MCTOM between 3 175 and 7 000 kg and required to carry a CVR in accordance with the OPS/CAT rules.
Questions to answer for each report reviewed	— What is the maximum occupancy of the helicopter provided in the type certificate datasheet? — What is the MTOM of the aircraft provided in the type certificate datasheet? — What is the number of engines? — What is the type of the engine (reciprocating, turboprop, turbojet)? — State of the investigation authority. — Provide the sequence of aviation occurrences identified in the report, or the category of the last occurrence (RE, CFIT, LOC-I, etc.). — Were there significant events or significant causal/contributory factors that could not have been established with certainty without the CVR? If yes: • List these events and causal/contributory factors (quote with paragraph references). • Indicate which were the useful audio channels. • Would the significant causal/contributory factors have been captured by ATC recording? — Did the data in the CVR recording provide additional information that was useful to identify and recommend corrective actions? (yes/no; what was (were) the corrective action(s); why was the recording useful; paragraph reference)

A sample of 5 safety investigation reports of helicopter accidents occurred from 2007 to 2011 was analysed. This sample is small because there have been only 2 or 3 accidents in average per year with helicopters operated for CAT[32] and registered in the EASA MSs in the last decade. The reference information on these accidents is presented in Table E.8.

Table E.8: Accidents whose investigation reports were analysed for Study 3

[32] In accordance with the European Air Operations requirements, helicopters not operated for commercial air transport may be required to carry a CVR only if they are manufactured on or after 1 January 2016.

Date of the accident	State of registry	Aircraft registration
11/07/2011	France	F-HJCS
01/04/2009	UK	G-REDL
09/03/2008	UK	G-BKXD
13/06/2007	Spain	EC-FBM
18/04/2007	Denmark	OY-HGZ

7.5.4.2. Conclusions

Study 3 could only provide partial data on the safety benefits brought by the CVR for accidents with large helicopters.

On the one hand, for all 5 cases analysed, the CVR helped in determining significant events or significant contributory factors that could not have been established with certainty without the CVR. These were: information on chronology and timeline; information on communication and CRM; information on the application of procedures and checklists; and information on alarms and technical failures.

On the other hand though, no investigation report clearly stated that the information obtained from the CVR was used to identify a corrective action. This can be explained by the fact that only 5 cases were analysed, only 2 investigation reports out of 5 mentioned corrective actions, and in these 2 investigation reports the link between the source of data, the information established and the potential corrective actions was not clearly made.

It was also not possible to conclude on the most useful audio channel(s) as the analysed investigation reports did not provide this information.

7.5.5. Study 4

7.5.5.1. Scope and study set

The objective of Study 4 was to assess what factual data could be specifically obtained from an airborne image recording and the benefit of that information for identifying and resolving safety issues. It was based on positive evidence. Only investigation reports mentioning the retrieval of image recordings from the interior of the aircraft were selected for Study 4.

Study 4 was meant to complement Study 2, as the latter had identified few cases of image recordings taken from the inside of the aircraft, hence making it difficult to draw meaningful conclusions with regard to image recordings.

A sample of safety investigation reports was analysed. The scope of the study and the questions are presented in Table E.9.

Table E.9: Scope of Study 4

Study 4	**Criteria applied to determine the study set and study questions**
Aircraft groups for Study 4	1. Aeroplanes with an MCTOM less than 5 700 kg 2. Helicopters with an MCTOM less than 3 175 kg 3. Sailplanes 4. Balloons and hot-air airships
Study period	Between 01/07/2011 and 01/07/2014
Occurrence class	Accidents
Aircraft registration	Aircraft registered in one of the EASA MSs
Severity	Fatal and non-fatal accidents
Investigation reports	Only final reports
Number of investigation reports reviewed for each aircraft group	At least 5 for each aircraft category. The final reports corresponding to at least the 5 most recent accidents in the study period were selected for the study.
Questions to answer for each report reviewed	— What is the category of aircraft (aeroplane, helicopter, balloon, sailplane)? — What is the aircraft maximum occupancy provided in the type certificate datasheet? (Or, if not available for balloons, the difference between maximum take-off mass and minimum landing mass provided in the type certificate datasheet.) — For aeroplanes, helicopters and sailplanes: what is the aircraft MTOM provided in the type certificate datasheet? — What is the number of engines? — What is the type of the engine (reciprocating, turboprop, turbojet)? — For aeroplanes and helicopters: was the aircraft certified for operation with a minimum crew of at least two pilots? — State of the investigation authority. — Provide the sequence of aviation occurrences identified in the report, or the category of the last occurrence (RE, CFIT, LOC-I, etc.). — What would be the applicable Part of the Air OPS rules (CAT, SPO, NCC, NCO)? — Was there any corrective action following the accident? — For each recording retrieved, did the image recording help in determining significant events and/or significant causal/contributory factors? If yes: • What was the source of the recording(s) (dedicated image recorder, action camera, smartphone, etc.)? • List the main events and contributory/causal factors that were established thanks to the recording and provide paragraph references. • Indicate the type of information used for determining the significant events and/or contributory/causal factors (physical condition and attention of the pilot, non-verbal communication, meteorological conditions, indications of instruments, etc.). • Was the information useful to identify and recommend corrective actions? (yes/no; what were the recommended corrective actions; why was the recording useful; paragraph reference.)

A sample of 20 final safety investigation reports of light-aircraft accidents occurred from 2011 to 2014 was analysed for Study 4. The reference information on these accidents is presented in Table E.10.

Note: One accident was an in-flight collision, hence involving two aircraft.

Table E.10: Accidents reviewed for Study 4

Date of the accident	State of registry	Aircraft registration	Aircraft category
07/11/2011	Switzerland	HB-ZGI	helicopter
20/09/2012	Switzerland	HB-UVT	aeroplane
28/04/2012	Switzerland	HB-PGA	aeroplane
24/06/2014	Norway	LN-OSY	helicopter
15/03/2013	Germany	D-EZKP	aeroplane
	Germany	D-EOTW	aeroplane
09/06/2012	Austria	OE-XKS	helicopter
21/06/2013	Germany	D-ECBZ	aeroplane
27/02/2014	France	F-BJQT	aeroplane
14/09/2011	France	F-HFBI	helicopter
07/08/2012	Switzerland	HB-KCF	aeroplane
23/09/2012	France	F-GBBY	aeroplane
04/07/2012	France	F-OHOR	helicopter
16/06/2013	France	F-BXRZ	aeroplane
16/02/2014	France	F-BUHP	aeroplane
24/10/2013	France	F-OIAB	aeroplane
20/04/2014	Finland	OH-XDZ	aeroplane
02/11/2012	Poland	SP-8050	sailplane
01/08/2013	France	F-CEAT	sailplane
18/12/2011	UK	G-BVXS	aeroplane
04/08/2012	UK	G-DDFN	sailplane

7.5.5.2. Conclusions

The general results of Study 4 can be summarised as follows:

— For the majority of the investigations, the recordings retrieved helped in determining significant events and/or significant contributory factors.

— All categories of recording equipment (not only dedicated image recording systems) helped to determine significant events and factors. In the majority of the cases even the recreational use of video recorders or portable devices were an essential source of data to establish the events.

— In particular, image recordings appeared relevant for two types of information used in investigation:

- information presented by analogic instruments in the flight crew compartment;
- information on the location of the aircraft when no radar data nor other recording of the flight path is available.

— Only 4 out of the 20 safety investigation reports identify a corrective action (safety recommendation or mention of any other kind of corrective action taken by the parties involved). Only in 1 of these 4 cases was the corrective action univocally linked to data recorded by an image recorder.

Note: There is no obligation (or even guidance) to specify, when writing an investigation report, whether the information obtained from a recording was useful to establish a given corrective action. In addition, corrective actions generally relate to several significant events and factors that are established based on the analysis of several sources of data. It is then difficult to assess a posteriori the contribution of a given recording to the identification of corrective actions.

7.6. Appendix F: Alternatives to dedicated in-flight recording equipment

In this Appendix, alternatives to dedicated in-flight recording equipment are reviewed. The alternative solutions should deliver information on the aircraft trajectory or status of the engines and essential systems, or of the situation on board, since such information is useful and facilitates the investigation of accidents.

7.6.1. Identified alternative solutions

The following categories of alternative solutions were identified:

— Portable GNSS receivers: this category includes all portable devices (installation not certified) that have a GNSS localisation function. This category also includes these GNSS receivers designated as 'IGC-approved flight recorders' by the International Gliding Commission (IGC), for which specifications exist.

— Panel-mounted GNSS receiver and navigation equipment: this category covers all aircraft systems using a GNSS localisation function and which are permanently installed on the instrument panel. Usually, the installation of such aircraft systems is performed by default or offered as an option by the aircraft manufacturer and it must be certified.

— Integrated cockpit: this category designates installations where all flight parameters and flight information needed for the piloting and flight management are concentrated and are usually made available in an integrated manner[33] (e.g. PFD, MFD).

— Anti-collision systems: this category designates products whose primary function is anti-collision and which are designed for light aircraft (e.g. TCAS I or FLARM).

— Terrain avoidance warning systems: this category designates products whose primary function is CFIT prevention and which are designed for light aircraft (such as Class C TAWS).

— SSR transponder and Mode S transponder: this category corresponds to the transponders used in civil aviation and capable of Mode A/C or of Mode S/ADS-B transmission. A Mode A/C transponder must be installed on all aeroplanes and helicopters operated under Part-CAT or Part-NCC (it must also be installed on aeroplanes and helicopters operated under Part-NCO and on sailplanes and balloons 'where required by the airspace being flown').

— ADS-B out capable transponder: this category designates SSR transponders capable of transmitting ADS-B surveillance data.

— Engine control system and related recording equipment (ECU, DECU, EDR, FADEC, etc.): this category designates aircraft systems whose primary purpose is to control and monitor the aircraft engines or to record engine parameters.

— Engine information system (VEMD, JP instruments): these are displays rendering parameters related to engine status and regime and fitted with internal memory.

— iPad/Tablets/PC/smartphones: this category includes all portable electronic devices on which aviation software or apps can be installed.

— Video: this category includes cameras and GoPro (installation not certified).

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[33] Generally, an integrated cockpit/flight deck combines a number of flight guidance, airplane systems, and situational awareness control and display functions onto a minimum number of interdependent electronic displays. It typically includes electronic display and control of primary aeroplane airspeed, altitude and attitude instruments, and essential navigation and communication functions. Integration may also include display and control of airborne surveillance, aeroplane systems and engine systems.

— Flight-tracking solutions: these are real-time aircraft tracking solutions which do not rely on ATM surveillance systems and are designed for light aircraft. Example: Spidertracks.

7.6.2. Assessment of the alternative solutions

The identified alternative solutions were assessed against several aspects, such as the equipment on which they rely, the aircraft categories on which they are commonly installed, what data they record, their cost, and overall relevance for safety investigation purposes.

The results are presented in Table F.1 and Table F.2.

The conclusions of this assessment for each category of aircraft that are within the scope of RMT.0271 & RMT.0272 are presented below.

7.6.2.1. Aeroplanes and helicopters

While portable GNSS receivers offer a good source of trajectory data, they are increasingly replaced by non-specialised electronic devices on which aviation applications are run (iPad, tablets, smartphones, etc.) The proprietary data format used by these devices make it very challenging to retrieve any useful data when the device is damaged (often the case after an accident) and their manufacturers usually provide little assistance to investigation authorities. The same applies to image and video recorders.

Terrain avoidance warning systems and airborne collision avoidance system are only installed on large aeroplanes and they are expensive. Engine control systems and engine information systems may record useful engine data; however, they do not usually provide trajectory information. Integrated cockpits may contain a wealth information; however, given their cost it is likely that they will stay in the short term reserved for the more expensive models among light aeroplanes and helicopters. Flight tracking solutions provides a position at intervals of typically 1 minutes because of the satellite communication cost; however, the rapid decrease of these cost may allow more frequent tracking in the future.

The SSR transponder is installed on-board most light aeroplanes and helicopters operated over the territory of EU Member states (because necessary to fly through airspace where it is required[34]), and provided the SSR transponder is on, it will most likely be detected by at least one civilian or military sensor (unless it is flying very low above the terrain or in a valley). Commission Implementing Regulation (EU) 2016/1185 introduced a requirement in Regulation (EU) No 923/2012 according to which an aircraft carrying a serviceable transponder must have it on at all times during the flight[35]:

'SERA.13001 Operation of an SSR transponder

(a) When an aircraft carries a serviceable SSR transponder, the pilot shall operate the transponder at all times during flight, regardless of whether the aircraft is within or outside airspace where SSR is used for ATS purposes.

(b) [...]

(c) Except for flight in airspace designated by the competent authority for mandatory operation of transponder, aircraft without sufficient electrical power supply are exempted from the requirement to operate the transponder at all times.'

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34 Refer to Commission Regulation (EU) No 965/2012, Annex VII (Part-NCO), points NCO.IDE.A.200 and NCC.IDE.H.200.

35 Commission Implementing Regulation (EU) No 923/2012 of 26 September 2012 laying down the common rules of the air and operational provisions regarding services and procedures in air navigation and amending Implementing Regulation (EU) No 1035/2011 and Regulations (EC) No 1265/2007, (EC) No 1794/2006, (EC) No 730/2006, (EC) No 1033/2006 and (EU) No 255/2010 (OJ L 281, 13.10.2012, p. 1). This Regulation is applicable, among other things, to all aircraft engaged in general air traffic and 'operating into, within or out of the Union' (Article 1).

Hence, it can be reasonably expected that most light and non-complex aeroplanes and helicopters operated over the territory of MSs will be tracked by radars all along the flight, even if they are not operated commercially.

7.6.2.2. Sailplanes

Two types of systems recording data are commonly carried on sailplanes: anti-collision systems such as FLARM (required to be affiliated by some national glider associations), and 'IGC-approved flight recorders', i.e. GNSS receivers which fulfil the IGC specifications (when the sailplane is used for competitions or badges).

Both types of systems essentially provide trajectory data, and studies of investigation reports tend to indicate that trajectory data is most of the time useful for explaining sailplane accidents (refer to Appendix E).

For both types of equipment, proprietary data formats are an issue for chip level data recovery (when the equipment is damaged).

The installation of FLARM under a standard change is allowed by CS-STAN (CS-SC051a, installation of 'FLARM' equipment). It is planned (under RMT.0690) to enable the installation of GNSS receivers under CS-STAN. The related NPA 2016-17, published in December 2016, can be consulted on the EASA website.

7.6.2.3. Balloons

When engaged in competition, balloons usually carry a GNSS receiver. This enables scorers to download each balloon's course and to calculate the results. As for other aircraft, proprietary data formats are an issue for chip level data recovery. NPA 2016-17 (RMT.0690) proposes to enable the installation of GNSS receivers under a standard change.

In addition, studies of investigation reports tend to indicate that trajectory data alone are not very useful for explaining balloon accidents; instead, airborne image recordings were much more helpful (refer to Appendix E). NPA 2016-17 (RMT.0690) proposes to enable the installation of light cameras on balloons under a standard change.

7.6.3. Recommendations for alternative solutions

For newly manufactured light aircraft, generic conditions could be defined for a solution to be an acceptable alternative to dedicated in-flight recording. These conditions, while not prescribing a given solution, would provide for a high probability that useful information could be retrieved by safety investigators in case of an accident, hence enhancing accident prevention in the long term.

Based on the review of best current alternative solutions, conditions have been identified that could be easily fulfilled by future airborne equipment designed for other primary purposes (i.e. anti-collision, engine monitoring, etc.) without significantly increasing the cost of this equipment.

Recording techniques

— The recording may be performed on board, or data may be transmitted to the ground, or elaborated on the ground based on a transponding system (such as an SSR), or any combination thereof.

— The recording function should use a digital method of storing the data in the memory medium. If the recording is performed on board, the memory medium should be non-volatile, but does not need to be crash-protected[36].

— When the recording of data does not rely on ATM surveillance systems (SSR, ADS-B, etc.), the memory used for recording should be managed in a way that there is always sufficient memory to completely record the current flight. For example, the recording could be circular, i.e. the most recent data overwriting the oldest data.

— Data compression and data encryption should not be used if the recording is performed on board (because the crash conditions might corrupt the recording file, making it impossible to decompress and/or decrypt with normal download software).

Recording format

When the recording of data does not rely on ATM surveillance systems, data should be recorded in a format that is easily identified and can be decoded with appropriate documentation.

Means of access to recorded information

When the recording of data does not rely on ATM surveillance systems, the user's means for downloading the recorded information from the recording medium should not erase, rewrite or alter the recording files.

Recording start-and-stop and recording delay

— The recording/transmitting/transponding function of the airborne equipment should automatically start when the airborne equipment is powered on and remain active as long as the airborne equipment is on.

— The user's interface with the airborne equipment should not offer any means to disable the recording/transmitting function when the equipment is on and used; however, this may be possible when the airborne equipment is connected to dedicated test or download equipment.

— In case where data is recorded on board, the delay between the computation of the data and the recording in the recording medium should not exceed a few seconds.

— In case where data is transmitted to the ground and not recorded on board, it should (to the extent possible) be transmitted throughout the flight. The transmission of data upon completion of the flight is not acceptable.

Erasure of recorded data

In case where data is recorded on board and it contains no privacy content (does not contain voices or images of the aircraft occupants), except for the overwriting of the oldest data by new data, no means for the erasure of data should be provided by the user's interface when the equipment is used; however, this may be possible on the ground, for example, if the recording is made on the ground or when the alternative solution is connected to dedicated test or read-out equipment. In addition, if the recording is likely to contain privacy content (e.g. sound in the flight crew compartment or a view of the basket area in case of a balloon are recorded), there should be a means to erase the recording.

[36] Adding any level of crashworthiness or hardening is nevertheless welcome.

Content to be recorded in case of image recording

Essential information to be captured

As a minimum, the alternative solution should capture:

— a view of the control panel sufficient to read information corresponding to:

- indicated airspeed, pressure altitude, magnetic heading and, when available, vertical speed, stabilised heading, OAT, aircraft attitude turn and slip, for aeroplanes;
- indicated airspeed, pressure altitude, magnetic heading, slip and, when available, vertical speed, aircraft attitude, OAT, and stabilised heading for helicopters;
- indicated airspeed, pressure altitude and, when available, magnetic heading, vertical speed, turn and slip, and attitude for sailplanes;

— a view of the outside sufficient to identify weather conditions.

An actual in-flight recording should be checked after installation to verify that the view is unobstructed by seats or pilot bodies and that the image quality is sufficient to read instrument conditions in normal daylight flight conditions.

Recording rate

The maximum recording/transmission time interval should not exceed a few seconds.

Data to be recorded in case of flight parameters recording

This section describes the minimum flight parameters to be recorded on board or on the ground.

Essential parameters to be recorded

The alternative solution should record the following information or provide sufficient information to reconstruct at least the following parameters:

— UTC time base;

— [aircraft 2D trajectory parameters] or [aircraft speed and aircraft track/heading] (both preferred, when available);

— vertical speed or altitude (both preferred, when available).

Recording rate

Except when the recording relies on ATM surveillance systems, the maximum recording/transmission time interval should not exceed a few seconds.

Essential parameters' performance

Documentation should indicate for each essential parameter recorded:

— its source, e.g. GNSS receiver, barometric sensors, accelerometers, IRS, etc.;

— its operational range, i.e. the range of values on which it is accurate; and

— its accuracy.

<u>*Additional data*</u>

Additional data related to the operation of the aircraft and that is available to the airborne equipment performing the recording or transmission of the essential parameters should, when practicable, be also recorded.

Examples of additional data are provided below. Additional data usually depend on the primary function of the airborne equipment.

Examples:

— Anti-collision advisories and corresponding resolutions produced by an anti-collision system (FLARM, TCAS).

— Terrain proximity warnings for a TAWS.

— Engine-related flight parameters used by an engine control and monitoring system.

— Active route, associated waypoints and last 'go-to' displayed by a navigation system.

— Data about the GNSS position accuracy (number of satellites in view, health and status of satellites, VDOP, PDOP) computed by the GNSS receiver.

— Attitude parameters.

Installation of the airborne equipment

The airborne equipment that is required to record the data or transmit it to the ground does not need to be certified for installation on the aircraft.

However, the airborne equipment or its mounting should not be removable from the aircraft without a dedicated tool or a dedicated key. For example, the use of Velcro or of a clipping system allowing quick removal should not be acceptable.

Table F.1: Summary of the assessment of the alternative solutions — A to F

Airborne equipment providing the alternative solution	**A. Portable GNSS receiver**	**B. Panel-mounted GNSS receiver and navigation equipment**	**C. Integrated cockpit**	**D. Anti-collision systems**	**E. Terrain avoidance warning systems**	**F. SSR transponder (capable of Mode A/C or capable of Mode S)**
1. Airborne equipment providing the alternative solution: short description and examples of models	All portable devices (installation not certified) that have a GNSS localisation function. Includes GNSS receivers designated as 'IGC-approved flight recorders' by the International Gliding Commission (IGC) Examples: Garmin, Zander	All aircraft systems using a GNSS localisation function and which are permanently installed on the instrument panel	Installations were all flight parameters and flight information needed for the piloting and managing the flight are concentrated and are usually made available in an integrated manner (e.g. PFD, MFD).	Products whose primary function is anti-collision and which are designed for light aircraft Examples: TCAS I, FLARM, low-power ADS-B transceiver (LPAT).	Products whose primary function whose primary function is CFIT prevention and which are designed for light aircraft (such as Class C TAWS).	Transponders used in the civilian domain and capable of Mode A/C or Mode S / ADS-B transmission.
2. Start-and-stop logic of data recording or data transmission to the ground	When powered on. On most models, recording is performed by default; however it can be deactivated.	No recording of track data; only frequencies, and flight plans	When powered on. Sometimes requires an SD card.	When powered on.	Record data around a warning.	When transponder is on and in SSR range.
3. Ground-based equipment needed to recover data that is recorded or transmitted to the aircraft operator during the flight	Recording files can be recovered and displayed using common cartography software or Google Earth. No dedicated hardware usually needed for readout, except for specific cables for older models and for IGC recorders.	None	Recording files can be recovered and displayed using common cartography software or Google Earth. No dedicated hardware usually needed for readout, data is usually recorded onto a removable medium.	Recording files can be recovered and displayed using common cartography software or Google Earth. No dedicated hardware usually needed for readout, except for specific cables for older models and for IGC recorders. New ones have removable medium.	Manufacturer bench.	Control centre
4. Other infrastructure which is needed for the transmission and/or recording of data, and which is not controlled by the aircraft	GNSS	GNSS	GNSS	GNSS for FLARM	Radio alti / GNSS / ADIR	ATS surveillance systems (SSR, ADS-B stations) **Transmitted Mode C/S data is stored on ground.**

Airborne equipment providing the alternative solution	A. Portable GNSS receiver	B. Panel-mounted GNSS receiver and navigation equipment	C. Integrated cockpit	D. Anti-collision systems	E. Terrain avoidance warning systems	F. SSR transponder (capable of Mode A/C or capable of Mode S)
owner/operator (satellites, ATS surveillance systems, etc.)						
5. Primary purpose of the alternative solution: navigation, anti-collision, engine monitoring, badges and diploma, etc.	Navigation	Navigation	Flight parameters and navigation data display	Anti-collision	Protection against CFIT	Air traffic control
6. Aircraft categories and types of operation for which the airborne equipment is required to be installed (if any)	None	None	None	ACAS: turbine-powered aeroplanes with an MCTOM of more than 5 700 kg or an MOPSC of more than 19 (Part CAT and Part NCC) FLARM: Gliders (required to be affiliated to French FFVV).	Aeroplanes having an MCTOM of more than 5 700 kg or an MOPSC of more than 9 (Part-CAT and Part-NCC).	Mode A/C: all flying in controlled area + mandated for all aeroplanes and helicopters operated under Part CAT or Part NCC, whatever the airspace being flown. Mode S elementary surveillance: all IFR flights + VFR flights, depending on the State Mode S enhanced surveillance: All fixed wing aircraft, having a maximum take-off mass greater that 5,700 kg or a maximum cruising true airspeed in excess of 250 kt, intending to fly IFR.
7. Aircraft categories and types of operation for which the airborne equipment is commonly installed or used on a voluntary basis	All light aircraft.	All light aircraft.	All motor-powered aircraft.	Gliders (required to be affiliated to French FFVV).		Mode A/C: All aeroplanes and helicopters.

Airborne equipment providing the alternative solution	A. Portable GNSS receiver	B. Panel-mounted GNSS receiver and navigation equipment	C. Integrated cockpit	D. Anti-collision systems	E. Terrain avoidance warning systems	F. SSR transponder (capable of Mode A/C or capable of Mode S)
8. Description of recorded information: flight parameters (which ones), image (of what), audio?	GNSS track , typically 1 point every 4 seconds (for new generation GNSS receivers, every second, but could vary depending on the aircraft position, with proprietary algorithm) (for some models used for glider competition: ambient noise level, total and static pressure)	Current and standby frequencies, and recorded flight plans	GNSS track, air data, engine and attitude parameters, typically, 1 point every second	GNSS track , 1 point every 4 seconds	Sometimes track data, A/C parameters (Vz, HDG, etc.) failure codes when triggered.	Mode A/C: radar position (range and bearing) and FL Elementary Mode S: Mode C data + 0,25FL Mode S enhanced surveillance= any programmed parameter (track attitude, AP, etc.) and 0,25FL.
9. Quality of the recorded data: typical sampling rate, typical accuracy and resolution, reliability issue, other limitations	Accuracy dependent on the GNSS service and receiver (usually better than 10 meter lateral and 20 vertical). Last points of a trajectory may be predictive positions.	n/a	Accuracy dependent on the GNSS service and receiver (usually better than 10 meter lateral and 20 vertical). Last points of a trajectory may be predictive positions. Accuracy dependent of the installed sensors by the A/C manufacturer.	Accuracy dependent on the GNSS service and receiver (usually better than 10 meter lateral and 20 vertical).		Radar position accuracy depend on the radar head proximity and performance. Sampling rate depends on the radar rotation period (typically 4 or 6 s for a SSR).
10. Limitations to recording data during a normal flight: airborne equipment not switched on, airborne equipment not recording continuously, transmission of data not successful, etc.	High attitude angles (dependent on the location of the GNSS receiver antenna). Older model have limited memory capacity. Normally memory is circular by default but this setting can be changed. Could not be in a recorder mode.	n/a	None	Up to 2 minutes of flight can be lost due to the buffer memory.		Not in range of an SSR transponder not switched on attitude of the A/C. In some States, listening to SSR frequencies may not be authorised.
11. Possible reasons for not retrieving recorded	Volatile memories on older models.	Volatile memory	Proprietary data formats are an issue for chip	Proprietary data formats are an issue for chip	Proprietary data formats are an issue for chip	Data not stored by the control centre long

Airborne equipment providing the alternative solution	**A. Portable GNSS receiver**	**B. Panel-mounted GNSS receiver and navigation equipment**	**C. Integrated cockpit**	**D. Anti-collision systems**	**E. Terrain avoidance warning systems**	**F. SSR transponder (capable of Mode A/C or capable of Mode S)**
data after an accident: volatile memory, proprietary data format, encryption, etc.	Proprietary data formats are an issue for chip level recovery. Increased complexity of memory media is requiring more and more advanced means for chip level recovery.		level recovery. Increased complexity of memory media is requiring more and more advanced means for chip level recovery.	level recovery. Increased complexity of memory media is requiring more and more advanced means for chip level recovery.	level recovery. Manufacturers are providing assistance.	enough (ex: mode S data is only stored for 3 out of 25 of the radar in France, in the UK everything is already recorded). In addition, there are non-ATC networks such as FlightRadar24 In according with Commission Implementing Regulation (EU) No 1207/2011, 'Air navigation service providers shall ensure that, by 2 January 2020 at the latest, the cooperative surveillance chain has the necessary capability to allow them to establish individual aircraft identification using downlinked aircraft identification made available by aircraft equipped in accordance with Annex II', where Annex II Parts A and C correspond to Mode S capability.
12. Overall relevance of the alternative solution to support investigation purposes	Provides accurate time-stamped trajectory and flight plan. For IGC recorders, a few additional parameters are recorded.	Know the active flight plan especially for CFIT accident. Progressively replaced by integrated cockpit.	Provides accurate time-stamped trajectory, flight plan and engine data.	Provides accurate time-stamped trajectory and flight plan.	Provides partial trajectory and aircraft data.	Provides accurate trajectory and additional aircraft data (if enhanced surveillance).

Airborne equipment providing the alternative solution	**A. Portable GNSS receiver**	**B. Panel-mounted GNSS receiver and navigation equipment**	**C. Integrated cockpit**	**D. Anti-collision systems**	**E. Terrain avoidance warning systems**	**F. SSR transponder (capable of Mode A/C or capable of Mode S)**
	Progressively replaced by iPad, tablets and smartphones.					
13. Range of purchase cost of the airborne equipment	Usually a few hundreds of euros, up to a few thousands.	Usually a few ten thousands of euros.	Up to EUR 50 000	EUR 500		EUR 2 000 to 3 000
14. Range of purchase cost of the ground-based equipment (excluding ATM surveillance systems)	Cable and software usually included.	Data are only viewable on the screen.	data is recorded in TXT or XLS file. If proprietary format, manufacturers have tools to convert data.	Cable and software usually included.	Manufacturer bench	n/a
15. Cost of operating the solution (hourly, per flight or per unit of recorded/transmitted data)	Database updates	Database updates	Database updates	Database updates		n/a

Table F.1: Summary of the assessment of the alternative solutions — G to L

Airborne equipment providing the alternative solution	**G. SSR transponder capable of ADS-B**	**H. Engine control system and related recording equipment**	**I. Engine information system**	**J. Navigation applications on iPad/tablets/PC/smartphones**	**K. Video**	**L. Flight-tracking solutions**
1. Airborne equipment providing the alternative solution: short description and examples of models	ADS-B broadcasting unit (need to get an outlook of ADS-B deployment in Europe)	Aircraft systems whose primary purpose is to control and monitor the aircraft engine, or to record engine parameters Examples: ECU, DECU, EDR.	Displays rendering parameters related to engine status and regime and fitted with internal memory (e.g. VEMD, EDM from JP Instruments).	All portable electronic devices on which aviation software or apps can be installed.	Cameras installed in the aircraft in order to film the flight crew compartment and/or the outside Example: GoPro, Contour.	Equipment capable of transmitting (typically via satellites) the real-time position of the aircraft. Example: Spidertracks.
2. Start-and-stop logic of data recording or data transmission to the ground	When transponder is on and in range of an ADS-B station.	When powered on	When powered on/above a certain power.	When powered on. On most models, recording is performed by default; however it can be deactivated.	When switched on	When switched on
3. Ground-based equipment needed to recover data that is recorded or transmitted to the aircraft operator during the flight	ADS-B station (or non ATC receivers such as FlightRadar24 receivers).	Manufacturer bench	Manufacturer bench for VEMD no dedicated hardware for JPI	Recording files can be recovered and displayed using common cartography software or Google Earth. No dedicated hardware usually needed for readout, except for specific cables for older models and for IGC recorders.	No dedicated hardware necessary	Tracking platform
4. Other infrastructure which is needed for the transmission and/or recording of data, and which is not controlled by the aircraft owner/operator (satellites, ATS surveillance systems, etc.)	ATS surveillance systems (SSR, ADS-B stations) Transmitted Mode C/S data is stored on ground	None	None	GNSS/Bluetooth	None	Example Spidertracks: GNSS+Iridium.
5. Primary purpose of the alternative solution: navigation, anti-collision, engine monitoring, badges and	Air traffic control and traffic alert.	Engine control, engine condition monitoring.	Engine control	General public use (not designed for aviation-specific use).	Private (pictures of own flight), training.	Real-time fleet tracking Alerting (backup to ELT).

Airborne equipment providing the alternative solution	**G. SSR transponder capable of ADS-B**	**H. Engine control system and related recording equipment**	**I. Engine information system**	**J. Navigation applications on iPad/tablets/PC/smartphones**	**K. Video**	**L. Flight-tracking solutions**
diploma, etc.						
6. Aircraft categories and types of operation for which the airborne equipment is required to be installed (if any)	ADS-B out capability only required for newly manufactured aircraft with a maximum certified take-off mass exceeding 5 700 kg or having a maximum cruising true airspeed capability greater than 250 kt, and operated under IFR.	Engine with electronic fuel regulation Diesel engines	None	None	None	None
7. Aircraft categories and types of operation for which the airborne equipment is commonly installed or used on a voluntary basis	Large aeroplanes and large helicopters.	All motor-powered aircraft.	All motor-powered aircraft.	All	All	All
8. Description of recorded information: flight parameters (which ones), image (of what), audio?	Extended squitter includes: Aircraft address and identification Lat/Long Pressure altitude and Geometric altitude Groundspeed Vertical speed Selected altitude, Baro setting roll angle Mag heading True track angle.	Failure codes engine parameters	Failure codes engine parameters	GNSS track , typically 1 point every second Flight preparation	External environment, pilot behaviour, flight controls, flight panel sound	Track data, sometimes 1 point every minute.
9. Quality of the recorded data: typical sampling rate, typical accuracy and resolution, reliability	Dependent on the aircraft systems producing the flight parameters transmitted in the			Accuracy dependent on the GNSS service and receiver (usually better than 10 meter lateral and 20 vertical). Last points of a trajectory may be	Depends on the camera sensor.	

Airborne equipment providing the alternative solution	G. SSR transponder capable of ADS-B	H. Engine control system and related recording equipment	I. Engine information system	J. Navigation applications on iPad/tablets/PC/smartphones	K. Video	L. Flight-tracking solutions
issue, other limitations	ADS-B messages.			predictive positions.		
10. Limitations to recording data during a normal flight: airborne equipment not switched on, airborne equipment not recording continuously, transmission of data not successful, etc.	Not in range of an ADS-B station transponder not switched on			Device not switched on. Application not active.	Light issue, movement/vibration issue	High attitude angles (dependent on the location of the GNSS/iridium receiver antenna). Older model have limited memory capacity. Normally memory is circular by default but this setting can be changed. Could not be in a recorder mode.
11. Possible reasons for not retrieving recorded data after an accident: volatile memory, proprietary data format, encryption, etc.	Data not stored by ATS long enough. In accordance with Commission Implementing Regulation (EU) No 1207/2011, 'Air navigation service providers shall ensure that, by 2 January 2020 at the latest, the cooperative surveillance chain has the necessary capability to allow them to establish individual aircraft identification using downlinked aircraft identification made available by aircraft equipped in accordance with Annex II', where Annex II Part B	Proprietary data formats are an issue for chip level recovery. Manufacturers are providing assistance	Proprietary data formats are an issue for chip level recovery. Manufacturers are providing assistance	Proprietary data formats are an issue for chip level recovery. Increased complexity of memory media is requiring more and more advanced means for chip level recovery.	Corrupted files at accident switched off (to be clarified) Increased complexity of memory media is requiring more and more advanced means for chip level recovery.	Access to the tracking platform

Airborne equipment providing the alternative solution	**G. SSR transponder capable of ADS-B**	**H. Engine control system and related recording equipment**	**I. Engine information system**	**J. Navigation applications on iPad/tablets/PC/smartphones**	**K. Video**	**L. Flight-tracking solutions**
	corresponds to ADS-B out capability.					
12. Overall relevance of the alternative solution to support investigation purposes	Provides accurate trajectory and data on aircraft speed and attitude angles.	Provides engine data.	Provides engine data.	May provide accurate time-stamped trajectory and flight plan.	Provides a good overview of the situation in the flight crew compartment.	Provides accurate time-stamped trajectory and flight plan. Provides the last position of the aircraft, which facilitates wreckage localisation.
13. Range of purchase cost of the airborne equipment	EUR 2 000 to 3 000	Several ten thousands of euros	A few thousands of euros. Several ten thousands of euros for VEMD.	EUR 500	EUR 500	EUR 1 000
14. Range of purchase cost of the ground-based equipment (excluding ATM surveillance systems)	n/a	Manufacturer bench	Cable and software usually included/ manufacturer bench	None	None	Included
15. Cost of operating the solution (hourly, per flight or per unit of recorded/transmitted data)	n/a			None	None	None

7.7. Appendix G: Results of the survey on cost and benefits of dedicated in-flight recording

EASA conducted a survey between 7 May and 9 June 2015, which focused on aircraft systems that are permanently installed on light aeroplanes and light helicopters, and whose primary function is to record data, audio or image, for later analysis or investigation. The survey consisted in a questionnaire which was distributed to the Safety Standards Consultative Committee (SSCC) and to equipment manufacturers. 12 organisations responded (8 aircraft manufacturers, 6 equipment manufacturers and 1 aircraft owner). In addition, informal feedback was received from ECOGAS, the new European Helicopter Association ('common position'), a representative of sailplane manufacturers at the SSCC, and a flight school. The results of the survey are presented in Table G.1.

Table G.1: Summary of replies to the industry survey on cost, operational impact and benefits of dedicated in-flight recording systems

Number	Question	Comment	Reply
0	Please provide contact information	— Following the receipt of a filled form, phone contact may be requested in order to obtain more background information or clarify some replies; — The objective of this questionnaire is to support Rulemaking task RMT.0271. Individual replies to this questionnaire will be kept strictly confidential and only fully de-identified information will be shared.	(confidential information, the identity of responders and the organisations they represent is not provided here).
1	You are: — An aircraft manufacturer — An equipment manufacturer — An aircraft operator or owner — Other (please specify)		Replies from — 8 aircraft manufacturers (light aeroplanes and light helicopters). — 6 equipment manufacturers — 2 flight schools — 3 industry associations
2	Applicable aircraft make(s) and model(s)	Only provide the aircraft models on which the equipment was successfully installed.	Many models were mentioned in the replies, including aeroplane models with less than 2 250 kg MCTOM and reciprocating engines (example Piper PA-28, Diamond DA-40, Cessna 172, Socata TB20, etc.), and helicopters with MCTOM close to or less than 2 250 kg (Bell 206, AS350, EC130). Heavier and more complex aircraft models were also mentioned.
3	Case considered: forward fit or retrofit		For aircraft manufacturers: mainly forward-fit, standard installation on new light models. limited retrofit. Equipment manufacturers: STCs mainly for light helicopter models Flight school: retrofit.
4	Recording equipment model(s)		For aircraft manufacturers: mainly ED-155 like recording equipment. Some install ED-112 crash protected CVFDR on the heavier models. One has aircraft manufacturer SD card on panel-mounted navigation equipment, another mentioned a lightweight Quick Access Recorder (QAR)

Number	Question	Comment	Reply
			Equipment manufacturers: ED-155 like recording equipment Flight school: ED-155 like recording equipment. EHA: referred to airborne equipment installed for usage monitoring system (required by CAT.POL.H.305 i.e. for helicopters without an assured safe force landing possibility at take-off or landing).
5	Functions offered by the recording equipment model (flight parameters, audio, image, data-link messages, etc.)	Specify if some functions are not always included in the recording equipment (e.g. in the case of a modular system that can perform several recording functions).	Aircraft manufacturers: always flight parameters recording function. Some install equipment combining flight parameters + cockpit audio + image. Equipment manufacturers: flight parameters and audio, or flight parameters, audio and image
6a	Recording equipment: is it compliant with EUROCAE MOPS for crash-protected flight recorders or lightweight flight recorders? (ED55, ED56A, ED112, ED112A, ED155)?		Aircraft manufacturers: some equipment models are compliant with ED-155 or ED-112 (or ED-55/56A), others are not fully compliant with these industry standards. Equipment manufacturers: some equipment models are compliant with ED-155 or ED-112, others are not fully compliant.
6b	Recording equipment: does it have a TSO/ETSO authorisation?	Provide the TSO or ETSO number according to which the recording equipment was authorised	Aircraft manufacturers: one of the recording equipment models has TSO-C197. Others are deemed compliant with ED-155 yet they do not have TSO-C197. Others are not fully compliant with ED-155 Equipment manufacturers: no.
7a	Cost of installation design and documentation (not including installation test)	— Normally once per aircraft model (non-recurring); — Cost should include the installation drawings, Installation Instructions, Maintenance Instructions, AFM and the decoding documentation in the case of an FDR or, ADRS.	Aircraft manufacturers: very diverse assessment of cost depending on the company and the type of recording equipment assumed. As a minimum, around 10 000 € for 7a, 7b and 7c when considering recording equipment that is not fully ED-155 compliant. When considering a fully ED-155 compliant recording equipment, one manufacturer assessed the total cost for 7a, 7b and 7c at 300 000 Euros, another to more than 100 000 Euros, another to more than 150 000 Euros. Equipment manufacturers: between 10 000 and 60 000 € for an STC

Number	Question	Comment	Reply
7b	Cost of installation test	— Normally once per aircraft model (non-recurring) — Cost should include flight-test and evaluation of recording quality. — If applicable, indicate the cost of test for the flight parameter function only, the audio recording function only, and with all functions included	Aircraft manufacturers: See 7a. Equipment manufacturers: between 2 000 and 5 000 € per individual aircraft.
7c	Cost of certifying the installation	— Normally once per aircraft model (non-recurring); — Indicate if this was a Major Change (STC) or a Minor Change and indicate the certification fees.	Aircraft manufacturers: installation was part of the aircraft TC and handled as a minor change. Equipment manufacturers: in the range 10 000 to 60 000 € for an STC.
8	Unit price, including the recording equipment and its dedicated wires, connectors, sensors + the price of the installation kit and of voltage/current transformers (if applicable)	— Normally once per individual aircraft (recurring); — Indicate unit price range if the number of units induce a significant difference in price; — If applicable, indicate unit price for the flight parameter function only, the audio recording function only, and with all functions included.	Aircraft manufacturers: for ED-155 like recording equipment, the unit price is in the range from 4 000 to 8 000 Euros. For an ED-112 compliant crash-protected recorder, price in the range 30 000 to 50 000 Euros. Equipment manufacturers: four gave price indications. one product is ‘less than 10 000 €’ including software for readout and internal memory retrieval, the three others are in the range 5 000 to 15 000 €, also depending on customer choices. Flight school: total cost of 20 000 € per individual aircraft, including recording equipment, installation on the aircraft, testing and documentation. EHA: cost associated with a usage monitoring system for a non-complex aircraft are around 10 000 €.

Number	Question	Comment	Reply
9	Main cost drivers	Indicate what specifications are, in your opinion, driving the total cost of recording equipment: — flight parameters to record, — crashworthiness specifications, — start and termination logic, — testing, — certification, — necessary airframe modifications prior to this installation, — aircraft down-time, — etc.	Aircraft manufacturers: for ED-155 like recording equipment: main drivers are certification (if item required to have a TSO/ETSO authorisation), testing (ground and flight test), and flight parameters (if dedicated sensors need to be installed). For ED-112 crash-protected flight recorder, in addition to the above, development of a data frame layout for the FDR recording. Equipment manufacturers: STC cost, installation of dedicated sensors (in particular for analogue cockpits), crashworthiness, economies of scale are too small. Flight school: STC cost, airframe modification (wirings), crashworthiness.
10	Total weight of equipage, including the recording equipment and its dedicated wires, connectors, sensors + the weight of the installation kit and of voltage/current transformers (if applicable)	If applicable, indicate: — the weight of an installation that is recording flight parameters only; — the weight of an installation that is recording audio only; — and the weight when all functions are included.	Aircraft manufacturers: weight above 5 kg and up to 10 kg for ED-112 compliant crash-protected flight recorders (without dedicated connectors, sensors, acquisition unit etc.). Between 1 kg and 4 kg total weight for ED-155 like recording equipment. Equipment manufacturers: less than 5 kg total weight for ED-155 like recording equipment. Flight school: 4 kg total weight for ED-155 like recording equipment.
11	Total power consumption of the recording equipment, including dedicated sensors	If applicable, indicate power consumption: — for the flight parameter recording function only; — for the audio recording function only; and — with all functions included.	Aircraft manufacturers: between 4 and 10 W for ED-155 like recording equipment. From 6 to 40 W for ED-112 compliant crash-protected recorder. Flight school: 10W max. Equipment manufacturers: 10 to 30W for the total power consumption
12a	Retrofit: aircraft down time	If the aircraft down time varies significantly from one aircraft model to the next (or from one individual aircraft to the next), please explain and provide a range of aircraft down times.	Aircraft manufacturers: 1 to 2 days for ED-155 like recording equipment (several aircraft manufacturers indicate they do not perform retrofit). Flight school: around 3 days. Equipment manufacturers: 1 day in the best case, more often 2 to 6 days.
12b	Retrofit: number of man-	— number of man hours for mechanical	Equipment manufacturers: between 1 and 3 days for 2 mechanics (16 to 48 man

Number	Question	Comment	Reply
	hours needed	and electrical part of installation; — including functional test after installation; — If the number of man-hours varies significantly from one aircraft model to the next (or from one individual aircraft to the next), please explain and provide a range of man-hours; — Note: labour cost may vary depending on the country where the installation is performed.	hours). Flight school: about 50 man-hours.
12c	Retrofit: main drivers for down-time and man-hours	Please indicate which are the main drivers of the down-time and man-hours needed for installing recording equipment: — sensors installation, — ground testing, — flight testing, — etc.	Aircraft manufacturers: for ED-155-like recording equipment, the main drivers are installation of sensors (flight parameter sensors and camera in the cockpit) and wirings, and ground testing. Equipment manufacturer: installation of wiring, accessibility to sensors and cables. Flight school: mechanical and wiring installation.
13	Download and replay equipment	— Specify if downloading the data requires dedicated hardware / software (connecting cables, special junction boxes, operating system, etc.); — Specify if converting the data files into ready-to-analyse data requires dedicated software (i.e. flight parameters expressed in engineering units, audio files in a common audio format), or if the data files cannot be converted from a proprietary format. In this case, please give the unit price of the download and replay equipment; — Indicate if data can only be analysed	Aircraft manufacturers: dedicated hardware is not always necessary; however, dedicated readout software is needed in any case for ED-155 like recording equipment as for crash-protected ED-112 compliant crash-protected flight recorders. The data can be analysed without assistance of an external service provider. Equipment manufacturers: dedicated software needed for configuring the unit and reading it out; however, using standard connexion or standard memory media. The data can be analysed without assistance of an external service provider. Flight school: proprietary readout software provided with the recording equipment.

Number	Question	Comment	Reply
		by an external service provider.	
14	Maintenance scheduled tasks: time intervals and cost	— List all scheduled tasks, with their periodicity and LLP´s (Life limited parts) — This should; include the recording equipment and its dedicated sensors; — Take into account the usage made of the recorder (e.g. used for FDM) which may have an impact on the maintenance cost (wear and tear).	Aircraft manufacturers: scheduled maintenance tasks not always defined. For ED-155 like recording equipment, typically one recording inspection per year and operational check (control of LED status) before the 1st flight of the day.. Equipment manufacturers: no limited life part, except for one (change of battery every 10 years). One manufacturer indicated having defined a functional test to be run during scheduled maintenance of the aircraft. Flight school: no limited life part. No preventive maintenance prescribed.
15	Any other issue not captured by the questions above	Any issue related to cost, weight, volume, effect on aircraft performance, restrictions to installation, impact on aircraft operation, aircraft maintenance, etc.	Aircraft manufacturers: authorities should not impose retrospective requirements on voluntary installations of recording equipment. Acceptance of aircraft operators and pilots. If for some aircraft models crash-protected ED-112 recorder was considered necessary, do not impose more than Type II FDR and allow one single flight data and cockpit voice combination recorder, to limit cost, weight, consumption (the use of Type IA FDR (78 parameters, according to ICAO Annex 6) in this kind of aeroplanes increases more than 8 kg in weight (sensors, wiring, etc.) and cost is around 50 000 Euros). Big internal effort to have the ED-155 like recording equipment certified on the A/C. Equipment manufacturers: making the recording equipment a MEL item may create operational restrictions. Lack of a regulatory framework that is commensurate to the case of light aircraft. Flight school: problem of design and/or installation with dedicated sensors, unreliable software on the recording unit, data transfer is too long. EHA: recording equipment should not be included in the MMEL of the helicopter with a rectification interval of level A or B or C, as it does not need to be serviceable at the start of every flight.
16	Savings generated by the equipment once installed	— Savings could be lower insurance premiums, better aircraft condition or usage monitoring, better company	Aircraft manufacturers: there could be a possibility in the future to influence the insurance rate for the product liability as the data may help to decrease the cost in a legal case. Avoidance of unnecessary maintenance. (e.g. MGB expertise in case of

Number	Question	Comment	Reply
		image, more accurate billing information, etc.; — Please provide concrete examples and an assessment of the saved amount.	over limit). Good safety image of the company. Possibility to adapt the billing according to the usage of the helicopter Equipment manufacturers: avoid costly and invasive engine inspections. Reduced fuel consumptions by eliminating impractical procedures. Annual insurance premium increases can be curtailed by providing proof of operating a FOQA program. Companies operating under an Air Taxi AOC can qualify for more sales due to compliance with customer FDM requirements and have more trust from their customers thanks to the capability to better analyse their incidents. Those who are reimbursed by Distance Flown can show and justify course deviations in their billing data. Disprove claims of flight over forbidden areas, thus saving the associated penalty. Flight school: Increase of operating cost, due to the unexpected cost to correct installation problems. Installed system remains mechanically fragile.
17a	Safety benefits other than for ICAO Annex 13 investigations	Please provide concrete examples of safety benefits, specifying the organisation and evidence that the recorded information was used to improve or to better monitor the safety level (e.g. support for training courses).	Aircraft manufacturers: ensuring SOPs are followed across the fleet. For instance, some helicopter offshore operators limit the aircraft speed below certain altitude when flying close to the shore to minimize risk of bird strike. Proactively identify and reduce the risk. 3D replay for training or for other analysis. However one aircraft manufacturer thinks that the protection of recorded data could limit the potential use of data. The recorded data are not typically used for maintenance or a full-fledge FDM programme. Equipment manufacturers: enhanced training using real-word examples, standard of practice analysis to improve safety procedures. The pilots know that they are monitored and therefore take less risk. Better understand accidents and take effective corrective actions. Detect unsafe situations before an accident occurs (e.g. at one operator, it was detected that torque was exceeded almost daily at take-off. The take-off procedure was amended) Flight school: better understand incidents (one case where it was helpful). However restrictive policy to download the data could be a hindrance for using them for maintenance purposes.
17b	Benefits other than safety-	Please provide concrete examples	Two aircraft manufacturers believe that these data may support legal cases

Number	Question	Comment	Reply
	related (e.g. legal cases: was the recording already used in court cases and approved as a piece of evidence by judicial authorities?)		(provide better evidence against plaintiff's theories). One aircraft manufacturers thinks they could be used to collect data related to warranty claims against the aircraft. Equipment manufacturers: - Insurance benefits; some companies offer reduced rates for FDM installation - Liability; operators, owners alike can use the data to mitigate or support findings.

7.8. Appendix H: General principles of the safety risk assessment

7.8.1. Common methodology used for the safety risk assessment

Safety risk assessment is the assessment of the consequences of a hazard assuming the worst foreseeable situation expressed in terms of predicted probability and severity.

What is risk?

Risk is the assessment of the consequences of a hazard assuming the worst foreseeable situation expressed in terms of predicted probability and severity.

Key elements of risk assessment:

— probability of the event,

— severity,

— risk matrix.

This information is based on the available information at the Pre-RIA stage.

In order to define the elements 'probability' and 'severity', the following tables were developed based on the ICAO framework.

Table H.1: Probability of occurrence[37]

Definition	**Description**
Frequent	Likely to occur many times (has occurred frequently)
Occasional	Likely to occur sometimes (has occurred infrequently)
Remote	Unlikely, but possible to occur (has occurred rarely)
Improbable	Very unlikely to occur
Extremely improbable	Almost inconceivable that the event will occur

[37] These categories need to be applicable to a wide range of safety issues and are taken from the ICAO Safety Management Manual. The description is harmonised with CS-25. Note that these descriptions are indicative only and may have to be adjusted to different rulemaking tasks depending on subsector of aviation.

Table H.2: Severity of occurrence

Definition	Description
Catastrophic	Multiple deaths and equipment destroyed (hull loss)
Hazardous	A large reduction of safety margins Maximum two fatalities Serious injury Major equipment damage
Major	A significant reduction of safety margins Serious incident Injury of persons
Minor	Nuisance Operating limitations Use of emergency procedures Minor incident
Negligible	Little consequences

A scale for the 'severity' and 'probability' parameters is used to measure the risk (severity × probability).
This results in a **safety risk level:** High/Medium/Low.

The outcome is presented in the following matrix.

Table H.3: Risk index matrix

Probability of occurrence		**Severity of occurrence**				
		Negligible	**Minor**	**Major**	**Hazardous**	**Catastrophic**
Extremely improbable						
Improbable						
Remote						
Occasional						
Frequent						

Table H.4: Description of the different risk levels

Risk level		Description [38]
	High significance	Unacceptable under the existing regulatory circumstances. Rulemaking action required.
	Medium/high significance	Based on feedback from stakeholders, this combination of probability and severity may be considered to be of a high or a medium risk depending on the issue. Reasoning to be provided in Section 2.2 of the Pre-RIA.
	Medium significance	Tolerable based on risk mitigation by the stakeholders and/or rulemaking action.
	Low significance	Acceptable, but monitoring or non-rulemaking action required. Under certain circumstances, rulemaking may be required. Reasoning to be provided in Section 2.2. of the Pre-RIA

7.8.2. *Special considerations related to general aviation*

The following extract from Section 2 of the document 'European General Aviation Safety Strategy – discussion paper', dated 30 August 2012[39], gives the rationale for a different safety assessment between general aviation and commercial operations:

'It is important to recognise the differences between commercial and non-commercial environments from a safety management perspective.

1.Control of Risk

End-use stakeholders in non-CAT aviation generally have much more ability to assess and control the risk of the operation. In many cases, with the exception of very limited risk to third parties, the operators are the only stakeholders exposed to risk. Even when passengers (or more often and precisely 'participants') are carried, they are usually much closer to the process by which risk is assessed and managed, and their participation is discretionary, not an intrinsic part of their day-to-day business. Operational control is particularly important in determining appropriate target levels of safety. This is, and has been traditionally, a good justification for offering a high level of autonomy to the pilot.

[…]

2.Level Playing Field

In the competitive CAT market, a level playing field between actors is necessary to ensure that safety does not enter a vicious spiral. If the level of safety expenditure, or the value of safety compared to operational success, is left to the discretion of individual operators, a competitive advantage often

[38] The descriptions are based on the ICAO Safety Management Systems Handbook. However, as the SMS system is geared towards operators and not regulators, the descriptions were adjusted to better reflect EASA's needs and in line with comments received from stakeholders.

[39] https://easa.europa.eu/system/files/dfu/European%20GA%20Safety%20Strategy%20Discussion%20Paper.pdf

arises for the operator who takes more risk. In essence, provided nothing catastrophic occurs, the braver airline succeeds at the expense of the more cautious. Thus without explicit standards set by the regulator, safety would be eroded. There is no corresponding effect for non-CAT aviation. Risk management in a non-commercial operation will typically be carried out by the pilot who is able to take account of his own aversion to risk in making operational decisions. If the pilot chooses a more cautious approach, the operator does not suffer business failure.'

7.9. Appendix I: Requirements related to indications of instruments on board aeroplanes and helicopters

This Appendix summarises the flight parameters required to be displayed on board aeroplanes and helicopters operated under Part-CAT or Part-SPO. It was prepared in order to get a picture of what flight parameters are likely to be already available in the aircraft, which then could be recorded either as flight data or by means of recording images of the flight instruments.

7.9.1. Aeroplanes

The requirements related to flight and navigational instruments can be found in CAT.IDE.A.125 and CAT.IDE.A.130 of Part-CAT, and in SPO.IDE.A.120 and SPO.IDE.A.125 of Part-SPO.

Table I.1 presents the indications required to be presented on the flight instruments of aeroplanes operated under Part-CAT. Table I.2 presents the indications required to be presented on the flight instruments of aeroplanes operated under Part-SPO.

Table I.1: Indications to be presented on the flight instruments of an aeroplane (Part-CAT)

Presented information	Description	Eligible aeroplane types	Eligible operating conditions
Magnetic heading		All	VFR by day; VFR at night; IFR
Time	Time in hours, minutes and seconds.	All	VFR by day; VFR at night; IFR
Pressure altitude		All	VFR by day; VFR at night; IFR
Indicated airspeed		All	VFR by day; VFR at night; IFR
Vertical speed		All	VFR by day; VFR at night; IFR
Turn and slip	Sensing the rate of turn, but not the rate of bank.	All except single-engined aeroplanes first issued with an individual CofA before 22 May 1995 if the compliance would require retrofitting under VFR by day.	VFR by day; VFR at night; IFR
Attitude		All except single-engined aeroplanes first issued with an individual CofA before 22 May 1995 if the compliance would require retrofitting under VFR by day.	VFR by day; VFR at night; IFR
Heading		All except single-engined aeroplanes first issued with an individual CofA before 22 May 1995 if the compliance would require retrofitting under VFR by day.	VFR by day
Outside air temperature		All except single-engined aeroplanes first issued with an individual CofA before 22 May 1995 if the compliance would require retrofitting under VFR by day.	VFR by day; VFR at night; IFR
Mach number		Aeroplanes for which speed limitations are expressed in terms of Mach number.	VFR by day; VFR by night; IFR
Stabilised heading		All	VFR at night; IFR

Table I.2: Indications to be presented on the flight instruments of an aeroplane (Part-SPO)

Presented information	Description	Eligible aeroplane types	Eligible operating conditions
Magnetic heading		All	VFR by day; IFR
Time	Time in hours, minutes and seconds.	All	VFR by day; IFR
Pressure altitude		All	VFR by day; IFR
Indicated airspeed		All	VFR by day; IFR
Vertical speed		All	VMC at night; IFR
Turn and slip	Sensing the rate of turn, but not the rate of bank.	All	VMC at night; IFR
Attitude		All	VMC at night; IFR
Outside air temperature		All	IFR
Mach number		Aeroplanes for which speed limitations are expressed in terms of Mach number.	VFR by day; IFR
Stabilised heading		All	VFR at night; IFR

7.9.2. Helicopters

The requirements related to flight and navigational instruments can be found in CAT.IDE.H.125 and CAT.IDE.H.130 of Part-CAT, and in SPO.IDE.H.120 and SPO.IDE.H.125 of Part-SPO.

Table I.3 presents the indications required to be presented on the flight instruments of helicopters operated under Part-CAT.

Table I.4 presents the indications required to be presented on the flight instruments of helicopters operated under Part-SPO.

Table I.3: Indications to be presented on the flight instruments of a helicopter (Part-CAT)

Presented information	Description	Eligible helicopter types	Eligible operating conditions
Magnetic heading		All	VFR by day; VFR by day for helicopters with an MCTOM of more than 3 175 kg, or any helicopter operating over water when out of sight of land, or when the visibility is less than 1 500 m; VFR at night; IFR
Time	Time in hours, minutes and seconds.	All	VFR by day; VFR at night; IFR
Pressure altitude		All	VFR by day
Indicated airspeed		All	VFR by day; VFR at night; IFR
Vertical speed		All	VFR by day; VFR at night; IFR
Slip		All	VFR by day; VFR at night; IFR
Attitude		All	VFR by day for helicopters with an MCTOM of more than 3 175 kg, or any helicopter operating over water when out of sight of land, or when the visibility is less than 1 500 m; VFR at night; IFR
Outside air temperature		All	VFR by day; VFR at night; IFR
Stabilised heading		All	VFR at night; IFR

Table I.4: Indications to be presented on the flight instruments of a helicopter (Part-SPO)

Presented information	Description	Eligible helicopter types	Eligible operating conditions
Magnetic heading		All	VFR by day; VMC over water and out of sight of the land, or under VMC at night; IFR
Time	Time in hours, minutes and seconds.	All	VFR by day; VMC over water and out of sight of land, or under VMC at night; IFR
Pressure altitude		All	VFR by day; VMC over water and out of sight of land, or under VMC at night; IFR
Indicated airspeed		All	VFR by day; VMC over water and out of sight of land or under VMC at night; IFR
Vertical speed		All	VMC over water and out of sight of land, or under VMC at night; IFR
Slip		All	VFR by day; VMC over water and out of sight of land, or under VMC at night; IFR
Attitude		All	VMC over water and out of sight of land, or under VMC at night; IFR
Outside air temperature		All	IFR
Stabilised heading		All	VMC over water and out of sight of land, or under VMC at night; IFR

7.10. Appendix J: Examples of in-flight recording systems

Table J.1 contains examples of models of in-flight recording systems which can be installed on light aircraft and are known to EASA.

This table is purely illustrative, non-exhaustive, and it should not be understood in any manner as EASA recommendations. This table is only intended to provide concrete examples of in-flight recording systems for the purpose of better understanding the analysis made in the impact assessment.

The systems are presented by equipment manufacturer name in alphabetical order.

Table J.1: Examples of in-flight recording systems

Name of equipment manufacturer	Equipment brand name
Appareo	GAU 3000
Appareo	Vision 1000
ETEP	Sentinel
Flight Data Vision	MDU 379
Free Flight Systems	Memory Management System
Iaero	Apibox
ISEI	Safetyplane
KAPI Electronics	Kapi Air
L3Com	Lightweight Data Recorder
North Flight Data System	CV2R
North Flight Data System	OVVR
NSE	Brite Saver
Outerlink	IRIS