European Aviation Safety Agency — Rulemaking Directorate

Notice of Proposed Amendment 2013-26

Amendment of requirements for flight recorders and underwater locating devices

RMT.0400 & RMT.0401 (OPS.090(A) & OPS.090(B)) — 20.12.2013

EXECUTIVE SUMMARY

This Notice of Proposed Amendment (NPA) addresses safety issues related to the reliability and preservation of flight recorders and to locating the aircraft after an accident over water.

ICAO Annex 6 prescribes the discontinuation of recording technologies such as magnetic tape, magnetic wire or frequency modulation, which are not reliable enough, as confirmed in several investigations. ICAO Annex 6 also prescribes that all cockpit voice recorders have a minimum recording duration of two hours from 2016. Several investigations point at an insufficient recording duration of the cockpit voice recorder.

In order to facilitate the recovery of aircraft wreckage, ICAO Annex 6 extends the transmission time of the flight recorder underwater locating device and prescribes that aeroplanes performing long-range overwater flights carry a new kind of underwater locating device with a very large detection range.

The specific objectives of this NPA are to improve the overall serviceability of flight recorders and facilitate the recovery of an aircraft and its flight recorders after an accident over water.

This NPA proposes:

— A draft Opinion amending Annexes IV (Part CAT), VI (Part NCC) and VIII (Part SPO) to Commission Regulation (EU) No 965/2012 as last amended by Commission Regulation (EU) No 800/2013;

— Draft Decisions amending ED Decision 2012/017/R (AMC/GM to Part ORO), ED Decision 2012/018/R (AMC/GM to Part CAT), ED Decision 2013/021/R (AMC/GM to Part NCC) and future ED Decision on AMC/GM to Part SPO.

The proposed changes are expected to increase safety by facilitating the recovery of information by safety investigation authorities. They will also improve ICAO compliance, and bring economic benefits for flight recorder maintenance and preservation and for the retrieval of an aircraft after an accident over water.

Applicability		**Process map**	
Affected regulations and decisions:	Annexes IV, VI and VIII to Commission Regulation (EU) No 965/2012 Decision 2012/017/R, Decision 2012/018/R, Decision 2013/021/R, future Decision on AMC/GM to Part SPO	Concept Paper:	No
		Terms of Reference:	24.09.2012
		Rulemaking group:	No
		RIA type:	Full & Light
Affected stakeholders:	Aircraft operators, flight crew members, aircraft pilots	Technical consultation during NPA drafting:	No
		Duration of NPA consultation:	3 months
Driver/origin:	Safety, Legal obligation (ICAO Standards)	Review group:	No
Reference:	ICAO Annex 6 Part I, Part II, and Part III Safety recommendations CAND-1999-002 (McDonnell Douglas MD11, HB-IWF, 02/09/1998), GREC-2006-045 (B737 of Helios, 5B-DBY, 14/08/2005), NORW-2006-013 (ATR 42, OY-JRJ 31/01/2005), NETH-2011-015 (Boeing 737, PH-BDP, 10/02/2010), UNKG-2012-013 (Boeing 767, G-OOBK, 03/10/2010), FRAN-2012-025 (Airbus 340, F-GLZU, 22/07/2011), FINL-2012-003 (Airbus A330, OH-LTO,11/12/2010), FRAN-2009-016, FRAN-2009-017, FRAN-2009-018, FRAN-2011-017 and FRAN-2011-018 (Airbus A330, F-GZCP, 01/06/2009), UNKG-2008-020 (ATR42, EI-SLD, 18/01/2007).	Focussed consultation:	No
		Publication date of the Opinion:	2015/Q2
		Publication date of the Decision:	2016/Q2

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1. Procedural information

1.1. The rule development procedure

The European Aviation Safety Agency (hereinafter referred to as the 'Agency') developed this Notice of Proposed Amendment (NPA) in line with Regulation (EC) No 216/2008[1] (hereinafter referred to as the 'Basic Regulation') and the Rulemaking Procedure[2].

This rulemaking activity is included in the Agency's Rulemaking Programme 2014-2017 as rulemaking tasks RMT.0400 and RMT.0401 (former task number OPS.090(a) and OPS.090(b)).

The text of this NPA has been developed by the Agency. It is hereby submitted for consultation of all interested parties[3].

The process map on the title page contains the major milestones of this rulemaking activity to date and provides an outlook of the timescale of the next steps.

1.2. The structure of this NPA and related documents

Chapter 1 of this NPA contains the procedural information related to this task. Chapter 2 (Explanatory Note) explains the core technical content. Chapter 3 contains the proposed text for the new requirements. The Regulatory Impact Assessments showing in details which options were considered and what impacts were identified, are contained in separate documents.

1.3. How to comment on this NPA

Please submit your comments using the automated **Comment-Response Tool (CRT)** available at **http://hub.easa.europa.eu/crt/**[4].

The deadline for submission of comments is **20 March 2014.**

1.4. The next steps in the procedure

Following the closing of the NPA public consultation period, the Agency will review all comments.

The outcome of the NPA public consultation will be reflected in the respective Comment-Response Document (CRD).

The Agency will publish the CRD together with the Opinion depending on the comments received during the public consultation phase of the NPA. The Decision will be published shortly after publication of the Regulation.

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1 Regulation (EC) No 216/2008 of the European Parliament and 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), as last amended by Commission Regulation (EU) No 6/2013 of 8 January 2013 (OJ L 4, 9.1.2013, p. 34).

2 The Agency is bound to follow a structured rulemaking process as required by Article 52(1) of the Basic Regulation. Such process has been adopted by the Agency's Management Board and is referred to as the 'Rulemaking Procedure'. See Management Board Decision concerning the procedure to be applied by the Agency for the issuing of Opinions, Certification Specifications and Guidance Material (Rulemaking Procedure), EASA MB Decision No 01-2012 of 13 March 2012.

3 In accordance with Article 52 of the Basic Regulation and Articles 5(3) and 6 of the Rulemaking Procedure.

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

Opinions published by the Agency contain proposed changes to EU regulations and are addressed to the European Commission as a technical basis for legislative proposals.

Decisions containing Acceptable Means of Compliance (AMC) and Guidance Material (GM) are published by the Agency once the related Implementing Rules are adopted.

2. Explanatory Note

2.1. Overview of the issues to be addressed

There are four issues covered by this NPA, each of them being addressed by a dedicated Regulatory Impact Assessment (RIA):

(a) The unreliability of obsolete recording technologies such as magnetic tape, magnetic wire and frequency modulation; these technologies are still in use among flight recorders on board aircraft registered in Europe (refer to RIA A: 'Discontinuation of obsolete recording technologies');

(b) Frequent cases of the cockpit voice recorder (CVR) overwriting the recording after an accident or a serious incident (also called 'CVR overrun'), making the CVR useless for the safety investigation (refer to RIA B: 'CVR overrun after an accident or a serious incident');

(c) The insufficient transmission time of underwater locating devices (ULD) fitted to flight recorders. In several cases, the signal of the flight recorder ULD faded out before it could be located (refer to RIA C: 'Transmission time of flight recorder underwater locating device'); and

(d) When insufficient information on the accident location is available, and when in addition the seafloor is so deep that the signal of a flight recorder ULD cannot be detected from the sea surface, locating the wreckage can be extremely challenging (refer to RIA D: 'Very long detection range underwater locating device for wreckage localisation in oceanic areas').

All four issues translate into essential recorded information or pieces of evidence being lost or recovered with very significant delay. They hinder or delay significantly the reconstruction of the sequence of events that led to an occurrence and the understanding of causes, making corrective actions impossible or too late.

2.2. 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 Chapter 2 of this NPA.

The specific objectives of this proposal are to address the issues of:

(a) obsolete recording technologies for flight recorders installed on board aeroplanes and helicopters required to carry a FDR or a CVR;

(b) CVR overruns for CVRs installed on board aeroplanes and helicopters required to carry a CVR;

(c) transmission time of flight recorder ULDs when considering aeroplanes and helicopters required to carry a FDR or a CVR; and

(d) safety benefits of an additional ULD with a much higher detection range for wreckage localisation in oceanic areas.

2.3. Overview of the proposals and impacts

Note:
This section contains a very succinct summary of the proposals of this NPA. More detailed information can be found in Chapter 4 and in the RIAs in the annexes to this NPA.

2.3.1. Preferred options

The preferred options are the following:

— Recommend more frequent recording inspections for flight recorders using magnetic wire and frequency modulation, and less frequent recording inspections for solid-state flight recorders;
— Recommend that the oral or visual means for pre-flight checking the flight recorder for proper operation are, when available, used every day. If these means are not available, an operational check of the flight recorders is recommended at time intervals not exceeding 7 days;
— Recommend that aircraft operators develop comprehensive procedures to ensure flight recorder preservation following an accident or serious incident or if directed by the investigation authority;
— Mandate that from 1 January 2019, the CVR fitting an aeroplane operated for commercial air transport has a minimum recording duration of 2 hours and is not recording on magnetic tape or magnetic wire;
— Mandate that from 1 January 2019, the CVR fitting an helicopter operated for commercial air transport is not recording on magnetic tape or magnetic wire; and
— Mandate that aeroplanes operated for commercial air transport with an MCTOM of over 27 000 kg and first issued with an individual CofA on or after 1 January 2019 be equipped with a CVR that has a minimum recording duration of 15 hours;
— Mandate that the ULDs of all crash-protected flight recorders have a transmission time of 90 days by 1 January 2020; and
— Mandate that large aeroplanes are equipped by 1 January 2019 with an 8.8 kHz ULD when they:
  - are operated for commercial air transport and performing long-range over-water flights,
  - were first issued with an individual CofA on or after 1 January 2005, and
  - are not equipped with a reliable means to determine, in case of an accident, the location of the impact point with the Earth surface within 6 NM accuracy.

2.3.2. Impacts

Table 1 presents a summary of the impacts of preferred options. In addition, a summary of quantified economic impacts is presented in Table 2. For more details, refer to Chapter 4.

Note 1:

The following acronyms are used for categories of impacts in Table 1:

— *SAF stands for Safety*
— *ECO stands for Economic*
— *PRP stands for Proportionality*
— *REG stands for Regulatory coordination and harmonisation*

Note 2:

In Table 1, '-/+' means a slightly negative/positive impact, '--/++' means a medium negative/positive impact, and '---/+++' means a very negative/positive impact

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Table 1 – Summary of impacts of the preferred options

<table>
<tr><th rowspan="2">Preferred options</th><th colspan="5">Impacts</th></tr>
<tr><th>SAF</th><th>ECO</th><th>PRP</th><th>REG</th><th>Overall</th></tr>
<tr><td>RIA A and RIA B:
— More frequent recording inspections for flight recorders using magnetic wire and frequency modulation, and fewer recording inspections for solid-state flight recorders; and
— Modify the OPS rules in order to mandate that from 1 January 2019:
• all aeroplanes operated for commercial air transport and required to carry a CVR, be fitted with a CVR having a minimum recording duration of 2 hours, that is not recording on magnetic tape or magnetic wire; and
• all helicopters operated for commercial air transport and required to carry a CVR, be fitted with a CVR that is not recording on magnetic tape or magnetic wire.
— Require that aircraft operators develop comprehensive procedures to ensure flight recorder preservation following an accident or serious incident, while relaxing the requirement in the case of an incident subject to mandatory reporting; and
— Require that all aeroplanes with an MCTOM of over 27 000 kg and first issued with an individual CofA on or after 1 January 2019 be equipped with a CVR with recording duration > 15 hours.</td><td>+++
(unreliable recording technologies are phased out and causes of CVR overruns are addressed)</td><td>++
(savings for solid-state recorders and less cases of mandatory preservation of flight recorders)</td><td>-
(small operators more impacted)</td><td>+
(better alignment with ICAO Annex 6)</td><td>+++</td></tr>
<tr><td>RIA C and RIA D:
— Mandate that the ULDs of crash-protected flight recorders fitting all aircraft required to carry a flight recorder have an underwater transmission time of 90 days by 1 January 2020.
— Mandate that aeroplanes which:
• have an MCTOM of over 27 000 kg, are operated for commercial air transport, perform long-range over-water flights, were first issued with an individual CofA on or after 1 January 2005, and
• are not equipped with a reliable means to determine, in case of an accident, the location of the impact point with the Earth surface within 6 NM accuracy,
are equipped by 1 January 2019 with an 8.8 kHz ULD.</td><td>+++
(robust solution to timely recover aircraft and flight recorder after an accident over water)</td><td>-/+
(retrofit cost for industry, savings for underwater search operation supports by States)</td><td>+
(the more expensive retrofit with an 8.8 kHz ULD is only for CAT operators of large aircraft performing oceanic flights)</td><td>+/++ +
(better alignment with ICAO Annex 6)</td><td>+++</td></tr>
</table>

Table 2 – Summary of quantified economic impacts of the preferred options

Preferred options	Differential cost with Option 0 ('do nothing')
Combined impacts of RIA A and RIA B	Total savings of EUR 82 823 000 for the period from 2015 to 2019, Annual savings of EUR 13 400 000 after 2019
Combined impacts of RIA C and RIA D	Cost of EUR 21 400 000 for the period from 2015 to 2019 When considering lower band of Option 0: annual savings of EUR 1 000 000 after 2019 for States (=21 years to cover the cost) When considering higher band of Option 0: annual savings of EUR 5 500 000 after 2019 for States (=4 years to cover the cost)

2.4. Overview of the proposed amendments

2.4.1. Content of the operations manual and preservation of flight recorder recordings

(a) It is proposed to amend AMC3 ORO.MLR.100 of the AMCs to Part ORO, which is about the content of the operations manual (OM) when the aircraft is used for commercial air transport.

(1) In section A of AMC3 ORO.MLR.100 (general requirements), the mention that the OM should contain procedures for the preservation of recordings is modified to mention that it is only necessary in case of an accident, a serious incident or when directed so by the investigating authority. Also, this provision is completed to recommend that a paragraph mentioning in the OM the obligation of the aircraft operator is quoted, and that instructions are specified to prevent any reactivation or maintenance on the flight recorders until decision is made by the investigation authority.

(2) In section B of AMC3 ORO.MLR.100 (aircraft type related information), a provision is added to recommend that a paragraph mentioning the obligation of the flight crew is quoted, and that instructions are specified so that the flight crew is able to effectively deactivate the flight recorders and to inform others.

(b) It is also proposed to amend AMC2 ORO.MLR.100 of the AMCs to Part ORO, which is about the content of the operations manual (OM) when the aircraft is complex and not used for commercial operations. The amended wording of paragraph (q) of AMC2 ORO.MLR.100 recommends explicitly that procedures preventing the inadvertent reactivation, repair or reinstallation of the flight recorders are inserted in the OM.

(c) It is proposed to amend the provisions of Part CAT and its AMCs related to the preservation of the flight recorder recordings by the flight crew and the aircraft operators.

(1) CAT.GEN.MPA.105(a)(10) is amended so that a distinction is made between occurrences subject to a safety investigation (accidents, serious incidents and some incidents investigated by the safety investigation authority) and occurrences that must simply be reported in accordance with paragraph ORO.GEN.160 of Part ORO. Indeed, since flight recorders are identified in the Minimum Equipment List of most aircraft, deactivating them each time an occurrence subject to mandatory reporting occurs can have a significant operational impact. There are many more occurrences subject to mandatory reporting than accidents and serious incidents. To address this issue, it is proposed that:

(i) occurrences subject to a safety investigation require taking all the measures necessary to preserve the flight recorder recordings, in accordance with Regulation (EU) No 996/2010;

(ii) other occurrences, which correspond to in-flight incidents and are much more frequent, do not require quarantining the flight recorders. Nevertheless, these occurrences are subject to mandatory reporting to the competent authority according to ORO.GEN.160(a). Therefore, the recording of flight recorders shall not be erased by the flight crew, as it could be useful for an internal incident analysis or for reassessing the aircraft type airworthiness in accordance with Commission Regulation (EU) No 748/2012;

(iii) since it may be difficult for the commander to determine quickly the severity of an occurrence, references to the definitions of an accident, a serious incident and an occurrence in Regulation (EU) 996/2010 and in Directive 2003/42/EC are provided in a newly created GM1 CAT.GEN.MPA.105(a)(10); and

(iv) it is also proposed to amend the provision requiring that the commander ensures that the flight recorders are not reactivated following an accident or a serious incident until the investigation authority agrees with their reactivation. The commander should only be responsible for ensuring that instructions in the operations manual are complied with and that precautionary measures are taken to preserve the recordings before leaving the flight deck. The operator is responsible for the subsequent actions.

(2) CAT.GEN.MPA.195(a) is modified so that the requirement on the aircraft operator to preserve the flight recorder recordings is restricted to accidents, serious incidents and incidents indicated by the investigation authority. Preserving the flight recorder recording has operational consequences and there are many more reportable occurrences according to ORO.GEN.160 than occurrences which are subject to an official safety investigation.

(3) A new AMC to CAT.GEN.MPA.195(a) is added to recommend that the operator defines robust procedures for preserving the flight recorder recordings in case of an accident, a serious incident or when directed so by the investigation authority. It echoes the additions proposed in AMC3 ORO.MLR.100, nevertheless, it is considered important that a provision appears directly in an AMC to Part CAT.

(4) The subtitle of GM1 CAT.GEN.MPA.195(a) is changed for consistency with the proposed changes to CAT.GEN.MPA.195(a) (see above).

(d) It is proposed, as for Part CAT, to amend the provisions of Part NCC and its AMCs related to the preservation of the flight recorder recordings by the flight crew and the aircraft operators.

(1) NCC.GEN.106(a)(9) is amended so that a distinction is made between occurrences subject to a safety investigation (accidents, serious incidents and some incidents indicated by the safety investigation authority) and occurrences that must simply be reported in accordance with a mandatory occurrence reporting system, if any. References to the definitions of an accident, a serious incident and an occurrence in Regulation (EU) No 996/2010 and in Directive 2003/42/EC are provided in a newly created GM1 NCC.GEN.106(a)(9). It is also proposed to amend the provision requiring that the commander ensures that the flight recorders are not reactivated following an accident or a serious incident until the investigation authority agrees with their reactivation.

(2) NCC.GEN.145(a) is modified so that the requirement on the aircraft operator to preserve the flight recorder recordings is restricted to accidents, serious incidents and incidents indicated by the investigation authority. Preserving the flight recorder recording has operational consequences and, depending on the mandatory occurrence reporting system in place for NCC aircraft, there could be many more reportable occurrences than those which are subject to an official safety investigation.

(3) A new AMC to NCC.GEN.145(a) is added to recommend that the operator defines robust procedures, included in the operations manual, for preserving the flight recorder recordings in case of an accident, a serious incident or when directed so by the investigation authority.

(4) The subtitle of GM1 NCC.GEN.145(a) is changed for consistency with the proposed changes to NCC.GEN.145(a) (see above).

(e) It is proposed, as for Part CAT, to amend the provisions of Part SPO and its AMCs related to the preservation of the flight recorder recordings by the flight crew and the aircraft operators.

(1) SPO.GEN.107(a)(9) is amended so that a distinction is made between occurrences subject to a safety investigation (accidents, serious incidents and some incidents indicated by the safety investigation authority) and occurrences that must simply be reported in accordance with a mandatory occurrence reporting system, if any. References to the definitions of an accident, a serious incident and an occurrence in Regulation (EU) No 996/2010 and in Directive 2003/42/EC are provided in a newly created GM1 SPO.GEN.107(a)(9). It is also proposed to amend the provision requiring that the commander ensures that the flight recorders are not reactivated following an accident or a serious incident until the investigation authority agrees with their reactivation.

(2) SPO.GEN.150(a) is modified so that the requirement on the aircraft operator to preserve the flight recorder recordings is restricted to accidents, serious incidents and incidents indicated by the investigation authority. Preserving the flight recorder recording has operational consequences and, depending on the mandatory occurrence reporting system in place for SPO aircraft, there could be many more reportable occurrences than those which are subject to an official safety investigation.

(3) A new AMC to SPO.GEN.150(a) is added to recommend that the operator defines robust procedures, included in the operations manual where applicable, for preserving the flight recorder recordings in case of an accident, a serious incident or when directed so by the investigation authority.

(4) The subtitle of GM1 SPO.GEN.150(a) is changed for consistency with the proposed changes to SPO.GEN.150(a) (see above).

2.4.2. Flight recorder serviceability tasks

(a) Several amendments are proposed for AMC1 CAT.GEN.MPA.195(b) on flight recorder operational checks:

(1) The condition 'fitted with an internal built-in-test equipment sufficient to monitor reception and recording of data' is replaced by 'fitted with continuous monitoring for proper operation' because it is less prescriptive and better aligned with the existing provisions of paragraph 1459 of Certification Specifications for large aeroplanes (CS-25) and of EUROCAE Specifications. In addition, this monitoring should apply to the flight recorder system, that is to say the flight recorder, its dedicated sensors and the dedicated acquisition equipment;

(2) The minimum frequency of recording inspections is increased to 4 times a year for flight recorders using magnetic wire or frequency modulation to mitigate the poor reliability of these recording technologies.

(3) Conversely, the minimum frequency of recording inspections is decreased to once every two years for solid-state flight recorders fitted with continuous self-monitoring, because such flight recorders are more reliable.

(4) The recording of a magnetic-tape flight recorder should still be inspected with the default periodicity of one year.

(5) A new provision is added recommending that the means for pre-flight checking the flight recorder for proper operation should be checked daily, when available, or that an alternative operational check is performed at time intervals not exceeding 7 days. This is consistent with the maximum duration recommended by the future Certification Specifications related to the development of a Master Minimum Equipment List (CS-MMEL) for flying with one flight recorder inoperative. This is made necessary by the extension of the time interval between recording inspections beyond 2 years for solid-state flight recorders, as, in that case, the serviceability of the solid-state flight recorder should be checked frequently. This new provision brings also OPS rules in better

compliance with ICAO Annex 6, as a Standard in Parts I and III of Annex 6 requires a daily operational check of flight recorders.

(6) The alleviation applicable to an aircraft equipped with two FDRs and the alleviation that applies to an aircraft equipped with two CVRs were felt too theoretical and not clear, therefore, they are replaced by the practical case these alleviations correspond to, namely an aircraft fitted with two flight data and cockpit voice combination recorders.

(7) The alleviation applicable to an aircraft equipped with a solid-state FDR and subject to an FDM programme is modified. In particular a minimum periodicity of 1 year is recommended for the inspection of the mandatory flight parameters. This is to make sure that at least once a year these parameters are checked for integrity, even if they are not used by the FDM programme.

(b) It is proposed to amend GM1 CAT.GEN.MPA.195(b) which contains guidance on how to perform the recording inspection. In particular, provisions are added in paragraph (a) to refer to the FDR decoding documentation that has to be retained by the aircraft operator, so that this documentation is indeed used for decoding FDR raw data and any inconsistency or missing data in this documentation is corrected.

(c) A new paragraph GM2 CAT.GEN.MPA.195(b) is proposed that refers to the CS-MMEL for assessing if a flight data recorder with non-valid flight parameters may still be considered operative. The Comment-Response Document to NPA 2011-11 containing the draft CS-MMEL is published.

(d) A new paragraph GM3 CAT.GEN.MPA.195(b) is added to provide definitions for the terms ‘continuous monitoring for proper operation’, ‘operational check’ and ‘means for pre-flight checking proper operation’ when applied to a flight recorder. A definition of a ‘flight recorder system’ is also provided. This new paragraph is meant to support the correct understanding of AMC1 CAT.GEN.MPA.195(b).

(e) Several amendments are proposed for AMC1 NCC.GEN.145(b) that are similar to those proposed for AMC1 CAT.GEN.MPA.195(b):

(1) The condition ‘fitted with an internal built-in-test equipment sufficient to monitor reception and recording of data’ is replaced by ‘fitted with continuous monitoring for proper operation’;

(2) The minimum frequency of recording inspections is increased to 4 times a year for flight recorders using magnetic wire or frequency modulation;

(3) The minimum frequency of recording inspections is decreased to once every two years for solid-state flight recorders fitted with continuous self-monitoring;

(4) A new provision is added recommending that the means for pre-flight checking the flight recorder for proper operation should be checked daily, when available, or that an alternative operational check is performed at time intervals not exceeding 7 days.

(5) The alleviations applicable to an aircraft equipped with two FDRs or with two CVRs are replaced by the practical case of an aircraft fitted with two flight data and cockpit voice combination recorders;

(6) The alleviation applicable to an aircraft equipped with a solid-state FDR and subject to an FDM programme is modified. In particular, a minimum periodicity of 1 year is recommended for the inspection of the mandatory flight parameters.

(f) It is proposed to amend GM1 NCC.GEN.145(b). In paragraph (a), provisions are added to refer to the FDR decoding documentation that has to be retained by the aircraft operator;

(g) A new paragraph GM2 NCC.GEN.145(b) is proposed that refers to the CS-MMEL for assessing if a flight data recorder with non-valid flight parameters may still be considered operative.

(h) A new paragraph GM3 NCC.GEN.145(b) is added to provide definitions for the terms 'continuous monitoring for proper operation', 'operational check', 'flight recorder system' and 'means for pre-flight checking proper operation', in order to support the correct understanding of AMC1 NCC.GEN.145(b).

(i) Several amendments are proposed for AMC1 SPO.GEN.145(b) that are similar to those proposed for AMC1 CAT.GEN.MPA.195(b):

(1) The condition 'fitted with an internal built-in-test equipment sufficient to monitor reception and recording of data' is replaced by 'fitted with continuous monitoring for proper operation';

(2) The minimum frequency of recording inspections is increased to 4 times a year for flight recorders using magnetic wire or frequency modulation;

(3) The minimum frequency of recording inspections is decreased to once every two years for solid-state flight recorders fitted with continuous self-monitoring;

(4) A new provision is added recommending that the means for pre-flight checking the flight recorder for proper operation should be checked daily, when available, or that an alternative operational check is performed at time intervals not exceeding 7 days;

(5) The alleviations applicable to an aircraft equipped with two FDRs or with two CVRs are replaced by the practical case of an aircraft fitted with two flight data and cockpit voice combination recorders.

(6) The alleviation applicable to an aircraft equipped with a solid-state FDR and subject to an FDM programme is modified, in particular a minimum periodicity of 1 year is recommended for the inspection of the mandatory flight parameters.

(j) It is proposed to amend GM1 SPO.GEN.145(b) in a manner similar to GM1 CAT.GEN.MPA.195(b). In paragraph (a), provisions are added to refer to the FDR decoding documentation that has to be retained by the aircraft operator.

(k) A new paragraph GM2 SPO.GEN.145(b) is proposed that refers to the CS-MMEL for assessing if a flight data recorder with non-valid flight parameters may still be considered operative.

(l) A new paragraph GM3 SPO.GEN.145(b) is added to provide definitions for the terms 'continuous monitoring for proper operation', 'operational check', 'flight recorder system' and 'means for pre-flight checking proper operation', in order to support the correct understanding of AMC1 SPO.GEN.145(b).

2.4.3. Flight recorder performance (commercial air transport)

(a) It is proposed to amend CAT.IDE.A.185 (CVR on board an aeroplane operated for commercial air transport), and more specifically CAT.IDE.A.185(b) so that after 1 January 2019:

(1) a CVR using obsolete recording technologies such as magnetic wire or magnetic tape is not allowed anymore,

(2) the CVR must have a minimum recording duration of at 2 hours, and

(3) for a newly manufactured aeroplane (first issued with an individual CofA on or after 1 January 2019) with an MCTOM of over 27 000 kg, the CVR must have a minimum recording duration of 15 hours.

(b) It is proposed to insert a provision into CAT.IDE.H.185 (CVR on board an helicopter operated for commercial air transport), so that after 1 January 2019 obsolete recording technologies such as magnetic wire or magnetic tape are not allowed anymore. However, the minimum recording duration of the CVR is not increased because there are no known cases of CVR overrun with a helicopter.

(c) It is proposed to complete the requirement of a ULD for the FDR, the CVR and the data link recorder (if applicable), by an additional requirement that after 1 January 2020, the ULD has a minimum underwater transmission time of 90 days. The modified provisions are CAT.IDE.A.185(f), CAT.IDE.A.190(e), CAT.IDE.A.195(d), CAT.IDE.H.185(f), CAT.IDE.H.190(e), and CAT.IDE.H.195(d). In addition, AMCs to these provisions are created, in order to introduce a reference to TSO-C121b, which contains the technical specifications of a 90-day ULD.

2.4.4. Flight over water

(a) It is proposed to insert a provision into CAT.IDE.A.185 (flight over water with an aeroplane operated for commercial air transport) to require that aeroplanes with an MCTOM of over 27 000 kg and first issued with an individual CofA on or after 1 January 2005 are, no later than 2019, equipped with an 8.8 kHz ULD (ULD with a very long detection range). There are two alleviations to this requirement:

(1) The aeroplane is operated over routes that do not go farther than 180 NM from a shore, meaning that the aeroplane does not fly over oceanic areas; or

(2) The aeroplane is equipped with an automatic means to determine, following an accident, the location of the point of impact with the Earth surface with sufficient accuracy (6 NM is proposed) so that the underwater search area is of a size that does not justify the use of an 8.8 kHz ULD.

(b) This new paragraph (f) of CAT.IDE.A.285 is completed with AMCs and GM:

(1) The draft AMC1 CAT.IDE.A.285(f) recommends that the 8.8 kHz ULD complies with ETSO-C200 of the Certification Specifications for European Technical Standard Orders (CS-ETSO), which is precisely specifying the performance of such a ULD, and that it is not installed in the wings or empennage, because there is a higher probability that these parts are separated from the rest of the aircraft after a mid-air collision or an in-flight breakup, or that they float and drift away from the location of the point of impact with water.

(2) The draft AMC2 CAT.IDE.A.285(f) provides conditions for the automatic means to determine, following an accident, the location of the point of impact, when it is used as an alternative to the 8.8 kHz ULD. In particular, this automatic means should be active throughout the flight, work almost everywhere on Earth, and work also in non-survivable conditions unlike current models of automatic fixed Emergency Locator Transmitter (ELT) which were primarily designed for helping search and rescue operations.

(3) The draft GM1 CAT.IDE.A.285(f) explains why the conventional ELT installations cannot be used as an acceptable means for determining the location of the point of impact after an accident. It also provides examples of technological solutions that have been identified by the Flight Data Recovery working group and the Triggered Flight Data Transmission working group as acceptable (Refer to RIA D).

2.4.5. Flight recorder performance (other than commercial air transport)

(a) It is proposed to amend NCC.IDE.A.160 (CVR on board an aeroplane operated for non-commercial operations) to require that in the case of an aeroplane first issued with an individual CofA on or after 1 January 2019 and with an MCTOM of over 27 000 kg, the CVR has a minimum recording duration of 15 hours.

(b) It is proposed to amend SPO.IDE.A.140 (CVR on board an aeroplane operated for specialised operations) to require that in the case of an aeroplane first issued with an individual CofA on or after 1 January 2019 and with an MCTOM of over 27 000 kg, the CVR has a minimum recording duration of 15 hours.

(c) It is proposed to complete, in Part NCC, the requirement of a ULD for the FDR, the CVR and the data link recorder (if applicable), by an additional requirement that after 1 January 2020, the ULD has a minimum underwater transmission time of 90 days. The modified provisions are NCC.IDE.A.160(f), NCC.IDE.A.165(e), NCC.IDE.A.170(d), NCC.IDE.H.160(f), NCC.IDE.H.165(e), and NCC.IDE.H.170(d). In addition, AMCs to these provisions are created, in order to introduce a reference to TSO-C121b, which contains the technical specifications of a 90-day ULD.

(d) It is proposed to complete, in Part SPO, the requirement of a ULD for the FDR, the CVR and the data link recorder (if applicable), by an additional requirement that after 1 January 2020, the ULD has a minimum underwater transmission time of 90 days. The modified provisions are SPO.IDE.A.140(f), SPO.IDE.A.145(e), SPO.IDE.A.150(d), SPO.IDE.H.140(f), SPO.IDE.H.145(e), and SPO.IDE.H.150(d). In addition AMCs to these provisions are created, in order to introduce a reference to TSO-C121b, which contains the technical specifications of a 90 day ULD.

2.5. Interface with airworthiness provisions

The proposals introduce a few new technologies in the air operation rules. Some of these new technologies are already taken into account by current Certification Specifications, while others are expected to be addressed in future revisions of Certification Specifications:

— ETSO-C121b applicable to flight recorder ULDs refers to industry standard SAE AS8045A, which specifies that such ULDs should have an underwater transmission time of at least 90 days. Therefore, this ETSO does not need to be amended;

— ETSO-C123b needs to be updated to refer to revision A of EUROCAE Document 112, in which a new class of CVRs with a recording duration of 15 hours is introduced;

— ETSO-C124b applicable to FDRs already refers to EUROCAE Document 112, which already provides specifications applicable to solid-state flight recorders. Therefore, this ETSO does not need to be amended;

— An AMC for the 'aural or visual means for pre-flight checking the recorder for proper operation' of the CVR is missing in paragraph 1457 of Certification Specifications for large aeroplanes (CS-25), large rotorcraft (CS-29), normal, utility, aerobatic and commuter aeroplanes (CS-23) and small rotorcraft (CS-27). Such an AMC is already defined for the FDR.

3. Proposed amendments

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

(a) deleted text is marked with ~~strike through~~;

(b) new or amended text is highlighted in grey;

(c) an ellipsis (…) indicates that the remaining text is unchanged in front of or following the reflected amendment.

3.1. Draft amendment of air operation rules (Draft EASA Opinion)

Draft amendment of Annexes to Commission Regulation (EU) No 965/2012 – air operation rules

3.1.1. Amendments to Annex IV (Part CAT — Commercial air transport operations)

SUBPART A – GENERAL REQUIREMENTS

CAT.GEN.MPA.105 Responsibilities of the commander

(a) The commander, in addition to complying with CAT.GEN.MPA.100, shall:

(…)

(10) ensure that ~~flight recorders~~:

(i) flight recorders are not disabled or switched off during flight; ~~and~~

(ii) in the event of an occurrence other than an accident or a serious incident that shall be reported according to ORO.GEN.160(a), flight recorders are not intentionally erased; and

~~(ii)~~(iii) in the event of an accident or a serious incident, or if preservation of recordings of flight recorders is directed by the investigating authority: ~~or an incident that is subject to mandatory reporting:~~

(A) flight recorders are not intentionally erased;

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

(C) precautionary measures to preserve the recordings of flight recorders are taken before leaving the flight deck.

(…)

CAT.GEN.MPA.195 Preservation, production and use of flight recorder recordings

(a) Following an accident or a serious incident, or if directed by the investigating authority, the operator of an aircraft shall preserve the original recorded data for a period of 60 days or until otherwise directed by the investigating authority.

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

(c) (…)

SUBPART D – INSTRUMENTS, DATA, EQUIPMENT

SECTION 1 -Aeroplanes

CAT.IDE.A.185 Cockpit voice recorder

(a) The following aeroplanes shall be equipped with a cockpit voice recorder (CVR):

(1) aeroplanes with an MCTOM of more than 5 700 kg; and

(2) multi-engined turbine-powered aeroplanes with an MCTOM of 5 700 kg or less, with an MOPSC of more than nine and first issued with an individual CofA on or after 1 January 1990.

(b) Until 31 December 2018, the CVR shall be capable of retaining the data recorded during at least:

(1) the preceding two hours in the case of aeroplanes referred to in (a)(1) when the individual CofA has been issued on or after 1 April 1998;

(2) the preceding 30 minutes for aeroplanes referred to in (a)(1) when the individual CofA has been issued before 1 April 1998; or

(3) the preceding 30 minutes, in the case of aeroplanes referred to in (a)(2).

(c) From 1 January 2019, the CVR installed on board an aeroplane shall not record on a magnetic tape or a magnetic wire, and it shall be capable of retaining the data recorded during at least:

(1) the preceding 15 hours for aeroplanes with an MCTOM of more than 27 000 kg and first issued with an individual CofA on or after 1 January 2019; or

(2) the preceding 2 hours for aeroplanes with an MCTOM of up to 27 000 kg or that were first issued with an individual CofA before 1 January 2019.

~~(c)~~(d) The CVR shall record with reference to a timescale:

(1) voice communications transmitted from or received in the flight crew compartment by radio;

(2) flight crew members' voice communications using the interphone system and the public address system, if installed;

(3) the aural environment of the flight crew compartment, including without interruption:

(i) for aeroplanes first issued with an individual CofA on or after 1 April 1998, the audio signals received from each boom and mask microphone in use;

(ii) for aeroplanes referred to in (a)(2) and first issued with an individual CofA before 1 April 1998, the audio signals received from each boom and mask microphone, where practicable;

and

~~(d)~~(e) The CVR shall start to record prior to the aeroplane moving under its own power and shall continue to record until the termination of the flight when the aeroplane is no longer capable of moving under its own power. In addition, in the case of aeroplanes issued with an individual CofA on or after 1 April 1998, the CVR shall start automatically to record prior to the aeroplane moving under its own power and continue to record until the termination of the flight when the aeroplane is no longer capable of moving under its own power. (4) voice or audio signals identifying navigation or approach aids introduced into a headset or speaker.

~~(e)~~(f) In addition to (d), depending on the availability of electrical power, the CVR shall start to record as early as possible during the cockpit checks prior to engine start at the beginning of the flight until the cockpit checks immediately following engine shutdown at the end of the flight, in the case of:

(1) aeroplanes referred to in (a)(1) and issued with an individual CofA after 1 April 1998; or

(2) aeroplanes referred to in (a)(2).

~~(f)~~(g) The CVR shall have a device to assist in locating it in water. From 1 January 2020, this device shall have a minimum underwater transmission time of 90 days.

CAT.IDE.A.190 Flight data recorder

(…)

(e) The FDR shall have a device to assist in locating it in water. From 1 January 2020, this device shall have a minimum underwater transmission time of 90 days.

CAT.IDE.A.195 Data link recording

(…)

(d) The recorder shall have a device to assist in locating it in water. From 1 January 2020, this device shall have a minimum underwater transmission time of 90 days.

(…)

CAT.IDE.A.285 Flight over water

(…)

(f) From 1 January 2019, aeroplanes with an MCTOM of more than 27 000 kg and first issued with an individual CofA on or after 1 January 2005 shall be fitted with a securely attached underwater locating device that operates at a frequency of 8.8 kHz ± 1 kHz, unless:

(1) The aeroplane is operated over routes on which it is at no point at a distance of more than 180 NM from the shore; or

(2) The aeroplane is equipped with an automatic means to determine, following an accident, the location of the point of impact with the Earth's surface within 6 NM accuracy.

Section 2 - Helicopters

CAT.IDE.H.185 Cockpit voice recorder

(…)

(c) From 1 January 2019, the CVR installed on board an helicopter shall not record on a magnetic tape or a magnetic wire.

(d)~~(c)~~ The CVR shall record with reference to a timescale: (…)

(e)~~(d)~~ The CVR shall start to record prior to the helicopter moving under its own power and shall continue to record until the termination of the flight when the helicopter is no longer capable of moving under its own power.

(f)~~(e)~~ In addition to (d), (…)

(g)~~(f)~~ The CVR shall have a device to assist in locating it in water. From 1 January 2020, this device shall have a minimum underwater transmission time of 90 days.

CAT.IDE.H.190 Flight data recorder

(…)

(e) The FDR shall have a device to assist in locating it in water. From 1 January 2020, this device shall have a minimum underwater transmission time of 90 days.

CAT.IDE.H.195 Data link recording

(…)

(d) The recorder shall have a device to assist in locating it in water. From 1 January 2020, this device shall have a minimum underwater transmission time of 90 days.

(…)

3.1.2 Amendments to Annex VI (Part NCC Non-commercial operations with complex motor-powered aircraft)

SUBPART A – GENERAL REQUIREMENTS

NCC.GEN.106 Pilot-in-command responsibilities and authority

(a) The pilot-in-command shall be responsible for:

(…)

(9) ensuring that ~~flight recorders~~:

(i) flight recorders are not disabled or switched off during flight; and

(ii) in the event of an occurrence other than an accident or a serious incident that shall be reported according to ORO.GEN.160(a), flight recorders are not intentionally erased; and

~~(ii)~~(iii) in the event of an accident or a serious incident, or if preservation of recordings of flight recorders is directed by the investigating authority: ~~or an incident that is subject to mandatory reporting:~~

(A) flight recorders are not intentionally erased;

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

(C) precautionary measures to preserve the recordings of flight recorders are taken before leaving the flight deck.

(…)

NCC.GEN.145 Preservation, production and use of flight recorder recordings

(a) Following an accident ~~or an incident that is subject to mandatory reporting~~, a serious incident or if directed by the investigating authority, the operator of an aircraft shall preserve the original recorded data for a period of 60 days ~~unless~~ or until otherwise directed by the investigating authority.

(…)

SUBPART D – INSTRUMENTS, DATA AND EQUIPMENT

Section 1 – Aeroplanes

NCC.IDE.A.160 Cockpit voice recorder

(…)

(b) The CVR shall be capable of retaining data recorded during at least ~~the preceding 2 hours~~:

(1) the preceding 15 hours for aeroplanes with an MCTOM of more than 27 000 kg and first issued with an individual CofA on or after 1 January 2019; or

(2) the preceding 2 hours for aeroplanes with an MCTOM of up to 27 000 kg or that were first issued with an individual CofA before 1 January 2019.

(…)

(f) The CVR shall have a device to assist in locating it in water. From 1 January 2020, this device shall have a minimum underwater transmission time of 90 days.

NCC.IDE.A.165 Flight data recorder

(…)

(e) The FDR shall have a device to assist in locating it in water. From 1 January 2020, this device shall have a minimum underwater transmission time of 90 days.

NCC.IDE.A.170 Data link recording

(…)

(d) The recorder shall have a device to assist in locating it in water. From 1 January 2020, this device shall have a minimum underwater transmission time of 90 days.

(…)

Section 2 – Helicopters

NCC.IDE.H.160 Cockpit voice recorder

(…)

(f) The CVR shall have a device to assist in locating it in water. From 1 January 2020, this device shall have a minimum underwater transmission time of 90 days.

NCC.IDE.H.165 Flight data recorder

(…)

(e) The FDR shall have a device to assist in locating it in water. From 1 January 2020, this device shall have a minimum underwater transmission time of 90 days.

NCC.IDE.H.170 Data link recording

(…)

(d) The recorder shall have a device to assist in locating it in water. From 1 January 2020, this device shall have a minimum underwater transmission time of 90 days.

(…)

3.1.3 Amendments to Annex VIII (Part SPO — Specialised operations)

SUBPART A – GENERAL REQUIREMENTS

SPO.GEN.107 Pilot-in-command responsibilities and authority

(a) The pilot-in-command shall be responsible for:

(…)

(9) ensuring that~~, when installed, flight recorders~~:

(i) flight recorders are not disabled or switched off during flight; ~~and~~

(ii) in the event of an an occurrence other than an accident or a serious incident that shall be reported according to ORO.GEN.160(a), flight recorders are not intentionally erased; and

~~(ii)~~(iii) in the event of an accident or a serious incident, or if preservation of recordings of flight recorders is directed by the investigating authority: ~~or an incident that is subject to mandatory reporting:~~

(A) flight recorders are not intentionally erased;

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

(C) precautionary measures to preserve the recordings of flight recorders are taken before leaving the flight deck.

(…)

SPO.GEN.150 Preservation, production and use of flight recorder recordings — operations with complex motor-powered aircraft

(a) Following an accident or a serious incident or if directed by the investigating authority, the operator of an aircraft shall preserve the original recorded data for a period of 60 days ~~unless~~ or until otherwise directed by the investigating authority.

(…)

SUBPART D – INSTRUMENTS, DATA AND EQUIPMENT

Section 1 – Aeroplanes

SPO.IDE.A.140 Cockpit voice recorder

(…)

(b) The CVR shall be capable of retaining data recorded during at least ~~the preceding 2 hours~~:

(1) the preceding 15 hours for aeroplanes with an MCTOM of more than 27 000 kg and first issued with an individual CofA on or after 1 January 2019; or

(2) the preceding 2 hours for aeroplanes with an MCTOM of up to 27 000 kg or that were first issued with an individual CofA before 1 January 2019.

(…)

(f) The CVR shall have a device to assist in locating it in water. From 1 January 2020, this device shall have a minimum underwater transmission time of 90 days.

SPO.IDE.A.145 Flight data recorder

(…)

(e) The FDR shall have a device to assist in locating it in water. From 1 January 2020, this device shall have a minimum underwater transmission time of 90 days.

SPO.IDE.A.150 Data link recording

(…)

(d) The recorder shall have a device to assist in locating it in water. From 1 January 2020, this device shall have a minimum underwater transmission time of 90 days.

(…)

Section 2 – Helicopters

SPO.IDE.H.140 Cockpit voice recorder

(…)

(f) The CVR shall have a device to assist in locating it in water. From 1 January 2020, this device shall have a minimum underwater transmission time of 90 days.

SPO.IDE.H.145 Flight data recorder

(…)

(e) The FDR shall have a device to assist in locating it in water. From 1 January 2020, this device shall have a minimum underwater transmission time of 90 days.

SPO.IDE.H.150 Data link recording

(…)

(d) The recorder shall have a device to assist in locating it in water. From 1 January 2020, this device shall have a minimum underwater transmission time of 90 days.

(…)

3.2. Draft amendment of Acceptable Means of Compliance and Guidance Material of air operation rules (Draft EASA Decision)

3.2.1 Amendment of AMC/GM to Annex III (Part ORO Organisation requirements)

Subpart MLR – Manuals, logs and records

AMC2 ORO.MLR.100 Operations manual — General

CONTENTS – NON-COMMERCIAL OPERATIONS WITH COMPLEX MOTOR-POWERED AIRCRAFT
The OM should contain at least the following information, where applicable:
(…)
(q) ~~Use/protection of flight data recorder (FDR)/cockpit voice recorder (CVR) records, where applicable~~ Procedures for the preservation of recordings of the flight recorders, in order to prevent inadvertent reactivation, repair or reinstallation of the flight recorders following an accident or a serious incident or when this preservation is directed by the investigation authority.

AMC3 ORO.MLR.100 Operations manual — General

CONTENTS — COMMERCIAL AIR TRANSPORT OPERATIONS

(a) The OM should contain at least the following information, where applicable, as relevant for the area and type of operation:

A GENERAL/BASIC

(…)

11 HANDLING, NOTIFYING AND REPORTING ACCIDENTS, INCIDENTS AND OCCURRENCES

Procedures for handling, notifying and reporting accidents, incidents and occurrences. This section should include the following:

(…)

(g) Procedures for the preservation of recordings following ~~a reportable event~~ an accident or a serious incident or when so directed by the investigation authority. These procedures should include:

(1) a full quote of the following paragraph:

'According to air operation rules, following an accident or a serious incident or if directed by the investigation authority, the operator of an aircraft shall preserve the original recorded data for a period of 60 days or until otherwise directed by the investigating authority.'; 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.

(…)

B AIRCRAFT OPERATING MATTERS – TYPE RELATED

Taking account of the differences between types/classes, and variants of types, under the following headings:

(…)

12 PROCEDURES FOR THE PRESERVATION OF FLIGHT RECORDER RECORDINGS FOLLOWING AN ACCIDENT OR A SERIOUS INCIDENT OR WHEN SO DIRECTED BY THE INVESTIGATION AUTHORITY

12.1 A full quote of the following paragraph:

'According to accident investigation rules, any person involved in an investigated occurrence shall take all necessary steps to preserve documents, material and recordings in relation to the event, in particular so as to prevent erasure of recordings of conversations and alarms after the flight. According to air operation rules, the commander or the pilot-in-command is responsible for the preservation of the recordings of flight recorders.'

and

12.2 Instructions and means for the flight crew to deactivate the flight recorders immediately after completion of the flight and inform others that the flight recorder recordings shall be preserved.

~~12~~13 AIRCRAFT SYSTEMS

A description of the aircraft systems, related controls and indications and operating instructions. Consideration should be given to use the ATA number system when allocating chapters and numbers.

(…)

3.2.2 Amendment of AMC/GM to Annex IV (Part CAT — Commercial air transport operations)

Subpart A – General requirements

Section 1 – Motor-powered aircraft

GM1 CAT.GEN.MPA.105(a)(10) Responsibilities of the commander

IDENTIFICATION OF THE SEVERITY OF AN OCCURRENCE BY THE COMMANDER

For the purpose of quick identification of occurrences that must be reported and of occurrences subject to an official safety investigation:

(a) definitions of an accident and a serious incident as well as examples of serious incidents are provided in Regulation (EU) No 996/2010 of the European Parliament and of the Council; and

(b) the definition of an occurrence other than an accident or a serious incident, and examples thereof, are provided in Directive 2003/42/EC.

AMC1 CAT.GEN.MPA.195(a) Preservation, production and use of flight recorder recordings

PRESERVATION OF RECORDED DATA FOR THE INVESTIGATION

(a) The operator should establish robust procedures to ensure that flight recorder recordings are appropriately preserved for the investigating authority.

(b) The procedures should include:

(1) instructions for flight crew members to deactivate the flight recorders immediately after completion of the flight and to preserve their recording; and

(2) instructions to prevent inadvertent reactivation, test, repair or reinstallation of the flight recorders by operator personnel or during maintenance or ground handling activities performed by third parties.

GM1 CAT.GEN.MPA.195(a) Preservation, production and use of flight recorder recordings

REMOVAL OF RECORDERS IN CASE OF AN INVESTIGATION

The need for removal of the recorders from the aircraft is determined by the investigating authority with due regard to the seriousness of an occurrence and the circumstances, including the impact on the operation.

AMC1 CAT.GEN.MPA.195(b) Preservation, production and use of flight recorder recordings

~~OPERATIONAL~~ CHECKS AND INSPECTIONS OF RECORDINGS

Whenever a recorder is required to be carried~~, the operator should~~:

(a) the operator should perform an ~~annual~~ inspection of FDR recording and CVR recording every year, unless one or more of the following applies:

(1) The time interval between two inspections of the recording should not exceed 3 months for a flight recorder that is recording on magnetic wire or is using frequency modulation technology.

~~(1) Where two solid-state FDRs both fitted with internal built-in-test equipment sufficient to monitor reception and recording of data share the same acquisition unit, a~~

~~comprehensive recording inspection need only be performed for one FDR. For the second FDR, checking its internal built-in test equipment is sufficient. The inspection should be performed alternately such that each FDR is inspected once every other year.~~

(2) The time interval between two inspections of the recording may be up to 2 years if the flight recorder is solid-state and the flight recorder system is fitted with continuous monitoring for proper operation.

(3) In the case of an aircraft equipped with two solid-state flight data and cockpit voice combination recorders, where

(i) the flight recorder systems are fitted with continuous monitoring for proper operation, and

(ii) the flight recorders share the same flight data acquisition,

a comprehensive inspection of the recording need only to be performed for one flight recorder position. The inspection should be performed alternately such that each flight recorder position is inspected at least every 4 years.

(4)~~(2)~~ Where all of the following conditions are met, the ~~FDR recording~~ inspection of the FDR recording is not needed:

(i) the aircraft flight data are collected in the frame of a flight data monitoring (FDM) programme;

(ii) the data acquisition of mandatory flight parameters is the same for the FDR and for the recorder used for the FDM programme;

(iii) the integrity of all mandatory flight parameters is verified by the FDM programme at time intervals not exceeding 1 year; and

(iv) the FDR is solid-state and the FDR system is fitted with continuous monitoring for proper operation ~~an internal built-in-test equipment sufficient to monitor reception and recording of data~~.

~~(3) Where two solid-state CVRs are both fitted with internal built-in-test equipment sufficient to monitor reception and recording of data, a comprehensive recording inspection need only to be performed for one CVR. For the second CVR, checking its internal built-in-test equipment is sufficient. The inspection should be performed alternately such that each CVR is inspected once every other year.~~

(b) the operator should perform every 5 years an inspection of the data link recording.

(c) when installed, the aural or visual means for pre-flight checking the flight recorders for proper operation should be used every day. 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 7 days.

~~(c)~~(d) the operator should check every 5 years, or in accordance with the recommendations of the sensor manufacturer (…)

GM1 CAT.GEN.MPA.195(b) Preservation, production and use of flight recorders recordings

INSPECTION OF THE FLIGHT RECORDERS RECORDINGS

(a) The inspection of the FDR recording 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 .

~~(2)~~(3) Examining a whole flight in engineering units to evaluate the validity of all mandatory parameters - this could reveal defects or noise in the measuring and processing chains and indicate necessary maintenance actions. The following should be considered:

(i) when applicable, each parameter should be expressed in engineering units and checked for different values of its operational range - for this purpose, some parameters may need to be inspected at different flight phases; and

(ii) if the parameter is delivered by a digital data bus and the same data are utilised for the operation of the aircraft, then a reasonableness check may be sufficient; otherwise a correlation check may need to be performed;

(A) a reasonableness check is understood in this context as a subjective, qualitative evaluation, requiring technical judgement, of the recordings from a complete flight; and

(B) a correlation check is understood in this context as the process of comparing data recorded by the flight data recorder against the corresponding data derived from flight instruments, indicators or the expected values obtained during specified portion(s) of a flight profile or during ground checks that are conducted for that purpose.

~~(3)~~(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.

(…)

GM2 CAT.GEN.MPA.195(b) Preservation, production and use of flight recorders recordings

FDR WITH FLIGHT PARAMETERS NOT PROPERLY RECORDED

Certification Specifications and Guidance Material related to the development of a Master Minimum Equipment List, item 31-31-1 (FDR) determines the conditions under which an FDR with flight parameters not properly recorded may be considered inoperative.

GM3 CAT.GEN.MPA.195(b) Preservation, production and use of flight recorders recordings

MONITORING AND CHECKING THE PROPER OPERATION OF FLIGHT RECORDERS

For the purpose of operational checks:

(a) the operational check of a flight recorder is a check of the flight recorder for proper operation. It is not a check of the quality of the recording, and, therefore, it is not equivalent to a inspection of the recording.

(b) an 'aural or visual means for pre-flight checking a flight recorder for proper operation' is an aural or visual means for the flight crew to check, before the flight, the results of an automatically or manually initiated test of the flight recorder for proper operation. Such a means provides for an operational check that can be performed by the flight crew.

(c) Checking through a maintenance task, the proper operation of a flight recorder is also an operational check.

(d) the 'flight recorder system' designates the flight recorder, its dedicated sensors and transducers and its dedicated acquisition and processing equipment.

(e) 'continuous monitoring for proper operation' means for a flight recorder system, a combination of system monitors and built-in test functions which operates continuously in order to detect the following:

(i) Loss of electrical power to the flight recorder system;

(ii) Failure of the equipment performing acquisition and processing;

(iii) Failure of the recording medium and/or drive mechanism; and

(iv) Failure of the recorder to store the data in the recording medium as shown by checks of the recorded data including, as reasonably practicable for the storage medium concerned, correct correspondence with input data.

Subpart D – Instruments, data, equipment

Section 1 – Aeroplanes

AMC1 CAT.IDE.A.185(f) Cockpit voice recorder

COCKPIT VOICE RECORDER UNDERWATER LOCATING DEVICE

From 1 January 2020, the underwater locating device should be as defined in ETSO-C121b or equivalent.

AMC1 CAT.IDE.A.190(e) Flight data recorder

FLIGHT DATA RECORDER UNDERWATER LOCATING DEVICE

From 1 January 2020, the underwater locating device should be as defined in ETSO-C121b or equivalent.

AMC1 CAT.IDE.A.195(d) Data link recording

UNDERWATER LOCATING DEVICE

From 1 January 2020, the underwater locating device should be as defined in ETSO-C121b or equivalent.

AMC1 CAT.IDE.A.285(f) Flight over water

LOW-FREQUENCY UNDERWATER LOCATING DEVICE

(a) The aircraft underwater locating device should be as defined in ETSO-C200 or equivalent.

(b) The aircraft underwater locating device should not be installed in wings or empennage.

AMC2 CAT.IDE.A.285(f) Flight over water

AUTOMATIC MEANS TO DETERMINE THE LOCATION OF THE POINT OF IMPACT WITH THE EARTH'S SURFACE WITHIN 6 NM ACCURACY

(a) The automatic means to determine the location of the point of impact with the Earth's surface within 6 NM accuracy should:

(1) be operational whenever the aeroplane is airborne;

(2) be so designed that it is very likely to work, indistinctively if the accident is survivable or not;

(3) work at most locations on Earth, including oceanic areas and remote land areas; and

(4) be so designed that the location of the point of impact can be determined within 6 NM accuracy and within 3 hours of the accident time.

(b) The automatic means to determine the location of the point of impact with the Earth's surface within 6 NM accuracy may use any technology. However, an automatic fixed ELT or an automatic portable ELT are not acceptable if they are not designed to successfully emit in extreme non-survivable accident conditions. In addition, an automatic deployable ELT that only relies on water immersion sensors and negative acceleration sensors ('g' switches) for detecting impact with water or ground is not acceptable.

GM1 CAT.IDE.A.285(f) Flight over water

AUTOMATIC MEANS TO DETERMINE THE LOCATION OF THE POINT OF IMPACT WITH THE EARTH'S SURFACE WITHIN 6 NM ACCURACY

(a) Historical data of large aeroplane accidents that occurred in the 1990s and 2000s have shown that quite frequently the ELT, while compliant with industry standards, did not emit a signal because it was destroyed, its antenna was destroyed or the link between the ELT and the antenna was cut. It is expected that if used to comply with CAT.IDE.A.285(f)(2), an automatic fixed ELT or an automatic portable ELT would be capable of emitting a signal upon detection of an emergency situation (i.e. before the time of impact) or that it would be designed to successfully emit a signal even in non-survivable accident conditions.

(b) Historical data of helicopter accidents in the 1990s and 2000s have revealed many cases of unintended deployment or missed deployment of automatic deployable ELTs due to their negative acceleration sensors ('g' switches). Several cases of premature end of recording with flight recorders installed on board aeroplane and helicopters involved in accidents have raised concern about the reliability of 'g' switches for detecting impact initiation. This is why EUROCAE Document 112 (Minimum Operational Performance Specifications for crash-protected airborne recorder systems) specifies that the impact sensors of an automatic deployable flight recorder should be designed such that they will only trigger when the structure has been significantly deformed, and that negative acceleration sensors should not be used as the sole means of detection. It is expected that if used to comply with CAT.IDE.A.285(f)(2), an automatic deployable ELT would have impact detection means as robust as those specified for automatic deployable flight recorders.

(c) Examples of automatic means to determine the location of the point of impact with the Earth's surface within 6 NM accuracy are:

(1) periodic transmission by the aeroplane of its latitude and longitude, from take-off to landing, at time intervals not exceeding 1 minute and to a ground infrastructure where they are stored; the transmission would be successful from most locations on Earth and robust to loss of normal electrical power on board;

(2) emission by the aeroplane of a signal upon detection of an emergency situation or a situation likely to result into an accident. The emission would start within seconds of detection and continue until the detection criteria have disappeared. The emission would be robust to high aircraft attitudes and to loss of normal electrical power on board. There would be reliable ground infrastructure to receive the emergency signal, store it and trigger an alert. The signal would contain position information or post-processing of the signal would allow determining the aircraft position. Examples of criteria triggering transmission are: unusual aircraft attitude, unusual airspeed or vertical speed, stall, excessive accelerations, GPWS/TAWS hard warning, ACAS/TCAS Resolution Advisory, cabin altitude warning, fire warning, multiple engine failure;

(3) an automatic deployable flight recorder fitted with an ELT, as defined in ETSO-C123b, ETSO-C124b, ETSO-C177 or equivalent.

Section 2 - Helicopters

AMC1 CAT.IDE.H.185(g) Cockpit voice recorder

COCKPIT VOICE RECORDER UNDERWATER LOCATING DEVICE

From 1 January 2020, the underwater locating device should be as defined in ETSO-C121b or equivalent.

AMC1 CAT.IDE.H.190(e) Flight data recorder

FLIGHT DATA RECORDER UNDERWATER LOCATING DEVICE

From 1 January 2020, the underwater locating device should be as defined in ETSO-C121b or equivalent.

AMC1 CAT.IDE.H.195(d) Data link recording

UNDERWATER LOCATING DEVICE

From 1 January 2020, the underwater locating device should be as defined in ETSO-C121b or equivalent.

3.2.3 Amendment of AMC/GM to Annex VI (Part NCC Non-commercial operations with complex motor-powered aircraft)

Subpart A — General requirements

GM1 NCC.GEN.106(a)(9) Pilot-in-command responsibilities and authority

IDENTIFICATION OF THE SEVERITY OF AN OCCURRENCE BY THE PILOT-IN-COMMAND

For the purpose of quick identification of occurrences that must be reported and of occurrences subject to an official safety investigation:

(a) definitions of an accident and a serious incident as well as examples of serious incidents are provided in Regulation (EU) No 996/2010 of the European Parliament and of the Council; and

(b) the definition of an occurrence other than an accident or a serious incident, and examples thereof, are provided in Directive 2003/42/EC.

AMC1 NCC.GEN.145(a) Preservation, production and use of flight recorder recordings

PRESERVATION OF RECORDED DATA FOR THE INVESTIGATION

(a) The operator should establish robust procedures to ensure that flight recorder recordings are appropriately preserved for the investigating authority.

(b) The procedures should include:

  (1) instructions for pilots to deactivate the flight recorders immediately after completion of the flight and to preserve their recording; and

  (2) instructions to prevent inadvertent reactivation, repair or reinstallation of the flight recorders by any operator personnel, or during maintenance or ground handling activities performed by third parties.

GM1 NCC.GEN.145(a) Preservation, production and use of flight recorder recordings

REMOVAL OF RECORDERS ~~AFTER A REPORTABLE OCCURENCE~~IN CASE OF AN INVESTIGATION

The need for removal of the recorders from the aircraft is determined by the investigating authority with due regard to the seriousness of an occurrence and the circumstances, including the impact on the operation.

AMC1 NCC.GEN.145(b) Preservation, production and use of flight recorder recordings

~~OPERATIONAL~~ CHECKS AND INSPECTIONS OF RECORDINGS

Whenever a recorder is required to be carried~~, the operator should~~:

(a) The operator should perform an ~~annual~~ inspection of ~~flight data recorder (FDR) recording and cockpit voice recorder (CVR) recording~~ FDR recording and CVR recording every year, unless one or more of the following applies:

(1) The time interval between two inspections of the recording should not exceed 3 months for a flight recorder that is recording on magnetic wire or is using frequency modulation technology.

~~(1) Where two solid-state FDRs both fitted with internal built-in-test equipment sufficient to monitor reception and recording of data share the same acquisition unit, a comprehensive recording inspection need only be performed for one FDR. For the second FDR, checking its internal built-in-test equipment is sufficient. The inspection should be performed alternately such that each FDR is inspected once every other year.~~

(2) The time interval between two inspections of the recording may be up to 2 years if the flight recorder is solid-state and the flight recorder system is fitted with continuous monitoring for proper operation.

(3) In the case of an aircraft equipped with two solid-state flight data and cockpit voice combination recorders, where

(i) the flight recorder systems are fitted with continuous monitoring for proper operation, and

(ii) the flight recorders share the same flight data acquisition unit,

a comprehensive inspection of the recording needs only to be performed for one flight recorder position. The inspection should be performed alternately such that each flight recorder position is inspected at least every 4 years.

~~(2)~~ (4) Where all of the following conditions are met, the ~~FDR recording~~ inspection of FDR recording is not needed:

(i) the aircraft flight data are collected in the frame of a flight data monitoring (FDM) programme;

(ii) the data acquisition of mandatory flight parameters is the same for the FDR and for the recorder used for the FDM programme;

(iii) the integrity of all mandatory flight parameters is verified by the FDM programme at time intervals not exceeding 1 year; and

(iv) the FDR is solid-state and the FDR system is fitted with continuous monitoring for proper operation ~~an internal built-in-test equipment sufficient to monitor reception and recording of data~~.

~~(3) Where two solid-state CVRs are both fitted with internal built-in-test equipment sufficient to monitor reception and recording of data, a comprehensive recording~~

~~inspection need only to be performed for one CVR. For the second CVR, checking its internal built-in-test equipment is sufficient. The inspection should be performed alternately such that each CVR is inspected once every other year.~~

(b) The operator should perform every 5 years an inspection of the data link recording.

(c) When installed, the aural or visual means for pre-flight checking the flight recorders for proper operation should be used every day. 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 7 days.

~~(c)~~(d) The operator should check every 5 years, or in accordance with the recommendations of the sensor manufacturer (…)

GM1 NCC.GEN.145(b) Preservation, production and use of flight recorder recordings

INSPECTION OF THE FLIGHT RECORDERS RECORDINGS

(a) The inspection of the FDR recording 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 ;

~~(2)~~(3) Examining a whole flight in engineering units to evaluate the validity of all mandatory parameters - this could reveal defects or noise in the measuring and processing chains and indicate necessary maintenance actions. The following should be considered:

(i) when applicable, each parameter should be expressed in engineering units and checked for different values of its operational range - for this purpose, some parameters may need to be inspected at different flight phases; and

(ii) if the parameter is delivered by a digital data bus and the same data are utilised for the operation of the aircraft, then a reasonableness check may be sufficient; otherwise a correlation check may need to be performed;

(A) a reasonableness check is understood in this context as a subjective, qualitative evaluation, requiring technical judgement, of the recordings from a complete flight; and

(B) a correlation check is understood in this context as the process of comparing data recorded by the flight data recorder against the corresponding data derived from flight instruments, indicators or the expected values obtained during specified portion(s) of a flight profile or during ground checks that are conducted for that purpose.

~~(3)~~(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.

(…)

GM2 NCC.GEN.145(b) Preservation, production and use of flight recorder recordings

FDR WITH FLIGHT PARAMETERS NOT PROPERLY RECORDED

Certification Specifications and Guidance Material related to the development of a Master Minimum Equipment List, item 31-31-1 (FDR) determines the conditions under which an FDR with flight parameters not properly recorded may be considered inoperative.

GM3 NCC.GEN.145(b) Preservation, production and use of flight recorders recordings

For the purpose of operational checks:

(a) The operational check of a flight recorder is a check of the flight recorder for proper operation. It is not a check of the quality of the recording, and, therefore, it is not equivalent to an inspection of the recording.

(b) An 'aural or visual means for pre-flight checking a flight recorder for proper operation' is an aural or visual means for the flight crew to check, before the flight, the results of an automatically or manually initiated test of the flight recorder for proper operation. Such a means provides for an operational check that can be performed by the flight crew.

(c) Checking through a maintenance task, the proper operation of a flight recorder is also an operational check.

(d) The 'flight recorder system' designates the flight recorder, its dedicated sensors and transducers and its dedicated acquisition and processing equipment.

(e) 'continuous monitoring for proper operation' means, for a flight recorder system, a combination of system monitors and built-in test functions which operates continuously in order to detect the following:

  (i) loss of electrical power to the flight recorder system;

  (ii) failure of the equipment performing acquisition and processing;

  (iii) failure of the recording medium and/or drive mechanism; and

  (iv) failure of the recorder to store the data in the recording medium as shown by checks of the recorded data including, as reasonably practicable for the storage medium concerned, correct correspondence with input data.

Subpart D – Instruments, data, equipment

Section 1 – Aeroplanes

AMC1 NCC.IDE.A.160(f) Cockpit voice recorder

COCKPIT VOICE RECORDER UNDERWATER LOCATING DEVICE

From 1 January 2020, the underwater locating device should be as defined in ETSO-C121b or equivalent.

AMC1 NCC.IDE.A.165(e) Flight data recorder

FLIGHT DATA RECORDER UNDERWATER LOCATING DEVICE

From 1 January 2020, the underwater locating device should be as defined in ETSO-C121b or equivalent.

AMC1 NCC.IDE.A.170(d) Data link recording

UNDERWATER LOCATING DEVICE

From 1 January 2020, the underwater locating device should be as defined in ETSO-C121b or equivalent.

Section 2 - Helicopters

AMC1 NCC.IDE.H.160(f) Cockpit voice recorder

COCKPIT VOICE RECORDER UNDERWATER LOCATING DEVICE

From 1 January 2020, the underwater locating device should be as defined in ETSO-C121b or equivalent.

AMC1 NCC.IDE.H.165(e) Flight data recorder

FLIGHT DATA RECORDER UNDERWATER LOCATING DEVICE

From 1 January 2020, the underwater locating device should be as defined in ETSO-C121b or equivalent.

AMC1 NCC.IDE.H.170(d) Data link recording

UNDERWATER LOCATING DEVICE

From 1 January 2020, the underwater locating device should be as defined in ETSO-C121b or equivalent.

3.2.4 Amendment of AMC/GM to Annex VIII (Part SPO Specialised operations)

Subpart A — General requirements

GM1 SPO.GEN.107(a)(9) Pilot-in-command responsibilities and authority

IDENTIFICATION OF THE SEVERITY OF AN OCCURRENCE BY THE PILOT-IN-COMMAND

For the purpose of quick identification of occurrences that must be reported and of occurrences subject to an official safety investigation:

(a) definitions of an accident and a serious incident as well as examples of serious incidents are provided in Regulation (EU) No 996/2010 of the European Parliament and of the Council; and

(b) the definition of an occurrence other than an accident or a serious incident, and examples thereof, are provided in Directive 2003/42/EC.

AMC1 SPO.GEN.145(a) Preservation, production and use of flight recorder recordings — operations with complex motor-powered aircraft

PRESERVATION OF RECORDED DATA FOR THE INVESTIGATION

(a) The operator should establish robust procedures to ensure that flight recorder recordings are appropriately preserved for the investigating authority.

(b) The procedures should include:

  (1) instructions for pilots to deactivate the flight recorders immediately after completion of the flight and to preserve their recording; and

  (2) instructions to prevent inadvertent reactivation, repair or reinstallation of the flight recorders by any operator personnel, or during maintenance or ground handling activities performed by third parties.

GM1 SPO.GEN.145(a) Preservation, production and use of flight recorder recordings — operations with complex motor-powered aircraft

REMOVAL OF RECORDERS ~~AFTER A REPORTABLE OCCURENCE~~IN CASE OF AN INVESTIGATION

The need for removal of the recorders from the aircraft is determined by the investigating authority with due regard to the seriousness of an occurrence and the circumstances, including the impact on the operation.

AMC1 SPO.GEN.145(b) Preservation, production and use of flight recorder recordings — operations with complex motor-powered aircraft

~~OPERATIONAL~~ CHECKS AND INSPECTIONS OF RECORDINGS

Whenever a recorder is required to be carried~~, the operator should~~:

(a) the operator should perform an ~~annual~~ inspection of ~~flight data recorder (FDR) recording and cockpit voice recorder (CVR) recording~~ FDR recording and CVR recording every year, unless one or more of the following applies:

(1) The time interval between two inspections of the recording should not exceed 3 months for a flight recorder that is recording on magnetic wire or is using frequency modulation technology.

(2) The time interval between two inspections of the recording may be up to 2 years if the flight recorder is solid-state and the flight recorder system is fitted with continuous monitoring for proper operation.

(3) In the case of an aircraft equipped with two solid-state flight data and cockpit voice combination recorders, where

(i) the flight recorder systems are fitted with continuous monitoring for proper operation, and

(ii) the flight recorders share the same flight data acquisition unit,

an inspection of the recording needs only to be performed for one flight recorder position. The inspection should be performed alternately such that each flight recorder position is inspected at least every 4 years.

~~(1) Where two solid-state FDRs both fitted with internal built-in-test equipment sufficient to monitor reception and recording of data share the same acquisition unit, a comprehensive recording inspection need only be performed for one FDR. For the second FDR, checking its internal built-in-test equipment is sufficient. The inspection should be performed alternately such that each FDR is inspected once every other year.~~

~~(2)~~(4) Where all of the following conditions are met, the ~~FDR recording~~ inspection of the FDR recording is not needed:

(i) the aircraft flight data are collected in the frame of a flight data monitoring (FDM) programme;

(ii) the data acquisition of mandatory flight parameters is the same for the FDR and for the recorder used for the FDM programme;

(iii) the integrity of all mandatory flight parameters is verified by the FDM programme at time intervals not exceeding 1 year; and

(iv) the FDR is solid-state and the FDR system is fitted with continuous monitoring for proper operation ~~an internal built-in-test equipment sufficient to monitor reception and recording of data~~.

~~(3) Where two solid-state CVRs are both fitted with internal built-in-test equipment sufficient to monitor reception and recording of data, a comprehensive recording inspection need only to be performed for one CVR. For the second CVR, checking its internal built-in-test equipment is sufficient. The inspection should be performed alternately such that each CVR is inspected once every other year.~~

(b) the operator should perform every 5 years an inspection of the data link recording.

(c) when installed, the aural or visual means for pre-flight checking the flight recorders for proper operation should be used every day. 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 7 days.

~~(c)~~(d) the operator should check every 5 years, or in accordance with the recommendations of the sensor manufacturer (…)

GM1 SPO.GEN.145(b) Preservation, production and use of flight recorder recordings

INSPECTION OF THE FLIGHT RECORDERS RECORDINGS

(a) The inspection of the FDR recording 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.

~~(2)~~(3) Examining a whole flight in engineering units to evaluate the validity of all mandatory parameters - this could reveal defects or noise in the measuring and processing chains and indicate necessary maintenance actions. The following should be considered:

(i) when applicable, each parameter should be expressed in engineering units and checked for different values of its operational range - for this purpose, some parameters may need to be inspected at different flight phases; and
(ii) if the parameter is delivered by a digital data bus and the same data are utilised for the operation of the aircraft, then a reasonableness check may be sufficient; otherwise a correlation check may need to be performed;

(A) a reasonableness check is understood in this context as a subjective, qualitative evaluation, requiring technical judgement, of the recordings from a complete flight; and

(B) a correlation check is understood in this context as the process of comparing data recorded by the flight data recorder against the corresponding data derived from flight instruments, indicators or the expected values obtained during specified portion(s) of a flight profile or during ground checks that are conducted for that purpose.

~~(3)~~(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.

GM2 SPO.GEN.145(b) Preservation, production and use of flight recorder recordings

FDR WITH FLIGHT PARAMETERS NOT PROPERLY RECORDED

Certification Specifications and Guidance Material related to the development of a Master Minimum Equipment List, item 31-31-1 (FDR) determines the conditions under which an FDR with flight parameters not properly recorded may be considered inoperative.

GM3 SPO.GEN.145(b) Preservation, production and use of flight recorders recordings

For the purpose of operational checks:

(a) The operational check of a flight recorder is a check of the flight recorder for proper operation. It is not a check of the quality of the recording, and, therefore, it is not equivalent to an inspection of the recording.

(b) An 'aural or visual means for pre-flight checking a flight recorder for proper operation' is an aural or visual means for the flight crew to check, before the flight, the results of an automatically or manually initiated test of the flight recorder for proper operation. Such a means provides for an operational check that can be performed by the flight crew.

(c) Checking through a maintenance task, the proper operation of a flight recorder is also an operational check.

(d) The 'flight recorder system' designates the flight recorder, its dedicated sensors and transducers and its dedicated acquisition and processing equipment.

(e) 'continuous monitoring for proper operation' means for a flight recorder system, a combination of system monitors and built-in test functions which operates continuously in order to detect the following:

 (i) loss of electrical power to the flight recorder system;

 (ii) failure of the equipment performing acquisition and processing;

 (iii) failure of the recording medium and/or drive mechanism; and

 (iv) failure of the recorder to store the data in the recording medium as shown by checks of the recorded data including, as reasonably practicable for the storage medium concerned, correct correspondence with input data.

Subpart D – Instruments, data, equipment

Section 1 – Aeroplanes

AMC1 SPO.IDE.A.140(f) Cockpit voice recorder

COCKPIT VOICE RECORDER UNDERWATER LOCATING DEVICE

From 1 January 2020, the underwater locating device should be as defined in ETSO-C121b or equivalent.

AMC1 SPO.IDE.A.145(e) Flight data recorder

FLIGHT DATA RECORDER UNDERWATER LOCATING DEVICE

From 1 January 2020, the underwater locating device should be as defined in ETSO-C121b or equivalent.

AMC1 SPO.IDE.A.150(d) Data link recording

UNDERWATER LOCATING DEVICE

From 1 January 2020, the underwater locating device should be as defined in ETSO-C121b or equivalent.

Section 2 - Helicopters

AMC1 SPO.IDE.H.140(f) Cockpit voice recorder

COCKPIT VOICE RECORDER UNDERWATER LOCATING DEVICE

From 1 January 2020, the underwater locating device should be as defined in ETSO-C121b or equivalent.

AMC1 SPO.IDE.H.145(e) Flight data recorder

FLIGHT DATA RECORDER UNDERWATER LOCATING DEVICE

From 1 January 2020, the underwater locating device should be as defined in ETSO-C121b or equivalent.

AMC1 SPO.IDE.H.150(d) Data link recording

UNDERWATER LOCATING DEVICE

From 1 January 2020, the underwater locating device should be as defined in ETSO-C121b or equivalent.

4. Regulatory Impact Assessments

4.1. Overview of the issues to be addressed

There are four issues covered by this NPA, each of them being addressed by a dedicated RIA:

(a) The unreliability of obsolete recording technologies such as magnetic tape, magnetic wire and frequency modulation; these technologies are still in use among flight recorders on board aircraft registered in Europe. This has impeded many safety investigations because the recorder had failed or the recorded data were of poor quality. Refer to RIA A on discontinuation of obsolete recording technologies;

(b) Frequent cases of the cockpit voice recorder (CVR) overwriting the recording after an accident or a serious incident (also called 'CVR overrun'), making the CVR useless for the safety investigation. The main causes are the insufficient duration of the CVR and the flight crew or the maintenance staff failing to take necessary measures to preserve the CVR recording. The lack of clear and complete operational procedures is a frequent contributing factor. Refer to RIA B on CVR overrun after an accident or a serious incident;

(c) The insufficient transmission time of underwater locating devices (ULD) fitted to flight recorders. A transmission time of 30 days can be too short when considering the time to bring specialised underwater search equipment on site as well as unfavourable sea surface conditions that delay underwater search operations. In several cases, the signal of the flight recorder ULD faded out before it could be located. Refer to RIA C on transmission time of the flight recorder underwater locating device;

(d) The case of an accident over an oceanic area highlighted by the accident of the Airbus A330 of Air France registered F-GZCP in June 2009. When the accident occurs out of reach of ATM surveillance means, resulting in insufficient information on its location and a very large search area, and when in addition the seafloor is so deep that the signal of a flight recorder ULD cannot be detected from the sea surface, locating the wreckage can be extremely challenging. Refer to RIA D on very long underwater range ULD for wreckage localisation in oceanic areas.

All four issues translate into essential recorded information or pieces of evidence being lost or recovered with very significant delay. They hinder or delay significantly the reconstruction of the sequence of events that led to an occurrence and the understanding of causes, making corrective actions impossible or too late.

4.2. 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 this Chapter.

The specific objectives of this proposal are to address:

(a) the unreliability of obsolete recording technologies for flight recorders installed on board aeroplanes and helicopters required to carry a FDR or a CVR;

(b) CVR overruns for CVRs installed on board aeroplanes and helicopters required to carry a CVR;

(c) insufficient transmission time of flight recorder ULDs when considering aeroplanes and helicopters required to carry a FDR or a CVR; and

(d) safety benefits of an additional ULD with a much higher detection range for wreckage localisation after an accident over an oceanic area.

4.3. Obsolete recording technologies and CVR overrun

Note:

This is a summary of the conclusions of RIA A 'Discontinuation of obsolete recording technologies' and RIA B 'CVR overrun after an accident or a serious incident'. For more detailed information, refer to RIA A and RIA B.

RIA A and RIA B are summarised together since magnetic-tape cockpit voice recorders have a recording duration of only 30 minutes, and such a short recording duration is a causal factor of CVR overruns. Phasing out magnetic tape CVRs would, therefore, help in addressing both the recording duration issue and the reliability issue. Therefore, Option 3 of RIA A is coupled with Option 2 of RIA B.

Table 3: RIA A — discontinuation of obsolete recording technologies

Option No	**Description**
0	Baseline option (No change in rules; risks remain as outlined in the issue analysis)
1	Modify the AMC to OPS rules in order to recommend: — more frequent recording inspections for flight recorders (FDRs and CVRs) using magnetic wire and frequency modulation; — less frequent recording inspections for solid-state flight recorders (FDRs and CVRs), when there is a means for pre-flight checking of the flight recorder for proper operation; and — frequent check of the flight recorders for proper operation.
2	Modify OPS rules for commercial air transport in order to prohibit recording technologies using magnetic tape, magnetic wire or frequency modulation on or after 1 January 2019, for: — aeroplanes required to carry a CVR; — aeroplanes first issued with an individual CofA on or after 1 June 1990 and required to carry a FDR; — helicopters required to carry a CVR; — helicopters required to carry a FDR.
3	Modify the OPS rules in order to mandate that from 1 January 2019: — all aeroplanes operated for commercial air transport and required to carry a CVR, be fitted with a CVR having a minimum recording duration of 2 hours, that is not recording on magnetic tape or magnetic wire; and — all helicopters operated for commercial air transport and required to carry a CVR, be fitted with a CVR that is not recording on magnetic tape or magnetic wire. (Coupled with Option 2 of Regulatory Impact Assessment B on CVR overrun after an accident or serious incident)
Option 4	Option 1 and Option 3

The preferred option of RIA A is Option 4, that is to say the combination of Option 1 and Option 3. Option 1 would provide for a short-term mitigation and economic incentive to replace obsolete flight recorders, while Option 3 would address the largest group among obsolete flight recorders i.e. magnetic tape CVRs. In addition, Option 3 would phase out

CVRs with a recording duration of 30 minutes installed on board aeroplanes, and by doing this, contribute to reducing the number of CVR overruns.

Table 4: RIA B — CVR overrun after an accident or a serious incident

Option No	Description
0	Baseline option (No change in rules; risks remain as outlined in the issue analysis.)
1	Require that aircraft operators develop comprehensive procedures to ensure flight recorder preservation following an accident or serious incident, while relaxing the requirement in the case of an incident subject to mandatory reporting.
2	Modify the OPS rules in order to mandate that from 1 January 2019, all aeroplanes operated for commercial air transport and required to carry a CVR, be fitted with a CVR having a minimum recording duration of 2 hours, that is not recording on magnetic tape or magnetic wire. (Coupled with Option 3 of Regulatory Impact Assessment A on discontinuation of obsolete recording technologies)
3	Require that aeroplanes operated for commercial air transport with an MCTOM of over 27 000 kg and first issued with an individual CofA on or after 1 January 2019 be equipped with a CVR that has a minimum recording duration of 15 hours;
4	Options 1 and 2 and 3

The preferred option of RIA B is Option 4, that is to say the combination of Option 1, Option 2 and Option 3. Option 1 is a short-term mitigation based on procedural improvements. However, in the case of aeroplanes, Option 1 would really become effective if the recording duration of the CVR is brought to a minimum of two hours, which is proposed by Option 2. Option 2 would bring EASA Member States in better compliance with ICAO Standards. Option 2 would also phase out obsolete recording technologies and, therefore, contribute to increasing flight recorder serviceability. Option 3 would fix the problem of CVR overruns in the specific case of serious incidents with large aeroplanes and would be a robust technical solution against inadvertent CVR overruns, but it is a long-term solution.

Combination of preferred options for RIA A and RIA B

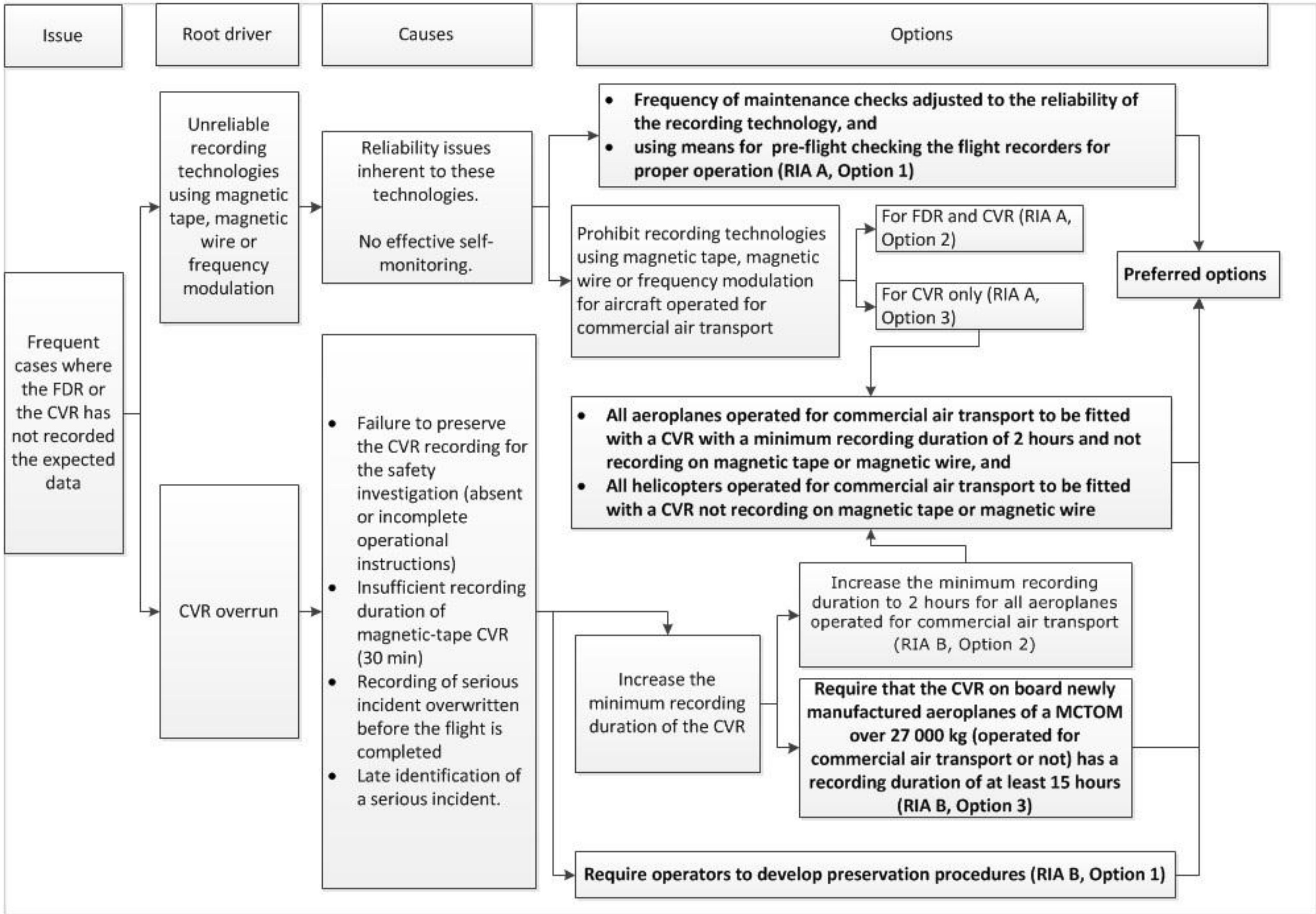
RIA A Option 3 and RIA B Option 2 partially overlap, so that the final set of preferred options for both RIAs is the following:

— Recommend more frequent recording inspections for flight recorders using magnetic wire and frequency modulation, and less frequent recording inspections for solid-state flight recorders;
— Recommend that a check of the serviceability of flight recorders is performed at frequent intervals;
— Recommend that aircraft operators develop comprehensive procedures to ensure flight recorder preservation following an accident or serious incident or if directed by the investigation authority;
— Mandate that from 1 January 2019, the CVR fitting an aeroplane operated for commercial air transport has a minimum recording duration of 2 hours and is not recording on magnetic tape or magnetic wire;

- Mandate that from 1 January 2019, the CVR fitting an helicopter operated for commercial air transport is not recording on magnetic tape or magnetic wire; and
- Mandate that aeroplanes operated for commercial air transport with an MCTOM of over 27 000 kg and first issued with an individual CofA on or after 1 January 2019 be equipped with a CVR that has a minimum recording duration of 15 hours.

Figure 1 shows the main steps of the options selection process.

Figure 1 – options selection process for RIA A and RIA B



4.4. Transmission time of the flight recorder ULD and very long detection range ULD

Note:

This is a summary of the conclusions of RIA C 'Transmission time of flight recorder underwater locating device' and RIA D 'Very long detection range underwater locating device for wreckage localisation in oceanic areas'. For more detailed information, refer to RIA C and RIA D.

RIA C and RIA D are summarised together since both relate to finding an aircraft and its flight recorders, yet under different conditions. Therefore, Option 1 in RIA D is covered by Option 3 of RIA C.

Table 5: RIA C- transmission time of the flight recorder ULD

Option No	**Description**
0	Baseline option (No change in rules; risks remain as outlined in the issue analysis)
1	Revoke ETSO authorisations, similar to withdrawal by FAA of TSO authorisations issued for the production of ULD manufactured to the TSO–C121 and TSO–C121a specifications scheduled in March 2015
2	Mandate that the ULDs of crash-protected flight recorders fitting aeroplanes operated for commercial air transport have an underwater transmission time of 90 days by 1 January 2020.
3	Mandate that the ULDs of crash-protected flight recorders fitting all aircraft required to carry a flight recorder have an underwater transmission time of 90 days by 1 January 2020.

The preferred option of RIA C is Option 3. Indeed, this Option would have the best safety impact. In particular, it would facilitate the retrieval of flight recorders after an accident over water of any kind of aircraft required to carry a crash-protected flight recorder. It would also bring EASA Member States in better compliance with current and future ICAO Standards.

Table 6: RIA D- very long detection range ULD for wreckage localisation in oceanic areas

Option No	Description
0	Baseline option (No change in rules; risks remain as outlined in the issue analysis)
1	Mandate that the ULDs of crash-protected flight recorders fitting aeroplanes operated for commercial air transport have an underwater transmission time of 90 days by 1 January 2020.
2	Mandate that large aeroplanes which: — are operated for commercial air transport, — are performing long-range over-water flights, — were first issued with an individual CofA on or after 1 January 2005, and — are not equipped with a reliable means to determine, in case of an accident, the location of the impact point with the Earth surface within 6 NM accuracy, are equipped by 1 January 2019 with an 8.8 kHz ULD.

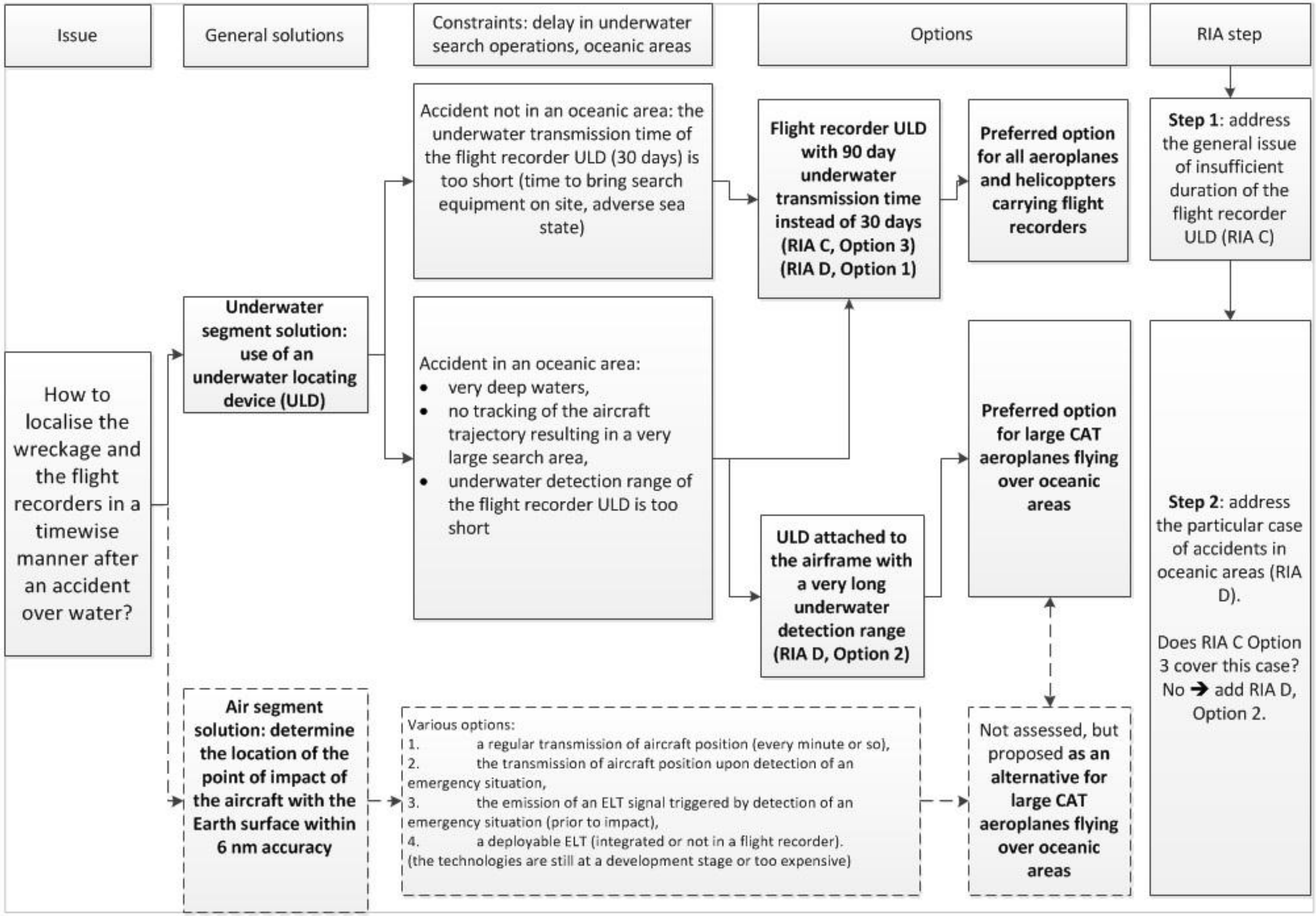
The preferred option of RIA D is Option 2. A ULD with a very long detection range is considered to be the only effective solution to locate the wreckage of an aircraft after an accident in an oceanic area, when there is no accurate information available on the location of the point of impact with water. Option 2 would also bring EASA Member States in better compliance with ICAO Standards.

Combination of preferred options for RIA C and RIA D

— Mandate that the ULDs of all crash-protected flight recorders have a transmission time of 90 days by 1 January 2020; and
— Mandate that large aeroplanes are equipped by 1 January 2019 with an 8.8 kHz ULD when they:
  - are operated for commercial air transport and performing long-range over-water flights,
  - were first issued with an individual CofA on or after 1 January 2005, and
  - are not equipped with a reliable means to determine, in case of an accident, the location of the impact point with the Earth surface within 6 NM accuracy.

Figure 2 shows the main steps of the options selection process.

Figure 2: Options selection process for RIA C and RIA D



4.5. Summaries of impacts

Tables 7 and 8 present summaries of the impacts of options.

Impacts are assessed according to the methodology described in Appendix M. The more detailed assessment of impacts is presented in the Regulatory Impact Assessments.

Note:

The following acronyms are used for categories of impacts in Tables 7 and 8:

- *SAF for Safety*
- *ENV for Environment*
- *SOC for Social*
- *ECO for Economic*
- *PRP for Proportionality*
- *REG for Regulatory coordination and harmonisation*

Some options overlap with others. In order to avoid double-counting of their economic impacts, an economic impact summary is presented in Tables 9 and 10.

Table 7: Summary of impacts for RIA A and RIA B (Obsolete recording technologies and CVR overrun)

Options	Impacts						
	SAF	ENV	SOC	ECO	PRP	REG	Overall
RIA A - Discontinuation of obsolete recording technologies							
Option 0 - Baseline option (No change in rules: risks remain as today)	0	0	0	0	0	0	0
Option 1 More frequent recording inspections for flight recorders using magnetic wire and frequency modulation, and fewer recording inspections for solid-state flight recorders.	**+1**	**0**	**0**	**+3**	**-1**	**+1**	**+4**
Option 2 Prohibit magnetic tape, magnetic wire and frequency modulation after 1 January 2019, for: — CVR installed on board aeroplanes; — FDR installed on board aeroplanes first issued with an individual CofA after 1 June; — CVR and FDR installed on board helicopters.	+3	0	0	-3	-3	+3	0
Option 3 (also covering RIA B option 2) Modify the OPS rules in order to mandate that from 1 January 2019: — all aeroplanes operated for commercial air transport and required to carry a CVR, be fitted with a CVR having a minimum recording duration of 2 hours, that is not recording on magnetic tape or magnetic wire; and — all helicopters operated for commercial air transport and required to carry a CVR, be fitted with a CVR that is not recording on magnetic tape or magnetic wire	+3	0	0	-3	-1	+3	+2
Option 4 (Preferred Option)	**+5**	**0**	**0**	**+1**	**-1**	**+3**	**+8**
RIA B - CVR overrun after an accident or a serious incident							
Option 0 - Baseline option (No change in rules: risks remain as today)	0	0	0	0	0	0	0
Option 1 Require that aircraft operators develop comprehensive procedures to ensure flight recorder preservation following an accident or serious incident, while relaxing the requirement in the case of an incident subject to mandatory reporting.	+1	0	0	+3	0	0	+4
Option 2 (also covered by RIA A option 3) Modify the OPS rules in order to mandate that from 1 January 2019, all aeroplanes operated for commercial air transport and required to carry a CVR, be fitted with a CVR having recording duration > 2 hours, that is not recording on magnetic tape or magnetic wire.	+3	0	0	-3	-1	+3	+2
Option 3	+5	0	-1	-1	0	0	+3

Require that all aeroplanes with an MCTOM over 27 000 kg and first issued with an individual CofA on or after 1 January 2019 be equipped with a CVR with recording duration > 15 hours.							
Option 4 (Preferred option) **Option 1 and Option 2 and Option 3**	**+5**	**0**	**-1**	**+1**	**-1**	**+3**	**+7**

Table 8: Summary of impacts for RIA C and RIA D (Transmission time of the flight recorder ULD and very long detection range ULD for wreckage localisation)

Options	Impacts						
	SAF	ENV	SOC	ECO	PRP	REG	Overall
RIA C – Transmission time of the flight recorder underwater locating device							
Option 0 - Baseline option (No change in rules: risks remain as today)	0	0	0	0	0	0	0
Option 1 Revoke ETSO authorisations, similar to withdrawal by FAA of TSO authorisations issued for the production of ULD manufactured to the TSO– C121 and TSO–C121a specifications scheduled in March 2015	0	0	0	0	0	0	0
Option 2 Mandate that the ULDs of crash-protected flight recorders fitting aeroplanes operated for commercial air transport have an underwater transmission time of 90 days by 1 January 2020	+	0	0	-/+	0	+	+
Option 3 (preferred option) **Mandate that the ULDs of crash-protected flight recorders fitting all aircraft required to carry a flight recorder have an underwater transmission time of 90 days by 1 January 2020.**	**+++**	**0**	**0**	**-/+**	**0**	**+/+++**	**+++**
RIA D - Very long detection range ULD for wreckage localisation in oceanic areas							
Option 0 - Baseline option (No change in rules: risks remain as today)	0	0	0	0	0	0	0
Option 1 Mandate that the ULDs of crash-protected flight recorders fitting aeroplanes operated for commercial air transport have an underwater transmission time of 90 days by 1 January 2020	+	0	0	-	0	0	0/+

Option 2 (preferred option) **Mandate that aeroplanes which:** — **have a MCTOM > 27 000 kg, are operated for commercial air transport, are performing long-range over-water flights, were first issued with an individual CofA on or after 1 January 2005, and** — **are not equipped with a reliable means to determine, in case of an accident, the location of the impact point with the Earth surface within 6 NM accuracy,** **are equipped by 1 January 2019 with an 8.8 kHz ULD.**	**+++**	**0**	**0**	**-/+**	**+**	**+**	**+++**

Table 9: Summary of economic impacts for RIA A and RIA B

Options	**Differential costs between option 0 and the other options**
Discontinuation of obsolete recording technologies and CVR overrun	
RIA A - Discontinuation of obsolete recording technologies	
Option 0	Neutral economic impact
Option 1	Saving of EUR 800 per year for an aircraft fitted with one solid-state flight recorder, or EUR 1 600 per year for an aircraft fitted with two solid-state flight recorders Saving over the period 2015 to 2019: EUR 83 370 000
Option 2	Cost of EUR 25 000 per aircraft retrofitted with a single function solid-state flight recorder, and cost of EUR 35 000 per aircraft retrofitted with a solid-state combination recorder Total fleet retrofit cost: EUR 80 020 000 in 2018
Option 3	Cost of EUR 25 000 per aircraft retrofitted with a single function solid-state flight recorder, and cost of EUR 35 000 per aircraft retrofitted with a solid-state combination recorder Total fleet retrofit cost: EUR 63 550 000 in 2018
Option 4	Saving of EUR 83 373 000 – 63 550 000 = EUR 19 823 000 for the fleet for the period 2015 to 2019
RIA B - CVR overrun after an accident or a serious incident	
Option 0	Slightly negative, set at EUR 0 in the absence of data

Option 1	Initial cost for the fleet to define preservation procedures: EUR 8 000 000 in 2015 , 5 × 14 400 000 = EUR 72 000 000 saved for the fleet over the period 2015 to 2019, EUR 14 400 000 saved annually for the fleet after 2019
Option 2 (covered by RIA A Option 3)	Cost of EUR 25 000 per aircraft retrofitted with a solid-state CVR Total CVR retrofit cost for the fleet: EUR 22 400 000 in 2018
Option 3	Increase in the CVR price for each aircraft manufactured after 1 January 2019: EUR 5 000 Annual costs for the fleet after 2018: EUR 1 000 000
Preferred option: Option 4 (= Options 1+2+3)	Total savings of EUR 72 000 000 – 22 400 000- 8 000 000 – 1 000 000 = EUR 40 600 000 over the period 2015 to 2019, Annual savings of 14 400 000 – 1 000 000 = EUR 13 400 000 after 2019
Combined impacts of RIA A and RIA B	
RIA A Option 4 (also covering RIA B Option 2)	Saving of EUR 19 823 000 for the period 2015 to 2019
RIA B Option 1 and Option 3	Total savings of 72 000 000 – 8 000 000 – 1 000 000 = EUR 63 000 000 over the period 2015 to 2019, Annual savings of 14 400 000 - 1 000 000 = EUR 13 400 000 after 2019
All options together	**Total savings of 63 000 000 + 19 823 000 =** EUR **82 823 000 for the period 2015 to 2019, Annual savings of** EUR **13 400 000 after 2019**

Table 10: Summary of economic impacts for RIA C and RIA D

Options	**Total costs**	**Differential costs between option 0 and the other options**
Underwater locating devices		
RIA C - Transmission time of the flight recorder ULD		
Option 0 & 1	Annual cost of locating the wreckage and the flight recorder after an accident over water, in the absence of a ULD signal: EUR 500 000 to 5 000 000 Cost for the period 2015-2019: 500 000 × 5 = EUR 2 500 000 to 5 000 000 × 5 = EUR 25 000 000 (supported by Member States)	

Option 1	Annual cost of EUR 500 000 to 5 000 000 Cost for the period 2015-2019: EUR 2 500 000 to 25 000 000 (supported by Member States)	Neutral (EUR 0)
Option 2	Cost per aircraft: EUR 420 (if fitted with one flight recorder) or EUR 840 (if fitted with two flight recorders) Total fleet retrofit cost in 2019: EUR 7 400 000 (supported by the industry)	When considering lower band of Option 0: Cost of EUR 7 400 000 for the period 2015 to 2019, annual savings of EUR 500 000 after 2019 (10 years to recover the cost) When considering higher band of Option 0: Cost of EUR 7 400 000 for the period 2015 to 2019, annual savings of EUR 5 000 000 after 2019 (2 years to recover the cost)
Option 3 (covering RIA D Option 1)	Cost per aircraft: EUR 420 (if fitted with one flight recorder) or EUR 840 (if fitted with two flight recorders) Total fleet retrofit cost in 2019: EUR 12 100 000 (supported by the industry)	When considering lower band of Option 0: Cost of EUR 12 100 000 for the period 2015 to 2019, annual savings of EUR 500 000 after 2019 (24 years to recover the cost) When considering higher band of Option 0: Cost of EUR 12 100 000 for the period 2015 to 2019, annual savings of EUR 5 000 000 after 2019 (3 years to recover the cost)
RIA D - very long detection range ULD for wreckage localisation in oceanic areas		
Option 0	Annual average cost of locating the wreckage after an accident over an oceanic area (deep area, no tracking of the aircraft by ATM surveillance): EUR 1 500 000 for the period 2015-2019: EUR 7 500 000 (supported by Member States)	
Option 1 (covered by RIA C Option2)	Cost per aircraft: EUR 420 (if fitted with one flight recorder) or EUR 840 (if fitted with two flight recorders) Total fleet retrofit cost in 2019: EUR 7 400 000 (supported by the industry)	Cost of EUR 7 400 000 in 2019. No saving.
Option 2	Cost per aircraft: between EUR 2 400 and EUR 4 500 Total fleet retrofit cost for the period 2015 to 2018: EUR 9 800 000 Annual fleet cost after 2018: EUR 700 000 (supported by the industry)	Cost of 9 800 000 + 700 000 - 1 200 000 = EUR 9 300 000 for the period 2015 to 2019, Annual savings of 1 200 000 - 700 000 = EUR 500 000 after 2019 (20 years to recover the cost).
Combined impacts of RIA C and RIA D		

RIA C Option 3		When considering lower band of Option 0: Cost of EUR 12 100 000 for the period 2015 to 2019, annual savings of EUR 500 000 after 2019 (24 years to recover the cost) When considering higher band of Option 0: Cost of EUR 12 100 000 for the period 2015 to 2019, annual savings of EUR 5 000 000 after 2019 (3 years to recover the cost)
RIA D Option 2		Cost of EUR 9 300 000 for the period 2015 to 2019, Annual savings of EUR 500 000 after 2019.
All options together		**Cost of 12 100 000 + 9 300 000 = EUR 21 400 000 for the period 2015 to 2019** **When considering lower band of Option 0: annual savings of EUR 1 000 000 after 2019 (=21 years to cover the cost)** **When considering higher band of Option 0: annual savings of EUR 5 500 000 after 2019 (=4 years to cover the cost)**

5. References

5.1. Affected regulations

Commission Regulation (EU) No 965/2012 of 5 October 2012 as last amended 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.

5.2. Reference documents

Decision 2012/17/R of the Executive Director of the European Aviation Safety Agency of 24 October 2012 as last amended on Acceptable Means of Compliance and Guidance Material to Commission Regulation (EU) No 965/2012 of 05/10/2012 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.

Decision 2012/18/R of the Executive Director of the European Aviation Safety Agency of 24 October 2012 on Acceptable Means of Compliance and Guidance Material to Commission Regulation (EU) No 965/2012 of 05/10/2012 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.

Decision 2013/21/R of the Executive Director of the European Aviation Safety Agency of 23 August 2013 adopting Acceptable Means of Compliance and Guidance Material for non-commercial operations with complex motor-powered aircraft.

6. Appendices

(i) — Appendix M: Data and methodology

M.1. Data requirements

The data supporting the regulatory impact assessments comes from:

— Investigation reports and safety recommendations issued by safety investigation authorities;

— Data provided by safety investigation authorities, mainly of France, UK, Germany and Italy (for example, on the time and cost of underwater search operations, to make an inventory of all cases of CVR overruns, or of flight recorder reliability problems);

— Results of surveys conducted by national aviation authorities with their aircraft operators (for example, on magnetic-tape flight recorders in service, or on the implementation of the flight recorder pre-flight check);

— Replies by flight recorder manufacturers, ULD manufacturers and maintenance organisations to questionnaires (for example, related to the production of magnetic-tape flight recorders, the implementation of the recording inspection task, feasibility and cost of a CVR with a very long recording duration, cost and performance of 90-day ULDs and 8.8 kHz ULD);

— Queries of EASA safety occurrence database;

— Ascend aircraft and airlines data.

M.2. Methodology to assess the options

M2.1. General

Impact assessment is a process to provide justifications supporting a proposal according to 5 logical steps:

Issue analysis	What is the problem?
Objective	What do I want to achieve?
Definition of options	What are the different solutions?
Analysis of options	Which consequences of these solutions?
Conclusion	What do I decide?

These logical steps are also the core headings of the EASA regulatory impact assessment report.

Once the issues have been analysed, the objectives can be defined and options can be proposed to achieve these objectives and solve the issues. The analysis of the impacts of these options can be performed with different methodologies depending on the availability and types of data. In addition, one of the main principles of impact assessment is to provide an in-depth analysis in proportion to the scale of the issue.

Considering the limited availability of data, which in addition is a mixture of qualitative and quantitative types, it was decided to use the multi-criteria analysis (MCA) to assess the options proposed to solve the issues. The following section explains the principles of the MCA and how it was applied in a way proportionate to the issues.

M2.2. Criteria for the impact analysis

The options are assessed against a wide range of criteria derived from the objectives of the Basic Regulation as described in Table M.1.

Table M.1 — Assessment criteria for the options

Overall objectives	Specific objectives and assessment criteria	
	Weight	**Description**
Safety	1	Maintain or improve the level of safety.
Economic	1	Ensure cost-effectiveness. Ensure 'level playing field'.
Environmental	1	Avoid negative effects on the environment.
Social	1	Avoid negative effects on employment in Air Traffic Control. Promote high-quality jobs in the private sector for Air Traffic Control. Facilitate mobility.
Proportionality	1	Ensure proportionate rules for Small and Medium-sized Enterprises (SMEs), General Aviation, Business Aviation.
Regulatory harmonisation	1	Ensure full consistency with EU laws and regulations. Ensure compliance with ICAO Standards (if appropriate). Achieve the maximum appropriate degree of harmonisation within Europe.

—

These impacts are detailed only when they are relevant in the analysis.

M2.3. Applied methodology: multi-criteria analysis (MCA)

Multi-criteria analysis (MCA) covers a wide range of techniques that aim at combining 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 must be measurable, at least in qualitative terms);

— 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 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 guidelines for the Regulatory Impact Assessment developed by the European Commission. The principal objective of the Agency 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.

These principles were fully applied for the analysis of the changes related to the RIA A 'Discontinuation of obsolete recording technologies' and RIA B 'CVR overrun after an accident or a serious incident'. RIA A and RIA B required the use of detailed scores from -5 to +5 as explained in the following section.

A lighter implementation of the MCA principles was applied for RIA C 'Transmission time of the flight recorder underwater locating device' and D 'Very long detection range ULD for wreckage localisation in oceanic areas', based on the proportionality principle: this is explained in Section 5.2.5.

M2.4. Multi-criteria analysis for RIA A and RIA B

Further to the previous section, the impacts on assessment areas are attributed an equal weight (i.e. 1). Each option is assessed in relation with each criteria (safety, economic, environmental, social, proportionality, regulatory harmonisation). Scores are used to show the degree to which each options achieve the assessment criteria. The scoring is performed on a scale between –5 and +5. Table M.2 gives an overview of the scores and their interpretation.

Table M.2: Scores for the multi-criteria analysis

Score	Descriptions	Example for scoring options
+5	Highly positive impact	Highly positive safety, social or environmental protection impact. Savings of more than 5 % of annual turnover for any single firm; total annual savings of more than EUR 100 million.
+3	Medium positive impact	Medium positive social, safety or environmental protection impact. Savings of 1–5 % of annual turnover for any single firm; total annual savings of EUR 10–100 million.
+1	Low positive impact	Low positive safety, social or environmental protection impact. Savings of less than 1 % of annual turnover for any single firm; total annual savings of less than EUR 10 million.
0	No impact	
–1	Low negative impact	Low negative safety, social or environmental protection impact. Costs of less than 1 % of annual turnover for any single firm; total annual costs of less than EUR 10 million.
–3	Medium negative impact	Medium negative safety, social or environmental protection impact. Costs of 1–5 % of annual turnover for any single firm; total annual costs of EUR 10–100 million.
–5	Highly negative impact	Highly negative safety, social or environmental protection impact. Costs of more than 5 % of annual turnover for any single firm; total annual costs of more than EUR 100 million.

M2.5. Multi-criteria analysis for the RIA C and D

RIA C and RIA D require less effort to select the preferred options. In this case, the scoring of the impacts uses a simple scale with '+' and '–' to indicate the positive and negative impacts. A score '+++' or '---' would be used to indicate a very different level of impact compared to a logical '+' or '-'.

(ii) — RIA A: Discontinuation of obsolete recording technologies

1. Issues to be addressed

1.1. What is the issue and the current regulatory framework?

This proposal is intended to address the unreliability of obsolete recording technologies such as magnetic tape, magnetic wire and frequency modulation; these technologies are still in use among flight recorders on board aircraft registered in Europe. This reliability issue has prevented the retrieval of complete and accurate information from flight recorders in many safety investigations, because of:

— a failure of the recording mechanism resulting in the occurrence flight not being recorded; or

— a bad condition of the recording medium, forcing the investigation authority to develop time-consuming techniques to retrieve the data; or

— in the case of frequency modulation, inaccuracy and non-repeatability of read-out data.

1.1.1. Root causes and drivers

The main reasons for the unreliability of magnetic tape, magnetic wire and frequency modulation are:

(a) The intensive maintenance required in order to ensure the continued serviceability of the recording medium and of the recording mechanism.

(1) The recording process causes recording media wear over time. As a consequence, the recording medium needs to be changed as a preventive measure.

(2) The replacement of the recording medium requires disassembly and careful reassembly of small mechanical parts.

(3) There is no easy way to check regularly the quality of the recorded data: a reliable self-monitoring of the recording medium condition is not in place with these kinds of recording technologies. In addition, the recovery of the recorded data is not 'quick access', which does not encourage a frequent read-out of the recorder.

(b) The termination of customer support for flight recorders working with these recording technologies. As a consequence, flight recorders using these technologies are growing old and their reliability is decreasing.

(c) In the specific case of frequency modulation, the instability of the analogue airborne converting equipment and of the analogue ground replay equipment translates into non-fully repeatable read-out results.

All the models of flight recorders developed in the last decade rely on solid-state electronics for processing and recording data. Solid-state flight recorders are deemed to be reliable. In addition, solid-state flight recorder models usually have a built-in test feature that detects most internal failures. There are fewer problems with solid-state flight recorders reported by safety investigation authorities than with flight recorders using older recording technologies (see statistics in 2.2.1.3)

1.1.2. Reasons for action

Action is justified by:

(a) the inclusion of Standards into ICAO Annex 6 Part I, II and III stating that the use of analogue FDRs using frequency modulation (FM) shall be discontinued by 1 January 2012, and that the use of magnetic tape and magnetic wire FDRs and CVRs shall be discontinued by 1 January 2016. This followed recurrent problems reported by four safety investigation authorities[5] through working papers submitted to ICAO Flight Recorder Panel (FLIRECP) in 2006 and 2007; and

(b) data gathered with the help of safety investigation authorities and data from EASA safety occurrence database confirming frequent problems with flight recorders using recording technologies such as magnetic tape, magnetic wire or frequency modulation.

1.1.3. Regulatory status

The current regulatory status is the following:

1.1.3.1. ICAO Annexes

ICAO Annex 6 (Operation of Aircraft) Part I (International Commercial Air Transport – Aeroplanes) Amendment 36 is applicable since 15 November 2012 and contains the following Standards and Recommended Practices in Section 6.3 (Flight recorders):

'6.3.1.3 Discontinuation
6.3.1.3.1 The use of engraving metal foil FDRs shall be discontinued.
6.3.1.3.2 Recommendation.— The use of analogue FDRs using frequency modulation (FM) should be discontinued.
6.3.1.3.3 The use of analogue FDRs using frequency modulation (FM) shall be discontinued by 1 January 2012.
6.3.1.3.4 The use of photographic film FDRs shall be discontinued.
6.3.1.3.5 Recommendation.— The use of magnetic tape FDRs should be discontinued by 1 January 2011.
6.3.1.3.6 The use of magnetic tape FDRs shall be discontinued by 1 January 2016.'
'6.3.2.2 Discontinuation
6.3.2.2.1 The use of magnetic tape and wire CVRs shall be discontinued by 1 January 2016.
6.3.2.2.2 Recommendation.— The use of magnetic tape and wire CVRs should be discontinued by 1 January 2011.'
Similar Standards and Recommended Practices are stated in ICAO Annex 6 Part II (International General Aviation – Aeroplanes) Amendment 31 paragraphs 2.4.16.1.3 and 2.4.16.2.2 and in Annex 6 Part III (International Operations – Helicopters) Amendment 17 paragraphs 4.3.1.3 and 4.3.2.2.

1.1.3.2. Current regulatory framework in EASA Member States

Air operation rules

Annex I to Commission Regulation (EC) No 859/2008 (hereinafter referred to as the '**EU-OPS**') and JAR-OPS 3 contain the former air operation requirements applicable to the commercial operation of aeroplanes and helicopters in EASA Member States. Refer to:

— paragraphs OPS 1.700 to 1.710 for the requirements related to CVR on board aeroplanes,

— paragraphs OPS 1.715 to OPS 1.725 for the requirements related to FDR on board aeroplanes,

— paragraphs JAR-OPS 3.700 and JAR-OPS 3.705 for the requirements related to CVR on board helicopters,

[5] These are safety investigation authorities of the United States (NTSB), France (BEA), Australia (ATSB), Russia (MAK). These safety investigation authorities have their own flight recorder laboratories and perform a long experience with flight recorder.

— paragraphs JAR-OPS 3.715 and JAR-OPS 3.720 for the requirements related to FDR on board helicopters.

EU-OPS and JAR-OPS 3 may remain applicable until October 2014 in some Member States, depending on the duration of the opt-out option taken with regard to Commission Regulation (EU) No 965/2012 (new air operation rules). Annex IV to this Regulation contains the new requirements for commercial air transport and is hereinafter referred to as the '**OPS Part CAT**'. In OPS Part CAT, the provisions related to flight recorders are in the following paragraphs:

— CAT.IDE.A.185 for the CVR on board an aeroplane,

— CAT.IDE.A.190 for the FDR on board an aeroplane,

— CAT.IDE.H.185 for the CVR on board an helicopter,

— CAT.IDE.H.190 for the FDR on board an helicopter.

EU-OPS and JAR-OPS 3 state that the FDR must use 'a digital method of recording and storing data and a method of readily retrieving that data from the storage medium is available' (see EU-OPS 1.715, 1.720 and 1.725 and JAR-OPS 3.715 and 3.720). OPS Part CAT contains similar provisions in paragraph CAT.IDE.A.190 and CAT.IDE.H.190.

These provisions exclude the oldest recording technologies for the FDR such as photographic film or metal foil, but they do not exclude frequency modulation or magnetic tape or magnetic wire for the FDR or the CVR.

With regard to checking the quality of the recording, OPS Part CAT requires in paragraph CAT.GEN.MPA.195 the following:

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

The corresponding acceptable means of compliance AMC1 CAT.GEN.MPA.195(b) (see EASA ED Decision 2012/018/R) recommends that except in some particular cases, the operator performs an annual inspection of the FDR recording and of the CVR recording in order to ensure their serviceability.

Airworthiness rules

The Agency's European Technical Standard Orders (ETSOs) C-123b (CVR) and C-124b (FDR) which were adopted in 2010 (see EASA ED Decision 2010/010/R) have introduced a reference to EUROCAE Document ED-112[6]. ED-112 specifies in its paragraph 2-1.2 that 'The recorder shall use a digital method of recording. Magnetic tape, wire and photographic methods shall not be used'.

As a result, new designs of flight recorders submitted to the Agency for an ETSO authorisation cannot work with recording technologies such as magnetic tape or magnetic wire.

1.1.3.3. Applicable industry standards

Industry standards provide for the interchangeability of flight recorders. In particular, ARINC characteristics establish specific form factors, mounting provisions, interwiring, output signal data, and power supply standards for the FDR and the CVR.

ARINC characteristics applicable to the FDR are:

— ARINC Characteristics 573 and 717. ARINC Characteristic 573 utilises an analogue technology in the Flight Data Acquisition Unit (FDAU), while ARINC Characteristic 717 makes use of digital technology in a Digital Flight Data Acquisition Unit (DFDAU);

6 Minimum Operational Performance Specification for Crash-protected airborne recorder system, March 2003.

- ARINC 542A. This characteristic addresses the installation of a magnetic tape FDR for early generation airline aircraft, previously fitted with a metal foil FDR or a photographic film FDR;
- ARINC 747 provides design guidance for the installation of a solid state FDR.

ARINC characteristics applicable to the CVR are:

- ARINC 557 (now withdrawn). It describes installation standards for the earlier CVR that used analogue technologies (magnetic wire or magnetic tape);
- ARINC 757, addressing solid state CVR.

1.2. Safety risk assessment

The flight recorders are not critical for the safe conduct of the flight, however, they are essential safety investigation tools. The FDR records accurately the aircraft trajectory, the engine performance, the position of flight surfaces and flight controls, the avionics system activity, the status of fuel, hydraulic circuits, brakes, automatic warnings, etc. The CVR records oral communication between flight crew members, with cabin crew members or other crew members, with ATC Officers, as well as alarms and background sounds that may contain important evidence.

Therefore, a risk assessment focussed on operational safety is not appropriate. The risk to be assessed here is the risk for safety investigation authorities and aviation regulators to be unable to timely identify a hazard that would normally be captured by the flight recorder.

1.2.1. Risk frequency

The risk frequency can be assessed on the basis of the number of safety investigations delayed or hindered because of problems with the recording of one flight recorder. In practice, the average annual number of obsolete and defective flight recorders carried by aircraft of European Member State operators involved in accidents and serious incidents was assessed. Aircraft of European Member State operators are subject to European air operation rules, which are the Agency’s responsibility.

The following assumptions are made:

- The fleet considered is aircraft registered in an EASA Member State and required to carry a flight recorder. For simplification, two subsets are considered:
  - commercial air transport aeroplanes with an MCTOM of over 5 700 kg and
  - commercial air transport helicopters with an MCTOM of over 2 250 kg. Indeed, OPS Part CAT requires that helicopters of an MCTOM of over 3 175 kg are fitted with flight recorders. However, EASA safety occurrence database does not provide for a weight break at 3 175 kg, so that a larger set covering all helicopters with a MCTOM exceeding 2 250 kg is considered here.
- The context considered is the investigations into accidents and serious incidents of these aircraft. According to ICAO Annex 13 and to Regulation (EU) No 996/2010, every accident and serious incident shall be subject to an official safety investigation by a safety investigation authority. The flight recorders are essential to ensure the timely conduct of the investigation.
- The risk arises from the unreliability of obsolete recording technologies: their proportion in flight recorders fitted to aircraft subject to OPS rules as well as their failure rate allow to assess the number of safety investigations which are delayed or hindered because of this issue.

1.2.1.1. Accidents and serious incidents of aircraft of EASA Member State operators that are required to carry a flight recorder

According to a query of EASA safety occurrence database, there occurred between 1 January 2008 and 31 December 2012:

— 136 accidents and 511 serious incidents involving a commercial air transport aeroplane with an MCTOM of over 5 700 kg and operated by an EASA Member State operator; and

— 28 accidents and 11 serious incidents involving a commercial air transport helicopter with an MCTOM of over 2 250 kg and operated by an EASA Member State operator.

Hence, on this 5-year time period, 136+511=647 accidents and serious incidents involving an aeroplane required to carry a FDR and a CVR occurred, while 28+11=39 accidents and serious incidents involving an helicopter with an MCTOM of over 2 250 kg happened. This corresponds to a ratio of 16 to 1.

Therefore, **only aeroplanes are considered for this risk assessment**.

1.2.1.2. Proportion of aircraft of EASA Member State operators fitted with an obsolete flight recorder

Almost all flight recorders using an obsolete technology and fitted on aircraft operated by an EASA Member State operator are actually magnetic tape flight recorders. Therefore, **frequency modulation and magnetic wire are not considered for this risk assessment**.

1.2.1.3. Proportion of flight recorders for which the recording quality is not satisfactory

According to a query of EASA safety occurrence database, in the decade from 1 January 2003 to 31 December 2012, there were worldwide 8 628 aeroplanes with an MCTOM of over 5 700 kg involved in a safety occurrence.

(a) For 195 of these aeroplanes, the field 'CVR recording medium' is neither empty nor has the value 'Unknown'.

  (1) For 40 aeroplanes where the CVR recording medium is known, it has the value 'plastic tape' (i.e. magnetic tape).

    (i) For 25 of the 40 magnetic tape CVRs, the CVR recording quality field is neither empty nor has the value 'Unknown';

    (ii) **For 6 of the 25 magnetic tape CVRs where the recording quality is known, the latter is indicated as 'Poor'**, for the other 19 CVRs it is indicated as 'Good' or 'Excellent'; and

    (iii) For 30 of the 40 magnetic tape CVRs, the recording duration was indicated and for all 30 it was around 30 minutes (between 29 and 32 minutes).

  (2) For 139 aeroplanes where the CVR recording medium is known, it has the value 'Solid state'.

    (i) For 91 of the 139 solid state CVRs, the CVR recording quality field is neither empty nor has the value 'Unknown';

    (ii) **For 4 of the 91 solid-state flight recorders where the CVR recording quality is known, the latter is indicated as 'Poor'**, for 89 it is indicated as 'Good' or 'Excellent';

(b) For 203 of these aeroplanes, the field 'FDR recording medium' is neither empty nor has the value 'Unknown'.

(1) For 25 aeroplanes where the FDR recording medium is known, it has the value 'plastic tape' (i.e. magnetic tape).

(i) For 20 of the 25 magnetic tape FDRs, the FDR data recovery field is neither empty nor has the value 'Unknown';

(ii) **For 7 of the 20 magnetic tape FDRs where the data recovery is documented, the latter is indicated as 'Not recovered' or 'Partially recovered'**, for the other 13 FDRs it is 'Completely recovered'.

(2) For 157 aeroplanes where the FDR recording medium is known, it has the value 'Solid state'.

(i) For 128 of the 157 solid state FDRs, the FDR data recovery field is neither empty nor has the value 'Unknown';

(ii) **For 7 of the 128 solid state FDRs where the data recovery is documented, the latter is indicated as 'Not recovered' or 'Partially recovered'**, for the other 121 FDRs it is 'Completely recovered'.

Based on these results, with the assumption that the types of aircraft involved in safety occurrences represent fairly the aircraft fleet in operation, it can be deduced that:

— The proportion of magnetic tape CVRs worldwide is around 40/195~**21 %**,

— The proportion of solid state CVRs worldwide is around 139/195~**71 %**,

— The proportion of magnetic tape FDRs worldwide is around 25/203~**12 %**, and

— The proportion of solid state FDRs worldwide is around 157/203~**77 %.**

These figures are consistent with the proportions of magnetic tape CVRs and magnetic tape FDRs among those fitted to aeroplanes registered at one of EASA Member States, which are respectively 33 % and 18 %, while the proportions of solid state CVRs and solid state FDRs are respectively 67 % and 82 % (see 2.3, Tables A.2a and A.2b). In the following, it is assumed that:

— 30 % of CVRs installed on board aeroplanes operated by EASA Member States operators are magnetic tape CVRs on 1 January 2013; and

— 20 % of FDRs installed on board aeroplanes operated by EASA Member States operators are magnetic tape FDRs on 1 January 2013.

It can be further implied from the query results that:

— **the proportion of magnetic tape FDRs for which all the data cannot be recovered is around 7/20=35 %, and**

— **the proportion of magnetic tape CVRs for which the quality of the recording is insufficient is around 6/25~24 %.**

By comparison, the proportion of solid state FDRs for which all the data could not be recovered is 7/128=5 %, and the proportion of solid state CVRs for which the quality of the recording was found insufficient is 4/91=4 %

Finally, this query confirms that **most magnetic tape CVRs have a recording duration of 30 minutes**, which is consistent with Table A.2b.

1.2.1.4. Proportion of aeroplanes of EASA Member State operators involved in an accident or serious incident and for which the magnetic-tape flight recorder was found unserviceable

Based on the previous assumptions:

(a) the proportion of aeroplanes involved in an accident or a serious incident and for which a defective magnetic tape FDR is impeding the investigation is assessed to be (20 %)×(35 %) ~ 7 %; and

(b) the proportion of aeroplanes involved in an accident or a serious incident and for which a defective magnetic tape CVR is impeding the investigation is assessed to be (30 %)×(24 %) ~ 7 %.

Overall, in 2012, **7 % of aeroplanes of EASA Member States operators involved in accidents and serious incidents are found with a FDR recording which is not complete and accurate**. **7 % of aeroplanes of EASA Member States operators are found with a CVR recording which is not complete and of sufficient quality**.

According to 2.2.1.1, 647/5~129 accidents and serious incidents involving aeroplanes of EASA Member State operators occur in average every year. 7 % of 129 represent **9 accidents and serious incidents of aeroplanes of EASA Member States operators every year**.

Assuming a decrease of the proportion of magnetic tape FDRs and magnetic tape CVRs (see 2.2.3), then **in 2019**:

(a) the proportion of aeroplanes involved in an accident or a serious incident and for which a defective magnetic tape FDR is impeding the investigation is assessed to be (0 %)×(35 %) =0 %; and

(b) the proportion of aeroplanes involved in an accident or a serious incident and for which a defective magnetic tape CVR is impeding the investigation is assessed to be (10 %)×(24 %) ~ 2.5 %.

This 2.5 % of 129 accidents and serious incidents corresponds to **3 accidents and serious incidents of aeroplanes of EASA Member States operators every year where the sufficient quality of the CVR will be an issue.**

1.2.2. Risk severity

If an important causal factor of an accident or a serious incident is missed because the recording of the FDR or the CVR is incomplete or of poor quality, no effective safety action can be taken. The same causal factor may then contribute to other accidents and serious incidents.

1.3. Who is affected?

1.3.1. Stakeholders

The unreliability of old recording technologies has been impeding the work of safety investigation authorities as it has delayed or hindered the determination of the causes of a number of accidents and serious incidents. The taking of appropriate corrective actions by the Agency and other authorities was accordingly hindered.

1.3.2. Affected fleet

The affected fleet are all aircraft required to carry a FDR or a CVR according to the air operation rules.

Those aircraft are:

— aeroplanes operated for commercial air transport and with an MCTOM of more than 5 700 kg;

— multi-engine turbine-powered aeroplanes operated for commercial air transport, with an MCTOM of 5 700 kg or less, with a maximum operational passenger seating configuration (MOPSC) of more than 9 and first issued with an individual Certificate of Airworthiness (CofA) on or after 1 January 1990;

— helicopters operated for commercial air transport and with an MCTOM of more than 7 000 kg; and

— helicopters operated for commercial air transport and with an MCTOM of more than 3 175 kg and first issued with an individual CofA on or after 1 January 1987.

In addition, Commission Regulation (EU) No 800/2013 (Air operation rules, non-commercial operation of complex motor-powered aircraft, hereinafter referred to as the '**OPS Part NCC**') has introduced new requirements to carry flight recorders on board aeroplanes with an MCTOM of more than 5 700 kg and helicopters with an MCTOM of more than 3 175 kg, when they are operated for general aviation and first issued with an individual CofA on or after 1 January 2016. Similarly, EASA Opinion No 02/2012 (Air operation rules, specialised operations, hereinafter referred to as '**OPS Part SPO**') proposes new requirement to carry flight recorders on board aeroplanes with an MCTOM of more than 5 700 kg and helicopters with an MCTOM of more than 3 175 kg, when they are operated for aerial work and first issued with an individual CofA on or after 1 January 2016.

Although it is theoretically possible to install a flight recorder with an obsolete technology on a brand new aircraft, it is not expected that the aircraft subject to OPS Part NCC or OPS Part SPO will carry flight recorders with obsolete technologies. Indeed, these aircraft will be offered with an option to carry solid-state flight recorders by the aircraft manufacturers, which will probably be cheaper than fitting them with flight recorders using an older recording technology. In addition, with regard to the CVR, it will be required to have a recording duration of 2 hours and no magnetic tape CVR is known to have such a recording duration.

1.3.3. Proportion of aircraft fitted with flight recorders working with an obsolete recording technology

Proportion of frequency modulation FDRs and magnetic wire CVRs

Flight recorders using frequency modulation and magnetic wire have been designed by equipment manufacturers based in the UK and in former States of the USSR. Such flight recorders are still installed on aircraft designed by aircraft manufacturers of the Commonwealth of Independent States (CIS).

According to a query of EASA safety occurrence database, in the decade from 1 January 2003 to 31 December 2012, there were worldwide 9 275 aircraft with an MCTOM of over 2 250 kg involved in a safety occurrence. Only for 1 aircraft was the CVR a magnetic wire CVR, and it was not registered in an EASA Member State. No magnetic wire CVR or frequency modulation FDR installed on an aircraft of an EASA Member State operator was read out by BEA, AAIB or BFU in the past few years.

Hence, very few magnetic wire CVRs and frequency modulation FDRs are assumed to remain installed on aircraft of European Member State operators.

Proportion of magnetic tape flight recorders

Magnetic tape flight recorders are still relatively common, especially magnetic tape CVRs. Two national aviation authorities surveyed their national operators in 2011 in order to determine the proportion of flight recorders using magnetic tape technology.

— The first survey indicates that the proportion of magnetic tape FDRs on board aeroplanes is about 1 in 5, while the proportion of magnetic tape CVRs is roughly 1 in 3, and that most 30-minute recording duration CVRs record on a magnetic tape (see Tables A.2a and A.2b);

— The second survey indicates that magnetic tape CVRs seem to be concentrated on aircraft operated by small-sized operators (see Table 3).

Table A.2a: Number and proportion of magnetic-tape FDRs installed on board aeroplanes of a sample of operators registered by National Aviation Authority A

	Sample	Magnetic-tape FDRs	Solid-state FDRs
Number of FDRs	427	76	351
Proportion of FDRs	100 %	18 %	82 %

Table A.2b: Number and proportion of magnetic-tape CVRs installed on board aeroplanes of a sample of operators registered by national aviation authority A

<table>
<tr><th></th><th>Sample</th><th>Magnetic-tape CVRs (30-minute recording duration)</th><th>Solid-state CVRs with 30-minute recording duration</th><th>Solid-state CVRs with 2-hour recording duration</th></tr>
<tr><td>Number of CVRs</td><td>433</td><td>127</td><td>18</td><td>288</td></tr>
<tr><td rowspan="2">Proportion of CVRs</td><td rowspan="2">100 %</td><td>29 %</td><td>4 %</td><td rowspan="2">67 %</td></tr>
<tr><td colspan="2">33 %</td></tr>
</table>

Table A.3: Number of operators registered by National Aviation Authority B and which operate magnetic-tape CVRs

Category of operator	Total number of responders per category	Number of responders which operate magnetic-tape CVRs on part or all of their fleet
Large or middle-sized aeroplane operator	11	0
Small-sized aeroplane operator	10	5
Helicopter operator	1	0

Therefore, magnetic tape FDRs and CVRs are assumed to be installed on a significant proportion of aeroplanes, in particular when considering small-sized operators. **A conservative assumption is that on 1 January 2013, 20 % of FDRs and 30 % of CVRs installed on aeroplanes operated for commercial air transport by European member States operators are using magnetic tape technology**.

In the next years, the proportions of magnetic tape FDRs and magnetic tape CVRs are expected to decrease at a rate corresponding to the renewal rate of the fleets of aeroplanes of EASA Member States operators. **Assuming that the economic life cycle of an aeroplane is 30 years**, the proportion of magnetic tape FDRs and CVRs on board aeroplanes is expected to decrease by 10 % every 3 years**.** With this assumption, **by 1 January 2019 the proportion of aeroplanes fitted with a magnetic tape FDR would be 0 %, and the proportion of aeroplanes fitted with a magnetic tape CVR would be 10 %**. By 2022, the proportion of aeroplanes fitted with a magnetic tape CVR would also be close to 0 %.

In addition, according to a query of Ascend aircraft and airlines data of year 2012, 8 930 aeroplanes are operated by European Member States operators and required by OPS rules to carry a FDR, while 8 950 are required to carry a CVR.

With these figures, it is assumed that there are on 1 January 2013:

— 20 % of 8 930 = 1 786 aeroplanes fitted with a magnetic tape FDR;

— 30 % of 8 950 = 2 685 aeroplanes fitted with a magnetic tape CVR.

In addition, assuming that the fleet remains constant, it is expected that there will be on 1 January 2019:

— 0 % of 8 930 = 0 aeroplanes fitted with a magnetic tape FDR;

— 10 % of 8 950 = 895 aeroplanes fitted with a magnetic tape CVR.

With regard to helicopters, according to a query of EASA safety occurrence database, in the decade from 1 January 2003 to 31 December 2012, there were worldwide 1 021 helicopters with an MCTOM of over 2 250 kg involved in a safety occurrence.

(a) For 9 of these 1 021 helicopters, the field 'CVR recording medium' is neither empty nor has the value 'Unknown'.

4 of these 9 CVRs are solid-state, the others are magnetic tape.

(b) For 3 of these 1021 helicopters, the field 'FDR recording medium' is neither empty nor has the value 'Unknown'.

2 of these 3 are solid-state FDRs, the other is magnetic tape.

In view of the size of these samples, they cannot be used to assess proportion of magnetic tape FDRs and magnetic tape CVRs. In the absence of other data, it is considered that only helicopters manufactured in the last 15 years are fitted with solid-state flight recorders[7]. Assuming that the economic life cycle of a helicopter is 30 years, **the proportion of magnetic tape FDRs and magnetic tape CVRs among those installed on board helicopters is assumed to be 50 % on 1 January 2013 (15 year after 1998)**.

In the next years, the proportions of magnetic tape FDRs and magnetic tape CVRs are expected to decrease at a rate corresponding to the renewal rate of the fleets of helicopters of EASA Member States operators. Assuming that the economic life cycle of a helicopter is 30 years, the proportion of magnetic tape FDRs and CVRs on board aeroplanes is expected to decrease by 10 % every 3 years. This would mean a proportion of **30 % of helicopters fitted with a magnetic tape FDR and 30 % of helicopters fitted with a magnetic tape CVR by 1 January 2019. These proportions would become 0 % by 2028.**

In addition, according to a query of Ascend aircraft and airlines data of year 2012, 3 040 helicopters are operated by European member States operators and required by OPS rules to carry a FDR, while 5 490 are required to carry a CVR.

With these figures, it is assumed that there are on 1 January 2013:

— 50 % of 3 040 = 1 520 helicopters fitted with a magnetic tape FDR;

— 50 % of 5 490 = 2 745 helicopters fitted with a magnetic tape CVR.

In addition, assuming that the fleet remains constant, it is expected that there will be on 1 January 2019:

— 30 % of 3 040 = 912 helicopters fitted with a magnetic tape FDR;

— 30 % of 5 490 = 1 647 helicopters fitted with a magnetic tape CVR.

[7] Note: A recording duration of two hours is required for aeroplanes first issued with an individual CofA on or after 1.4.1998. Only solid-state CVR models achieve a recording duration of two hours. This means that at least since 1998 (15 years before 2013), solid-state flight recorders have been installed on board aircraft. This can be applicable to helicopters as well, as flight recorder models are not specific to the type of aircraft they are installed in. A large helicopter manufacturer confirmed that they have been installing solid-state flight recorders on their models since 1998.

1.4. How could the issue/problem evolve?

The safety investigation authorities of Germany (BFU), United Kingdom (AAIB) and France (BEA) have provided the Agency with data on flight recorder read-outs performed between January 2006 and November 2010. The aggregated results are represented in Figure 1 and Table A.1.

These statistics indicate a decrease in the proportion of magnetic tape flight recorders (FDR and CVR together), from 26 % in 2006 to 15 % in 2010.

They also indicate that the proportion of magnetic tape CVRs remains about 10 % higher than the proportion of magnetic tape FDRs over this period. This is explained by the fact that a solid-state 'quick access' FDR may be used by an operator for a Flight Data Monitoring (FDM) programme[8]. On the contrary, a CVR cannot be routinely used by an operator to improve the safety of its operation, since air operation rules prohibit its usage for purposes other than safety investigation (see EU-OPS, paragraph OPS 1.160 and OPS Part CAT, paragraph CAT.GEN.MPA.195). Therefore, the natural discontinuation of magnetic tape CVRs is likely to take the renewal of the fleets.

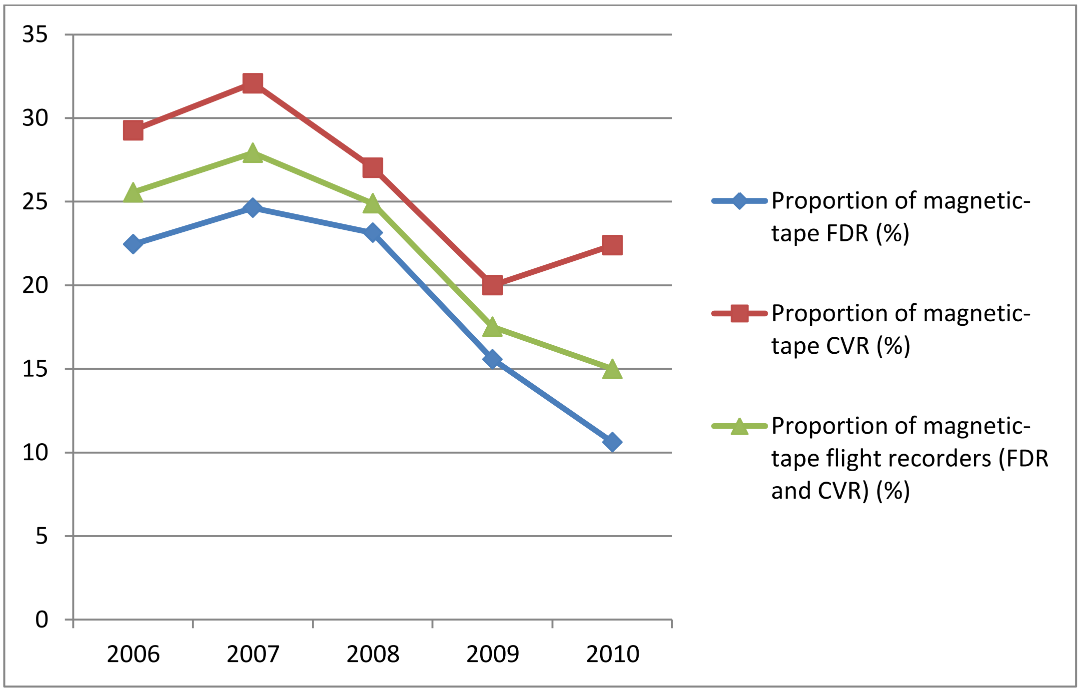
This problem needs to be addressed by the Agency because it is responsible for the air operation rules applicable to the EASA Member States according to the Basic Regulation.

Table A.1: Aggregated numbers of flight recorders read out by BFU, AAIB and BEA between 01 January 2006 and 20 November 2010

	FDR		CVR				
Year	Magnetic Tape FDR	Solid State FDR	Magnetic Tape CVR	Solid State CVR	Proportion of magnetic tape FDR (%)	Proportion of magnetic tape CVR (%)	Overall proportion of magnetic tape recorders (%)
2006	22	76	24	58	22	29	26
2007	33	101	34	72	25	32	28
2008	31	103	30	81	23	27	25
2009	19	103	19	76	16	20	18
2010 (until November)	12	101	15	52	11	22	15

[8] Indeed, solid-state recording media allow for a much faster recovery of flight data, and this can be done without removing the flight recorder from the aircraft. A FDM programme is mandatory for aeroplanes operated for commercial air transport and that have a maximum certificated take-off mass (MCTOM) in excess of 27 000 kg. According to Ascend data on aircraft and airlines, around two thirds of aircraft of EASA Member States operators that are required to carry FDRs have an MCTOM exceeding 27 000 kg, meaning that they must also be fitted with FDM airborne equipment.

Figure 1: aggregated numbers of flight recorders read out by BFU, AAIB and BEA and between 01 January 2006 and 20 November 2010.



1.5. Summary of the issues

Issue 1: obsolete recording technologies

— poor reliability: between one quarter and one third of recordings are found to be of insufficient quality;

— maintenance is not scheduled to maintain the appropriate reliability for magnetic tape and wire recorders.

Issue 2: the current situation in Europe

— solid-state flight recorders are proven to be more reliable than former technologies. However, OPS rules do not prohibit the use of magnetic tape or magnetic wire or frequency modulation for flight recorders;

— the proportion of magnetic tape flight recorders is still high on aircraft of EASA Member States operators:

- 30% magnetic tape CVRs and 20% magnetic tape FDRs on board aeroplanes,
- two thirds of magnetic tape FDRs and CVRs on board helicopters;

— the natural rate of replacement of FDR and CVR corresponds to the rate of renewal of the aircraft fleets.

Issue 3: the safety risk

— the risk is for authorities to be unable to timely identify a hazard that can be captured by the flight recorder;

— In average, there are currently 9 accidents and serious incidents of aeroplanes of EASA Member States operators every year where a flight recorder with an obsolete recording technology is found to be not fully serviceable. However, with the decrease of the proportion of magnetic tape flight recorder, this number will also decrease;

— Each time a flight recorder is found unserviceable during a safety investigation, the safety investigation is impeded and, therefore, the taking of effective safety action by the Agency.

2. Objectives

The overall objectives of the Agency are defined in Article 2 of the Basic Regulation.

This proposal will contribute to the overall objectives by addressing the issues outlined in Section 2. The specific objective of this proposal is, therefore, to increase the reliability of flight recorders currently installed on aircraft subject to European air operation rules.

3. Policy options

Table A.4: Selected policy options

Option No	Description
0	Baseline option (No change in rules; risks remain as outlined in the issue analysis)
1	Modify the AMC to OPS rules in order to recommend: — more frequent recording inspections for flight recorders (FDRs and CVRs) using magnetic wire and frequency modulation, — less frequent recording inspections for solid-state flight recorders (FDRs and CVRs) fitted with continuous monitoring for proper operation, and — frequent check of the flight recorders for proper operation.
2	Modify OPS rules for commercial air transport in order to prohibit recording technologies using magnetic tape, magnetic wire or frequency modulation on or after 1 January 2019, for: — aeroplanes required to carry a CVR; — aeroplanes first issued with an individual CofA on or after 1 June 1990 and required to carry a FDR; — helicopters required to carry a CVR; — helicopters required to carry a FDR.
3	Modify the OPS rules in order to mandate that from 1 January 2019: — all aeroplanes operated for commercial air transport and required to carry a CVR, be fitted with a CVR having a minimum recording duration of 2 hours, that is not recording on magnetic tape or magnetic wire; and — all helicopters operated for commercial air transport and required to carry a CVR, be fitted with a CVR that is not recording on magnetic tape or magnetic wire. (Coupled with Option 2 of the Regulatory Impact Assessment B on CVR overrun after an accident or serious incident)
4	Option 1 and Option 3

Option 0 consists in relying solely on ETSO-C123b and ETSO-C124b that prohibit magnetic tape and magnetic wire technology for phasing out these recording technologies, and in the meantime on the annual inspection of the flight recorder recording recommended by AMC1 CAT.GEN.MPA.195 (b) for ensuring the serviceability of flight recorders.

Option 1 consists in modifying AMC1 CAT.GEN.MPA.195 (b) in order to:

(a) add a recommendation that recording inspections are conducted every three months for flight recorders working with magnetic wire or frequency modulation technologies, in order to limit the time during which a problem with the recording can go unnoticed;

(b) relax the periodicity of the recording inspection to two years, when the flight recorder is solid-state and fitted with continuous monitoring for proper operation; and

(c) add a recommendation that a check of the serviceability of flight recorders is performed at frequent intervals. This operational check would be, when means are available, a daily pre-flight check of the flight recorders for proper operation. Otherwise, an operational check would be recommended at time intervals not exceeding 7 days. The operational check would allow maintaining a high serviceability of those flight recorders for which the time interval between two recording inspections is increased to 2 years, and it would also increase the serviceability of flight recorders using older recording technologies.

Note:

For the purpose of understanding, 'continuous monitoring for proper operation' means for a flight recorder system, a combination of system monitors and built-in test functions which operates continuously in order to detect the following:

(i) Loss of electrical power to the flight recorder system;

(ii) Failure of the equipment performing acquisition and processing;

(iii) Failure of the recording medium and/or drive mechanism; and

(iv) Failure of the recorder to store the data in the recording medium as shown by checks of the recorded data including, as reasonably practicable for the storage medium concerned, correct correspondence with input data.

Such a means is described in the Certification Specifications for large aeroplanes (CS-25), AMC 25.1459(a)(4) (for the FDR only) and in paragraph 2-1.4.2 of ED-112 (for all flight recorders).

'continuous monitoring for proper operation' means for a CVR, a combination of system monitors and built-in test functions which would detect and indicate the following:

(i) Loss of electrical power to the flight recorder system;

(ii) Failure of the audio acquisition;

(iii) Failure of the recording medium and/or drive mechanism; and

(iv) Failure of the recorder to store the data in the recording medium as shown by checks of the recorded data.

Option 2 is to introduce into the air operation rules an Implementing Rule (IR) prohibiting the use of magnetic tape, magnetic wire and frequency modulation for flight recorders from 01 January 2019, effectively forcing aircraft operators to phase out FDRs and CVRs using these technologies. This IR would apply to:

(a) aeroplanes required to carry a CVR;

(b) aeroplanes first issued with an individual CofA on or after 1 June 1990 and required to carry a FDR;

(c) helicopters required to carry a CVR;

(d) helicopters required to carry a FDR.

The deadline for phasing out obsolete recording technologies is 1 January 2019 and not 1 January 2016 as recommended in ICAO Annex 6, because the terms of reference foresee the publication of the Agency Opinion in the second quarter of 2015, and the adoption of the Executive Director's Decision in the second quarter of 2016. Sufficient time should be left to the aircraft operators to replace their flight recorders.

Option 2 excludes FDR installed on board aeroplanes first issued with an individual CofA before 1 June 1990, because for those aeroplanes the list of flight parameters to record is very short (see EU OPS, Table A of Appendix 1 to OPS 1.725), indicating the use of old technologies for flight parameter acquisition and FDR sensors. Therefore, retrofitting a solid-state flight recorder on such aeroplanes may be disproportionately expensive for the small number of flight parameters to record. According to Ascend aircraft and airlines data of year 2012, 18 % of aeroplanes of EASA Member States operators that have an MCTOM exceeding 5 700 kg were first issued with an individual CofA before 1 June 1990. Assuming an economic life cycle of 30 years (10 % less every 3 years), the proportion of such aeroplanes would be close to 0 % by 1 January 2019.

Option 2 applies only to aircraft operated for commercial air transport, as the requirements to carry a FDR or a CVR in general aviation or aerial work only apply to aircraft manufactured after 2016, and it is expected that those aircraft will be fitted with solid-state flight recorders. Therefore, Option 2 implies amending the following paragraphs in OPS Part CAT: CAT.IDE.A.185, CAT.IDE.A.190, CAT.IDE.H.185 and CAT.IDE.H.190.

Option 3 consists in modifying CAT.IDE.A.185 and CAT.IDE.H.185 to:

(a) prohibit magnetic tape CVRs and magnetic wire CVRs on board aeroplanes operated for commercial air transport after 1 January 2019, and require that the CVR has a minimum recording duration of 2 hours;

(b) prohibit magnetic tape CVRs and magnetic wire CVRs on board helicopters operated for commercial air transport after 1 January 2019, with no further requirement on the CVR recording duration.

Option 3 is meant to address two issues:

(a) The unreliability of magnetic wire and magnetic tape, and

(b) The insufficient recording duration of magnetic-tape CVRs (only 30 minutes) when installed on board an aeroplane (see the Regulatory Impact Assessment on CVR overrun after an accident or serious incident). This problem does not affect so much CVRs on board helicopters, therefore, Option 3 does not propose any change of the recording duration in that case.

Option 3 does not cover the replacement of FDRs using obsolete technologies.

The deadline for phasing out obsolete recording technologies is 2019 as in Option 2, because sufficient time should be left to the aircraft operators to replace their flight recorders.

Option 3 is also meant to address the issue of CVR overrun (overwriting of the relevant part of the recording, making the CVR useless). Option 3 is, therefore, coupled to Option 2 of the Regulatory Impact Assessment B on CVR overrun after an accident or serious incident.

Option 4 is the combination of Option 1 and Option 3.

As such, it combines the short-term effect of a change of serviceability tasks and the longer-term effect of a phasing-out of magnetic tape CVRs by 2019.

Table A.5: Comparative effects of Options

	ICAO	Option 0	Option1	Option 2	Option 3
FDR using frequency modulation	1 recording inspection per year Forbidden after 2012	1 recording inspection per year Not prohibited (but already very seldom among EASA MS operators)	4 recording inspections per year + operational check Not prohibited (but already very seldom among EASA MS operators)	1 recording inspection per year Prohibited by 1 January 2019 (except for aeroplanes first issued with an individual CofA before 1 June 1990, but they will have disappeared in 2019 with the natural renewal of the fleet)	1 recording inspection per year Not prohibited (but already very seldom among EASA MS operators)
FDR using magnetic tape	1 recording inspection per year Forbidden after 2016	1 recording inspection per year Not prohibited ➔ they will disappear with the natural renewal of the fleets (by 2019 on aeroplanes and 2028 on helicopters)	1 recording inspection per year + operational check Not prohibited ➔ they will disappear with the natural renewal of the fleets (by 2019 on aeroplanes and 2028 on helicopters)	1 recording inspection per year Prohibited by 1 January 2019 (except for aeroplanes first issued with an individual CofA before 1 June 1990, but they will have disappeared in 2019 with the natural renewal of the fleet)	1 recording inspection per year Not prohibited ➔ they will disappear with the natural renewal of the fleets (by 2019 on aeroplanes and 2028 on helicopters)
CVR using magnetic wire	1 recording inspection per year Forbidden after 2016	1 recording inspection per year Not prohibited (but already very seldom among EASA MS operators)	4 recording inspections per year + operational check Not prohibited (but already very seldom among EASA MS operators)	1 recording inspection per year Prohibited by 1 January 2019 (Already very seldom)	1 recording inspection per year Prohibited by 1 January 2019 (Already very seldom)
CVR using magnetic tape	1 recording inspection per year Forbidden after 2016	1 recording inspection per year Not prohibited ➔ they will disappear with the natural renewal of the fleets (by 2022 on aeroplanes and by 2028 on helicopters)	1 recording inspection per year + operational check Not prohibited ➔ they will disappear with the natural renewal of the fleets (by 2022 on aeroplanes and by 2028 on helicopters)	1 recording inspection per year Prohibited by 1 January 2019	1 recording inspection per year Prohibited by 1 January 2019
Solid-State FDR	1 recording inspection per year Technology allowed	1 recording inspection per year Technology allowed	1 recording inspection every 2 years + operational check Technology	1 recording inspection per year Technology allowed	1 recording inspection per year Technology allowed.

	ICAO	Option 0	Option1	Option 2	Option 3
			allowed		
Solid-State CVR	1 recording inspection per year Technology allowed	1 recording inspection per year Technology allowed	1 recording inspection every 2 years + operational check Technology allowed	1 recording inspection per year Technology allowed	1 recording inspection per year Technology allowed, however must be replaced by a 2-hour recording duration CVR by 1 January 2019 when installed on an aeroplane

4. Data and methodology

Refer to Appendix M.

5. Analysis of impacts

5.1. Safety impact

<u>*Note:*</u>

Whatever the option, the safety impacts are indirect, as flight recorders are safety investigation tools and not aircraft safety systems.

5.1.1. Option 0

The unreliability of magnetic tape, magnetic wire and frequency modulation translate into causal factors of accidents and serious incidents being missed or not timely identified. As flight recorders using these technologies are not produced anymore, their average age is increasing, so that their failure rate is expected to increase as well.

When considering magnetic tape flight recorders, which represent the biggest part of flight recorders using obsolete technologies, 2.1.2 indicates that magnetic tape FDRs are less widespread than magnetic tape CVRs when considering aeroplanes. One may expect that by 2019 magnetic tape FDRs will have become seldom on board aeroplanes, and magnetic tape CVRs by 2022.

When considering helicopters, the proportion of magnetic tape FDRs and CVRs are expected to remain non negligible until 2028, however, there have been 16 times less accidents and serious incidents of helicopters of EASA Member States operators than of aeroplanes. Therefore, the contribution of helicopters to the result of Option 0 is considered minor.

The publication of ETSO C-123b and ETSO C-124b in 2010 has not accelerated the phasing out of obsolete recording technologies, as they only address new equipment designs.

The recording inspection recommended every year by AMC1 CAT.GEN.MPA.195(b) is already an improvement compared to Temporary Guidance Leaflet 44 and JAR OPS 3 Section 2, which did not prescribe this task. A time interval of one year is consistent with the recommendations of former national guidance like CAP 731[9] published by the Civil Aviation Authority of United Kingdom, and it is considered adequate for a magnetic tape flight recorder.

However, an annual recording inspection is probably not sufficient for recording technologies such as frequency modulation or magnetic wire. The Guide on the

[9] CAP 731 recommends an examination of the recorded signal on the CVR at intervals not exceeding 12 months for a magnetic tape CVR. It also recommends an annual inspection of the FDR recording, independent of the recording medium technology.

organisation of the collection, processing and use of flight data information by the civil aviation operators of the Russian Federation (version of July 2001), chapter 3.4.2 prescribes the following tasks:

— read-out of FDR for processing in accordance with the listed tasks (e.g. express-analysis) to be performed by line maintenance after each landing of the aircraft at the base airport;

— readout of CVR in accordance with the monthly scheduled maintenance checks.

These requirements are designed for flight recorders recording with frequency modulation or magnetic wire, which were very common in the former USSR States. Therefore, they are considered good indications of the appropriate time intervals for ensuring the continued serviceability of magnetic wire CVRs and frequency modulation FDRs.

In conclusion, Option 0 would leave magnetic tape CVRs installed on board aeroplanes for another decade and even more in the case of helicopters, however, there are many less accidents and serious incidents involving helicopters. Around one quarter of magnetic tape CVRs are found to have an insufficient recording quality. Magnetic tape FDRs would disappear by themselves by 2019 when considering aeroplanes, but they would stay frequent among helicopters for more than a decade. Around one third of magnetic tape FDRs are found to have an insufficient recording quality. Also, Option 0 would not address the case of frequency modulation or magnetic wire, however, these technologies are already seldom among aircraft of EASA Member States operators.

Nevertheless, Option 0 being the baseline scenario, is allocated a score of 0.

5.1.2. Option 1

Option 1 would decrease the probability that a flight recorder using frequency modulation technology or magnetic wire technology remains in a failure condition for months until the next annual recording inspection takes place. However, few flight recorders installed on aircraft subject to European OPS rules are still working with these recording technologies.

Option 1 would also relax the periodicity of the recording inspection to two years for a solid-state flight recorder, under conditions that allow to assume a high level of reliability and a timely feedback if the flight recorder fails. These conditions are met if the proper operation of the flight recorder is effectively checked at regular intervals. The latter condition means that the oral or visual means for pre-flight checking the flight recorder status must, when installed in the cockpit, be checked every day. If such means is not available, then an operational check of the flight recorder at time intervals not exceeding 7 days would still provide for a timely discovery of a flight recorder failure.

A survey conducted by an NAA of an EASA Member State, to which 28 aircraft operators responded[10], revealed that significantly more cases of unserviceable condition of a flight recorder are detected with a pre-flight check than during scheduled maintenance. This result illustrates the expected benefit of frequent operational checks.

Hence, performing frequent operational checks would ensure a high level of serviceability for a solid-state flight recorder. It would also improve the serviceability of a flight recorder using an older recording technology such as magnetic wire, magnetic tape or frequency modulation. However, it must be noted that these older recording technologies do not allow for reliable internal failure detection, so that operational checks are not very effective. .

The effect of Option 1 on flight recorder serviceability would be immediate. However, the overall safety effect would be only slightly positive, when considering the most common

[10] The details of this survey cannot be published.

category of flight recorders among those using obsolete technologies, namely magnetic tape flight recorders (score +1).

5.1.3. Option 2

Option 2 provides assurance that most of flight recorders using obsolete technologies and installed on aircraft subject to European air operation rules are replaced by more modern equipment by 1 January 2019.

Nevertheless, Option 2 does not provide an immediate mitigation of the safety issue.

Option 2 excludes FDR retrofit for the oldest aeroplanes (individual CofA first issued before 1 June 1990), but for those aeroplanes the information recorded by the FDR is anyway limited to a few flight parameters, and it is likely that most of those aeroplanes will no longer be operated in Europe by 2019.

Option 2 would have a clearly positive, yet not immediate impact on safety (score +3).

5.1.4. Option 3

Option 3 provides assurance that magnetic tape CVRs and magnetic wire CVRs on board commercial air transport aircraft are replaced by more reliable CVRs by 1 January 2019.

Magnetic tape and frequency modulation FDRs are not addressed by Option 3. Indeed, frequency modulation FDRs are considered to be seldom among aircraft of EASA Member States operators. In addition, it is expected that magnetic tape FDRs will already be seldom on the aeroplane fleets of EASA Member States operators by 2019. When considering helicopters, the proportion of magnetic tape FDRs, which is assumed to be currently 50 %, would not become negligible before 2028. However, given that there are in average 16 accidents or serious incidents of aeroplanes of EASA Member States operators for 1 accident or serious incident of helicopter (see 2.2.1.1), a mandatory replacement of the magnetic tape FDRs on board helicopters by solid-state FDRs would bring limited safety benefits overall.

In addition, Option 3 requires that in the case of aeroplanes, the replacement be made with a 2-hour recording duration CVR, which addresses also the problem of CVR overruns (i.e. the relevant part of the CVR recording is found to be overwritten by safety investigation authorities) that has been reported in many investigations of serious incidents with aeroplanes, and was the subject of several safety recommendations by safety investigation authorities (see Regulatory Impact Assessment B on CVR overrun after an accident or serious incident).

For these reasons, it is expected that the impact on safety of Option 3 will be almost as good as Option 2, with the additional benefit of an increase in the duration of the CVR in the case of aeroplanes. Therefore, the safety impact of Option 3 is considered also medium positive (score +3).

5.1.5. Option 4

Option 4 combines the immediate safety effect of Option 1 and a long-term improvement of flight recorder reliability in phasing out magnetic-tape CVRs by 2019 (Option 3). In addition, after 2019, aeroplanes would be exclusively equipped with 2-hour recording duration CVRs, which would make it possible to reduce significantly the frequency of CVR overruns.

Therefore, the safety impact of Option 4 is considered very positive (score +5).

5.1.6. Conclusion

The comparative safety benefits are presented in Table A.6

Table A.6: Comparative safety benefits

	Option 0	Option 1	Option 2	Option 3	Option 4
Safety impact	**0**	**+1** **(by 2015)** (more frequent recording inspections for magnetic wire and frequency modulation, and use of the cockpit means for checking the flight recorder operation)	**+3** **(by 2019)** (replacement of all FDRs and CVRs working with obsolete recording technology)	**+3** **(by 2019)** (replacement of all CVRs working with obsolete recording technology, and longer recording duration for CVRs on board aeroplanes)	**+5**

5.2. Environmental impact

Whatever the option, no environmental impact is foreseen.

5.3. Social impact

No social impact is foreseen.

5.4. Economic impact

5.4.1. Option 0

Option 0, being the baseline scenario, is allocated an economic impact of 0. The economic impact of other options are the difference with Option 0.

5.4.2. Option 1

5.4.2.1. Impact of changing the periodicity of recording inspections

The inspection of a FDR recording as described in paragraph GM1 CAT.GEN.MPA.195(b), is expected to take one to six man-hours of work, as each mandatory flight parameter should be checked and a recording inspection report should be produced (the duration depends on the number of flight parameters to check, however, not more than a few tens of parameters are recorded on a frequency modulation FDR).

The inspection of a CVR recording as described in paragraph GM1 CAT.GEN.MPA.195(b) will probably take one to three man-hours of work, as all four tracks must be checked and an inspection report should be produced.

In both cases, the time to remove and reinstall the flight recorder must also be taken into account. An arbitrary work time of two hours is counted for these actions.

Overall, a recording inspection does not probably claim more than 8 man-hours of work per flight recorder, i.e. one man-day of work. For example, assuming an hourly cost of EUR 100, this corresponds to EUR 800.

Option 1 would add significant maintenance cost for those aircraft fitted with a magnetic wire CVR or a frequency modulation FDR and slightly reduce maintenance cost for those aircraft equipped with a solid-state flight recorder. This is illustrated in Table A.7, with an arbitrary cost per recording inspection of EUR 800. Option 1 would provide strong economic incentive to abandon magnetic wire and frequency modulation, but only a moderate economic incentive to install a solid-state flight recorder.

Note:

A periodicity of 3 months would allow an aircraft operator to organise the recording inspection during an A check (which periodicity is typically 600 flight hours or 300 flight cycles). Thus, no immobilisation cost is expected in the case of a magnetic wire CVR or a frequency modulation FDR.

Table A.7: Comparative cost of the recording inspection on a two-year period

Recording technology	Option 0 Number of recording inspections over 2 years	Option 0 Cost of recording inspections over 2 years, assuming EUR 800 per recording inspection	Option 1 Number of recording inspections over 2 years (Option 1)	Option 1 Cost of recording inspections over 2 years, assuming EUR 800 per recording inspection	Cost difference of Option 1 vs Option 0 over 2 years
Magnetic wire or frequency modulation	2 years x 1 inspection per year = 2	2 x 800 = EUR 1600	2 years ×4 inspections per year=8	8 × 800 = EUR 6 400	+ EUR 4 800
Magnetic tape	2 years x 1 inspection per year = 2	2 x 800 = EUR 1600	2 years ×1 inspection per year=2	2 × 800 = EUR 1 600	EUR 0
Solid-state	2 years x 1 inspection per year = 2	2 x 800 = EUR 1 600	1 inspection	EUR 800	- EUR 800

Assuming that:

— when considering aircraft of EASA Member State operators, there are on 01 January 2013:
  - 8 950 aeroplanes required to carry a CVR, 30 % of which carry a magnetic-tape CVR and 70 % a solid-state CVR;
  - 8 930 aeroplanes required to carry a FDR, 20 % of which carry a magnetic-tape FDR and 80 % a solid-state FDR;
  - 5 490 helicopters required to carry a CVR, 50 % of which carry a magnetic-tape CVR and 50 % a solid-state CVR; and
  - 3 040 helicopters required to carry a FDR, 50 % of which carry a magnetic-tape FDR and 50 % a solid-state FDR;

— Option 1 would apply as of 1 January 2015;

— the natural renewal of aircraft fleets being of 3 % per year, the proportions of solid-state FDR and CVR among aircraft of EASA Member State operators would be:

- 76 % of aeroplanes for solid-state CVRs on 1 January 2015, 79 % on 1 January 2016, 82 % on 1 January 2017, etc.
- 86 % of aeroplanes for solid-state FDRs on 1 January 2015, 89 % on 1 January 2016, 92 % on 1 January 2017, etc.
- 56 % of helicopters for solid-state CVRs on 1 January 2015, 59 % on 1 January 2016, 62 % on 1 January 2017, etc.
- 56 % of helicopters for solid-state FDRs on 1 January 2015, 59 % on 1 January 2016, 62 % on 1 January 2017, etc.

— the fleets numbers remain constant; and

— the cost of a recording inspection is EUR 800,

then the saving generated over the five years (2015 to 2019) would correspond to 104 216 recording inspections and amount to **EUR 83 373 000.**

5.4.2.2. Impact of frequent operational checks

Means for pre-flight checking the flight recorders for proper operation have been required by FAR Part 25 since 1965 (for the CVR) and 1966 (for the FDR), and by FAR Part 29, JAR 25 and JAR 29 since they exist, therefore, the vast majority of aircraft models offer these means, and most aircraft manufacturers already provide corresponding instructions. In order to account for the aircraft without any means in the cockpit and not impose any retrofit, the check of these means should be recommended only when they are already installed.

Surveys conducted by national aviation authorities with their aircraft operators have shown that many operators have their flight crew check these means during pre-flight checks.

The check procedure itself can, in some installations, take up to a few minutes, which can be operationally constraining if it were to be performed before each flight. However, a daily periodicity (for instance before the first flight of the day) provides for sufficient flexibility, so that no cost impact is expected in that case.

For the few legacy installations that do not enable pre-flight checking the flight recorder for proper operation from the flight deck, a maintenance task needs to be performed instead. In that case, a periodicity of 7 days for performing this operational check is considered acceptable, as it is commensurate with the time frame given by the future Certification Specifications and Guidance Material for Master Minimum Equipment List (CS-MMEL) for flying with an inoperative flight recorder (3 days or 8 flights in the case of a single-function flight recorder, 10 days in the case of cockpit voice and flight data combination flight recorder). However, these installations are assumed to be seldom.

Therefore, it is considered that introducing this task would mainly generate costs related to including this task in the operations manual, for those operators which have not yet done it. The economic impact is, therefore, expected to be very limited for most operators.

5.4.2.3. Overall economic impact

The overall economic impact of Option 1 is, therefore, expected to be clearly positive, as it would translate into less frequent recording inspections for the majority of flight recorders which are solid-state and the same frequency of recording inspections for magnetic-tape flight recorders. For the few aircraft operators which are still using magnetic wire CVRs and frequency modulation FDRs, the economic impact would be negative, which should encourage them to replace these flight recorders faster. The introduction of operational check would mainly translate into introducing, if not yet done, the daily check of the flight recorders for proper operation into the operations manual.

Therefore, a score of +3 is elected for Option 1.

5.4.3. Option 2

In the case of a forward-fit, the aircraft need anyway to be equipped with flight recorders. If sufficient notice is left to the aircraft manufacturer, the installation of a solid-state flight recorder instead of a flight recorder with an older technology is neutral in terms of cost. In addition, most or all newly produced flight recorders are solid-state.

5.4.3.1. Cost factors

In the case of a retrofit, the cost can be sorted into non-recurring and recurring cost:

Non-recurring cost

The change is assumed to be developed once per aircraft model (assuming that all flight recorders installed on aircraft of a given model are replaced by a unique model of FDR and/or a unique model of CVR). In case of a large fleet of the same aircraft model, the non-recurring costs can then be shared over this fleet. However, if the fleet is small, the non-recurring cost per aircraft is higher. For example, assuming that only 10 aircraft of a given aircraft model are still operated, then 1/10 of the non-recurring cost is supported by each individual aircraft.

The change encompasses changing wires and connectors between the flight recorder and the flight data acquisition unit (in the case of a FDR), the dedicated sensors (e.g. analogue sensors for a FDR, cockpit area microphone and audio transducers for a CVR) and status indicators in the cockpit. Industry standards like ARINC characteristics address the interchangeability of flight recorders and their sensors (see 2.4), but there is not a single standard, so that the change design and documentation may represent a significant amount of work.

Up to 2 man-weeks of work are assumed to design the change and produce the documentation for a CVR and up to 4 man-weeks for a FDR[11].

The change also encompasses post-flight recording evaluation: it is expected that the quality of the recording of the FDR and/or the CVR will be checked after a few flights. In the case of a CVR, EASA Certification Memorandum CM-AS-001 recommends that 'To ensure CVR systems are properly installed and to verify the audio signal recorded from all audio channels achieve the acceptable level of quality, applicants should conduct a check during flight. The recording obtained should be evaluated to confirm acceptable level of quality during all normal regimes of flight including taxiing, take-off, cruise, approach and landing'. Also, the CVR replay should be performed by a 'replay and evaluation centre'. Such an analysis would require the CVR to be removed from the aircraft, read out at the centre and then mounted again. The overall cost for the CVR is assessed to be EUR 2 000. In the case of the FDR, the post-flight evaluation could be performed by the aircraft operator, like in the case of a periodic recording inspection (as there is no such a privacy issue as for the CVR). Therefore, a cost of EUR 800 (cost of a flight inspection) is assumed for the FDR.

With regard to certification, the retrofit could be done through a minor change to the aircraft design, thus approval cost would only be a few hundreds of euros.

Recurring cost

The recurring cost encompasses:

— Purchase cost of the unit: between EUR 15 000 and EUR 25 000 for a single-function[12] flight recorder;

[11] More work is expected when installing a new FDR compared to installing a new CVR, because in the case of a new FDR, this implies changes at the level of the flight data acquisition unit and of dedicated analogue sensors, as well as updating the FDR decoding documentation.

[12] A single-function flight recorder can be a FDR or a CVR, it does not combine FDR and CVR functions.

- Purchase cost of wires and connectors: a maximal cost of EUR 1 000 is chosen for illustration;
- Cost of physically performing the installation: the replacement of wires and connectors in the cockpit and the avionics bay may require significant work. It is assumed that no more than 5 man-days are needed to perform this task for the FDR and 2 man-days for the CVR;
- Maintenance cost: they are expected to be lower with a solid-state flight recorder than with a flight recorder using an older technology, since solid-state flight recorders are more reliable and they are fitted with reliable built-in test feature so that less intensive maintenance is needed to maintain the serviceability of a solid-state flight recorder.

5.4.3.2. Cost distribution

An example of distribution of cost is presented in Table A.8. Figures are not accurate, they should only be considered as orders of cost.

In this example, the initial cost for every aircraft retrofitted can be split into:

- non-recurring cost (documentation and certification and post-flight recording evaluation), amounting for EUR 22 000 for a CVR retrofit and EUR 41 000 for a FDR retrofit, to be divided by the number of aircraft sharing this cost; and
- equipment purchase and installation cost ranging from (15 000 + 1 300) ~ EUR 16 000 to (26 000 + 3200) ~ EUR 29 000.

Hence, except in the case where the non-recurring cost is shared among few aircraft of the same model, most of the initial cost corresponds to the unit price of the flight recorder and its physical installation. For example, considering 20 aircraft of the same model, the non-recurring initial cost per individual aircraft of retrofitting the CVR would be 22 000 / 20 = EUR 1 100. The non-recurring initial cost per individual aircraft of retrofitting the FDR would be 41 000 / 20 = EUR 2 050.

With those assumptions:

- The initial cost for forward-fitted aircraft is considered negligible.
- The initial cost per retrofitted aircraft is expected to be roughly the price of one or two single-function flight recorders (unit price between EUR 15 000 and EUR 25 000) plus a few thousands of euros per flight recorder for designing and performing its installation.
- The maintenance cost would probably decrease after equipping the aircraft with a solid-state recorder.

Taking the figures presented in 2.3.3, it is assumed that there would be on 1 January 2019:

- 0 aeroplanes and 912 helicopters fitted with a magnetic tape FDR; and
- 895 aeroplanes and 1 647 helicopters fitted with a magnetic tape CVR.

Only those aircraft would need to be retrofitted with solid-state flight recorders by 1 January 2019.

In addition, a helicopter may also be equipped with a single flight data and cockpit voice combination recorder (refer to CAT.IDE.H.200), and it is expected that helicopters operators would take advantage of this possibility. As a consequence, the number of flight recorders retrofits needed on helicopters should be the highest number between 912 and 1 647, and not the sum of 912 and 1 647. However, some costs would still add up (design and documentation of the installation, wires) and a flight data and cockpit voice combination recorder is usually more expensive than a FDR or a CVR.

Hence, assuming an initial cost per FDR or CVR installed of EUR 25 000 and an initial cost per flight data and cockpit voice combination recorder installed of EUR 35 000, the total cost for the fleets of European Member States operators would amount to 895 × 25 000 + 1 647 × 35 000= **EUR 80 020 000.**

In conclusion, the economic cost of Option 2 is considered medium negative (score -3).

Table A.8: Example of distribution of cost when retrofitting an aeroplane with a solid-state flight recorder

Cost line	Nature of cost	Order of cost for a CVR	Order of cost for a FDR	Comment
Design and documentation cost (Installation drawing, Installation Instructions, Maintenance Instructions, AFM, decoding documentation in the case of the FDR)	Once per aircraft model	Up to 80 man-hours at EUR 250 per hour = EUR 20 000	Up to to 160 man-hours at EUR 250 per hour = up to EUR 40 000	Assuming one man-week is 40 man-hours, and between 2 man-weeks and 4 man-weeks are needed
Post-flight recording evaluation	Once per aircraft model	EUR 2 000	EUR 800	The CVR recording evaluation would be more expensive as it would require evaluation by a replay and evaluation centre
Certification fees (Minor Change)	Once per aircraft model	EUR 600	EUR 600	This would probably be a Minor Change. EASA Fees are EUR 564 per Minor Change.
Equipment purchase	Once per individual aircraft	EUR 15 000 to 26 000	EUR 15 000 to 26 000	Single-function solid-state flight recorder (unit price between EUR 15 000 and EUR 25 000) + wires and connectors (up to EUR 1 000)
Implementation of change	Once per individual aircraft	Up to 16 man-hours at EUR 80 per hour = 1 EUR 300	Up to 40 man-hours at EUR 80 per hour = EUR 3 200	Assuming that one man-day is 8 man hours. The aircraft immobilisation time is not taken into account, as it is assumed that this task could be performed during a heavy maintenance check (C check or D check).
Maintenance cost	Scheduled and unscheduled tasks, per individual aircraft			Maintenance cost is expected to be lower than with older technologies, as solid-state flight recorders are more reliable and have an effective self-monitoring function.

5.4.4. Option 3

The computation of cost induced by Option 3 is similar to that of Option 2, with the difference that only magnetic tape CVRs would need to be replaced. Taking the figures presented in 2.3.3, it is assumed that there would be, on 1 January 2019, 895 aeroplanes and 1 647 helicopters fitted with a magnetic tape CVR.

Hence, assuming an initial cost per CVR replaced of EUR 25 000, the total cost for the fleets of European Member States operators would amount to (895 + 1 647) × 25 000 = EUR **63 550 000**. The total cost is only EUR 20 000 000 lower than the total cost of Option 2, and, therefore, the same score is allocated for the economic impact (-3).

5.4.5. Option 4

The cumulated cost and savings of Option 1 and Option 3 would amount to:

83 373 000 - 63 550 000 = EUR 19 823 000 savings

Hence, the economic impact of Option 4 is considered slightly positive (score +1).

5.4.6. Conclusion

The comparative economic impacts are presented in Table A.9

Table A.9: Comparative economic impacts

	Option 0	**Option 1**	**Option 2**	**Option 3**	**Option 4**
Economic impact	**0**	**+3** **globally** (+ for aircraft fitted with solid-state flight recorders, - for aircraft fitted with magnetic wire CVRs of frequency modulation FDR)	**-3** (replacement of all FDRs and CVRs working with obsolete recording technology)	**-3** (replacement of all CVRs working with obsolete recording technology)	**+1**

5.5. Proportionality issues

5.5.1. Option 1

Option 1 would generate more savings for large operators than for small and medium-sized operators, as magnetic tape flight recorders tend to be concentrated among small and medium-sized operators. Therefore, it has a slightly negative proportionality impact (score -1).

5.5.2. Option 2

As indicated in 2.3.1, magnetic tape CVRs seem to be concentrated among small-sized aircraft operators. Therefore, a mandatory discontinuation of these CVRs would probably have a greater impact on those aircraft operators.

This could be magnified if magnetic tape FDRs are also concentrated among small-sized operators, especially in the case of helicopter operators (magnetic tape FDRs are expected to have disappeared with the natural renewal of the aeroplane fleets already in 2019). Therefore, the proportionality impact is considered medium negative (score -3).

5.5.3. Option 3

As for Option 2, a mandatory discontinuation of magnetic tape CVRs would probably have a greater impact on small-sized aircraft operators. The magnetic tape FDRs would not need to be replaced, therefore, no cumulated effect of CVR retrofit and FDR retrofit for the same aircraft is expected. The proportionality impact is considered slightly negative (score -1).

5.5.4. Option 4

As for Option 1 and Option 3, the impact of Option 4 can be considered slightly negative (score -1).

Table A.10: Comparative impact on proportionality issues

	Option 0	**Option 1**	**Option 2**	**Option 3**	**Option 4**
Proportionality issues	**0**	**-1** (more obsolete recorders installed on aeroplanes operated by small operators)	**-3** (small-sized operators more affected by FDR and CVR retrofit)	**-1** (small-sized operators more affected by CVR retrofit)	**-1**

5.6 Impact on regulatory coordination and harmonisation

5.6.1. Foreseeable implementation issues

Option 0

Not applicable.

Option 1

There is no particular problem foreseen with the implementation of Option 1.

Option 2

As this task is expected to be completed by 2015, and an additional year should be counted for the review and adoption by the European legislator, an applicability date such as the 1 January 2019 would leave about 3 years for aircraft operators to retrofit their flight recorders. A notice of 3 years is considered sufficient for the replacement of the subject flight recorders on in service aircraft, considering that a few months would be needed to design the change, and two additional years would allow for the change to take place during a C maintenance check or equivalent. If the rulemaking task was delayed, the applicability date would need to be offset accordingly.

Option 3

Same as Option 2.

5.6.2. Risk of conflict with other legislation or national action

Option 0

Not applicable.

Option 1

There is no risk of conflict.

Option 2

There is no danger of duplication at national level, as Commission Regulation (EU) No 965/2012 will have entered into force in all EASA Member States by 28 October 2014. The proposed requirement would be effective after this date, i.e. when the new air operation rules are applicable in all EASA Member States.

Option 3

Same as Option 2.

5.6.3. Impact on Member States' obligations towards ICAO

Option 0

The EASA Member States will not be in compliance with the ICAO Standards on discontinuing magnetic wire, magnetic tape and frequency modulation.

Option 1

Increasing the time interval between two recoding inspections for solid-state flight recorders may bring EASA Member States in better compliance with future ICAO Annex 6 Standards on the inspection of flight recorder systems. Indeed, ICAO proposed in its letter to Contracting States referenced SP 55/4-13/59, to increase the time interval between two recording inspections to two years for those flight recorders 'which have demonstrated a high integrity of serviceability and self-monitoring'. Most aircraft installations of solid-state flight recorders fulfil this criterion.

The addition of a provision recommending to check frequently the flight recorder for proper operation would bring EASA Member States in better compliance with ICAO Annex 6 Standard requiring that 'Prior to the first flight of the day, the built-in test features for the flight recorders and flight data acquisition unit (FDAU), when installed, shall be monitored by manual and/or automatic checks' (refer to paragraph 7.1 of Annex 6 Part I, Appendix 9, paragraph 7.1 of Annex 6 Part II Appendix 2.3, and paragraph 6.1 of Annex 6 Part III Appendix 5). So far, there have been no equivalent requirements or recommendations in OPS rules.

Option 2

The EASA Member States will not be fully in compliance with the ICAO Standards on discontinuing magnetic wire, magnetic tape and frequency modulation, as the proposed date of applicability is different. In addition, FDR fitting aeroplanes first issued an individual CofA before 1 June 1990 will not be retrofitted, however, their number is expected to be very small by 2019 anyway. Overall, the intent of ICAO Standards will be complied with.

Option 3

Option 3 will bring EASA Member States in better compliance with ICAO Standards for CVRs only. EASA Member States will be less compliant with ICAO Standards with Option 3 than with Option 2, especially when considering helicopters. However, Option 3 would improve compliance with ICAO Annex 6 Standard requiring that 'From 1 January 2016, all CVRs shall be capable of retaining the information recorded during at least the last two hours of operation' (refer to paragraph 6.3.2.3 of Part I of ICAO Annex 6)

5.6.4. Overall impact on regulatory coordination and harmonisation

— Option 0: As Option 0 is the baseline option, it is given a score of 0.

— Option 1: Option 1 will improve harmonisation with other ICAO Standards, therefore, a score of +1.

— Option 2: This is the best option with regard to compliance with ICAO Annex 6 Part I Standards on phasing out obsolete recording technologies. It is considered, therefore, medium positive (score +3)

— Option 3: This option would only partially bring EASA Member States in compliance with ICAO Annex 6, as only CVRs would be replaced. However, it would improve compliance with another Standard on the recording duration of the CVR. The impact is, therefore, considered medium positive (score +3).

— Option 4: the overall impact of Option 1 and Option 3 altogether is considered medium positive (+3).

Table A.11: Comparative impact on regulatory coordination and harmonisation

	Option 0	Option 1	Option 2	Option 3	Option 4
Regulatory coordination and harmonisation	**0**	**+1**	**+3** (better alignment with ICAO provisions requiring a phase-out of old technologies for the FDR and the CVR)	**+3** (better alignment with ICAO provisions requiring a phase-out of old technologies for the CVR + better alignment with ICAO provisions requiring extension of the recording duration to 2 hours)	**+3**

6. Conclusion and preferred option

6.1. Comparison of options

Strengths and weaknesses of each option are presented in **Table A.12 and Table A.13**.

Globally, Option 1 would have a slightly positive safety impact (mitigating the risk in the case of magnetic wire and frequency modulation) and a clearly positive economic impact. Option 1 would provide strong economic incentive to abandon magnetic wire and frequency modulation technologies, and a more moderate economic incentive to replace magnetic tape by solid-state. Hence, it is not certain that Option 1 would be sufficient for a quick discontinuation of magnetic tape, which is the most common among obsolete recording technologies. Therefore, while Option 1 is an interesting short-term measure (would enter into force around 2015), it is not considered sufficient.

Option 2 would have a positive safety impact on the long term and it would bring EASA Member States in better compliance with ICAO Standards. Option 2 would have a medium economic impact that in addition may affect disproportionately small-sized operators. Option 2 would only take full effect in 2019, and, therefore, this option does not provide for a short-term mitigation of the risk.

Option 3 would have a safety effect almost as good as Option 2 as regards to phasing out obsolete recording technology, and, in addition, it would address the issue of insufficient recording duration of CVRs installed on board aeroplanes. Option 3 would have an economic impact comparable to Option 2. However, it is expected that the proportionality issue is less severe with Option 3 than with Option 2. Option 3 would leave EASA Member States non-compliant with ICAO Standards with regard to FDR recording technology, however, in practice by 2019 almost all FDRs on board aeroplanes of EASA Member State operators will be solid state anyway. When considering helicopters, magnetic tape FDRs would disappear by 2028. In addition, Option 3 would bring EASA Member States in better compliance with ICAO Standard in Annex 6 Part I requiring that all CVRs have a recording duration of at least two hours by 2016.

For these reasons, **it is proposed to apply Option 4 (both Option 1 and Option 3)**. Option 1 will provide mitigation of risk as of 2015, while Option 3 will provide an ultimate solution to the safety issue by 2019. Option 1 alone is not considered sufficient, because its impact on safety is limited. Option 3 has as good a safety impact as Option 2, and less proportionality impact, therefore, it is preferred to Option 2.

Table A.12: Detailed comparison of impacts between the various options

Option	Option 0	Option 1	Option 2	Option 3	Option 4
Option description	Baseline option (No change in rules; risks remain as outlined in the issue analysis)	Modify the AMC to OPS rules in order to recommend: — more frequent recording inspections for flight recorders using magnetic wire and frequency modulation, and — less frequent recording inspections for solid-state flight recorders (FDRs and CVRs) fitted with continuous monitoring for proper operation. — frequent check of the flight recorders for proper operation.	Modify the OPS rules in order to prohibit magnetic tape, magnetic wire and frequency modulation on or after 1 January 2019, for: — CVR installed on board aeroplanes; — FDR installed on board aeroplanes first issued with an individual CofA on or after 1 June 1990; — CVR installed on board helicopters; and — FDR installed on board helicopters.	Modify the OPS rules in order to mandate that from 1 January 2019: — all aeroplanes operated for commercial air transport and required to carry a CVR, be fitted with a CVR having a minimum recording duration of 2 hours, that is not recording on magnetic tape or magnetic wire; and — all helicopters operated for commercial air transport and required to carry a CVR, be fitted with a CVR that is not recording on magnetic tape or magnetic wire.	Option 1 and Option 3
Safety impact	**0**	**+1** **(by 2015)** (more frequent recording inspections for magnetic wire and frequency modulation, and use of the cockpit means for checking the flight recorder operation)	**+3** **(by 2019)** (replacement of all FDRs and CVRs working with obsolete recording technology)	**+3** **(by 2019)** (replacement of all CVRs working with obsolete recording technology, and longer recording duration for CVRs on board aeroplanes)	**+5**

Option	Option 0	Option 1	Option 2	Option 3	Option 4
Environmental impact	**0**	**0**	**0**	**0**	**0**
Social impact	**0**	**0**	**0**	**0**	**0**
Economic impact	**0**	**+3** **globally** (+ for aircraft fitted with solid-state flight recorders, - for aircraft fitted with magnetic wire CVRs of frequency modulation FDR)	**-3** (replacement of all FDRs and CVRs working with obsolete recording technology)	**-3** (replacement of all CVRs working with obsolete recording technology)	**+3** (overall saving of around EUR 20 000 000)
Proportionality issues	**0**	**-1** (more obsolete recorders installed on aeroplanes operated by small operators)	**-3** (small-sized operators more affected by FDR and CVR retrofit)	**-1** (small-sized operators more affected by CVR retrofit)	**-1**
Regulatory coordination and harmonisation	**0**	**+1**	**+3** (better alignment with ICAO provisions requiring a phase-out of old technologies for the FDR and the CVR)	**+3** (better alignment with ICAO provisions requiring a phase-out of old technologies for the CVR + better alignment with ICAO provisions requiring extension of the recording duration to 2 hours)	**+3**

Table A.13: Comparison of impacts between various options (summary)

Types of impacts	_Weight_	_Score_				
		Option 0	Option1	Option 2	Option 3	Option 4
Safety	1	0	+1	+3	+3	+5
Environment	1	0	0	0	0	0
Social	1	0	0	0	0	0
Economic	1	0	+3	-3	-3	+1
Proportionality	1	0	-1	–3	-1	-1
Regulatory coordination and harmonisation	1	0	+1	+3	+3	+3
Total		**0**	**+4**	**0**	**+2**	**+8**

7. Annexes

Annex A: Acronyms and definitions

	Bureau d'Enquêtes et d'Analyses (French safety investigation authority)
CVR	Cockpit Voice Recorder
CofA	Certificate of Airworthiness
EFRPG	European Flight Recorder Partnership Group
ETSO	European Technical Standard Order
FAA	Federal Aviation Administration of the United States
FDR	Flight Data Recorder
ICAO	International Civil Aviation Organization
MAPSC	Maximum Approved Passenger Seating Configuration
MCTOM	Maximum Certificated Take-Off Mass
TSO	Technical Standard Order

Annex B: References

(1) ICAO Annex 6 Part I, International Commercial Air Transport – Aeroplanes, Amendment 36.

(2) ICAO Annex 6 Part II, International General Aviation – Aeroplanes, Amendment 31.

(3) ICAO Annex 6 Part III, International Operations – Helicopters, Amendment 17.

(4) ICAO Annex 13, Aircraft Accident and Incident Investigation, Amendment 13.

(5) Regulation (EU) No 996/2010 of 20 October 2010 on the investigation and prevention of accidents and incidents in civil aviation and repealing Directive 94/56/EC.

(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.

(7) Commission Regulation (EC) No 859/2008 of 20 August 2008 amending Council Regulation (EEC) No 3922/91 as regards common technical requirements and administrative procedures applicable to commercial transportation by aeroplane.

(8) Joint Aviation Requirements, JAR-OPS 3, Commercial Air Transportation (Helicopters).

(9) Opinion No 01/2012 of the European Aviation Safety Agency of 1 February 2012 for a Commission Regulation establishing Implementing Rules for air operations. Available under http://www.easa.europa.eu/agency-measures/opinions.php

(10) Opinion No 02/2012 of the European Aviation Safety Agency of 16 April 2012 for a Commission Regulation establishing Implementing Rules for air operations. Available under http://www.easa.europa.eu/agency-measures/opinions.php.

(11) EUROCAE Document ED-112, Minimum operational performance specification for crash protected airborne recorder systems, March 2003

(12) EUROCAE Document ED-112A, Minimum operational performance specification for crash protected airborne recorder systems, September 2013

(13) Guide on the organisation of the collection, processing and use of flight data information by the civil aviation operators of the Russian Federation (N°HA-296-p dated 31 July 2001), Ministry of Transport of the Russian Federation, Civil Aviation Administration.

(iii) — RIA B: CVR overrun after an accident or a serious incident

1. Issues to be addressed

This proposal is intended to address CVR overruns after accidents and serious incidents, the investigation of which is required according to ICAO Annex 13 and Regulation (EU) No 996/2010. A CVR overrun results in the relevant part of the CVR recording being lost, which makes the CVR useless for the investigation.

1.1. What is the issue and the current regulatory framework?

1.1.1. Root causes and drivers

The main reasons for frequent CVR overruns are:

— **Insufficient recording duration of magnetic tape CVRs**. A recording duration of only 30 minutes was initially required due to the limited recording capacity of the magnetic tape CVR when it was first introduced in the 1960s. Models of CVR using solid-state technologies appeared in the 1990s that could offer a greater recording capacity, therefore, a longer recording duration has been required for aeroplanes and helicopters issued with an individual Certificate of Airworthiness (CofA) since the late 1990s. Yet, still a large proportion of aircraft are fitted with 30-minute recording duration CVRs.

— **Entry into force of Regulation (EU) No 996/2010**[13]**.** With this Regulation, the **investigation of serious incidents** has become an obligation for safety investigation authorities of all EU Member States. Because there are around 4 times more serious incidents than accidents in Europe, the flight recorders need to be tailored to the investigation of serious incidents. The majority of cases of CVR overruns were found during the investigation of a serious incident, because after a serious incident the aircraft is still capable of flying and there is usually no need for an emergency landing.

— **Failure to preserve the CVR recording after the flight.** The flight crew fails to deactivate the CVR immediately after completion of the flight or it is inadvertently reactivated by the maintenance personnel. The lack of specific procedures is a very common contributing factor to this case. Safety recommendations addressed to the Agency and to CAA UK highlight this specific problem.

— **Late identification of a serious incident.** There were cases where the flight crew or the operator did not realise immediately the actual severity of an occurrence, and subsequently they did not take any action to preserve the CVR recording.

— **Flight duration.** Cases have been identified where the aircraft kept flying more than two hours after an occurrence. The following circumstances were identified:

- a serious incident occurs with no impact on the safe continuation of the flight, and the flight is continued as planned (e.g. airprox, runway incursion during take-off);
- the aircraft is in a remote area (desert or oceanic area) when a serious incident occurs and the next airfield is more than two hours flight from the place of occurrence (e.g. turbulence occurrence or multiple system failure in cruise in a remote area);

[13] Regulation (EU) No 996/2010 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)*.

- the cumulated durations to handle malfunctions, descend, dump fuel, land and manage the cabin evacuation exceed two hours[14]; or
- the aircraft is flying on its own after the occurrence, because of flight crew loss or flight crew incapacitation (e.g. after a cabin decompression).

1.1.2. Reasons for action

Action is justified by:

(a) **Standards in ICAO Annex 6** Part I, II and III stating that from 1 January 2016, CVRs shall have a recording duration of two hours.

(b) **Seven safety recommendations** addressed to the Agency:

(1) Safety recommendation CAND-1999-002 issued by the Transportation Safety Board (TSB) of Canada (accident of MD-11 of Swissair registered HB-IWF on 2 September 1998): 'As of 01 January 2005, all aircraft that require both an FDR and a CVR be required to be fitted with a CVR having a recording capacity of at least two hours.';

(2) Safety recommendation GREC-2006-045 issued by the Air Accident Investigation and Aviation Safety Board (AAIASB) of Greece to the Agency (accident of B737 of Helios registered 5B-DBY): 'EASA/JAA and ICAO require aircraft manufacturers to evaluate the feasibility of installation of a CVR that records the entire flight.';

(3) Safety recommendation NORW-2006-013 issued by the Accident Investigation Board (AIB) of Norway (accident of ATR 42 registered OY-JRJ on 31 May 2005): 'The AIBN has noted that several operators lack procedures to ensure that registered data is retained, and recommend that JAA/EASA consider whether the regulations (Appendix 1 JAR OPS 1.1045 pt. 11) should specify that procedures must be drawn up for preservation of data from flight and cockpit voice recorders are included in operation manuals, so that the JAR OPS 1.160 requirements are better adhered to.';

(4) Safety recommendation NETH-2011-015 issued by the Dutch Safety Board (DSB) of the Netherlands (serious incident of a B737 registered PH-BDP on 10 February 2010): 'The Board recommends that the European Aviation Safety Agency (EASA) and Federal Aviation Administration (FAA) increase the minimum recording time of the cockpit voice recorder (CVR) in order to better safeguard the availability of data for the purpose of incident and accident investigations.';

(5) Safety recommendation UNKG-2012-013 issued by AAIB UK (accident of a B767 registered G-OOBK on 03 October 2010): 'It is recommended that the European Aviation Safety Agency publishes guidance information that assists operators and National Aviation Authorities in the production and auditing of procedures to prevent the loss of Cockpit Voice Recorder recordings in accordance with the requirements of EU-OPS 1.160 and EU-OPS 1.085.';

(6) Safety recommendation FRAN-2012-025 issued by the Bureau d'Enquêtes et d'Analyses (BEA) of France (serious incident of an Airbus 340 registered F-GLZU on 22 July 2011): 'The BEA recommends that EASA and ICAO require that the minimum recording duration of CVR's be increased to allow the recording in full of long-haul flights.';

[14] It should be noted that in the case of a serious incident, the 'end of the flight' is not the time when the aircraft is on the ground again, but when it has stopped and is ready for disembarking. The taxiing and parking phases have to be taken into account when computing the flight duration.

(7) Safety recommendation FINL-2012-003 issued by the Safety Investigation Authority of Finland (serious incident of an Airbus A330 registered OH-LTO on 11 December 2010): 'It is recommended that EASA and ICAO sufficiently lengthen the time recording requirement of CVRs so as to cover the entire routing of the flight.';

(c) **Data gathered with the help of safety investigation authorities**. **38 investigation reports indicating a CVR overrun** are presented in Annex C, among which:

(1) 15 reports indicate an overrun of a 30-minute recording duration CVR;

(2) 10 reports indicate an overrun of a 2-hour recording duration CVR, where the aircraft kept flying more than two hours after the occurrence;

(3) 13 reports indicate an overrun of a 2-hour recording duration CVR, where the aircraft flew less than two hours after the occurrence, but the CVR recording was not preserved.

1.1.3. Regulatory status

The current regulatory status is the following:

1.1.3.1. ICAO Annexes

ICAO Annex 6 (Operation of Aircraft) Part I (International Commercial Air Transport – Aeroplanes) Amendment 36 is applicable since 15 November 2012 and contains the following Standards and Recommended Practices in Section 6.3 (Flight recorders):

'6.3.2.3.2 From 1 January 2016, all CVRs shall be capable of retaining the information recorded during at least the last two hours of their operation.'

Similar Standards and Recommended Practices are stated in Annex 6 Part II (International General Aviation – Aeroplanes) Amendment 31 paragraph 2.4.16.2.3.2 and in Annex 6 Part III (International Operations – Helicopters) Amendment 17 paragraph 4.3.2.3.2.

1.1.3.2. CVR design specifications and applicable industry standards

EASA Certification Specifications CS-25 and CS-29 do not contain any provision with regard to CVR recording duration.

European Technical Standard Order (ETSO) C-123b, adopted in 2010, refers to the operational specifications defined in EUROCAE Document ED-112, version of 2003. This document defines three classes of flight recorders, with recording durations of 2 hours, 1 hour and 30 minutes.

In September 2013, EUROCAE published ED-112A, which supersedes ED-112. This new document defines three additional classes of CVRs, with recording durations of 10 hours, 15 hours and 25 hours. The reason invoked for defining these new classes of CVRs is that ICAO is 'now requiring the investigation of serious incidents'.

Other industry standards provide for the interchangeability of flight recorders. In particular, ARINC characteristics establish specific form factors, mounting provisions, interwiring, output signal data, and power supply standards for the CVR. These are:

— ARINC 557 (now withdrawn). It describes installation standards for the earlier CVR that used analog technologies (magnetic wire or magnetic tape); and

— ARINC 757 which is addressing solid-state CVR.

1.1.3.3. Requirements on CVR recording duration in European air operation rules

The air operation rules and draft air operation rules considered here are:

— The air operation rules applicable to commercial air transport contained in Annex IV to Commission Regulation (EU) No 965/2012[15] (hereinafter referred to as the '**OPS Part CAT**'): see paragraphs CAT.IDE.A.185 (for aeroplanes) and CAT.IDE.H.185 (helicopters).

— The air operation rules applicable to the non-commercial operation of complex motor powered aircraft contained in Annex VI to Commission Regulation (EU) No 965/2012 modified by Commission Regulation (EU) No 800/2013 (hereinafter referred to as the '**OPS Part NCC**'): see paragraphs NCC.IDE.A.160 (for aeroplanes) and NCC.IDE.H.160 (helicopters)

— The draft air operation rules applicable to the specialised operations contained in draft Annex VIII[16] to Commission Regulation (EU) No 965/2012 (hereinafter referred to as the '**OPS Part SPO**'): see paragraphs SPO.IDE.A.140 (for aeroplanes) and SPO.IDE.H.140 (helicopters). EASA Opinion No 02/2012 presenting OPS Part SPO was adopted by EASA Committee in July 2013, and it still needs review by the Council and the European Parliament.

These OPS rules contain requirements for some categories of aircraft to be fitted with CVRs with a recording duration of 2 hours; one applicability criterion is the date of first issuance of the individual Certificate of Airworthiness (CofA):

— Among aeroplanes operated for commercial air transport, only those with an MCTOM of more than 5 700 kg and first issued with an individual CofA on or after 1 April 1998 are required to carry a CVR with a recording duration of at least 2 hours; the other aeroplanes operated for commercial air transport are only required to carry a CVR with a minimum recording duration of 30 minutes (see Table B.1a).

— All aeroplanes operated for general aviation or aerial work that are required to carry a CVR (individual CofA first issued on or after 1 January 2016) must carry a CVR with a minimum recording duration of 2 hours (see Table B.1b).

— Among helicopters operated for commercial air transport, those with an MCTOM of more than 3 175 kg and first issued with an individual CofA on or after 1 January 2016 must carry a CVR with a recording duration of 2 hours. Other helicopters are only required to carry a CVR with a minimum recording duration of 30 minutes or 1 hour (see Table B.1c).

— All helicopters operated for general aviation or aerial work and required to carry a CVR (individual CofA first issued on or after 1 January 2016) must carry a CVR with a minimum recording duration of 2 hours (see Table B.1d).

[15] Commission Regulation (EU) No 965/2012 of 5 October 2012, laying down technical requirements and administrative procedures related to air operations (OJ L 296, 25.10.2012, p. 1).

[16] Opinion No 02/2012 of the European Aviation Safety Agency of 16 April 2012 for a Commission Regulation establishing Implementing Rules for air operations. Available under http://www.easa.europa.eu/agency-measures/opinions.php. This Regulation is expected to be published in 2013.

Table B.1a: CVR carriage and duration requirements for commercial air transport aeroplanes (see CAT.IDE.A.185):

	MCTOM > 5 700 kg	**MCTOM < 5 700 kg**		
		first individual CofA issued before 1 January 1990	first individual CofA issued after 1 January 1990	
			Not multi-engine turbine powered or MASPC < 9	multi-engine turbine powered and MASPC > 9
Carriage requirement	CVR	NIL	NIL	CVR
Recording duration	30 minutes if first individual CofA issued before 1 April 1998; 2 hours if first individual CofA issued on or after 1 April 1998	N/A	N/A	30 minutes

Table B.1b: CVR carriage and duration requirements for aeroplanes operated for general aviation and aerial work (see NCC.IDE.A.160 and SPO.IDE.A.140):

	MCTOM> 27 000 kg		**2 250 kg < MCTOM<27 000 kg**		
	first individual CofA issued before 1 January 2016	first individual CofA issued after 1 January 2016	TC issued before 1 January 2016	TC issued on or after 1 January 2016	
				More than one turbojet engine or more than one turboprop engine and required to be operated by more than one pilot	No turbojet engine or one turboprop engine or no turboprop engine or not required to be operated by more than one pilot
Carriage requirement	NIL	CVR	NIL	CVR	NIL
Recording duration	N/A	2 hours	N/A	2 hours	N/A

Table B.1c: CVR carriage and duration requirements for helicopters operated for commercial air transport (see CAT.IDE.H.185):

	MCTOM >7 000 kg	3 175 kg <MCTOM<7 000 kg		MCTOM <3 175 kg
		first individual CofA issued before 1 January 1987	first individual CofA issued after 1 January 1987	
Carriage requirement	CVR	NIL	CVR	NIL
Recording duration	30 minutes if first individual CofA issued before 1 August 1999 1 hour if first individual CofA issued on or after 1 August 1999 and before 1 January 2016 2 hours if first individual CofA issued on or after 1 January 2016	N/A	30 minutes if first individual CofA issued before 1 January 2016 2 hours if first individual CofA issued on or after 1 January 2016	N/A

Table B.1d: CVR carriage and duration requirements for helicopters operated for general aviation and aerial work (see NCC.IDE.H.160 and SPO.IDE.H.140):

	MCTOM>7 000 kg		MCTOM<7 000 kg
	first individual CofA issued before 1 January 2016	first individual CofA issued on or after 1 January 2016	
Carriage requirement	NIL	CVR	NIL
Recording duration	N/A	2 hours	N/A

1.1.3.4. Requirement on European safety investigation authorities to investigate serious incidents

Regulation (EU) No 996/2010 (on the investigation and prevention of accidents and incidents in civil aviation) requires the following:

'Article 5 - Obligation to investigate

1. Every accident or serious incident involving aircraft other than specified in Annex II to Regulation (EC) No 216/2008 (…) shall be the subject of a safety investigation in the Member State in the territory of which the accident or serious incident occurred.
2. When an aircraft, other than specified in Annex II to Regulation (EC) No 216/2008, registered in a Member State is involved in an accident or serious incident the location of which cannot be definitely established as being in the territory of any State, a safety investigation shall be conducted by the safety investigation authority of the Member State of registration.'

Because Regulation (EU) No 996/2010 is now applicable in all EU Member States with no possibility for deviation or opt-out, safety investigation authorities of EU Member States must investigate all serious incidents occurring in their airspace, as well as serious incidents for which their State is the State of Registry and taking place outside of the airspace of any Member State (except for some categories of very light aircraft and collection aircraft).

1.1.3.5. Obligation to preserve the CVR recording after an accident or a serious incident

Obligations on the aircraft operator in European air operation rules

OPS Part CAT, paragraph CAT.GEN.MPA.195 contains a requirement (transposed from EU OPS 1.160) that the aircraft operator preserves the recordings of flight recorders after an accident or a serious incident:

'CAT.GEN.MPA.195 Preservation, production and use of flight recorder recordings

(a) Following an accident or an incident that is subject to mandatory reporting, the operator of an aircraft shall preserve the original recorded data for a period of 60 days unless otherwise directed by the investigating authority.'

Note:

Aircraft operators experience many more incidents than accidents and serious incidents together and preserving the CVR after each incident would have a serious economic impact on operation, because the flight recorders are MMEL items. It is believed that the wording 'subject to mandatory reporting' is confusing because it can be understood as an incident that should be reported to the national aviation authority according to the European Directive 2003/42/EC, while here the competent safety investigation authority should be informed. Safety investigation authorities are deciding if an investigation should be open and the CVR recording preserved, not the national aviation authorities. According to Regulation (EU) No 996/2010, safety investigation authorities of EASA Member States must investigate every accident and serious incident (see 2.1.3.4).

Hence in the case of an accident or a serious incident, the CVR recording should be preserved for the need of a safety investigation. The CVR should also be preserved after an incident if the safety investigation authority directs to do so (see Article 5 (4) of Regulation (EU) No 996/2010). In the other cases, there is no need to preserve the CVR.

In addition, acceptable means of compliance to Annex III of the air operation rules applicable to commercial air transport air operators (hereinafter referred to as the 'OPS

Part ORO') recommend that[17] aircraft operators include, in their general part of their operations manual (Part A), provisions on the preservation of the flight recorders.

'AMC3 ORO.MLR.100 Operations manual — General

CONTENTS — COMMERCIAL AIR TRANSPORT OPERATIONS

1. The OM should contain at least the following information, where applicable, as relevant for the area and type of operation:

A GENERAL/BASIC

(…)

11. HANDLING, NOTIFYING AND REPORTING ACCIDENTS, INCIDENTS AND OCCURRENCES

Procedures for handling, notifying and reporting accidents, incidents and occurrences. This section should include the following:

(…)

(g) Procedures for the preservation of recordings following a reportable event.'

However, AMC3 ORO.MLR.100 does not contain any recommendation on the content of Part B of the operations manual, which should address each aircraft type and variant. The instructions to deactivate the flight recorders, which are specific to a flight recorder installation, are not addressed by this AMC.

Obligations on the flight crew in European air operation rules

OPS Part CAT, paragraph CAT.GEN.MPA.105 requires action to be performed by the flight crew to preserve the recordings after an accident or a serious incident. In addition to requirements already contained in EU OPS 1.085, CAT.GEN.MPA.105 requires the flight crew to deactivate the flight recorders immediately after flight completion, in the case of an accident or a serious incident:

'CAT.GEN.MPA.105 Responsibilities of the commander

(a) The commander (…) shall:

(…)

(10) ensure that flight recorders:

(i) are not disabled or switched off during flight; and

(ii) in the event of an accident or an incident that is subject to mandatory reporting:

(A) are not intentionally erased;

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

(C) are reactivated only with the agreement of the investigating authority;'

Note:

Aircraft operators experience many more incidents than accidents and serious incidents together and preserving the CVR after each incident would have a serious economic impact on operation.

Hence, in the case of an accident or a serious incident, the CVR recording should be preserved for the need of a safety investigation. The CVR should also be preserved after an incident if the safety investigation authority directs to do so (see Article 5 (4) of Regulation (EU) No 996/2010). In the other cases, there is no need to preserve the CVR.

[17] See Annex to EASA ED Decision 2012/017/R

Regulation (EU) 996/2010 requires preservation of audio recordings after an accident or a serious incident, and this requirement is applicable to the flight crew:

'Article 13 – Preservation of evidence

(…)

3. Any person involved shall take all necessary steps to preserve documents, material and recordings in relation to the event, in particular so as to prevent erasure of recordings of conversations and alarms after the flight.'

Guidance of CAA UK on CVR preservation after an accident or a serious incident

UK CAA CAP 731 contains recommendations regarding the preservation of a CVR recording in its chapter 12:

'Operators and continuing airworthiness management organisations should ensure that robust procedures are in place and prescribed in the relevant Operations Manual and Expositions to ensure that CVR/FDR recordings that may assist in the investigation of an accident or incident are appropriately preserved. (…)

When appropriate, the relevant circuit breakers should be pulled and collared/tagged and an entry made in the aircraft technical log to make clear to any airline personnel that an investigation is progressing. Furthermore, confirmation from the investigation authority/operator is required to be obtained before systems are reactivated and power is restored.

Operators who contract their maintenance activities or ground handling to a third party should ensure that the contracted organisation is made aware of all their relevant procedures.'

1.2. Safety risk assessment

The flight recorders are not critical for the safe conduct of the flight, however, they are essential safety investigation tools. Therefore, a risk assessment focussed on operational safety is not appropriate. The risk to be assessed here is the risk for safety investigation authorities and aviation regulators to be unable to timely identify a hazard that would normally be captured by the flight recorder.

1.2.1. Risk frequency

The risk frequency can be assessed on the basis of the number of safety investigations delayed or hindered because of a CVR overrun. In practice, the average annual number of CVR overruns found on aircraft of European Member State operators involved in accidents and serious incidents was assessed. Aircraft of European Member State operators are subject to European air operation rules, which are the Agency's responsibility.

The following assumptions are made:

— The fleet considered is aircraft of EASA Member States operators that are required to carry a CVR;

— The context considered is the investigations into accidents and serious incidents of these aircraft. According to ICAO Annex 13 and to Regulation (EU) No 996/2010, every accident and serious incident shall be subject to an official safety investigation by a safety investigation authority. The CVR is essential to ensure the timely conduct of the investigation;

— The risk arises from an insufficient recording duration of the CVR: their proportion in flight recorders fitted to aircraft subject to OPS rules as well as their failure rate allow to assess the number of safety investigations which are delayed or hindered because of this issue.

Note:

Most of the 8 950 aeroplanes of EASA Member States operators that are required to carry a CVR (see 2.3.2) have an MCTOM of over 5 700 kg: only 116 out of 8 950 have an MCTOM of less than 5 700 kg.

1.2.1.1. Proportions of 30 minutes recording duration CVRs and of 2 hours recording duration CVRs

On request, a national aviation authority surveyed its national operators in 2011 in order to determine the proportion of CVRs using magnetic tape technology (see Table B.3).

It was found that about one third of CVRs installed on board aeroplanes have a recording duration of 30 minutes, and that most of these 30-minute recording duration CVRs are recording on a magnetic tape. This is consistent with 2.3.2.

EASA safety occurrence database was queried to determine the aircraft registered in an EASA Member State which were involved in an occurrence during the period between 1 January 2007 and 31 December 2012, and for which the CVR recording duration is indicated. 22 records were found, all related to an aeroplane. 8 of these 22 records indicate a recording duration of 30 minutes, and the rest indicate a recording duration of 120 minutes or longer. This is also consistent with the assumption that currently about a third of CVRs installed on board aeroplanes of EASA Member State operators have a recording duration of 30 minutes.

<u>Note:</u>

While there exist models of solid-state CVRs with a recording duration of 30 minutes, the Agency is not aware of a model of magnetic tape CVR with a recording duration of 2 hours.

Table B.3: Number and proportion of 30 minutes recording duration CVRs installed on board aeroplanes of a sample of operators registered by National Aviation Authority A.

<table>
<tr><th></th><th>Sample</th><th>Magnetic-tape CVRs (30 minutes recording duration)</th><th>Solid-state CVRs with 30 minutes recording duration</th><th>Solid-state CVRs with 2 hours recording duration</th></tr>
<tr><td>Number of CVRs</td><td>433</td><td>127</td><td>18</td><td>288</td></tr>
<tr><td rowspan="2">Proportion of CVRs</td><td rowspan="2">100 %</td><td>29 %</td><td>4 %</td><td rowspan="2">67 %</td></tr>
<tr><td colspan="2">33 %</td></tr>
</table>

Based on these results, it is assumed that 33 % of the fleet considered (aeroplanes operated by a European Member State operator for commercial air transport and required to carry a CVR) are fitted with a 30-minute recording duration CVR, and that 67 % are fitted with a 2-hour recording duration CVR.

1.2.1.2. Proportion of CVR overruns

The Agency safety occurrence database was queried to identify aeroplanes involved in an occurrence between 1 January 1997 and 31 December 2011 (15 year period), for which the recording duration is indicated. The results are the following:

— 266 records indicate a CVR recording duration of or close to 30 minutes; for 60 of those (i.e. 23 %), duration insufficient is indicated as a reason for CVR data loss.

— 98 records indicate a CVR recording duration of 2 hours; for 12 of those (i.e. 12 %), duration insufficient is indicated as a reason for CVR data loss.

However, CVR overruns are becoming more and more frequent with 2 hours recording duration CVR. This is probably because in accordance with ICAO Annex 13 (and in Europe Regulation (EU) No 996/2010) more serious incidents are now investigated, so that more cases are found where even 2 hours of recording are not sufficient. When considering the period from 1 January 2007 to 31 December 2011:

— 27 records indicate a CVR recording duration of or close to 30 minutes; for 7 of those (around 26 %), duration insufficient is indicated as a reason for CVR data loss; and

— 31 records indicate a CVR recording duration of 2 hours; for 7 of those (i.e. 23 %), duration insufficient is indicated as a reason for CVR data loss.

With these results, and assuming an increase in the safety investigations of serious incidents, the following assumptions are made:

— Around 26 % of 30 minutes recording duration CVRs read out for a safety investigation have overrun.

— Around 23 % of 2 hours recording duration CVRs read out for a safety investigation have overrun.

1.2.1.3. Proportion of aeroplanes of EASA Member State operators for which the CVR overruns after an accident or a serious incident

Based on the previous assumptions:

(a) the proportion of aeroplanes involved in an accident or a serious incident and for which a 30-minute recording duration CVR overruns is assessed to be (33 %)×(26 %)=9 %; and

(b) the proportion of aeroplanes involved in an accident or a serious incident and for which a 2-hour recording duration CVR overruns is assessed to be (67 %)×23 %=15 %.

On average, the problem of CVR overrun impedes (9+15)=24 % i.e. one quarter of safety investigations involving an aeroplane of an EASA Member State operator that carries a CVR. The Agency is responsible for the flight recorder carriage requirements applicable to those aircraft.

In the next years, the proportion of 2-hour recording duration CVRs is expected to increase at a rate corresponding to the renewal rate of the fleets of aeroplanes of EASA Member States operators. **Assuming that the economic life cycle of an aeroplane is 30 years**, the proportion of 2-hour recording duration CVRs on board aeroplanes, is assumed to be 67 % on 1 January 2013 and expected to be 87 % on 1 January 2019**.** The proportion of 30-minute recording duration CVRs on board aeroplanes, is assumed to be 33 % on 1 January 2013 and expected to be 13 % on 1 January 2019**.**

As a result, the proportion of accidents and serious incidents for which a CVR is found out to have overrun would be (13 %)×(26 %)+(87 %)×(23 %) = **23 % on 1 January 2019**. Hence, the progressive replacement of 30-minute duration CVRs by 2-hour duration CVRs would have little effect on the proportion of CVR overruns.

1.2.2. Risk severity

If an important causal factor of an accident or a serious incident is missed because the recording of the sequence of events is missing on the CVR, no effective safety action to address can be taken to address this causal factor. It may then contribute to other accidents and serious incidents.

1.3. Who is affected?

1.3.1. Stakeholders

CVR overruns are impeding the work of safety investigation authorities as the absence of useful information recorded on the CVR makes the determination of the causes of a number of accidents and serious incidents more difficult. The taking of appropriate corrective actions by the Agency and other authorities is accordingly hindered.

<u>Note:</u>

Most cases of CVR overruns reported by safety investigation authorities occur after a serious incident, and in that case the flight crew members are usually in a medical condition that allows for an interview.

However, investigation experience shows that the CVR recording and flight crew statement do not contain equivalent information. The CVR records faithfully the history of verbal communications, alarms and sounds heard in the cockpit, while a reconstruction simply based on human memory cannot be that accurate. On the other hand, the statements provided by flight crew members are very useful to understand unrecorded information, such as where their attention was focussed, what each member perceived of the occurrence, if they had non-verbal communications, what was their fatigue condition, etc.

Hence, the CVR recording and the flight crew interview should be considered complementary rather than equivalent sources of information for the safety investigation. Safety investigators usually make use of both sources to reconstruct an accurate and complete picture of the human-human interactions and human-machine interactions.

1.3.2. Affected fleet

The affected fleet a priori are all aircraft required to carry a CVR according to air operation rules. However, data indicate that this set can be reduced:

(a) **CVR overruns affect aeroplanes, not helicopters**. The Agency was not made aware of any case of CVR overrun with a CVR installed on board a helicopter. In addition, the Agency queried its safety occurrence database and found no occurrence between 1 January 1997 and 31 December 2011 involving a helicopter and indicating insufficient duration of the CVR as a reason for data loss. Over the same period, 96 records involving an aeroplane and pointing at a CVR overrun were found. The absence of CVR overruns on helicopters is probably due to the fact that the typical flight length duration of a helicopter is very short, and does not include any taxiing. In addition the CVR start and stop logic on a helicopter is different from what it is on an aeroplane. This leads to the CVR capturing a larger portion of the airborne phase when installed on a helicopter than on an aeroplane.

(b) **30-minute recording duration CVR are allowed on aeroplanes with an MCTOM of less than 5 700 kg and on aeroplanes with an MCTOM of more than 5 700 kg and first issued with an individual CofA before 1 April 1998**. According to a query of Ascend aircraft and airlines data of year 2012, 3 050 of the 8 950 aeroplanes operated by EASA Member States operators (i.e. operators that have their principal place of business in an EASA Member State) fulfil these criteria and, therefore, may carry a 30-minute recording duration CVR. This represents roughly one third of the aeroplanes fleets.

(c) **2-hour recording duration seems insufficient for large aeroplanes**. The Agency queried its safety occurrence database and found that between 1 January 1997 and 31 December 2011 there are 12 records of an aeroplane with an overrun of a 2-hour recording duration CVR. Only 1 out of 12 corresponds to an aeroplane with an MCTOM of less than 27 000 kg. In addition, all of the 10 cases in Annex C indicating that the aircraft kept flying more than two hours after the occurrence affect aeroplanes with an MCTOM of over 27 000 kg. According to a query of Ascend aircraft and airlines data of year 2012, there would be 6 020 aeroplanes with an MCTOM exceeding 27 000 kg that are operated by EASA Member States operators.

(d) **30-minute recording duration CVRs are concentrated among small-sized aircraft operators.** On request by EASA, a national aviation authority surveyed its national operators in 2011 in order to determine the distribution of flight recorders using magnetic tape technology among aircraft operators (see Table B.2). The results of this survey suggest that while large and medium-sized aeroplane operators operate almost exclusively 2-hour recording duration CVRs, many CVRs operated by small-sized aeroplane operators have a recording duration of 30 minutes.

Table B.2: Number of operators registered by National Aviation Authority B and which operate 30 minutes recording duration CVRs.

Category of operator	Total number of responders per category	Number of responders which operate only 2-hour recording duration CVRs	Number of responders which operate 2-hour recording duration CVRs and 30-minute recording duration CVRs	Number of responders which operate only 30-minute recording duration CVRs
Large or middle-sized aeroplane operators	11	10	1	0
Small-sized aeroplane operators	10	1	4 (2 with 30-minute duration SSCVRs)	5 (2 with 30-minute duration SSCVRs)

1.4. How could the issue/problem evolve?

The cockpit voice recorder is an investigation tool that brings no visible safety benefit to an aircraft operator, and even its recording is restricted by the air operation rules (refer to OPS Part CAT, CAT.GEN.MPA.195). Therefore, aircraft operators have no incentive to increase the recording duration of their CVRs or to update the CVR preservation procedures.

Subsequently, if no corrective action is taken by the Agency, the proportion of CVR overruns is expected to remain high, in particular after serious incidents. The investigations of serious incidents will remain often hindered by the absence of a useful CVR recording. Since 2010, safety investigation authorities of EASA Member States must investigate serious incidents (according to Regulation (EU) 996/2010), therefore, this issue is not likely to lose significance in the future.

1.5. Summary of the issues

Issue 1: CVR overruns occur frequently with aeroplanes

— Numerous cases of CVR overruns were found out at the occasion of safety investigations, and they were the subject of several safety recommendations addressed to the Agency.

— CVR overruns seem to affect only aeroplanes and the majority of them occurred after a serious incident.

— CVR overruns would occur in roughly one quarter of investigations of aeroplane accident and serious incidents.

— Most common causes of a CVR overrun are insufficient recording duration (especially in the case of a 30-minute duration CVRs), flight continued (in particular in the case of a serious incident), late identification of the severity of the event, or failure to preserve the CVR after flight completion (the lack of clear operating instructions being a contributing factor).

Issue 2: the particular case of large aeroplanes

— Most CVR overruns with a two-hour recording duration CVR occur with aeroplanes with an MCTOM of over 27 000 kg. A replacement of 30-minute recording duration CVRs by 2-hour recording duration CVRs would not fully solve the issue of CVR overruns for this mass category.

— This is probably due to the fact that large aeroplanes tend to perform longer flights, so that the recording of a serious incident is often overwritten before the flight is completed.

Issue 3: the current situation in Europe

— In the case of commercial air transport, the European air operation rules require that the recording duration of the CVR is at least two hours only when the aeroplane has an MCTOM of more than 5 700 kg and it was first issued with an individual CofA on or after 1 April 1998. Lighter or older aeroplanes may still carry a 30-minute recording duration CVRs. These lighter and older aeroplanes represent one third of aeroplanes operated for commercial air transport by EASA Member States operators.

— These lighter and older aeroplanes seem to be for the most part actually fitted with 30-minute recording duration CVRs, as illustrated by the result of a national survey. In addition, 30-minute recording duration CVRs seem to be more frequent on board aeroplanes operated by small-sized and medium-sized operators.

— The European air operation rules are not aligned with ICAO Standards which require that all CVRs have a recording duration of 2 hours by 2016.

— The European air operation rules require preservation of the flight recorders recordings following an accident or an 'incident subject to mandatory reporting'. But these provisions are not specific enough and guidance is missing. In addition, their wording is problematic, because most incidents subjects to mandatory reporting are not investigated and, thus, do not necessitate CVR preservation.

— The European investigation rules adopted in 2010 require that safety investigation authorities of EASA Member States not only investigate accidents but also all serious incidents. Before that, the safety investigation of serious incidents was only recommended by a directive. As CVR overruns affect mainly serious incidents, findings have multiplied in the last few years.

2. Objectives

The overall objectives of the Agency are defined in Article 2 of the Basic Regulation. This proposal will contribute to the overall objectives by addressing the issues outlined in Section 2. The specific objective of this proposal is, therefore, to reduce the probability of overruns of CVRs installed on board aircraft subject to European air operation rules.

3. Policy options

Table B.4: Selected policy options

Option No	Description
0	Baseline option (No change in rules; risks remain as outlined in the issue analysis.)

1	Require that aircraft operators develop comprehensive procedures to ensure flight recorder preservation following an accident or serious incident, while relaxing the requirement in the case of an incident subject to mandatory reporting.
2	Modify the OPS rules in order to mandate that from 1 January 2019, all aeroplanes operated for commercial air transport and required to carry a CVR, be fitted with a CVR having a minimum recording duration of 2 hours, that is not recording on magnetic tape or magnetic wire. (Coupled with Option 3 of the Regulatory Impact Assessment A on Discontinuation of obsolete recording technologies)
3	Require that all aeroplanes with an MCTOM over 27 000 kg and first issued with an individual CofA on or after 1 January 2019 be equipped with a CVR that has a minimum recording duration of 15 hours.
4	Options 1 and 2 and 3

Option 0 consists in not changing the current European air operation rules.

Option 1 consists in:

(a) Completing CAT.GEN.MPA.195(a) or AMC1 CAT.GEN.MPA.195(a), to explicitly require or recommend that aircraft operators have procedures in place to ensure that, in the event of an occurrence subject to an investigation by a safety investigation authority (such as an accident or serious incident), flight recorders are deactivated immediately after flight completion and not reactivated without the agreement of the safety investigation authority. Do the same for NCC.GEN.145(a) and SPO.GEN.150(a);

(b) Modifying the scope of CAT.GEN.MPA.195(a), so that preservation of original recorded data only applies in the case of an occurrence subject to an investigation by a safety investigation authority, and not for every incident subject to mandatory reporting, and do the same for NCC.GEN.145(a) and SPO.GEN.150(a);

(c) Modifying CAT.GEN.MPA.105(a)(10), NCC.GEN.106(a)(9) and SPO.GEN.107(a)(9) so that the obligation on the commander or pilot-in-command to ensure preservation of the recordings only applies in the case of an accident or a serious incident or when required by the safety investigation authority, and not each time there is an incident subject to mandatory reporting. In the latter case, only erasure of the flight recorders should be prohibited;

(d) adding in AMC3 ORO.MLR.100 (content of the operations Manual):

(1) general provisions in (A) on preserving the flight recorder recordings following an accident or a serious incident, such as deactivating the flight recorders immediately after flight completion, preventing their inadvertent reactivation by tagging or collaring the circuit breakers, informing the relevant airline personnel that the flight recorders must not be reactivated until agreement of the safety investigation authority is received; and

(2) specific provisions in (B) for each CVR system installation design, on deactivating the CVR and preventing their inadvertent reactivation.

Option 1 is meant to provide for short-term risk mitigation, by improving the preservation of the CVR recording after an accident or a serious incident. In addition, Option 1 aims at correcting an inconsistent provision that requires preservation of the flight recorder recordings each time there is an incident subject to mandatory reporting, which may have significant economic impact because the flight recorders are MMEL items and there are many more incidents subject to mandatory reporting as serious incidents.

Option 2 consists in requiring that all aeroplanes that are required to carry a CVR according to CAT.IDE.A.185, be fitted from 1 January 2019 with a CVR of a minimum recording duration of 2 hours, and that this CVR is neither a magnetic tape CVR nor a magnetic wire CVR. Option 2 is also meant to cover the issue of unreliable recording technologies addressed in the regulatory impact assessment (RIA) A on 'Discontinuation of obsolete recording technologies'. Therefore, Option 2 is coupled with Option 3 of that RIA.

Option 2 addresses the fact that 30 minutes is insufficient a duration for the investigation of serious incidents, which has become an obligation for safety investigation authorities of EASA Member States.

Option 2 covers aeroplanes operated for commercial air transport only, because Part NCC and draft Part SPO already require a minimum recording duration of 2 hours for new aeroplanes manufactured on or after 1 January 2016, and most, if not all, modern models of 2-hour recording duration CVRs are solid-state.

Option 2 does not address helicopters, because there is no evidence of CVR overruns with helicopters.

Option 3 consists in introducing in CAT.IDE.A.185, NCC.IDE.A.160 and SPO.IDE.A.140, a requirement that aeroplanes with an MCTOM over 27 000 kg and first issued with an individual CofA on or after 1 January 2019 be equipped with a CVR with a minimum recording duration of 15 hours.

Option 3 specifically addresses those cases where more than 2 hours elapse from the time of the safety occurrence until the end of the flight, so that a 2-hour recording duration CVR cannot retain the relevant information and improvement of CVR preservation has no effect on those cases.

4. Data and methodology

Refer to Appendix M.

5. Analysis of impacts

5.1. Safety impact

Note:

Whatever the option, the safety impacts are indirect as flight recorders are safety investigation tools and not aircraft safety systems.

5.1.1. Option 0

Around one quarter of investigations involving an aeroplane of an EASA Member State operator that is required to carry a CVR are hindered by a CVR overrun. This proportion is not expected to decrease if no action is taken.

5.1.2. Option 1:

Out of the 38 investigation reports collected and presented in Annex C, 21 of them point at a failure to preserve the CVR recording after completion of the flight. Hence, around two thirds of CVR overruns could have been avoided if appropriate measures had been taken to preserve the CVR recording.

However, with the increase of safety investigations on serious incidents, this proportion is expected to decrease, as 30 minutes is too short a recording duration in many serious incidents, whatever the effectiveness of CVR preservation measures. In fact, when considering investigation reports on occurrences which happened on or after 1 January 2007, the proportion is 10/19 i.e. **roughly half of CVR overruns could have been avoided if appropriate measures had been taken to preserve the CVR recording**.

Therefore, the safety impact of Option 1 is considered slightly positive, as it has the potential to address half of CVR overruns (score +1).

5.1.3. Option 2

The effectiveness of this option against CVR overruns is considered moderate. In Table B.C.1 of Annex C, for only 3 cases (HB-IWF, G-BZAT and C-GPAT) would a 2-hour recording duration CVR have made a difference with a 30-minute recording duration CVR. Statistics in 2.2.1.2 show a CVR overrun rate of 23 % for 2-hour recording duration CVRs, instead of 26 % for 30-minute recording duration CVRs.

However, it must be recognised that 30-minutes are not adequate a duration to preserve the CVR after completion of the flight. In the case of aeroplanes, 5 to 15 minutes usually elapse between the landing and the time when the flight can be considered completed (taxiing to parking stand or aircraft evacuation). A 2-hour recording duration would give better time margins in this regard, and, therefore, more chance to preserve the CVR recording, provided appropriate and timely measures are taken (see Option 1).

In addition, 30-minute CVRs are for the most part magnetic tape CVRs and, in addition to the duration issue, their reliability is problematic, as for 20 % of the CVRs read out in the frame of a safety investigation, the recording quality was found poor (see Regulatory Impact Assessment A on 'Discontinuation of obsolete recording technologies'). They should be replaced by more reliable CVRs.

For these reasons, the safety impact of Option 2 is considered overall to be medium positive (score +3).

5.1.4. Option 3

A CVR recording duration of 15 hours would allow preservation of the recording of any occurrence taking place during a 14-hour long flight, assuming that one hour is left to take appropriate measures to preserve the recording after completion of the flight. Most flights performed by large aeroplanes have a duration of less than 14 hours. In none of the 38 cases presented in Annex C did the flight last more than 14 hours.

In addition, a 15-hour recording duration would make the CVR recording more immune to inappropriate actions by the flight crew or maintenance personnel after a short-range flight, because in those cases the recording of the occurrence could be overwritten only if the CVR kept recording for hours after completion of the flight.

Option 3 is only addressing large aeroplanes (MCTOM over 27 000 kg) because they are the most affected by CVR overruns due to the flight ending more than two hours after the occurrence. Of the aircraft involved in the 10 occurrences of Table B.C.2 of Annex C, none has an MCTOM of less than 27 000 kg.

However, Option 3 only applies to aeroplanes first issued an individual CofA on or after 1 January 2019, so it will not have a visible safety impact in the short term.

The safety impact of Option 3 is considered very good, however, not short-term and limited to large aeroplanes. The safety impact of Option 3 is rated very positive (score +5)

5.1.5. Option 4

Combining Option 1, Option 2 and Option 3 would:

- reduce the case of CVR overruns in the short term (Option 1);
- reduce further the number of CVR overruns, by offering a better time margin for preserving the CVR, while phasing out unreliable magnetic tape CVRs (Option 2); and
- offer a very long recording duration for CVRs installed on large aeroplanes, which is the only solution for occurrences taking place more than 2 hours before the end of the flight, and also a robust solution against inadvertent CVR overruns (Option 3).

Option 4 would reduce in the short term the frequency of CVR overruns and provide for an ultimate solution in the longer term. The safety impact of Option 4 is, therefore, considered very positive (score +5).

5.1.6. Conclusion

The comparative safety benefits are presented in Table B.5

Table B.5: Comparative safety benefits

	Option 0	**Option 1**	**Option 2**	**Option 3**	**Option 4**
Safety impact	**0**	**+1**	**+3**	**+5**	**+5**
		(number of CVR overruns divided by 2 in the short term)	(larger time margin for preserving the CVR, + phasing out unreliable magnetic-tape CVRs, in the medium term)	(a robust solution, but long-term and only applicable to large aeroplanes)	(mitigation in the short term and satisfactory long-term solution)

5.2. Environmental impact

Whatever the option, it has no foreseeable environmental impact.

5.3. Social impact

5.3.1. Option 0

The social impact of Option 0 would be neutral (score 0).

5.3.2. Option 1

The social impact of Option 1 would be neutral (score 0).

5.3.3. Option 2

It is not expected that Option 2 has any social impact, as 2-hour recording duration CVRs are already common on board aeroplanes (score 0).

5.3.4. Option 3

The introduction of a CVR with a recording duration of 15 hours has raised several questions related to the protection of flight crew privacy, which are addressed below:

5.3.4.1. Protection of CVR recording in day-to-day operations

Since a recording duration of 15 hours would allow capturing greater portions of a flight, one could imagine that it would make it more tempting for an aircraft operator to use the CVR for internal incident investigations, or to complement their FDM programme.

However, OPS rules reserve the use of CVR recordings to investigations by safety investigation authorities: see for instance, in CAT.GEN.MPA.195:

‘(f) Without prejudice to Regulation (EU) No 996/2010 of the European Parliament and of the Council:

(1) CVR recordings shall only be used for purposes other than for the investigation of an accident or an incident subject to mandatory reporting, if all crew members and maintenance personnel concerned consent.'

A similar provision can be found in Part NCC and in Part SPO.

OPS rules are legally binding in all Member States, therefore, they can be used for prosecution. This is considered sufficiently dissuasive against abusive use of CVR during day-to-day operation.

In addition, CVR installations usually offer a bulk erase function. The Certification Specifications for large aeroplanes mention about this feature that 'the installation must be designed to minimise the probability of inadvertent operation and actuation of the device during crash impact' (see CS 25.1457 (f)).

CAT.GEN.MPA.105 requires the commander to ensure that the flight recorders are not erased only in the event of an accident or incident. After an uneventful flight, a flight crew can decide to run the CVR bulk erase function. In case of doubt, it is advisable that the flight crew does not run the bulk erase function after completion of the flight, instead it should deactivate the CVR as early as possible.

<u>*Note:*</u>

On most solid-state CVR models, the bulk erase function is so designed that the recording 'cannot be retrieved using any and all normal replay or copying techniques.' (refer to ED-112, paragraph I-2.1.7). Special techniques 'available to the recorder manufacturers and/or accident investigation authorities for dealing with severely damaged recorders' can still be used to retrieve the erased data.

In conclusion, the OPS rules provide for sufficient protection of the CVR recording in normal operation, by restricting the use of a CVR recording and by allowing its erasure after completion of an uneventful flight.

5.3.4.2. Protection of CVR recording in the frame of a safety investigation

In the case of a safety investigation, Regulation (EU) No 996/2010 states in Article 14 (Protection of sensitive safety information), paragraph 1 :

'1.The following records shall not be made available or used for purposes other than safety investigation:

(…)

(g) cockpit voice and image recordings and their transcripts, as well as voice recordings inside air traffic control units, ensuring also that information not relevant to the safety investigation, particularly information with a bearing on personal privacy, shall be appropriately protected, without prejudice to paragraph 3.'

Hence, Regulation (EU) No 996/2010 is restricting the use of the CVR recording when there is a safety investigation and makes it possible to prosecute leaks and abusive use by any investigation party or by third parties (including the media).

5.3.4.3. Protection of CVR recording in the frame of a judicial investigation

In the case of a judicial investigation, Regulation (EU) No 996/2010 states in Article 14, paragraph 3:

'3. Notwithstanding paragraphs 1 and 2, the administration of justice or the authority competent to decide on the disclosure of records according to national law may decide that the benefits of the disclosure of the records referred to in paragraphs 1 and 2 for any other purposes permitted by law outweigh the adverse domestic and international impact that such action may have on that or any future safety investigation. Member States may decide to limit the cases in which such a decision of disclosure may be taken, while respecting the legal acts of the Union.'

This means that the national judicial authorities may decide on their own that the benefits of disclosing the CVR recording outweigh the adverse impact that such action may have on future safety investigations. This can lead, during court cases, to CVR recordings being used in a manner that is contrary to the right of privacy of flight crews. This, unfortunately, happened in a few cases, however, cases of CVR recording misuse in the frame of a judicial investigation are not frequent in Europe.

An increase of the CVR recording duration would probably not lead to an increase of the frequency of cases where judicial authorities handle a CVR recording improperly. It might, however, lead to events not related to the occurrence (e.g. recording of previous flights) to be released to the public. This issue was so far theoretical given the short recording duration of the CVR, it could materialise with a 15 hours recording duration CVR.

However, Regulation (EU) No 996/2010 also requires in Article 12 (Coordination of investigations), that EU Member States set up advance arrangements between safety investigation authorities and judicial authorities, that cover the use of information.

‘3. Member States shall ensure that safety investigation authorities, on the one hand, and other authorities likely to be involved in the activities related to the safety investigation, such as the judicial, civil aviation, search and rescue authorities, on the other hand, cooperate with each other through advance arrangements. (…) Among others, the advance arrangements shall cover the following subjects:

(…)

(b) preservation of and access to evidence;

(…)

(d) exchange of information;

(e) appropriate use of safety information;

(…)

Member States shall communicate to the Commission those arrangements, which shall transmit them to the chairman of the Network, the European Parliament and the Council for information.’

It is expected that where needed, these arrangements will contain provisions addressing the protection of the CVR recording, so that the number of cases of CVR recording misuse, which are already seldom, will further decrease.

5.3.4.4. Conclusion on Option 3

In summary:

— the OPS rules provide for sufficient protection of the CVR recording in normal operation;

— the accident investigation rules provide for protection of the CVR recording in the frame of safety investigations conducted by any safety investigation authority of an EASA Member State;

— Both OPS rules and accident investigation rules are promulgated under European Regulations that are legally binding in all European Union Member States;

— National judicial authorities can, if judged appropriate by them, release a CVR recording to parties or to the public. The disclosure of the CVR recording during a judicial proceedings has a negative social impact, however, this is not frequent in Europe. Arrangements between safety investigation authorities and judicial authorities required by European accident investigation rules are expected to further improve the protection of CVR recordings;

— With a 15-hour recording duration CVR, more recording unrelated to an accident might be released by a judicial authority to the public.

Therefore, Option 3 may have a negative impact on flight crews privacy, in the seldom case of a judicial investigation. The social impact of Option 3 is considered slightly negative (score -1).

5.3.5. Option 4

As a combination of Option 1, Option 2 and Option 3, Option 4 is expected to have:

— a slightly positive social impact by requiring that aircraft operators develop procedures that allow flight crew members to discharge their responsibility with regard to CVR recording preservation;

— a slightly positive social impact by facilitating the decision of flight crew members with regard to preservation of the CVR, and

— a slightly negative social impact when considering the protection of flight crews privacy in the (seldom) case of a judicial investigation.

Therefore, the overall impact of Option 4 is considered neutral (score 0).

5.3.6. Conclusion

The comparative social impacts of all options are presented in Table B.6.

Table B.6: Comparative social impacts.

Option	**Option 0**	**Option 1**	**Option 2**	**Option 3**	**Option 4**
Social impact	**0**	**0**	**0**	**-1**	**0**
				Possible negative impact on flight crew privacy, in the case of a judicial investigation	Overall neutral impact

5.4. Economic impact

5.4.1. Option 0

When a safety investigation is delayed or hindered because of a CVR overrun, other aircraft are at risk of being subject to an accident with similar causes. In addition, an unexplained accident may have a negative impact on the brand image of the involved aircraft operator, as uncertainty on the causes of the safety occurrence remains. This is particularly true after an accident, as accidents tend to be more publicised.

However, the economic impact is difficult to assess. In the absence of data, it is assumed that the overall economic impact of CVR overruns on the EASA Member States operators is an arbitrary EUR 0 (score 0).

5.4.2. Option 1

Option 1 would result in all European Member States operators developing procedures for preserving the recording of the CVR after an accident and serious incident, and including these procedures in their operations manual for approval by their respective national aviation authorities.

A given flight recorder installation requires specific instructions for deactivating the flight recorders, so that this particular point would need to be reviewed for each type of CVR installation. The rest of the procedure could be unique for the fleet of an aircraft operator.

It is assumed that

- 2 man-hours of work are needed for drafting the instructions for deactivating the flight recorder for each CVR system installation design, and modifying Part B of the operations manual (aircraft operating matters) accordingly;
- 4 man-hours of work are needed for drafting the common part of the flight recorder preservation procedure, and modifying Part A of the operations manual (General/Basics) accordingly;
- 2 man-days (16 man-hours) of work are needed for general communication to the flight crew on CVR recording preservation and submitting the changes of the operations manual to the national aviation authority.

Assuming N different flight recorder installation designs on the aircraft operator fleet, this would represent in total:

2×N + 4 +16 = (2×N+20) man-hours of work

For example, assuming an hourly cost of EUR 100, the corresponding cost would be:

- (2 × 1 + 20) × 100 ~ EUR 2 200 if there is only one design of CVR system installation on the whole aircraft operator's fleet;
- (2 × 10 + 20) × 100 ~ EUR 4 000 if there are 10 distinct designs of CVR system installations on the aircraft operator's fleet (which is considered a high variety of CVR installations).

Hence, the cost for an aircraft operator of introducing or completing procedures on CVR recording preservation after an accident or a serious incident is expected to be no more than a few thousands euros. This would translate into a global cost for EASA Member States operators of a few millions of euros. A data campaign conducted in 2012 by the Agency for the purpose of continuous monitoring oversight identified around 1 200 air operator certificate holders in EASA Member States. However, a larger number, 2 000, is assumed, as the data collected is not fully exhaustive. **The estimated maximum cost for the industry for the update of CVR recording preservation procedures is assumed to be of** EUR **8 000 000** (2 000 operators and EUR 4 000 cost for each).

On the other hand, Option 1 would limit the necessary deactivation of the flight recorders to accidents and serious incidents, which is a significantly smaller set than all reportable occurrences. The flight recorders are MMEL items and an aircraft cannot fly with both flight recorders deactivated. Deactivating the flight recorders of an aircraft which only experienced an incident can, therefore, generate significant cost due to immobilisation and the need to have a spare part ready. From that perspective, Option 1 would generate savings that would probably be of the order of a few thousands euros per aircraft and year on average, assuming that each aircraft is subject to a few reportable occurrences every year[18]. When considering the fleet of EASA Member States operators, there are according to Ascend data of year 2012, 8 950 aeroplane and 5 490 helicopters required to carry a flight recorder, i.e. 14 440 aircraft in total. Then, even an average annual saving of EUR 1 000 per aircraft would translate into EUR **14 440 000 of annual savings for EASA Member States operators**.

Therefore, the overall impact of Option 1 over several years is considered medium positive (score +3).

5.4.3. Option 2

In the case of a CVR retrofit, the cost can be sorted into non-recurring cost and recurring cost:

[18] According to a large operator, they report on average 3 occurrence per aircraft every year.

5.4.3.1. Cost factors

Non-recurring cost

The change is assumed to be developed once per aircraft model (assuming that all CVRs installed on aircraft of a given model are replaced by a unique model of CVR). In case of a large fleet of the same aircraft model, the non-recurring costs can be then shared over this fleet. However, if the fleet is small, the non-recurring cost per aircraft is higher. For example, assuming that only 10 aircraft of a given aircraft model are still operated, then 1/10 of the non-recurring cost is supported by each individual aircraft.

The change encompasses changing wires and connectors between the flight recorder and the dedicated sensors (e.g. cockpit area microphone and audio transducers for a CVR) and status indicators in the cockpit. Industry standards like ARINC characteristics address the interchangeability of flight recorders and their sensors (see 2.1.3), but there is not a single standard, so that the change design and documentation may represent a significant amount of work. Up to 2 man-weeks of work are assumed to design the change and produce the documentation for a CVR.

The change also encompasses post-flight recording evaluation: it is expected that the quality of the CVR recording will be checked after a few flights. EASA Certification Memorandum CM-AS-001 recommends that 'To ensure CVR systems are properly installed and to verify the audio signal recorded from all audio channels achieve the acceptable level of quality, applicants should conduct a check during flight. The recording obtained should be evaluated to confirm acceptable level of quality during all normal regimes of flight including taxiing, take-off, cruise, approach and landing'. While it is not considered necessary to perform a flight dedicated to this check, EASA Certification Memorandum CM-AS-001 recommends that the replay is performed by a 'replay and evaluation centre'. Such an analysis would require the CVR to be removed from the aircraft, read out at the evaluation centre and then mounted again. The overall flight testing cost is assessed to be EUR 2 000.

Note:

The replay and evaluation centre may be part of the aircraft operator. However, according to EASA Certification Memorandum CM-AS-001, such a centre should have appropriate analysis equipment and trained personnel, and ensure the privacy of CVR recordings.

With regard to certification, the retrofit could be done through a Minor Change to the aircraft design, thus, approval cost would be only a few hundreds of Euros.

Recurring cost

The recurring cost encompasses:

— purchase cost of the unit: between EUR 15 000 and 25 000 for a single-function[19] flight recorder;

— purchase cost of wires and connectors: a maximal cost of EUR 1 000 is chosen for illustration;

— cost of physically performing the installation: the replacement of wires and connectors in the cockpit and the avionics bay may require significant work. It is assumed that no more than 2 man-days of work are needed to perform this task; and

— maintenance cost: they are expected to be lower with a solid-state CVR than with a magnetic tape CVR, since solid-state flight recorders are more reliable and they are fitted with reliable built-in test feature so that less intensive maintenance is needed to maintain the serviceability of a solid-state flight recorder.

[19] A single-function flight recorder can be a FDR or a CVR, it does not combine FDR and CVR functions.

5.4.3.2. Cost distribution

An example of distribution of cost is presented in Table B.7. Figures are not accurate, they should only be considered as orders of cost.

In this example, the initial cost for every aircraft retrofitted can be split into:

— non-recurring cost (documentation and certification and post-flight recording evaluation), amounting for EUR 22 000, to be divided by the number of aircraft sharing this cost; and

— equipment purchase and installation cost ranging from (15 000 + 1 300) to (26 000 + 1 300), i.e. from EUR 16 000 to EUR 27 000.

Therefore, except in the case where the non-recurring cost is shared among very few aircraft of the same model, most of the initial cost corresponds to the unit price of the flight recorder and its physical installation. For example, considering 20 aircraft of the same model, the non-recurring initial cost per individual aircraft of retrofitting the CVR would be 22 000/20 = EUR 1 100.

With those assumptions, the initial cost per retrofitted aircraft is expected to be rougly the price of the solid-state CVR (unit price between EUR 15 000 and EUR 25 000) plus a few thousands of euros for designing and documenting the installation.

Most 30-minute recording duration CVRs are actually magnetic tape CVRs, as illustrated by Table B.3 in 2.2. Hence, according to the economic assessment of Option 3 of the RIA on 'Discontinuation of obsolete recording technologies', by 1 January 2019 there would be 895 aeroplanes fitted with a magnetic tape CVR (with a recording duration of 30 minutes). Assuming an initial cost per CVR replaced of EUR 25 000 €, the total cost for the fleets of European Member States operators would amount to 895 × 25 000 = EUR **22 400 000 €**. This correspond to a medium negative economic impact (score -3).

<u>*Note:*</u>

The total cost computed here is different from the total cost assessed for Option 3 of the RIA on 'Discontinuation of obsolete recording technologies' because the latter also covers the discontinuation of CVRs installed on board helicopters.

Table B.7: Example of distribution of cost when retrofitting an aeroplane with a solid-state flight recorder

Cost line	Nature of cost	Order of cost	Comment
Design and documentation cost (Installation drawing, Installation Instructions, Maintenance Instructions, AFM)	Once per aircraft model	80 man-hours at EUR 250 per hour = EUR 20 000	Assuming one man-week is 40 man-hours and 2 man-weeks are needed
Post-flight recording evaluation	Once per aircraft model	EUR 2 000	Cost of CVR recording assessment by a replay and evaluation centre
Certification fees (Minor Change)	Once per aircraft model	EUR 600	This would probably be a Minor Change. EASA Fees are EUR 564 per Minor

Cost line	Nature of cost	Order of cost	Comment
			Change.
Equipment purchase	Once per individual aircraft	EUR 15 000 to 26 000	Solid-state CVR (unit price between EUR 15 000 and EUR 25 000) + wires and connectors (up to EUR 1 000)
Implementation of change	Once per individual aircraft	Up to 16 man-hours at EUR 80 per hour = EUR 1 300	Assuming one man-day is 8 man-hours, and 2 man-days are needed. The aircraft immobilisation time is not taken into account, as it is assumed that this task could be performed during a heavy maintenance check.
Maintenance cost	Scheduled and unscheduled tasks		Maintenance cost is expected to be lower than with older technologies, as solid-state flight recorders are more reliable and have an effective self-monitoring function.

5.4.4. *Option 3*

Installation cost

In the case of a forward-fit, the aircraft needs anyway to be equipped with a CVR. If the 15-hour recording duration CVR has the same operational specifications as the 2-hour recording duration CVR, and sufficient notice is given, no significant installation cost should be generated. 1st of January 2019 is about three years after time of publication of the requirement (expected in 2016) and this notice is considered sufficient. In case the rulemaking task is delayed, the applicability date could be moved accordingly.

Unit purchase price

With regard to the purchase price of a 15-hour recording duration CVR, several flight recorder manufacturers have been surveyed and they have indicated that designing a 15-hour recording duration CVR is feasible with today's technology, at a cost similar to or slightly higher than that of current models of 2-hour recording duration CVR. A couple of CVR models are available or planned, with recording durations ranging from 3 to 13 hours.

Nevertheless, flight recorder manufacturers have also given indications that, to this date, designing a CVR with a recording duration much longer than 15 hours at a price comparable to that of a 2-hour recording duration CVR may be challenging for the following reasons:

— The cheap memory that is being developed for USB drives, SD cards, etc. is not reliable enough for a flight recorder. The flight recorder memory must resist a low-temperature, long-burning fire. More reliable types of memories have to be used that are less compact, resulting in a larger crash survivable memory unit (CSMU). The CSMU armour is the heaviest part of a flight recorder and it is an expensive part.

— Solid-state memory wears out over time. In order to support a 30 year service life, particular measures need to be taken.

— The time it takes to mount and test the memory is critical for a flight recorder. ED-112 specifies that 'for interruptions with a duration of more than 200 milliseconds, the system, consisting of the recorder, area mic and CVR control panel (…) shall recover and commence storing information, in the recording medium, within 250 milliseconds'. Standard memory controllers and standard real time operating systems are not suitable because of this time constraint.

— Knowledge of algorithms used by standard memory controllers is intellectual property. This is not suitable for a flight recorder, since ED-112 specifies that: 'All forms of encoding should be readily reversible so that as much information as possible can be recovered from an incomplete or corrupted recording. Methods which require large, complete, error free records of encoded data in order to successfully reconstruct the information should be avoided.'

1st of January 2019 is about three years after time of publication of the requirement and this notice is considered sufficient for flight recorder manufacturers.

Conclusion

The increase in cost for an aircraft operator is expected to be slight, assuming a three-year notice to the manufacturing industry. The unit price difference between a 2-hour recording duration CVR and a 15-hour recording duration CVR is not expected to be more than a few thousands of euros. This is considered a small cost increase when considering that it would affect only newly operated aeroplanes with an MCTOM of over 27 000 kg.

For instance assuming that 200 large aeroplanes are added to the fleets of EASA Member States operators every year, and that a 15-hour recording duration CVR costs EUR 5 000 more per unit than a 2-hour recording duration CVR, this would mean an annual cost of 5 000 × 200 = **EUR 1 000 000 €**. The economic impact of Option 3 is considered slightly negative (score -1).

5.4.5. Option 4

A combination of Option 1, Option 2 and Option 3 would mean for an aeroplane operator:

— a few thousands of euros for developing procedures to ensure CVR recording preservation after an accident or a serious incident, but also much less risk of immobilising the aircraft after an incident because both flight recorders are deactivated and there are no spare parts (Option 1);

— EUR 15 000 to EUR 30 000 of CVR retrofit cost for each legacy aeroplane equipped with a 30-minute recording duration CVR (Option 2), distributed between 2016 and 2019; and

— an increase in cost of no more than a few thousands of euros per new large aeroplane delivered on or after 1 January 2019 (Option 3).

The overall economic impact of Option 4 for EASA Member States operators would be:

— EUR 8 000 000 in 2015 to define new recording preservation procedures, compensated by EUR 14 400 000 of savings every year after 2015 because preserving the flight recorders would not be required anymore for every reportable occurrence (Option 1);

— EUR 22 400 000 for retrofitting magnetic-tape CVRs on board aeroplane in 2018 (Option 2); and

— EUR 1 000 000 every year after 2018 for installing very long recording duration CVR after 2019 (Option3).

This would combine to generate

— 72 000 000 - 22 400 000- 8 000 000 - 1 000 000 = EUR 40 600 000 of savings over the period 2015 to 2019, and

— 14 400 000 - 1 000 000 = EUR 13 400 000 of annual saving after 2019.

The overall economic impact of Option 4 is, therefore, considered to be slightly positive (score +1).

5.4.6. Conclusion

The comparative economic impact scores of options are presented in Table B.8.

Table B.8: Comparative economic impact of options

	Option 0	**Option 1**	**Option 2**	**Option 3**	**Option 4**
Economic impact	**0**	**+3 globally**	**-3**	**-1**	**+1**
		(one-time cost of developing detailed CVR preservation procedures, annual savings generated by a decrease of the cases where the flight recorders have to be preserved)	(Replacement of all 30-minute CVRs installed on board aeroplanes by 2-hour CVRs)	(No technological challenge, the introduction would be limited to large aeroplanes and progressive)	(Overall slightly positive impact)

5.5. Proportionality issues

5.5.1. Option 0

Option 0 is not foreseen to bring any proportionality issue (Score 0).

5.5.2. Option 1

Option 1 will require moderate work from all aeroplane operators that do not have robust procedures in place to preserve the CVR recording after an accident or a serious incident. However, no issue of proportionality is foreseen (Score 0).

5.5.3. Option 2

It is expected that Option 2 impacts more small-sized aeroplane operators, as 30-minute recording duration CVRs seem to be more widespread among those operators (refer to 2.3.2). However, Option 2 would impact only those aeroplanes operated for commercial air transport (Score -1).

5.5.4. Option 3

Option 3 will affect only newly manufactured large aeroplanes. No issue of proportionality is foreseen (Score 0).

5.5.5. Option 4

The only proportionality issue is that of Option 2. The score of Option 4 is, therefore, also -1, like Option 2.

Table B.9: Comparative impact on proportionality issues

	Option 0	Option 1	Option 2	Option 3	Option 4
Proportionality issues	**0**	**0**	**-1** (small-sized aeroplane operators more affected by CVR retrofit)	**0**	**-1** (small-sized aeroplane operators more affected by CVR retrofit)

5.6. Impact on regulatory coordination and harmonisation

5.6.1. Option 0

The EASA Member States will not be in compliance with the ICAO Standards requiring that from 1 January 2016 all CVRs installed on board aeroplanes and helicopters have a recording duration of 2 hours. As Option 0 is the baseline option, it is given a score of 0.

5.6.2. Option 1

This Option is only addressing CVR recording preservation and it will not bring the EASA Member States in better compliance with ICAO Standards on CVR recording duration (score 0).

5.6.3. Option 2

With Option 2, EASA Member States will not be in compliance with the ICAO Standards on CVR recording duration in ICAO Annex 6 Part II and Part III, as Option 2 requires a retrofit only for aeroplanes operated for commercial air transport.

However, with Option 2 Member States would be in better compliance with Annex 6 Part I, and, therefore, its impact on regulatory harmonisation is considered medium positive (Score +3).

5.6.4. Option 3

Option 3 is not addressing any ICAO Standard (score 0). Option 3 would require updating the European Technical Standard Order (ETSO) C123b relative to the CVR, so that it includes specifications for a CVR with a recording duration of 15 hours. However, it would be sufficient to refer to EUROCAE Document ED-112A, which is the next revision of ED-112 currently referred to by ETSO-C123b. ED-112A defines a new class of CVR with a recording duration of 15 hours.

5.6.5. Option 4

Because Option 4 includes Option 2, it should get the same score with regard to proportionality, that is to say +3.

Table B.10: Comparative impact on regulatory coordination and harmonisation

	Option 0	Option 1	Option 2	Option 3	Option 4
Regulatory coordination and harmonisation	**0**	**0**	**+3** (better compliance with Annex 6 Part I)	**0**	**+3** (better compliance with Annex 6 Part I)

6. Conclusion and preferred option

6.1. Comparison of options

Strengths and weaknesses of each option are presented in **Table B.11 and Table B.12**.

In conclusion:

— Option 1 would reduce significantly and in the short term the frequency of CVR overruns, it would generate savings, and it would have a slightly positive social impact.

— Option 2 would further decrease the frequency of CVR overruns, it would also have a positive side effect on safety consisting in phasing out unreliable magnetic tape CVRs on board aeroplanes and with it EASA Member States would be in better compliance with ICAO Annex 6, for moderate cost that may, however, not be distributed in a fully proportionate manner between large and small operators.

— Option 3 would fix the problem of CVR overruns in the specific case of large aeroplanes for little cost, but it is a long-term solution and it could have some (limited) impact on the privacy of flight crew members.

— Option 4 would bring a fully satisfactory solution against CVR overruns and a better compliance with ICAO Annex 6, for moderate cost and maybe some limited proportionality issue. Also, Option 4 offers a phased approach, with Option 1 bringing a short-term improvement based on procedural changes, Option 2 replacing obsolete technology in the midterm and making Option 1 even more effective for all aeroplanes in the medium term, and Option 3 introducing a robust long-term technological solution in the specific case of large aeroplanes.

Therefore, Option 4 is the preferred option.

Table B.11: Detailed comparison of impacts between the various options

Option	Option 0	Option 1	Option 2	Option 3	Option 4
Option description	Baseline option (No change in rules; risks remain as outlined in the issue analysis)	Require that aircraft operators develop comprehensive procedures to ensure flight recorder preservation following an accident or serious incident, while relaxing the requirement in the case of an incident subject to mandatory reporting.	Modify the OPS rules in order to mandate that from 1 January 2019, all aeroplanes operated for commercial air transport and required to carry a CVR, be fitted with a CVR having a minimum recording duration of 2 hours, that is not recording on magnetic tape or magnetic wire. (Coupled with Option 3 of the Regulatory Impact Assessment A on 'Discontinuation of obsolete recording technologies')	Require that all aeroplanes with an MCTOM over 27 000 kg and first issued with an individual CofA on or after 1 January 2019 be equipped with a CVR that has a minimum recording duration of 15 hours.	Option 1 and Option 2 and Option 3
Safety impact	**0**	**+1** (number of CVR overruns divided by 2 in the short-term)	**+3** (larger time margin for preserving the CVR and phasing out unreliable magnetic-tape CVRs in the medium term)	**+5** (a robust solution, but long-term and only applicable to large aeroplanes)	**+5** (mitigation in the short term and satisfactory long-term solution)
Environmental impact	**0**	**0**	**0**	**0**	**0**

Option	Option 0	Option 1	Option 2	Option 3	Option 4
Social impact	**0**	**0**	**0**	**-1** (possible negative impact on flight crew privacy, in the case of a judicial investigation)	**-1** (Overall slightly negative impact)
Economic impact	**0**	**+3 globally** (one-time cost of developing detailed CVR preservation procedures, annual savings generated by a decrease of the cases where the flight recorders have to be preserved)	**-3** (replacement of all 30-minute CVRs installed on board aeroplanes by 2-hour CVRs)	**-1** (no technological challenge, the introduction would be limited to large aeroplanes and progressive)	**+1** (Overall slightly positive impact)
Proportionality issues	**0**	**0**	**-1** (small-sized aeroplane operators more affected by CVR retrofit)	**0**	**-1** (small-sized aeroplane operators more affected by CVR retrofit)
Regulatory coordination and harmonisation	**0**	**0**	**+3** (better compliance with Annex 6 Part I)	**0**	**+3** (better compliance with Annex 6 Part I)

Table B.12: Comparison of impacts between the various options (summary)

Types of impacts	*Weight*	*Score*				
		Option 0	Option1	Option 2	Option 3	Option 4
Safety	1	0	+1	+3	+5	+5
Environment	1	0	0	0	0	0
Social	1	0	0	0	-1	-1
Economic	1	0	+3	-3	-1	+1
Proportionality	1	0	0	−1	0	−1
Regulatory coordination and harmonisation	1	0	0	+3	0	+3
Total		**0**	**+4**	**+2**	**+3**	**+7**

7. Annexes

Annex A: Acronyms and definitions

CVR	Cockpit Voice Recorder
CofA	Certificate of Airworthiness
EFRPG	European Flight Recorder Partnership Group
ETSO	European Technical Standard Order
FAA	Federal Aviation Administration of the United States
FDR	Flight Data Recorder
ICAO	International Civil Aviation Organization
MAPSC	Maximum Approved Passenger Seating Configuration
MCTOM	Maximum Certificated Take-Off Mass
TSO	Technical Standard Order

Annex B: References

(a) ICAO Annex 6 Part I, International Commercial Air Transport – Aeroplanes, Amendment 36.

(b) ICAO Annex 6 Part II, International General Aviation – Aeroplanes, Amendment 31.

(c) ICAO Annex 6 Part III, International Operations – Helicopters, Amendment 17.

(d) ICAO Annex 13, Aircraft Accident and Incident Investigation, Amendment 13.

(e) Regulation (EU) No 996/2010 of 20 October 2010 on the investigation and prevention of accidents and incidents in civil aviation and repealing Directive 94/56/EC.

(f) 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, as modified by Commission Regulation (EU) No 800/2013.

(g) Commission Regulation (EC) 859/2008 of 20 August 2008 amending Council Regulation (EEC) No 3922/91 as regards common technical requirements and administrative procedures applicable to commercial transportation by aeroplane.

(h) Joint Aviation Requirements, JAR-OPS 3, Commercial Air Transportation (Helicopters).

(i) Opinion No 02/2012 of the European Aviation Safety Agency of 16 April 2012 for a Commission Regulation establishing Implementing Rules for air operations. Available under http://www.easa.europa.eu/agency-measures/opinions.php.

(j) EUROCAE Document ED-112, Minimum operational performance specification for crash protected airborne recorder systems, March 2003.

(k) EASA Certification Memorandum CM-AS-001, Issue 01, 12th June 2012.

(l) EUROCAE Document ED-112A, Minimum operational performance specification for crash protected airborne recorder systems, September 2013.

Annex C: reported cases of CVR overruns

- Table B.C.1 presents 15 investigation reports indicating overruns of 30-minute recording duration CVRs.
- Table B.C.2 presents 10 investigation reports indicating overruns of 2-hour recording duration CVRs where the aircraft kept flying longer than 2 hours after the occurrence.
- Table B.C.3 presents 13 investigation reports indicating overruns of 2-hour recording duration CVRs due to a failure to preserve the CVR recording.

Table B.C.1

Aircraft Make and Model	Aircraft registration and operator	Date of the occurrence	Investigation authority (Name and State)	Findings made in the investigation report; If any, safety recommendation	Type of issue
MDD, MD-11	HB-IWF, Swissair	2 September1998	TSB, Canada	Paragraph 2.2.2.1: 'A minimum two-hour CVR recording capability would have enabled a quicker and possibly more in-depth assessment of events that occurred earlier in the flight. For example, the investigation would have benefited considerably if CVR information had been available to help analyze earlier events such as the time period of the 13-minute, very-high frequency (VHF) communications gap.' Safety recommendation made to Transport Canada: 'As of 01 January 2005, all aircraft that require both an FDR and a CVR be required to be fitted with a CVR having a recording capacity of at least two hours. A99-02 (issued 9 March 1999) '	Flight ended more than thirty minutes after the occurrence took place
Bae 146	G-BZAT	10 February 2003	AAIB, UK	'The 30 minute CVR had recorded over the period of the takeoff from Glasgow, subsequent landing at Birmingham and taxi to stand. The recording of the events after this provided no useful information to the investigation.'	Flight ended more than thirty minutes after the occurrence took place
BAe-3202	G-BYRA	10 January 2004	AAIB, UK	'The aircraft was fitted with a 30 minute Fairchild A100A Cockpit Voice Recorder (CVR) and a 25 hour, 5 parameter Honeywell UFDR Flight Data Recorder (FDR). The CVR had been left running after the incident so did not yield any useful information.'(recording duration 0.5hr)	Failure to deactivate the CVR immediately after completion of the flight
B777	N781UA	14 July 2004	AAIB, UK	'The CVR was a 30 minute solid state unit manufactured by Honeywell. The unit was left running for more than 30 minutes after the incident and so information relating to the incident had been overwritten. Unusually, the circuit breaker for the CVR on the B777 is located in the electronics bay under the floor and this area is	Failure to deactivate the CVR immediately after completion of the flight

Aircraft Make and Model	Aircraft registration and operator	Date of the occurrence	Investigation authority (Name and State)	Findings made in the investigation report; If any, safety recommendation	Type of issue
				accessed via a hatch near the front left door. There is no apparent method for the crew to stop the CVR recording, and hence overwriting relevant data, from within the cockpit.'	
B747-400	G-BNLG	20 February 2005	AAIB, UK	(Public report identified with mention of the CVR overrun)	Failure to deactivate the CVR immediately after completion of the flight
Airbus, A310	C-GPAT, Air Transat	06 March 2005	TSB, Canada	Paragraph 2.4.1: 'The lack of information from the 30-minute CVR regarding the rudder-loss event, including the noises heard by the cockpit and cabin crew and the associated vibrations, hindered the investigation. A two-hour CVR would have captured the sounds of the vibrations on the cockpit area microphone, providing important information on the vibration frequencies.'	Flight ended more than thirty minutes after the occurrence took place
ATR 42	OY-JRJ	31 May 2005	AIB, Norway	Safety recommendation made to JAA and EASA: 'The cockpit voice recorder from the occurrence was recorded over, because the duration of the recording was only 30 minutes, and the power supply to the recorder was not disconnected after landing. The AIBN has noted that several operators lack procedures to ensure that registered data is retained, and recommend that JAA/EASA consider whether the regulations (Appendix 1 JAR OPS 1.1045 pt. 11) should specify that procedures must be drawn up for preservation of data from flight and cockpit voice recorders are included in operation manuals, so that the JAR OPS 1.160 requirements are better adhered to.'	Failure to deactivate the CVR immediately after completion of the flight
B757-200	G-BYAO	12 May 2005	AAIB, UK	'When the CVR was replayed the takeoff, approach and landing phases were found to have been overwritten as the CVR power had not been isolated in sufficient time to preserve information relating to the incident.'	Failure to deactivate the CVR immediately after completion of the flight
Boeing 737	5B-DBY, Helios	14 August 2005	AAIASB, Greece	Paragraph 3.1.7: 'The duration (30 minutes) of the CVR installed on the aircraft was insufficient to provide key information that would have clarified the chain of events during the climb phase of the flight.'	Flight ended more than thirty minutes after the occurrence took place

Aircraft Make and Model	Aircraft registration and operator	Date of the occurrence	Investigation authority (Name and State)	Findings made in the investigation report; If any, safety recommendation	Type of issue
				Safety recommendation made to EASA and ICAO: 'EASA/JAA and ICAO require aircraft manufacturers to evaluate the feasibility of installation of a CVR that records the entire flight.'	
767-300	ZS-PBI	11 July 2005	AAIB, UK	(Public report identified with mention of the CVR overrun)	Failure to deactivate the CVR immediately after completion of the flight
B737-400	SP-LLB	20 February 2006	AAIB, UK	(Public report identified with mention of the CVR overrun)	Failure to deactivate the CVR immediately after completion of the flight
B747-400	G-VHOT	7 December 2006	AAIB, UK	(Public report identified with mention of the CVR overrun)	Failure to deactivate the CVR immediately after completion of the flight
A340-300	G-VAIR	27 April 2008	AAIB, UK	'In accordance with the operator's procedure to preserve recordings made by flight recorders following an incident, the CBs for the CVR were pulled when the aircraft was on the ground at Mombasa. However, this was done the following day once the aircraft had been put in 'Airworthiness Hold' and ground checks, including engine idle runs, were being carried out prior to its flight back to Heathrow. The aircraft was powered for a total of 40 minutes, during which the CVR was recording, before the CVR CBs were pulled [...] The remaining 35 minutes of the recording was made while the aircraft was on the ground at Heathrow. A request was made for the CVR and FDR to be removed from the aircraft; however, the engineers were unable to get access to the CVR, which was located in the rear bulk hold, because of baggage being unloaded. In the meantime, rather than immediately remove the FDR, the engineers decided to follow their normal maintenance procedure following an incident, of downloading the recorder data onto a flash memory card, with the FDR still on the aircraft. [...] However, problems were	Failure to deactivate the CVR immediately after completion of the flight

Aircraft Make and Model	Aircraft registration and operator	Date of the occurrence	Investigation authority (Name and State)	Findings made in the investigation report; If any, safety recommendation	Type of issue
				experienced with the download so the engineer in charge decided to reset the CVR CBs. The problems continued for a further 35 minutes until the data was finally downloaded, throughout which the CVR was recording.'	
B737-3	G-CELC	7 February 2010	AAIB, UK	(Public report identified with mention of the CVR overrun)	Failure to deactivate the CVR immediately after completion of the flight
MD-83	EC-JJS	24 January 2012	CIAIC, Spain	'The cockpit voice recorder (…) was a magnetic tape unit with an approximate duration of 30 minutes. The information on the CVR was not preserved after the event and the aircraft was energized afterwards for maintenance tasks, as a result of which the CVR was recording during this time, meaning the recording from the accident flight was lost.'	Failure to deactivate the CVR immediately after completion of the flight

Table B.C.2

Aircraft Make and Model	Aircraft registration and operator	Date of the occurrence	Investigation authority (Name and State)	Findings made in the investigation report; If any, safety recommendation	Type of issue
B777	9V-SRC	27 June 2004	AAIB, Singapore	'During a flight from Singapore Changi Airport to Nagoya, Japan, a B777-200 aircraft encountered moderate turbulence near waypoint ARESI on airway L625. The occurrence resulted in a cabin crew member sustaining a cut above the left eye and two broken wrists.' 'The cockpit voice recorder (CVR) was not removed as the event occurred more than two hours prior to landing and any information pertaining to the turbulence encounter had been overwritten.'	Flight ended more than two hours after the occurrence took place
B737	5B-DBY, Helios Airways	14 August 2005	AAIASB, Greece	Main cause of the accident: 'Incapacitation of the flight crew due to hypoxia, resulting in continuation of the flight via the flight management computer and the autopilot, depletion of the fuel and engine flameout, and impact of the aircraft with the ground.' Safety recommendation: 'EASA/JAA and ICAO require aircraft manufacturers to evaluate the feasibility of installation of a CVR that records the entire flight.'	Flight ended more than two hours after the occurrence took place
Airbus, A330-243	G-OJMC	28 October 2008	AAIB, UK	'Due to an error in the takeoff performance calculations, incorrect takeoff speeds were used on departure. On rotation, the aircraft initially failed to become airborne as expected, causing the commander to select TOGA power.' 'Due to the length of the flight between Montego Bay (Jamaica) and the UK, the Cockpit Voice Recorder (CVR) had been overwritten.'	Flight ended more than two hours after the occurrence took place
Dash8 Q400 / Boeing 737	G-JECL / G-PJPJ	30 October 2009	AAIB, UK	'G-JECL was scheduled to operate from Exeter Airport, Devon, to Edinburgh Airport, Midlothian. After an uneventful pushback and start, taxi clearance was	Flight ended more than two hours after the occurrence took place

Aircraft Make and Model	Aircraft registration and operator	Date of the occurrence	Investigation authority (Name and State)	Findings made in the investigation report; If any, safety recommendation	Type of issue
				received from ATC to Holding Point Alpha One for Runway 08. (…) The crew subsequently crossed Alpha One and lined up on Runway 08; as they did so, a Boeing 737 landed on Runway 26.' 'When the Boeing 737 had cleared the runway, G-JECL received its clearance and departed.' 'Whilst the 25 hour FDR recording covered the incident period, the 2 hour CVR recording did not as the CVR was left running for the two sectors flown after the event.'	
A318/ PC12	F-GUGJ / EC-ISH	2 June 2010	BEA, France	Airprox in cruise	Flight ended more than two hours after the occurrence took place
Airbus, A380	Qantas	4 November 2010	ATSB, Australia	'The crew reported that, while maintaining 250 kts in the climb and passing 7,000 ft above mean sea level (AMSL), they heard two, almost coincident 'loud bangs'' (time 02 hrs 00 min UTC) 'The aircraft touched down at 0346' 'The passengers commenced disembarking from the aircraft via the No 2 main deck forward door about 55 minutes after the aircraft touched down.' (time around 04h 41 min UTC) 'The CVR contained over 2 hours of cockpit audio but, due to the continued running of the No 1 engine in Singapore, the audio at the time of the disc failure was overwritten. The available audio commenced during the landing approach and continued during the subsequent ground operations.'	Flight ended more than two hours after the occurrence took place
Bombardier, BD-100-1A10	OH-FLM	23 December 2010	SIA, Finland	'It is not clear whether the flight crew opened the CVR circuit breaker immediately after the flight or as they were leaving the aircraft. The	Failure to deactivate the CVR immediately after completion

Aircraft Make and Model	Aircraft registration and operator	Date of the occurrence	Investigation authority (Name and State)	Findings made in the investigation report; If any, safety recommendation	Type of issue
				investigation commission took possession of the CVR at Helsinki-Vantaa Airport and the recording was downloaded at Finnair Oyj under the supervision of the investigation commission. When the recording was being downloaded it became evident that the incident audio had been overwritten. Only maintenance-related talk and sounds could be heard.'	of the flight
Airbus, A320	OH-LXL	5 March 2011	SIA, Finland	'Since the CVR recording capacity was only two hours, it no longer contained the data from the time of the occurrence for the investigation because the flight time after the occurrence exceeded two hours. The interval between the incident and the aircraft parking was 2 h 13 min '	Flight ended more than two hours after the occurrence took place
A340	F-GLZU, Air France	22 July 2011	BEA, France	'The aeroplane was equipped with a CVR with a recording capacity of 2 hours. As the incident took place almost 8 hours before landing at Paris-Charles de Gaulle, the CVR no longer contained the cockpit voice recordings relating to the event. Significant elements of the investigation could not therefore be confirmed by the CVR.' Safety recommendation: 'Consequently, the BEA recommends that: EASA and ICAO require that the minimum recording duration of CVR's be increased to allow the recording in full of long-haul flights.'	Flight ended more than two hours after the occurrence took place
Airbus, A340-600	A6-EHF	2 February 2013	GCAA, UAE	'The CVR recorded the final 120 minutes of the flight. Since the diversion flight took approximately 3 hours from the occurrence until the Aircraft landing, the information pertaining to the incident was not captured.'	Flight ended more than two hours after the occurrence took place

Table B.C.3

Aircraft Make and Model	Aircraft registration and operator	Date of the occurrence	Investigation authority (Name and State)	Findings made in the investigation report; If any, safety recommendation	Type of issue
Embraer 170	EI-DFH	1 March 2005	BFU, Germany	[Unofficial translation] 'The CVR delivered no data on the flight history or on the approach briefing, since the combination recorder kept working two hours while on ground'	Failure to preserve the CVR data after completion of the flight
Canadair CL-604	VP-BJM	11 November 2005	AAIB, UK	'Although the CVR had a recording duration of 2 hours, electrical power had not been removed promptly at the conclusion of the flight. Hence the audio recording from the onset of the event some 70 minutes before touchdown, together with that from the landing phase, had been overwritten.'	Failure to preserve the CVR data after completion of the flight
B747-400	9M-MPL	18 May 2006	AAIB, UK	'The CVR recorded the last two hours of cockpit audio. However, despite timely requests to isolate power from the CVR, the useful recordings were overwritten by the time that the AAIB attended the aircraft.'	Failure to preserve the CVR data after completion of the flight
Airbus, A320-232	PR-MBB	17 December 2007	CENIPA, Brazil	'the CVR was not deactivated by the pilots after the occurrence, and so the recordings of the cabin were made well after the landing' 'the crew has a switch (RCDR / GND CTL switch 11TU) that allow recording on demand through the supply of power to the recorder (…) at any time while the aircraft is on the ground and all engines are shut down (provided that there is A/C power from the APU or external source. There was an item in the 'cockpit preparation' checklist to remind the pilot to turn on the RCDR / GND CTL. There was no item asking him to turn it off after landing or after shutting down the engines.'	Failure to preserve the CVR data after completion of the flight
A321	G-MARA	28 July 2008	AAIB, UK	'The FDR recorded just over 60 hours of data and the CVR 120 minutes of audio' 'Unfortunately, by the time the severity of damage to the nose gear had been identified, the CVR record relevant to the arrival at Manchester from Malaga, had been overwritten'	Late identification of the severity of the occurrence
A340-300	G-VAIR	27 April 2008	AAIB, UK	'Following the incident, the operator requested that the CVR, FDR and QAR optical disk be removed from the aircraft. However, due to a lack of replacement units at Mombasa, it was decided to conduct a non-revenue flight back to Heathrow with the recorders installed, but with the circuit breakers for the CVR pulled to preserve the two-hour recording.' 'Although the CVR circuit breakers (CBs) had been 'pulled and collared' at Mombasa as requested, the recording was inadvertently overwritten at Heathrow during subsequent attempts made by the operator to download the FDR, and during which the circuit breaker had been reset.'	Failure to preserve the CVR immediately after completion of the flight
Boeing, 717-200	VH-NXE	7 February 2008	ATSB, Australia	Hard bounced landing resulting in structural damage. 'The CVR data from the accident flight	Late identification of the severity of

Aircraft Make and Model	Aircraft registration and operator	Date of the occurrence	Investigation authority (Name and State)	Findings made in the investigation report; If any, safety recommendation	Type of issue
				had been overwritten as more than two hours had elapsed by the time the aircraft underwent an engineering inspection and the operator was advised of the outcome of that inspection'	the occurrence
B747	G-CIVB	11 July 2009	AAIB, UK	'the CVR fitted is designed to preserve at least the last 2 hours of audio information. Flight crew communications were considered important to this investigation (…) However, the CVR continued to run during the maintenance activities carried out after the event, so all the audio information relating to the event was lost.' Safety recommendation made to CAA UK: 'It is recommended that the Civil Aviation Authority review the relevant procedures and training for UK operators, to ensure the timely preservation of Cockpit Voice Recorder recordings of a reportable occurrence is achieved in accordance with the requirements of ICAO Annex 6 Part I, 11.6 and EU- OPS 1.160.'	Failure to preserve the CVR data after completion of the flight
Dash8 Q400	G-JEDI	21 December 2009	AAIB, UK	'The two-hour CVR had continued to run during the extensive maintenance activity after the flight and so had recorded over the airborne event and subsequent landing.'	Failure to preserve the CVR data after completion of the flight
B737	PH-BDP, KLM	10 February 2010	DSB, Netherlands	Take-off from a taxiway. 'A ground engineer in Warsaw switched off the CVR's electrical power after the crew had left the aircraft' (after landing at destination airport) 'Although switching off the CVR immediately upon arrival in Warsaw would have still been on time to prevent the relevant data from being overwritten, this was not the case.' 'CVR data was not available, due to the fact that the CVR has limited recording capacity (approximately two hours) and the data was not safeguarded on time.' Safety recommendation: 'The Board recommends that the European Aviation Safety Agency (EASA) and Federal Aviation Administration (FAA) increase the minimum recording time of the cockpit voice recorder (CVR) in order to better safeguard the availability of data for the purpose of incident and accident investigations.'	Failure to preserve the CVR data after completion of the flight
B767	G-OOBK	3 October 2010	AAIB, UK	'The aircraft was equipped with (…) a 120-minute Cockpit Voice Recorder (CVR). However, due to the time elapsed before the operator identified that the aircraft had been damaged, the entire audio record of the accident had been overwritten.' Safety recommendation: 'It is recommended that the European Aviation Safety Agency publishes guidance information that assists	Failure to preserve the CVR data after completion of the flight

Aircraft Make and Model	Aircraft registration and operator	Date of the occurrence	Investigation authority (Name and State)	Findings made in the investigation report; If any, safety recommendation	Type of issue
				operators and National Aviation Authorities in the production and auditing of procedures to prevent the loss of Cockpit Voice Recorder recordings in accordance with the requirements of EU-OPS 1.160 and EU-OPS 1.085.’	
Embraer, ERJ 190	OH-LKL	23 October 2010	SIA, Finland	‘The CVR recording from the flight was not available because the recording had not been stopped after the flight. Instead, the recording continued overnight. Since the capacity of the CVR is two hours, the recording would have been available to the investigation had it been stopped in Helsinki.’ ‘According to the account of one of the pilots, he did not know how to stop the CVR re-cording. Relevant information pertaining to the factors that resulted in the misaligned take-off was lost along with the CVR recording.’	Failure to preserve the CVR immediately after completion of the flight
A330	OH-LTO, Finnair	11 December 2010	SIA, Finland	During the cruise, both engines’ bleed air system failed. The cabin pressure dropped and the flight crew had to perform an emergency descent. After landing, ‘the flight crew attempted to preserve the Cockpit Voice Recorder (CVR) recording in the avionics bay by following the instructions of the operator’s technical personnel. However, they did not succeed in doing it’ Safety recommendation: ‘It is recommended that EASA and ICAO sufficiently lengthen the time recording requirement of CVRs so as to cover the entire routing of the flight.’	Failure to preserve the CVR data after completion of the flight

(iv) — RIA C: Transmission time of the flight recorder ULDs

1. Issues to be addressed

1.1. What is the issue and the current regulatory framework?

This proposal is intended to address the insufficient underwater transmission time of underwater locating devices (ULDs) fitted to crash-protected flight recorders. A transmission time of 30 days has, on several occasions, proved too short to help in locating the aircraft and the flight recorders after an accident over water.

1.1.1. Root causes and drivers

Bringing experts and specialised underwater search equipment on-site often takes several days, or even weeks.

This is because flight recorders ULDs emit a signal at a frequency of 37.5 KHz, which is out of the detection range of most sonars used by navies. Only dedicated equipment held by safety investigation authorities or specialised underwater exploration companies can detect such a signal.

In addition, the conduct of underwater search operations requires good conditions at the sea surface. If the wave height is too high or the weather is poor, the localisation of the ULD signal becomes very difficult.

In practice, the time to bring underwater search means on-site and the time lost because of unfavourable sea surface conditions can add up to let little time to search for the ULD signal before it fades out. When the ULD ceases emitting before its signal can be located, other means have to be used, which are much more time-consuming and expensive.

In addition, the French Bureau d'Enquêtes et d'Analyses (BEA) issued in 2009 the safety recommendation FRAN-2009-016:

'the BEA recommends that EASA and ICAO extend as rapidly as possible to 90 days the regulatory transmission time for ULB's installed on flight recorders on airplanes performing public transport flights over maritime areas;'

This is because BEA was faced with exceptional difficulties when looking for the wreckage of the Airbus A330 of Air France registered F-GZCP that crashed in the Atlantic Ocean on 1 June 2009. As explained in the second investigation interim report:

'The first difficulty is the remoteness of the zone, which requires transits of the order of two to four days from ports (…). The absence of any trace of the accident in the first days and absence of an emergency distress message and radar data complicated the searches.'

The search area was initially defined based on the airplane's route and the last position contained in the ACARS messages emitted by the aeroplanes. This made an area with a radius of 40 nm, extending over more than 17 000 km^2 and located more than 500 nm from the coasts. Under these conditions, the ULD signal could not be located within 30 days. The search had to be continued in the absence of any signal. There were in total five search phases and almost two years elapsed before the aircraft wreckage was eventually located.

In order to address the difficulties experienced during these underwater search operations, BEA decided to create an international working group called 'Flight Data Recovery' in order to look into new technology to safeguard data and locate the wreckage. Based on the results of the Flight Data Recovery working group[20], BEA issued recommendation FRAN-2009-016.

1.1.2. Reasons for action

This proposal is made for three reasons:

(a) Safety recommendation FRAN-2009-016, recommending that 'EASA and ICAO extend as rapidly as possible to 90 days the regulatory transmission time for ULB's installed on flight recorders on airplanes performing public transport flights over maritime areas'.

(b) The inclusion of a Standard into ICAO Annex 6 Part I (International commercial air transport – aeroplanes), stating that the containers of crash-protected flight recorders shall:

'have securely attached an automatically activated underwater locating device operating at a frequency of 37.5 kHz. At the earliest practicable date, but not later than 1 January 2018, this device shall operate for a minimum of 90 days.'

(c) Data gathered on historical accidents over water showing that not seldom an underwater transmission duration of 30 days is too short to locate the ULD, and, as a consequence, time-consuming and expensive underwater search means need to be deployed to locate the aircraft wreckage and the flight recorders.

1.1.3. Regulatory status

The current regulatory status is the following:

1. ICAO Annexes

ICAO Annex 6 Part I Amendment 36 is applicable since 15 November 2012 and contains the following Standard in its Appendix 8:

'1. General requirements

1.1 The flight recorder containers shall:

…

c) have securely attached an automatically activated underwater locating device operating at a frequency of 37.5 kHz. At the earliest practicable date but not later than 1 January 2018, this device shall operate for a minimum of 90 days.'

2. Actions taken by the Federal Aviation Administration

FAA requested in 2010 that SAE International revise the minimum performance standard AS8045, Underwater Locating Devices (Acoustic) (Self-Powered), to increase the minimum underwater transmission time of ULDs from 30 days to 90 days. SAE International performed this revision and published the new standard AS8045A in August 2011.

On 28 February 2012, FAA Technical Standard Order (TSO) C121b was published. This TSO refers to SAE AS8045A.

On 5 March 2012, FAA published a notice on the Federal register announcing the planned withdrawal of all Technical Standard Order authorisations issued for the production of ULD manufactured to the FAA TSO–C121 and TSO–C121a specifications no later than 1 March 2015. As a result, all ULDs produced after this date will have to be compliant with TSO C-121b.

[20] The final report of the Flight Data Recovery working group can be consulted at http://www.bea.aero/en/enquetes/flight.af.447/flight.data.recovery.working.group.final.report.pdf .

Nevertheless, ULDs in use will not need to be retrofitted. There are no specific requirements with regard to the transmission time of the ULD in FAA Parts 121, 125 or 135.

3. Actions taken by the Agency

On 9 October 2012, the Agency issued Notice of Proposed Amendment (NPA) 2012-16, which included the proposal of a new European Technical Standard Order (ETSO) C121b on ULDs. ETSO-C121b refers to SAE AS8045A.

There was no underwater transmission time of the ULD specified in the former air operation rules applicable to aeroplanes (Annex I to Commission Regulation (EC) No 859/2008, also called EU OPS) or helicopters (JAR OPS 3). In the new air operation rules for commercial air transport (Annex IV to Commission Regulation (EU) No 965/2012) hereinafter referred to as the 'OPS Part CAT', the FDR, CVR and data link recording paragraphs contain a provision that the flight recorder 'shall have a device to assist in locating it in water': see paragraphs CAT.IDE.A.185, CAT.IDE.A.190, CAT.IDE.A.195, CAT.IDE.H.185, CAT.IDE.H.190, CAT.IDE.H.195. However, these paragraphs do not contain any requirement on the transmission time of the ULD.

New air operation rules applicable to non-commercial operations with complex motor-powered aircraft (hereinafter referred to as the 'OPS Part NCC') have been published and can be found in Annex VI to Commission Regulation (EU) No 965/2012[21]. These other air operation rules contain also flight recorder provisions, including the provision that the flight recorder shall be fitted with a ULD, but without any specified transmission time.

Air operation rules are also in preparation to address aerial work (see EASA Opinion No 02/2012). They are designated as 'OPS Part SPO' (specialised operations). These draft air operation rules contain also flight recorder provisions, including the provision that the flight recorder shall be fitted with a ULD.

1.2. Safety risk assessment

Flight recorders are not critical for the safe conduct of the flight, however, they are essential safety investigation tools. Therefore, a risk assessment focussed on operational safety and using the conventional risk matrix (probability of failure versus potential severity of the outcome) is not appropriate. Instead, an approach based on the actual safety benefit of a flight recorder (i.e. providing reliable and accurate information after an accident or serious incident) is proposed here.

The risk to be assessed here is the risk for safety investigation authorities and aviation regulators to be unable to timely identify a hazard that would normally be captured by the flight recorder. In order for this risk to materialise, a number of events should occur in series:

(a) An accident over water has occurred to an aircraft required to carry a FDR and/or a CVR;

(b) This accident bears a causal or contributing factor not yet identified by previous investigations, and that can only be identified with the help of the FDR or the CVR (or both).

(c) The ULD signal cannot be localised within 30 days of the accident, and localisation of the flight recorders in the absence of a ULD signal is challenging[22].

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[21] As modified by Commission Regulation (EU) No 800/2013. Commission Regulation (EU) No 800/2013 of 14 August 2013 amending Regulation (EU) No 965/2012 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 Text with EEA relevance (OJ L 227, 24.8.2013, p. 1).

[22] There can be several reasons:
— the position of the impact point with water or of the wreckage on the sea floor may not be known accurately, so that the search area is very large

The identified safety hazard relates to the safety prevention function of the safety investigation (the rules of which are defined by ICAO Annex 13). As flight recorders are an essential tool for understanding the sequence of events that led to an accident or a serious incident, failure to retrieve their recording in a reasonable timeframe is adversely affecting the prevention of future occurrences.

1.2.1. Case of large aeroplanes operated for commercial air transport

Data on accidents of large aeroplanes that occurred over water for the last 40 years were collected. 37 occurrences were identified. Corresponding investigation reports were looked for. Investigation reports related to 23 accidents out of 37 have been collected. These 23 accidents are listed in Table C.1.

In 6 out of these 23 documented accidents, it took more than the standard underwater transmission time of 30 days to recover the recorders (see Table C.2). The most frequent causes for the important delays in recovering the wreckage and the flight recorders are:

— the adverse conditions on the sea surface (rough sea state and/or bad weather), and

— the unavailability of adequate underwater search equipment and/or experts in the vicinity of the accident.

These factors are independent of the aircraft type or technology. They are considered applicable to all types of aircraft required to carry flight recorders.

— the flight recorders cannot be apparent on the sea floor. In the case of the accident of the Airbus A-320 registered EK-32009 in Sotchi on 2.5.2006, the seafloor was muddy and both recorders were below the mud level.

Table C.1: Accidents of large aeroplanes over water for which an investigation report was found by the Agency

Aircraft type	Operator	Registration	Accident Date	Accident Location
B707	Panam	N417PA	22 July 1973	Near Tahiti
IAI 1124 Westwind	Pel-Air Aviation	VH-IWJ	10 October 1985	Sydney, Australia
B747	South African Airways	ZS-SAS	28 November 1987	Mauritius
DC9	ValueJet	N904VJ	11 May 1996	Everglades, Florida USA
B-757	Birgenair	TC-GEN	02 February 1996	Puerto Plata, Dominican Republic
B747	TWA	N93119	17 July 1996	New York, USA
B737	Silk Air	9V-TRF	19 December 1997	Palembang, Indonesia
MD-11	Swiss Air	HB-IWF	02 September 1998	Halifax, Canada
B767	Egypt Air #990	SU-GAP	31 October 1999	Connecticut, USA
A310	Kenya Airways	5Y-BEN	30 January 2000	Abidjan
MD-83	Alaska Airlines	N963AS	31 January 2000	Los Angeles, USA
A320	Gulf Air	A40-EK	23 August 2000	Muharraq, Bahrain
B747	China Airlines	B-18255	25 May 2002	Pengu Island, Taiwan
ATR72	Trans Asia	B22708	21 December 2002	Pengu Island, Taiwan
B737	Flash Airlines	SU-ZCF	3 January 2004	Sharm el-Sheikh, Egypt
ATR72	Tuninter	TS-LBB	6 August 2005	Palermo, Italy
A320	Armavia Air	EK-32009	2 May 2006	Sochi, Russia
B737	Adam Air	PK-KKW	1 January 2007	Pare Pare, Indonesia
DHC6	Air Moorea	F-OIQI	9 August 2007	Moorea, French Polynesia
Metro III	Charter	VH-OZA	9 April 2008	Sydney, Australia
A320	XL Airways	D-AXLA	27 November 2008	Perpignan, France
A330	Air France	F-GZCP	1 June 2009	Atlantic ocean
B747	Asiana Airlines	HL7604	28 July 2011	West of Jeju International airport

Table C.2: Accidents indicated in Table C.1 and for which it was determined that the time to recover the recorders exceeded 30 days

A/C Make and Model	Operator	Registration	Date	Depth of the wreckage (m)	Number of days to retrieve the CVR	Number of days to retrieve the FDR	Cause for long recovery operation of the flight recorders
IAI 1124 Westwind	Pel-Air Aviation	VH-IWJ	10 October 1985	90	150	150	Adverse weather and sea state. Inadequacy of local equipment that made the location of the wreckage difficult. Time to contract a company for underwater operations.
B747	South African Airways #295	ZS-SAS	28 November 1987	4 400	840	Not found	Poor weather conditions that delayed the sea search operations Temperature in excess of ULD environmental specifications that made the ULD inoperative Time to contract a company with special underwater search equipment and have it on-site and operational
B737	Adam Air #574	PK-KKW	1 January 2007	1 800	240	240	Locator beacon signals from the flight recorders were heard. However, it took eight months to get specialised underwater recovery equipment on-site.
Metro III	Charter	VH-OZA	9 April 2008	100	77	77	Poor weather conditions that delayed the sea search operations.
A330	Air France	F-GZCP	1 June 2009	4 000	692	690	Accident out of range of any ATC surveillance system and far away from any infrastructure. As a consequence, the first SAR means arrived days after the accident. The search area was 17 000 km^2
A310	Yemen Airways	7O-ADJ	30 June 2009	1 200	60	60	Time to contract a company with special underwater search equipment and have it on-site and operational

1.2.2. Other types of aircraft and operations

Not only large aeroplanes operated for commercial air transport can be subject to accidents over water. In order to determine the distribution of accidents over water by category of aircraft and by type of operation, queries were run on EASA safety occurrence database. This database contains records of all accidents and serious incidents reported to ICAO (it is synchronised with ICAO database on a regular basis), as well as records of accidents and serious incidents reported to the Agency but not necessarily to ICAO.

It was also important to sort the query results according to other criteria, such as:

— could the aircraft model be required to carry a FDR or a CVR according to European air operation rules (hereinafter referred to as the 'OPS rules')? Indeed, every FDR or CVR is required to be fitted with a ULD according to OPS rules;

— would the Agency be theoretically involved in the investigation, because the State of Occurrence or the State of Registry is an EASA Member State, or the aircraft is a European product?

A query of EASA safety occurrence database revealed that there were globally **82 aircraft subject to an accident outside of territorial waters** in the 20-year-long period between 1 January 1993 and 31 December 2012. Among those:

— 43 were aeroplanes with a maximum certificated take-off mass (MCTOM) in excess of 27 000 kg, 39 of which were operated for commercial air transport (the remaining 3 were performing a State flight);

— 4 were aeroplanes with an MCTOM comprised between 5 700 kg and 27 000 kg, 1 of which was operated for commercial air transport, the remaining 3 for general aviation;

— 25 were aeroplanes with an MCTOM comprised between 2 250 kg and 5 700 kg, 5 of which were operated for commercial air transport and the remaining 20 for general aviation. Most aeroplanes in this mass group are not required to carry a flight recorder according to OPS rules;

— 1 was an aeroplane with an MCTOM of less than 2 250 kg (not required to carry a flight recorder according to OPS rules);

— 5 were helicopters with an MCTOM exceeding 5 700 kg, all being operated for commercial air transport;

— 4 were helicopters with an MCTOM comprised between 2 250 kg and 5 700 kg, among which 1 had an MCTOM exceeding 3 175 kg and, therefore, could be required to carry a flight recorder according to OPS rules;

— 17 were registered in an EASA Member State, 13 of which were of a model eligible for carrying a flight recorder, according to OPS rules; and

— 15 were not registered in an EASA Member State and designed by an organisation under the Agency's responsibility. 10 out of these 15 aircraft were of a model eligible for carrying a flight recorder.

Nevertheless, accidents in extra-territorial waters only represent a small proportion of accidents over water. Most accidents over water take place in the territorial water of a State, or over fresh water. A query of EASA safety occurrence database revealed that globally, **586 aircraft** were subject to an accident in the period between 1 January 1993 and 31 December 2012, and the name of the accident location was containing one of the words 'lake', 'river', 'bay', 'gulf', and 'coast'.

Among those:

— 20 were aeroplanes with an MCTOM in excess of 27 000 kg, all being operated for commercial air transport;

- 49 were aeroplanes with an MCTOM comprised between 5 700 kg and 27 000 kg, 32 of which being operated for commercial air transport, 6 for aerial work, 9 for general aviation and the rest being State flight or unknown;
- 330 were aeroplanes with an MCTOM comprised between 2 250 kg and 5 700 kg, 187 of which being operated for commercial air transport, 36 for aerial work, 98 for general aviation and the rest being State flight or unknown. Most aeroplanes in this mass group are not required to carry a flight recorder according to OPS rules.
- 58 were aeroplanes with an MCTOM of less than 2 250 kg or microlight (not required to carry a flight recorder according to OPS rules);
- 16 were helicopters with an MCTOM exceeding 5 700 kg, 5 of which being operated for commercial air transport, 5 for aerial work, 4 for general aviation and the rest being State flights or unknown;
- 67 were helicopters with an MCTOM comprised between 2 250 kg and 5 700 kg, among which 42 had an MCTOM exceeding 3 175 kg and therefore would be required to carry a flight recorder according to OPS rules. 18 of these 42 helicopters were operated for commercial air transport, 15 for aerial work, 4 for general aviation, and 5 being State flights or unknown;
- 41 were helicopters with an MCTOM of less than 2 250 kg. Helicopters in this mass group are not required to carry a flight recorder according to OPS rules; and
- for 71, the accident took place in the territory of an EASA Member State. 10 out of 71 were of a model eligible for carrying a flight recorder.

Almost all of these accidents did not occur in extra-territorial waters, so that there is very little overlap between this set and the previous one.

From these figures, it can be computed that:

- globally, every year there have been on average 33 aircraft accidents over water;
- globally, every year there have been on average 9 accidents over water of aircraft of a model eligible for carrying a flight recorder (FDR or CVR or both) according to European OPS rules;
- **48 % of accidents over water** occurring to aircraft eligible for carrying a flight recorder occur **to aeroplanes with an MCTOM of more than 5 700 kg and operated for commercial air transport**. This subset can be further split into:
  - aeroplanes with an MCTOM exceeding 27 000 kg (27 %), and
  - aeroplanes with an MCTOM comprised between 5 700 kg and 27 000 kg (21 %);
- **11 % of accidents over water** occurring to aircraft eligible for carrying a flight recorder occur to **aeroplanes with an MCTOM of more than 5 700 kg and operated for general aviation or aerial work**;
- **40 % of accidents over water** occurring to aircraft eligible for carrying a flight recorder occur to **helicopters**; and
- **every year** there have been **on average 1.6 accidents over water** occurring in the territory of an EASA Member State, or for which an EASA Member State is the State of registry of the aircraft, or for which the Agency is the primary certification authority of the aircraft design, where in addition the aircraft was of a model eligible for carrying a flight recorder.

In conclusion, the accidents of large aeroplanes operated for commercial air transport over water only represent globally a quarter (27 %) of accidents over water of aircraft that could be required to carry a flight recorder, according to OPS rules. Even when considering all aeroplanes operated for commercial air transport, they only make half (48 %) of this set, the rest being aeroplanes operated for other purpose and helicopters. When considering those accidents where the Agency and/or an EASA Member State is involved, and the aircraft is of a model eligible for carrying flight recorders according to OPS rules, there are on average 1.6 accidents in average per year.

1.3. Who is affected?

1.3.1. Stakeholders

Difficulties in recovering the flight recorders after an accident over water delay or hinder the determination of the causes of this accident by safety investigation authorities. The taking of appropriate corrective actions by EASA and national aviation authorities is accordingly delayed.

1.3.2. Affected fleet

The difficulties in locating the flight recorders after an accident over water do not depend on the aircraft type or size. All aircraft required to carry a FDR or a CVR and susceptible to operate over water are affected indistinctively. These are, to this date:

(a) all aeroplanes with an MCTOM exceeding 5 700 kg and operated for commercial air transport by operators of EASA Member States: this fleet is roughly 8 830 aircraft[23];

(b) all helicopters with an MCTOM exceeding 7 000 kg that were first issued with an individual Certificate of Airworthiness (CofA) before 1 January 1987, and operated for commercial air transport by operators of EASA Member States: this fleet is roughly 1 460 aircraft;

(c) all helicopters with an MCTOM exceeding 3 175 kg that were first issued with an individual CofA on or after 1 January 1987, and operated for commercial air transport by operators of EASA Member States: this fleet is about 4 030 aircraft; and

(d) multi-engine turbine powered aeroplanes with a maximum approved passenger seating configuration (MAPSC) of more than 9 that were first issued with an individual CofA on or after 1 April 1998, and operated for commercial air transport by operators of an EASA Member State: this fleet is roughly 100 aircraft.

Hence, around 14 400 aircraft are currently operated by commercial operators of EASA Member States and required to carry a FDR or a CVR (or both).

In addition, aeroplanes with an MCTOM exceeding 5 700 kg and operated for general aviation or aerial work, and first issued with an individual CofA on or after 1 January 2016 will be required to carry a FDR, according to EASA Opinions No 01/2012 and No 02/2012. Helicopters with an MCTOM exceeding 3 175 kg and operated for general aviation or aerial work, and first issued with an individual CofA on or after 1 January 2016, will also be required to carry a FDR. These aeroplanes and helicopters will, therefore, also be affected once the rules for non-commercial operations and for specialised operations (aerial work) are applicable.

1.4. How could the issue/problem evolve?

In case no further action is taken by the Agency:

— new designs of flight recorder ULDs will have to be compliant with SAE AS8045A in order to be granted an approval according to TSO-C121b or ETSO-C121b; and

— flight recorder ULDs produced after 2015 will have to be compliant with SAE AS8045A in order to be granted a FAA TSO, as TSO-C121 and TSO-C121a will be withdrawn in 2015.

[23] The source of fleet numbers in section 2.3.2 is Ascend aircraft and airlines data, year 2012.

However, it will take roughly the service life of a ULD to get 30-day ULDs replaced by 90-day ULDs on most flight recorders. ULDs have service life of 20 years or even longer.

This problem needs to be addressed by the Agency as it is responsible for the air operation rules applicable in the EASA Member States according to the Basic Regulation, and a replacement of 30-day ULDs by 90-day ULDs is not expected to be implemented by European aircraft operators without a mandate, as they have no incentive to do it.

2. Objectives

The overall objectives of the Agency are defined in Article 2 of the Basic Regulation.

This proposal will contribute to the overall objectives by addressing the issues outlined in Section 2. The specific objective of this proposal is, therefore, to ensure that the underwater transmission time of flight recorder ULDs matches with the time actually needed for localising and retrieving the flight recorders.

3. Policy options

Table C.3: Selected policy options

Option No	Description
0	Baseline option (No change in rules; risks remain as outlined in the issue analysis)
1	Revoke ETSO authorisations, similar to withdrawal by FAA of TSO authorisations issued for the production of ULD manufactured to the TSO– C121 and TSO–C121a specifications scheduled in March 2015
2	Mandate that the ULDs of crash-protected flight recorders fitting aeroplanes operated for commercial air transport have an underwater transmission time of 90 days by 1 January 2020.
3	Mandate that the ULDs of crash-protected flight recorders fitting all aircraft required to carry a flight recorder have an underwater transmission time of 90 days by 1 January 2020.

Option 0 consists in not doing more than the planned update of CS ETSO-C121a to refer to SAE AS8045A. As a result, new designs of ULD that are submitted to the Agency for an ETSO authorisation will be compliant with SAE AS8045A that specifies an underwater transmission time of 90 days. Indeed, there exist underwater search means that allow scanning the seafloor and detecting aircraft wreckage in the absence of a locating signal: see Table C.5. In almost all accidents listed in Table C.1, both flight recorders could be retrieved.

Option 1 consists in revoking ETSO approvals granted under ETSO-C121 and ETSO-C121a which refer to the former SAE standard AS8045. This would stop the production of ULDs under ETSO-C121 or ETSO-C121a, only the production of ULDs under ETSO-C121b, i.e. with an underwater transmission time of 90 days would be allowed. FAA has already decided to withdraw TSO authorisations under TSO-C121 and TSO-C121a as of 2015.

Option 1 is prohibiting the production of 30-day ULDs from a given date, thus, affecting equipment manufacturers producing ULDs under ETSO.

Option 2 consists in introducing in OPS Part CAT a requirement that the ULDs of crash-protected flight recorders fitting aeroplanes have an underwater transmission time of 90 days, from 1 January 2020. The modified paragraphs would be:

— CAT.IDE.A.185 (CVR),

- CAT.IDE.A.190 (FDR),
- CAT.IDE.A.195 (Data link recording).

With this amendment EASA Member States would be in better compliance with amendment 36 of ICAO Annex 6 Part I. The applicability date is later than 1 January 2018 as recommended in ICAO Annex 6 Part I, because taking into account that the rules are expected to be adopted in year 2016, mandating a replacement by 1 January 2018 would leave less than two years for replacing all 30-day ULDs with 90-day ULDs.

Option 3 is an extension of option 2 to other categories of aircraft and operations. Option 3 requires that for all aircraft registered in an EASA Member State and required to carry a flight recorder (FDR, CVR or dedicated data link recorder) according to OPS rules, the flight recorder is fitted with a 90-day ULD no later than 1 January 2020.

Option 3 encompasses helicopters operated for commercial air transport, as well as aeroplanes and helicopters used for non-commercial operation or for aerial work. The following paragraphs of the OPS rules would be impacted by Option 3:

- In OPS Part CAT: CAT.IDE.A.185, CAT.IDE.A.190, CAT.IDE.A.195 (aeroplanes), CAT.IDE.H.185, CAT.IDE.H.190, CAT.IDE.H.195 (helicopters);
- In OPS Part NCC: NCC.IDE.A.160, NCC.IDE.A.165, NCC.IDE.A.170 (aeroplanes), NCC.IDE.H.160, NCC.IDE.H.165, NCC.IDE.H.170 (helicopters); and
- In OPS Part SPO: SPO.IDE.A.140, SPO.IDE.A.145, SPO.IDE.A.150 (aeroplanes), SPO.IDE.H.140, SPO.IDE.H.145, SPO.IDE.H.150 (helicopters).

4. Data and methodology

Refer to Appendix M.

5. Analysis of impacts

5.1. *Safety impact*

5.1.1. Option 0

In the absence of a ULD signal, the localisation of the wreckage and of the flight recorders can take months. This delay may be excessive compared to the expected timeframe to address some categories of safety issues, such as affecting the design of a product, of a part or appliance, standard operating procedures, etc.

In addition, the absence of a ULD signal forces a safety investigation authority to have recourse to expensive underwater search means to locate the aircraft wreckage (refer to 5.4). Cost is critical when only limited financial means can be dedicated to the underwater search operations.

5.1.2. Option 1

No approval according to ETSO-C121 or ETSO-C121a has been issued by EASA, thus, the revocation of these ETSOs would have no effect on the current production of 30-day ULDs. Option 1 would not bring more safety benefits than Option 0.

5.1.3. Option 2

Option 2 would improve the situation for aeroplanes operated for commercial air transport. However, half of the accidents occur to helicopters or to aeroplanes operated for general aviation or aerial work. So Option 2 would only address half of the accidents over water.

5.1.4. Option 3

Option 3 would cover all categories of aircraft required to carry a crash-protected flight recorder, and, therefore, benefit the investigations into accidents of aeroplanes and helicopters alike, operated for commercial air transport, general aviation and aerial work.

In the case of non-high-profile accident (aircraft carrying few passengers, operated for other purposes than commercial air transport), it is more difficult for a safety investigation authority to mobilise the considerable human and financial means needed for finding the aircraft wreckage and the flight recorders when the ULD has ceased emitting. Precisely the investigations of such accidents would benefit most from replacing the 30-day ULDs attached to the flight recorders by 90-day ULDs.

5.1.5. Conclusion

Only Option 3 is fully satisfactory from a safety point of view: see Table C.4

Table C.4: Comparative safety impact of options

	Option 0	Option 1	Option 2	Option 3
Safety impact	**0**	**0**	**+** (improvement for only half of accidents over water of aircraft carrying a flight recorder)	**+++** (improvement for all accidents over water of aircraft carrying a flight recorder)

5.2. Environmental impact

Whichever the option, the foreseeable environmental impact is negligible.

The weight of a 90-day ULD is similar to the weight of a 30-day ULD, so that no increase in fuel consumption would be caused by the introduction of 90-day ULDs.

5.3. Social impact

No social impact is foreseen.

5.4. Economic impact

5.4.1. Economic impact of Option 0 and Option 1

When the ULD ceases emitting before its signal can be located, it can mean additional days or even weeks of underwater search operations, since without a signal the search area would have to be scanned in a systematic manner.

The cost of underwater search operations is a function of their duration, which depends on the nature of the seafloor, the depth and the size of the area to explore (see Table C.5). Cost is critical when the safety investigation authority cannot dedicate large financial means to the underwater search operations.

For example, in an area where the seafloor is rugged, its exploration can only be conducted using a Remotely Operated Vehicle, which covers a small area per day. The average daily cost of using a Remotely Operated Vehicle in 2010 was of the order of USD 150 000 to 200 000. (Source: BEA, based on 12 underwater search operations). In addition, such a vehicle needs to be operated from a ship equipped with dynamic positioning systems. The rental of such a ship is also very expensive.

Every year, there are on average 1.6 accidents over water of an aircraft fitted with flight recorders and involving the responsibility of the Agency or of an EASA Member State. Therefore, the long-term economic impact of Option 0 and Option 1 for Europe is assessed to be of the order of EUR 500 000 to EUR 5 000 000 per year, mainly supported by EASA Member States. Over a ten years period, the cost of Option 0 or Option 1 would range between EUR 5 000 000 and EUR 50 000 000.

Table C.5: Comparison of underwater search means that can be used in the absence of a ULD signal.

Equipment	Seabed type	Ship type	Area coverage per 24 hours of operation
Towed SONAR	Relatively smooth	Consistent slow speed	100 km^2
Autonomous Underwater Vehicle	Medium slopes	Escort	200 km^2 with 2 AUV's
Remotely Operated Vehicle	All	Dynamic positioning	5 km^2

5.4.2. Economic impact of Option 2 and Option 3

5.4.2.1. Purchase price

90-day ULDs compliant with SAE AS8045 are available on the market. Their unit price is currently around EUR 500 and slightly higher than the unit price of 30-day flight recorder ULDs (approximately EUR 420 according to information provided by two equipment manufacturers). 90-day flight recorders ULDs compliant with the new SAE AS8045A are planned to be distributed as of 2014, at a similar unit price.

In addition, Option 2 and Option 3 would not mean replacing brand-new 30-day ULDs with 90-day ULDs. Assuming that the service life of a 30-day ULD is 20 years and that the economic life of an aircraft operated is longer than 20 years, then one can also assume that the ages of ULDs are evenly distributed between 0 and 20 years, and their average age is 10 years. This ageing translates into a depreciation of the ULD. To reflect this, it is assumed that the remaining value of a 10-year-old 30-day ULD is half the price of a brand-new ULD, i.e. 420/2= EUR 210. Hence, the extra cost generated by replacing 30-day ULDs with 90-day ULDs is assessed to be 80 (unit price difference) +210 (remaining value of the discarded 30-day ULD) = EUR 290.

5.4.2.2. Replacement cost

The 90-day ULD has the same dimensions as the 30-day ULD, so that they are interchangeable. 1 man-hour is considered sufficient to perform this replacement (EUR 80). The cost of aircraft turndown can be minimised by electing a notice time such that the ULD can be replaced during scheduled maintenance. Assuming that the rule is published in 2016, an applicability date such as 1 January 2020 would leave more than 3 years of notice, which is more than sufficient a notice for scheduling the replacement during maintenance operations.

5.4.2.3. Approval and documentation cost

The replacement of a 30-day ULD by a 90-day ULD would require little documentation, since a 90-day ULD has the same dimensions as a 30-day ULD, and SAE AS8045A contains the similar or more stringent specifications than the former SAE AS8045.

No particular approval of ULD replacement would be needed, provided the model of the new ULD has been granted an ETSO authorisation.

Therefore, it is arbitrarily assumed that the approval cost would amount to EUR 50 per ULD replaced, corresponding to changing the pages related to the ULD in the flight recorder documentation.

5.4.2.4. Total cost of Option 2 and Option 3 for aircraft registered in EASA Member States

It is assumed that the cost generated by the replacement of one 30-day ULD by one 90-day ULD is:

EUR 290 (extra cost) + EUR 80 (cost of physical replacement) + EUR 50 (update of flight recorder documentation)= EUR 420

This means EUR 420 or EUR 840 per aircraft, depending if it is fitted with one or two flight recorders.

Option 2:

8 830 aeroplanes would potentially be affected, which means up to 17 660 ULD replacements (some aircraft models are required to carry two flight recorders).

Then, the total cost for this fleet would be up to 420 × 17 660 ≈ **EUR 7 400 000**.

Option 3:

14 400 aircraft would potentially be affected, which means up to 28 800 ULD replacements.

The total cost for this fleet would be up to 420 × 28 800 = **EUR 12 100 000.**

5.4.3. Conclusion

Whichever the option considered, the economic impact is limited. However, Option 0 and Option 1 generate every year a cost related to underwater search in the absence of a ULD signal, while Option 2 and Option 3 costs are related to the retrofit of the ULDs, after which the 90-day ULDs are expected to help saving underwater search cost. Table C.5 displays the comparative impact.

Note:

The cost generated by Option 2 or Option 3 would be supported by the aircraft operators. The cost of underwater search operations (Option 0) is mainly supported by safety investigation authorities, which usually rely on national subsidies.

Table C.5: Comparative economic impact of options

	Option 0	**Option 1**	**Option 2**	**Option 3**
Overall economic impact	Cost of EUR 500 000 to EUR 5 000 000 every year (supported by EASA Member States)	Cost of EUR 500 000 to EUR 5 000 000 every year (supported by EASA Member States)	Cost of EUR 7 400 000 for the period 2015 to 2019 (supported by operators), then annual savings of EUR 500 000 to EUR 5 000 000 after 2019 (for EASA Member States)	Cost of EUR 12 100 000 one time (supported by operators), then annual savings of EUR 500 000 to EUR 5 000 000 after 2019 (for EASA Member States)
Economic impact score	**0** (current cost of underwater search)	**0** (current cost of underwater search)	**-/+** (- for the industry, + for States)	**-/+** (—for the industry, + for States)

5.5. Proportionality issues

Given the limited cost of introducing 90-day ULDs, any option would have a limited impact on small-sized operators and on general aviation.

It should be noted that the replacement of 30-day ULDs by 90-day ULDs would only affect those aircraft required to carry crash-protected flight recorders. Should lightweight flight recorders, such as defined by ICAO Annex 6 Part I, be required in the future on some categories of light aircraft[24], they would not be required to be fitted with a ULD. Hence, they would not be affected by any of the options presented here.

No negative impact is foreseen to affect any particular sector of the industry or any particular region.

5.6. Impact on regulatory coordination and harmonisation

5.6.1. Foreseeable implementation issues

Option 1:

There is no particular problem foreseen with the implementation.

Options 2:

There is no particular problem foreseen with the implementation.

Option 3:

Given the large number of aircraft potentially impacted, the supply of 90-day ULDs may not meet the demand if the timeframe for implementation is too short. Therefore, an interval of several years between the time of publication and the time of applicability is recommended.

5.6.2. Risk of conflict with other legislation or national action

Whichever the option, it would not affect another regulation or legislation.

Option 1:

There is no danger of duplication at national level, as only the Agency can grant and revoke ETSO approvals.

Options 2 and 3:

There is no danger of duplication at national level, as Commission Regulation (EU) No 965/2012 will have entered into force in all EASA Member States by 28 October 2014. Any mandatory replacement of 30-day ULDs by 90-day-ULDs would be effective after this date, i.e. when the new air operation rules are applicable in all EASA Member States.

5.6.3. Impact on Member States' obligations towards ICAO

Option 1:

The EASA Member States will not be in compliance with the Standard 1.1c) of Appendix 8 of ICAO Annex 6 Part I.

Option 2:

The EASA Member States will be in compliance with the Standard 1.1c) of Appendix 9 of ICAO Annex 6 Part I except that the applicability date is 1 January 2020 and not 1 January 2018.

Option 3:

[24] Rulemaking task RMT.0271 'Recorders for small aircraft' is scheduled to start in 2013 according to Rulemaking Programme 2013-2016.

The EASA Member States will be in compliance with the Standard 1.1c) of Appendix 9 of ICAO Annex 6 Part I except that the applicability date is 1 January 2020 and not 1 January 2018.

In addition, ICAO has issued on 5 July 2013 a State Letter proposing, among others, to introduce a similar Standard in ICAO Annex 6 Part II (International general aviation – aeroplanes) and Part III (International operations – helicopters). If this proposal is adopted, only Option 3 will bring the EASA Member States in compliance with the next amendments of ICAO Annex 6 Part II and III.

5.6.4. Harmonisation with third-country requirements

Option 1 would echo the decision made by FAA to withdraw TSO-C121 authorisations and TSO-C121a authorisations by 2015.

Options 2 and 3 are changes to air operation rules applicable to European operators only, therefore, there is no potential harmonisation issue. In addition, an alignment with related Standards in ICAO Annex 6 would lead to harmonisation with the third-countries regulations.

5.6.5. Conclusion

The comparative impact of options are presented in Table C.6.

Table C.6: Comparative impact on regulatory coordination and harmonisation

	Option 0	**Option 1**	**Option 2**	**Option 3**
Regulatory coordination and harmonisation	**0** (ICAO Standard not transposed)	**0** (ICAO Standard not transposed)	**+**	**+/+++** (**+++** if Standards on 90-day ULDs are introduced in future amendments of ICAO Annex 6 Parts II and III)

6. Conclusion and preferred option

A summary of the strengths and weaknesses of each option is presented in Table C.7.

Table C.7: Comparison of impacts between the various options ('+' means a positive impact, '-' a negative impact, '0' no significant impact)

Option	Option 0	Option 1	Option 2	Option 3
Option description	Baseline option (No change in rules; risks remain as outlined in the issue analysis)	Revoke ETSO authorisations, similar to withdrawal by FAA of TSO authorisations issued for the production of ULD manufactured to the TSO–C121 and TSO–C121a specifications scheduled in March 2015	Mandate that the ULDs of crash-protected flight recorders fitting aeroplanes operated for commercial air transport have an underwater transmission time of 90 days by 1 January 2020.	Mandate that the ULDs of crash-protected flight recorders fitting all aircraft required to carry a flight recorder have an underwater transmission time of 90 days by 1 January 2020.
Safety impact	**0**	**0**	**+** (improvement for only half of accidents over water of aircraft carrying a flight recorder)	**+++** (improvement for all accidents over water of aircraft carrying a flight recorder)
Environmental impact	**0**	**0**	**0**	**0**
Social impact	**0**	**0**	**0**	**0**
Economic impact	**0** (current cost of underwater search)	**0** (current cost of underwater search)	**-/+** (- for the industry, + for States)	**-/+** (—for the industry, + for States)
Proportionality issues	**0**	**0**	**0**	**0**
Impact on regulatory coordination and harmonisation	**0** (ICAO Standard not transposed)	**0** (ICAO Standard not transposed)	**+**	**+/+++** (**+++** if Standards on 90 day ULD are introduced in future amendments of ICAO Annex 6 Parts II and III)
Overall impact	**0**	**0**	**+**	**+++**

It appears that Option 3 would have the best safety impact and it would bring EASA Member States in compliance with current and future ICAO Standards applicable to flight recorder ULDs. Option 3 would be equivalent to other options with regard to environmental, social, economic or proportionality aspects.

Therefore, Option 3 is the preferred option to address the issue of insufficient transmission time of flight recorder ULDs. When implementing Option 3, the following precautions should be taken:

— The time interval between the publication of the requirement and its date of application should be sufficient to allow for replacing the ULD when maintenance on the ULD is scheduled; and

— The time interval between the publication of the requirement and its date of application should also be sufficient to allow for the ULD supply to meet the demand.

It is currently considered that setting the applicability on 1 January 2020 provides for sufficient notice for meeting the two conditions above, however, this could be adjusted if the publication of the rules is needed or if the supply of 90-day ULD is insufficient.

<u>Note:</u>

Option 3 of this Regulatory Impact Assessment is also assessed in the regulatory impact assessment D on 'Very long detection range ULD for wreckage localisation in oceanic areas', where it appears as Option 1. Regulatory Impact Assessment D is dedicated to addressing the difficulty of locating aircraft wreckage after an accident over an oceanic area (deep maritime area out of range of ATM ground surveillance).

Annexes

Annex A: Acronyms and definitions

BEA	Bureau d'Enquêtes et d'Analyses (French safety investigation authority)
CVR	Cockpit Voice Recorder
CofA	Certificate of Airworthiness
EFRPG	European Flight Recorder Partnership Group
ETSO	European Technical Standard Order
FAA	Federal Aviation Administration of the United States
FDR	Flight Data Recorder
ICAO	International Civil Aviation Organization
MAPSC	Maximum Approved Passenger Seating Configuration
MCTOM	Maximum Certificated Take-Off Mass
OPS Part CAT	Air operation rules, provisions dedicated to commercial air transport
OPS Part NCC	Air operation rules, provisions dedicated to non-commercial operations with complex motor-powered aircraft
OPS Part SPO	Air operation rules, provisions dedicated to specialised operations
OPS rules	Air operation rules
TSO	Technical Standard Order
ULB	Underwater Locator Beacon (other name for the ULD)
ULD	Underwater Locating Device

Annex B: References

(a) ICAO Annex 6 Part I, International Commercial Air Transport – Aeroplanes, Amendment 36.

(b) ICAO Annex 13, Aircraft Accident and Incident Investigation, Amendment 13.

(c) 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, as amended by Commission Regulation (EU) No 800/2013.

(d) Commission Regulation (EC) No 859/2008 of 20 August 2008 amending Council Regulation (EEC) No 3922/91 as regards common technical requirements and administrative procedures applicable to commercial transportation by aeroplane.

(e) Joint Aviation Requirements, JAR-OPS 3, Commercial Air Transportation (Helicopters).

(f) Opinion No 02/2012 of the European Aviation Safety Agency of 16 April 2012 for a Commission Regulation establishing Implementing Rules for air operations. Available under http://www.easa.europa.eu/agency-measures/opinions.php.

(g) Decision 2013/012/R of the Executive Director of the European Aviation Safety Agency adopting amendment 8 of Decision 2003/10/RM of the Executive Director of the European Aviation Safety Agency of 24 October 2003 on certification specifications, including airworthiness codes and acceptable means of compliance, for European Technical Standard Orders (CS-ETSO) 'Systematic review and transposition of existing FAA TSO standards for parts and appliances into EASA ETSOs'.

(h) Federal Register, Vol. 77, No. 43, Monday March 5, 2012, Notice of revocation of Technical Standard Orders (TSO) C–121 and C–121a, Underwater Locating Devices (ULD).

(i) SAE Aerospace Standard 8045 rev. A, Minimum Performance Standard for Underwater Locating Devices (Acoustic) (Self-Powered).

(j) Flight Data Recovery Working Group Report, available on the website of the French Bureau d’Enquêtes et d’Analyses under http://www.bea.aero/en/enquetes/flight.af.447/flight.data.recovery.working.group.final.report.pdf

(v) — RIA D: Very long detection range ULD for wreckage localisation in oceanic areas

1. Issues to be addressed

Note:

In this Regulatory Impact Assessment,

— the ULD with a very long underwater range is referred to as the **8.8 kHz ULD**. This type of ULD is currently not required by European air operation rules;

— the 37.5 kHz ULD attached to a crash-protected flight recorder is referred to as the **37.5 kHz ULD**. It can be a 37.5 kHz, 30-day transmission time ULD or a 90-day transmission time ULD.A 37.5 kHz that is currently required to be attached to all flight recorders by European air operation rules.

1.1. What is the issue and the current regulatory framework?

This proposal is intended to address the case of accidents over oceanic areas. When the aircraft wreckage is lying very deep, the signal of the flight recorder ULDs cannot not be detected from the sea surface. In addition, most of oceanic areas are out of range of ATM surveillance means, so that in the event of an accident in such an area, its location may be unknown or very inaccurate, and as a result the search area will be very large.

1.1.1. Root causes and drivers

There have been several accidents of large aeroplanes where the aircraft crashed over a very deep maritime area and the ULD signal could not be detected using detection means operated close to the sea surface. In some of these cases, the sea floor had, in addition, great variations in depth (steep slopes, cliffs and canyons), making it difficult to maintain a signal detection means in an optimal range of height above the seafloor.

In particular, the French Bureau d’Enquêtes et d’Analyses (BEA) was faced with exceptional difficulties when looking for the wreckage of the Airbus A330 of Air France registered F-GZCP that crashed into the Atlantic Ocean on 1 June 2009 (hereinafter referred to as the ‘AF 447’). As explained in the second interim report of this investigation:

‘The first difficulty is the remoteness of the zone, which requires transits of the order of two to four days from ports (…). The absence of any trace of the accident in the first days and absence of an emergency distress message and radar data complicated the searches.’

The search area was initially defined based on the airplane’s route and the last position contained in the ACARS messages emitted by the aeroplanes. This made an area with a radius of 40 nm, extending over more than 17 000 km^2 and located more than 500 nm from the coasts. Under these conditions, the ULD signal could not be located within 30 days. The search had to be continued in the absence of any signal. There were in total five search phases and almost two years elapsed before the aircraft wreckage was eventually located.

BEA tested at the occasion of these search operations several advanced underwater search means, among which some do not rely on a ULD signal: these are, for example, autonomous underwater vehicles (AUVs) and remotely operated underwater vehicles (ROVs): see Table D.1. Nevertheless, these means require operation by experts and can only be operated from a specialised vessel. In addition, the depth and the condition of the seafloor (rugged terrain, mud, sand) determines the most adequate means. In the worst case where only an ROV is appropriate, only a few square kilometres can be covered in a day.

Because of this, the underwater search operations can be very long, and the understanding of the causal factors of an accident will be accordingly delayed.

Table D.1: Comparison of underwater search means that can be used in the absence of a ULD signal.

Equipment	Seabed type	Ship type	Area coverage	Time needed to cover a 40 nm radius circular area
Towed SONAR	Relatively smooth	Consistent slow speed	100 km^2 per day	172 days = almost 6 months
Autonomous Underwater Vehicle (AUV)	Medium slopes	Escort	200 km^2 per day with 2 AUV's	86 days = almost 3 months
Remotely Operated Underwater Vehicle (ROV)	All	Dynamic positioning	5 km^2 per day	3 448 days = 9 years and 5 months

In order to address the difficulties experienced during the underwater search operations of the AF 447, BEA decided to create an international working group called 'Flight Data Recovery' in order to look into new technology to safeguard data and locate the wreckage. Based on the results of the Flight Data Recovery working group[25], BEA issued a safety recommendation to EASA and ICAO.

1.1.2. Reasons for action

This proposal is made for three reasons:

(a) Safety recommendation FRAN-2009-017, recommending that '*EASA and ICAO make it mandatory for aeroplanes performing public transport flights over maritime areas, to be equipped with an additional ULD capable of transmitting on a frequency (e.g. between 8.5 and 9.5 kHz) and for a duration adapted to the pre-localisation of the wreckage.'*

(b) The inclusion of a Standard into ICAO Annex 6 Part I, stating that aeroplanes of a maximum certificated take-off mass (MCTOM) of over 27 000 kg performing long-range overwater flights should, under certain conditions, be fitted with a ULD operating at a frequency of 8.8 kHz.

(c) Data gathered on historical accidents over water showing that, in some cases, a combination of a very large search area and a deep seafloor made it very difficult and expensive to locate the aircraft wreckage.

There is no implementation problem with the current regulation, as a requirement to carry an 8.8 kHz ULD does not exist neither in the former European air operation rules (EU OPS and JAR OPS 3) nor the new European air operation rules (Annexes to Commission Regulation (EU) No 965/2012). These European air operation rules are all designated together by the term 'OPS rules'.

1.1.3. Regulatory status

The current regulatory status is the following:

[25] The final report of the Flight Data Recovery working group can be consulted at http://www.bea.aero/en/enquetes/flight.af.447/flight.data.recovery.working.group.final.report.pdf .

(a) <u>ICAO Annexes</u>

ICAO Annex 6 Part I Amendment 36 is applicable since 15 November 2012 and contains the following Standard:

'6.5.3 All aeroplanes on long-range over-water flights

6.5.3.1 In addition to the equipment prescribed in 6.5.1 or 6.5.2 whichever is applicable, the following equipment shall be installed in all aeroplanes when used over routes on which the aeroplane may be over water and at more than a distance corresponding to 120 minutes at cruising speed or 740 km (400 NM), whichever is the lesser, away from land suitable for making an emergency landing in the case of aircraft operated in accordance with 5.2.9 or 5.2.10, and 30 minutes or 185 km (100 NM), whichever is the lesser, for all other aeroplanes:

(…)

c) at the earliest practicable date but not later than 1 January 2018, on all aeroplanes of a maximum certificated take-off mass of over 27 000 kg, a securely attached underwater locating device operating at a frequency of 8.8 kHz. This automatically activated underwater locating device shall operate for a minimum of 30 days and shall not be installed in wings or empennage.

Note.— Underwater Locator Beacon (ULD) performance requirements are as contained in the SAE AS6254, Minimum Performance Standard for Underwater Locating Devices (Acoustic) (Self-Powered), or equivalent documents.'

No similar provision was introduced into Annex 6 Part II (aeroplanes – international general aviation) or Annex 6 Part III (helicopters – international operations)

(b) <u>SAE Aerospace 6254</u>

SAE produces industry standards, which are referred to by several regulators, including the Agency. SAE published on 6 January 2012 the Aerospace Standard (AS) 6254 titled 'Minimum Performance Standard for Low Frequency Underwater Locating Devices (Acoustic) (Self-Powered)'. SAE specifications for the 8.8 kHz ULD are, among others:

— Operating Frequency: 8.8 ± 1 kHz.

— Repetition Rate: 1 pulse every 10 s as a minimum.

— Operating Life: 30 days or longer.

— Operating depth: up to 6 000 metres or deeper.

(c) <u>Actions taken by the Federal Aviation Administration</u>

FAA issued on 26 June 2012 a Technical Standard Order (TSO) on 'Airframe Low Frequency Underwater Locating Devices', numbered TSO-C200.

This TSO requires that new models '*meet the MPS qualification and documentation requirements in section 3 and 4 of SAE International's Aerospace Standard (AS) 6254, Minimum Performance Standard for Low Frequency Underwater Locating Devices (Acoustic) (Self-Powered)'*

(d) <u>Actions taken by the Agency</u>

The Agency's Executive Director Decision 2013/012/R of 12 July 2013 adopting amendment 8 of Decision 2003/10/RM (CS-ETSO) has introduced a new European Technical Standard Order (ETSO) C200 on Low-frequency Underwater Locating Device. The content of this ETSO is similar to FAA TSO-C200.

1.2. Safety risk assessment

The issue addressed by this assessment relates to the capability of a safety investigation authority to retrieve the evidence needed for conducting a proper investigation. Therefore, a risk assessment focussed on operational safety is not appropriate.

The risk to be assessed here is the risk for safety investigation authorities and aviation regulators to be unable to timely identify a hazard because they are missing the evidence of this hazard. In order for this risk to materialise, a number of events should occur in series:

(a) An accident over a deep maritime area has occurred to an aircraft;

(b) This accident bears a causal or contributing factor not yet identified by previous investigations and that can only be identified with some parts of the aircraft wreckage and/or the flight recorders; and

(c) The wreckage cannot be localised, making it impossible to identify this causal or contributing factor.

This scenario has come true in the case of the accident of the AF 447. When the aircraft wreckage could eventually be located after two years of sea search campaigns and the flight recorders were retrieved, new causal factors were identified that had not been considered before because of missing evidence.

Data on accidents of large aeroplanes that occurred over water for the last 40 years were collected. 37 occurrences were identified.

Three accidents out of 37 happened far away from the shoreline (> 180 nm) in areas where there is no radar coverage:

— a Boeing 707 operated by Varig and registered PP-VLU on 30 January 1979

— a Boeing 727 operated by Faucett Airlines and registered OB-1303 on 11 September 1990, and

— an Airbus A330 operated by Air France and registered F-GZCP on 1 June 2009.

In all three cases, the search area was very large. In the two older accidents, the wreckage was never located and no investigation report was published.

In addition, in 7 out of the 37 accidents, the wreckage was localised at a depth exceeding 1 000 m: see Table D.2.

— For the 2 accidents of Table D.2 with wreckage depth of 1 030 m and 1 200 m, the signal could be detected from the sea surface.

— For the 5 other accidents of Table D.2, the wreckage depth ranges from 1 440 m to 4 400 m and the signal was not detected using surface search means.

  - For the 2 accidents, it took more than 30 days to locate the wreckage. In both cases, the wreckage depth was 4 000 m or more, but other factors explain the time to locate the wreckage: inoperative ULDs in the case of B747 ZS-SAS and a remote and very large search area in the case of AF 447;
  - For the 3 other accidents, the wreckage was located in less than 30 days.

— For all accidents of Table D.2 except the accident of AF 447, the distance of the accident site to the next seashore was less than 180 nm. Excluding the case of the B747 registered ZS-SAS where the ULD were made inoperative by a fire, in all cases where the distance to the seashore was less than 180 nm, the ULD signal could be detected within 30 days.

In summary, the history of accidents of large transport aeroplanes over water shows that:

(a) There is on average one accident of a large transport aeroplane over water every year (37 accidents over 40 years, 13 in the decade 2000 to 2009) in the world.

(b) Beyond a depth of about 1 300 m, it was historically difficult to detect the signal of a 37.5 kHz ULD from the sea surface, and in that case more complex underwater search means had to be brought.

(c) In 6 out of 37 overwater accidents of large aeroplanes, the wreckage was lying very deep (more than 1 300 m depth) i.e. roughly 1 out of 6 accidents for which detection of a 37.5 kHz ULD signal was difficult from the sea surface. But it is not only the sea floor depth that makes the wreckage localisation a difficult task. The size of the search area can be a very challenging factor as well.

(d) When considering accidents into deep water with a distance to the seashore of less than 180 nm, the signal of the flight recorders ULDs, when emitted, was always detected less than 30 days after the accident time.

Table D.2: Accidents over water for which the wreckage was found to be lying at a depth exceeding 1 000 m

A/C Make and Model	Operator	Registration	Date	Location	Depth of the wreckage(m)	Distance to the shore (nm)	Number of days to locate the aircraft wreckage	Number of days to retrieve the CVR	Number of days to retrieve the FDR	Circumstances of the localisation of the wreckage and flight recorders
B707	Varig	PP-VLU	30 January 1979	Pacific Ocean Circa 200 nm East North East of Tokyo	Unknown, probably several thousands of metres	Unknown	Not located	Not retrieved	Not retrieved	The aircraft wreckage was never retrieved.
B747	South African Airways	ZS-SAS	28 November 1987	Mauritius, Indian Ocean	4 400	135	60	840	Not found	Poor weather conditions delayed the sea search operations. Temperature in excess of ULD environmental specifications made the ULD inoperative. Time to contract a company with special underwater search equipment and have it on site and operational.
B727	Faucett Airlines	OB1303	11 September 1990	Atlantic Ocean, 180 nm South-East of Newfoundland, Canada	Unknown	Not retrieved	Not located	Not retrieved	Not retrieved	The aircraft wreckage was never retrieved.
B757	Birgenair	TC-GEN	06 February 1996	Dominican Republic	2 200	A few nm (less than 5 minutes from take-off to crash)	Unknown	22	22	The accident occurred minutes after take-off and no particular problem with locating the wreckage is mentioned.
B737	Flash Airlines	SU-ZCF	03 January 2004	Sharm-el-Sheir, Red Sea	1 030	1	12	13	12	The ULD signal was detected from the sea surface. The CVR ULD was detached.
ATR72	Tuninte	TS-LBB	06 Aug	Palerm	1 440	12	13	23	24	The central section and the wings were found floating only 30

A/C Make and Model	Operator	Registration	Date	Location	Depth of the wreckage(m)	Distance to the shore (nm)	Number of days to locate the aircraft wreckage	Number of days to retrieve the CVR	Number of days to retrieve the FDR	Circumstances of the localisation of the wreckage and flight recorders
	r		2005	o, Mediterranean Sea						minutes after the accident. The location of the rest of the wreckage was determined by bathymetry, not based on ULD signals. ULD signals were detected from the surface after the general location of the wreckage had been established.
B737	Adam Air	PK-KKW	01 January 2007	Pare Pare, Indonesia	1 800	50	Unknown (less than 30 days)	240	240	ULD signals were not detected from the water surface, they were detected using a towed pinger locator (TPL). Nevertheless, it took eight months to get specialised underwater recovery equipment on-site.
A330	Air France	F-GZCP	01 June 2009	South Atlantic Ocean	4 000	600	662	692	690	Accident out of range of any ATC surveillance system and far away from any infrastructure. As a consequence, the search area was 17 000 km^2. TPLs were used in the first search phase, without success.
A310	Yemen Airways	7O-ADJ	30 June 2009	Comoros Islands, Indian Ocean	1 200	3	5	60	60	(No report published) The ULD signals were detected from the sea surface. Time to contract a company with special underwater search equipment and have it on-site and operational.

1.3. Who is affected?

1.3.1. Stakeholders

The affected stakeholders are :

— safety investigation authorities;

— the Agency and national aviation authorities; and

— aircraft operators of EASA Member States.

Difficulties in locating the aircraft wreckage after an accident over water delay or hinder the determination of the causes of this accident by safety investigation authorities. Without prior location of the aircraft wreckage, the flight recorders cannot be retrieved. In addition, parts of the aircraft usually need to be collected to confirm the findings made with the help of flight recorders.

The taking of appropriate corrective actions by the Agency and national aviation authorities is accordingly delayed.

Aircraft operators of EASA Member States would be affected by a new OPS rule requiring the installation of 8.8 kHz ULD on board aircraft.

1.3.2. Affected fleet

In order to determine the affected fleet, several aspects should be considered.

1.3.2.1. ULD detection range and depth of seas and oceans

The theoretical detection range of a 37.5 kHz ULD compliant with SAE AS 8045A is between 1 nm (1 900 m) and 1.6 nm (2 900 m) with a sea state 3. However, a more conservative detection range value of **1 500 m** (0.81 nm) is assumed for this type of ULD because it better reflects historical underwater search operations (see 2.2), as well as the variability of factors, such as emission power, underwater propagation, attenuation, reflections, background noise (of sea and ships), hydrophone sensitivity and directivity, signal processing techniques, etc. Assuming a detection range of 1 500 m, the detection of the 37.5 kHz ULD signal from the sea surface would become difficult for any depth greater than **1 300 m**: see Annex C.

With the same assumptions, the theoretical detection range of an 8.8 kHz ULD compliant with SAE AS6254 is between 5.8 nm (10 700 m) and 7.2 nm (13 300 m). The detection range value adopted in the rest of the document is the most conservative: 5.8 nm i.e. **10 700 m**. However, the pressure test prescribed by SAE AS6254 only requires that the 8.8 kHz ULD is exposed to an external pressure corresponding to a water depth of 6 096 m (20 000 ft). Therefore, it is not assumed that the 8.8 kHz would work at a depth greater than 6 000 m.

When considering the world oceans, large parts of the ocean floor are at much greater depths than 1 300 m (see figure 1). However, only a small area of the ocean floor has a depth exceeding 6 000 m.

1.3.2.2. Tracking of aircraft by ATM ground surveillance means

The problem of locating an aircraft wreckage after an accident over water can be decomposed in:

— an 'aerial segment' (locating the position of the impact point with water to some accuracy, in order to be able to delimit a search area), and

— an 'underwater segment' (locating the wreckage on the sea floor inside the search area).

These two components are interdependent, i.e. less accuracy on the position of the impact causes a larger area for underwater search operations.

Most of the traffic flying over Europe, including its seas, is monitored by air traffic management (ATM) ground surveillance means such as secondary surveillance radars (SSR) or Mode S radars[26]. This means that the trajectory of an aircraft flying over Europe with its transponder on is tracked at all times by ATM. The location of the accident can be determined with sufficient accuracy and the search area can be limited to a size that does not justify the fitment of an 8.8 kHz ULD.

Therefore, there is an issue only for medium-range and long-range aeroplanes flying over oceans. These are primarily large aeroplanes. Small aeroplanes have shorter ranges and, therefore, are less likely to fly over deep maritime areas and out of reach of ATM ground surveillance means.

Even when considering large aeroplanes, a large part of the traffic is taking place over Europe. Only those large aeroplanes flying out of range of ATM ground surveillance are affected. The proposed criterion to determine if an aircraft is in the range of ATM ground surveillance or not is the distance to the next seashore, as ATM ground surveillance means are installed on firm land.

For example, **a distance threshold value of 333 km (180 nm)** to the next seashore seems adequate, for the following reasons:

— the usual range of ground surveillance means is higher; and

— ground surveillance means are detecting aircraft in line of sight. Assuming a ground sensor located at an altitude of 100 m or higher, all aircraft at 180 nm from this ground sensor that are flying at an altitude higher than 23 000 ft would be above the horizon, therefore, detectable by this ground sensor;

— large aeroplanes reach an altitude of 23 000 ft in significantly less than 180 nm, even where their climb performance is reduced; and

— installing a ground sensor at low altitude and close to the coastline is not favourable for detecting traffic flying far away. Actually, SSRs are often located deeper in the hinterlands and at a higher altitude (several hundreds of metres, in some cases more than 1 000 metres) and have a better line-of-sight visibility.

Hence, the problematic fleet is those large aeroplanes operated far away from any sea shore and, therefore, out of reach of ATM ground surveillance.

1.3.2.3. Accident localisation outside of ATM ground surveillance areas

An aircraft equipped with a robust means to determine its location in the case of an accident, wherever it occurs, would not need be fitted with an 8.8 kHz ULD. Several solutions have been identified by the Flight Data Recovery working group to determine the location of the impact point with the Earth surface within 4 or 6 nm accuracy[27]. These are:

(a) a regular transmission of aircraft position (every minute or so);

(b) the transmission of aircraft position upon detection of an emergency situation;

(c) the emission of an Emergency Locator Transmitter (ELT) signal triggered by detection of an emergency situation (prior to impact);

(d) an automatic deployable ELT; and

(e) a deployable flight recorder integrated with an ELT.

[26] Typically, the range of an en route SSR is 250 nm (line-of-sight) and its rotation period is 12 s or shorter.

[27] For example, assuming that the position of the accident is known with an accuracy of 6 nm, the search area would be a circular area with a radius of 6 nm and it could be covered within a few days of continuous search operation. ICAO Flight Recorder Panel (FLIRECP) determined during their meeting in 2011 that 6 nm was an appropriate accuracy for locating the point of contact with water. ICAO FLIRECP submitted to ICAO Air Navigation Commission a draft Standard to require that future large aeroplanes operated for commercial air transport are equipped with a means to locate the position of an accident over water within 6 nm.

Unlike 8.8 kHz ULDs, these solutions would also help for accidents over remote land areas and they would facilitate the search and rescue operations. However, it must be noted that of the four solutions listed above, only the first is available to this date but its operating cost are high and it would claim a high bandwidth if applied to all aeroplanes performing long-range overwater flights, as pointed in the Work Package 2 report of OPTIMI on the implementation feasibility of oceanic flight tracking service[28]. In addition, deployable ELTs have raised concerns about the reliability of their crash-detection sensors.

Note 1:

The current models of automatic fixed ELT mandated on aeroplanes cannot be considered a reliable means to locate an accident over water. This is because, often the ELT is damaged by the impact, the link from the ELT to the ELT antenna is damaged, the antenna is damaged or pieces of wreckage mask the antenna emission[29]. The solutions 3 and 4 identified by the Flight Data Recovery working group were meant to address these limitations of current ELT models.

Note 2:

Helicopter accidents have revealed many cases of unintended deployment or missed deployment of automatic deployable ELTs. They have diverse causes, among which the use of negative acceleration sensors ('g' switches) for detecting the impact. Several cases of premature end of recording with flight recorders installed on board aeroplane and helicopters involved in accidents have also raised concern about the reliability of 'g' switches[30]. This is why EUROCAE Document 112 (Minimum Operational Performance Specifications for crash-protected airborne recorder systems) specifies that impact sensors of an automatic deployable flight recorder should be designed such that they will only trigger when the structure has been significantly deformed and that negative acceleration sensors should not be used as sole means of detection.

Following the results of the Flight Data Recovery working group, BEA made the following recommendation to ICAO and the Agency:

— FRAN-2009-018: 'The BEA recommends that EASA and ICAO study the possibility of making it mandatory for airplanes performing public transport flights to regularly transmit basic flight parameters (for example position, altitude, speed, heading).'

Following additional work performed by the Triggered Flight Data Transmission working group[31], BEA made two additional safety recommendations:

— FRAN-2011-017: 'The BEA recommends that EASA and ICAO make mandatory as quickly as possible, for airplanes making public transport flights with passengers over maritime or remote areas, triggering of data transmission to facilitate localisation as soon as an emergency situation is detected on board.'

— FRAN-2011-018: 'The BEA recommends that EASA and ICAO study the possibility of making mandatory, for airplanes making public transport flights with

[28] Refer to OPTIMI Lot 1, Work Package 2 Report – Implementation feasibility of the OPTIMI Flight Tracking Service.

[29] For more information on missed activations of ELT, consult for example Australian Transportation Safety Board Study titled 'A review of emergency locator transmitters in aviation accidents', dated May 2013.

[30] Refer to the investigation reports of the following occurrences : accident of a Sikorsky S-61N registered G-BEWL on 25/07/1990, accident of a Eurocopter AS332 registered G-TIGK on 19/01/1995, accident of a Eurocopter AS332 registered G-BWZX on 12/12/1997, accident of a Sikorsky S76 registered G-BMAL on 12/07/2001, Accident to Bombardier BD700, registration VP-CRC, on 29/01/2008, accident of a Sikorsky S92 registered C-GZCH on 12/03/2009, accident of a Eurocopter AS332 registered G-REDL on 01/04/2009.

[31] The report of the Triggered Transmission of Flight Data working group can be consulted at http://www.bea.aero/en/enquetes/flight.af.447/triggered.transmission.of.flight.data.pdf

passengers over maritime or remote areas, the activation of the emergency locator transmitter (ELT), as soon as an emergency situation is detected on board.'

These three safety recommendations aim at improving the localisation of an accident in oceanic and remote land areas. They are currently under consideration at ICAO and the Agency.

1.3.2.4. Conclusion on the affected fleet

Based on the considerations of this section, the affected aircraft are mainly:

(a) large aeroplanes,

(b) operated over routes that go far away from any seashore (for example more than 180 nm), so that it is likely that they fly out of reach of ATM ground surveillance means, and

(c) that are not fitted with a reliable means to determine, in the case of an accident, the location of the impact point with the Earth surface within a few nautical mile accuracy.

The size of this fleet is cannot be determined accurately. However, according to Ascend aircraft and airlines data of year 2012, there are around 6 000 aeroplanes with an MCTOM exceeding 27 000 kg that are registered in EASA Member States. Among those, around 600 are of long-range model such as Airbus A330, A340, A380, Boeing B747, B777 and B787. Hence, the fleet size is comprised between 600 and 6 000 aircraft.

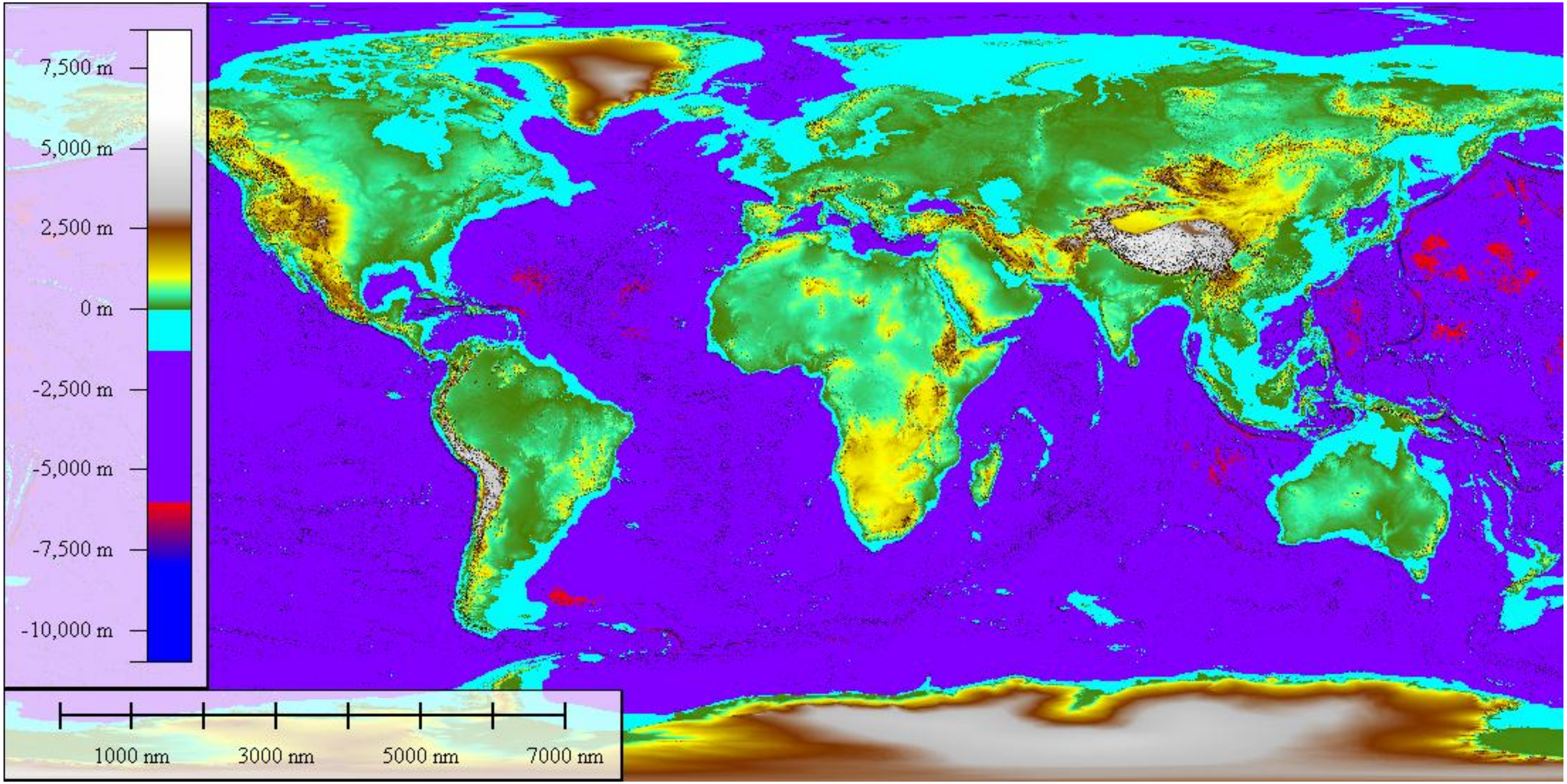

Figure 1: world bathymetry plot.

The maritime areas in light blue indicate a depth of less than 1 300 metres, the maritime areas in dark blue indicate a depth comprised between 1 300 m and 6 000 m and the maritime areas in red indicate a depth of more than 6 000 m
(Source: The General Bathymetric Chart of the Oceans (GEBCO), One Minute Grid, version 2.0, http://www.gebco.net).

1.3.3. Relevance of applicability criteria in the ICAO Standard on 8.8 kHz ULD

It is noteworthy that the new Standard of ICAO on 8.8 kHz ULD has been introduced in section 6.5 of ICAO Annex 6 Part I. This section is not meant for locating aircraft wreckage under water, but for increasing the chance of survival of aeroplane occupants after a survivable accident or a forced landing over water.

In particular, the higher distance values of paragraph 6.5.3.1 of ICAO Annex 6 Part I (120 minutes at cruising speed or 400 nm, whichever is the lesser) are applicable when the aeroplane is capable of continuing the flight to an aerodrome with one or several engines inoperative. Otherwise, the distance values to apply are 30 minutes at cruising speed or 100 nm, whichever is the lesser.

Hence, the distance values in paragraph 6.5.3.1 of ICAO Annex 6 Part I are determined based on the likelihood that a forced landing over water would be needed after an engine failure, and not based on considerations such as ATM ground surveillance coverage or size of the search area.

Therefore, the criteria of paragraph 6.5.3.1 of ICAO Annex 6 Part I are considered not relevant when deciding if an aeroplane should be equipped with an 8.8 kHz ULD. Instead, criteria based on the assessment made in section 2.3.2 of this RIA are preferred.

1.4. How could the issue/problem evolve?

In case no further action is taken by the Agency, the approval of 8.8 kHz ULD will be facilitated by the issuance of EASA ETSO-C200 when an aircraft operator wants to comply with ICAO on a voluntary basis. But there will be no obligation to install an 8.8 kHz ULD for aircraft operators of EASA Member States.

This problem needs to be addressed by the Agency which is responsible for the OPS rules according to the Basic Regulation. European aircraft operators have no incentive to install 8.8 kHz ULDs: this piece of equipment is only meant to facilitate the retrieval of the wreckage after an accident and it does not bring any operational benefits.

2. Objectives

The overall objectives of the Agency are defined in Article 2 of the Basic Regulation.

This proposal will contribute to the overall objectives by addressing the issues outlined in Section 2. The specific objective of this proposal is, therefore, to facilitate the localisation of the aircraft wreckage after an accident over a very deep maritime area when the location of the accident is not known.

3. Policy options

Table D.3: Selected policy options

Option No	Description
0	Baseline option (No change in rules; risks remain as outlined in the issue analysis)
1	Mandate that the ULDs of crash-protected flight recorders fitting aeroplanes operated for commercial air transport have an underwater transmission time of 90 days by 1 January 2020. (covered by Option 3 of RIA C on underwater transmission time of the flight recorder underwater locating device)
2	Mandate that aeroplanes that: — have an MCTOM of over 27 000 kg, — are operated for commercial air transport, — perform long-range overwater flights, — were first issued with an individual Certificate of Airworthiness (CofA) on or after 1 January 2005, and — are not equipped with a reliable means to determine, in case of an accident, the location of the impact point with the Earth surface within 6 nm accuracy, are equipped by 1 January 2019 with an 8.8 kHz ULD.

<u>Option 0</u> consists in not introducing any requirement that would facilitate the localisation of the wreckage after an accident over water. Option 0 excludes as well the extension of the transmission time of ULDs fitting crash-protected flight recorders to 90 days. Option 0 only relies on the technological development of means to locate objects on the seafloor in the absence of a signal. These means include towed side-scan sonar, autonomous underwater vehicles (AUV) or remotely operated underwater vehicle (ROV).

<u>Option 1</u> foresees the replacement of all 37.5 kHz ULDs fitting crash-protected flight recorders by 37.5 kHz ULDs with a transmission time of 90 days. Option 1 corresponds to Option 3 in RIA C on transmission time of the flight recorder ULD. Tripling the transmission time of crash-protected flight recorders ULDs from 30 days to 90 days would already allow for searching a larger area before the ULD signal fades out.

<u>Note:</u>

RIA C on transmission time of the flight recorder ULD addresses the issue of the insufficient transmission time of 37.5 kHz ULDs. This transmission time, which is usually 30 days, was found at several occasions to be too short, mainly because of the time needed to bring experts and specialised search equipment on-site, and of adverse sea conditions that delay the search operations. RIA C concludes that the best solution is to mandate in the OPS rules that 'the ULDs of crash-protected flight recorders fitting any kind of aircraft have an underwater transmission time of 90 days'.

Option 2 consists in:

(a) adding a provision to paragraph CAT.IDE.A.285 'Flight over water' in Part CAT of the OPS rules[32] in order to mandate that an aeroplane operated for commercial air transport with an MCTOM exceeding 27 000 kg and first issued with an individual CofA on or after 1 January 2005 be fitted no later than 1 January 2019 with an 8.8 kHz ULD compliant with SAE AS6254 unless:

(1) the aeroplane is not used over routes on which it is at any point at a distance of more than 333 km (180 nm) from the next shore, or

(2) the aeroplane is equipped with a reliable means to determine, following an accident, the location of the impact point with the Earth surface within 6 nm accuracy, such as those described in 1.3.2.3;

(b) creating an AMC to this new requirement to define the performance and location of the 8.8 kHz ULD; and

(c) creating a second AMC to this new requirement to define the performance of the means to determine the location of the impact point within 6 nm accuracy, when this alternate solution is elected, and list acceptable technologies.

Note 1:

An option identical to Standard 6.5.3.1 c) of ICAO Annex 6 Part I is not proposed here, because the flight distance and flight time criteria applicable to the carriage of survival equipment are not considered appropriate for 8.8 kHz ULD (see section 2.2.3). Instead, Option 2 was developed based on the assessment made in 2.2.2. Option 2 is considered to address the intent of ICAO Standard 6.5.3.1 c).

Note 2:

As explained in 2.3.2.3, most current models of fixed ELT installed on legacy aircraft would not qualify as a reliable means to determine the location of the aircraft after an accident, because historical data have shown that often they do not emit after an accident over water.

4. Data and methodology

Refer to Appendix M.

5. Analysis of impacts

5.1. Safety impact

The consequences of not being able to retrieve pieces of evidence should not be underestimated. Some safety issues cannot be identified as long as the aircraft wreckage is not retrieved. In the case of AF 447, it took two years before the flight recorders could be eventually recovered and downloaded, revealing unsuspected safety issues, such as related to flight crew training, cruise relief pilot, flight simulators, cockpit ergonomics, etc.

A delay of several days or weeks in identifying a significant safety risk might be acceptable to the Agency, depending on the nature of this risk. A delay of several years is not acceptable in any case. Therefore, it is essential to ensure that the timeframe to locate the aircraft wreckage after an accident of a large aeroplane over water is improved.

5.1.1. Option 0

Assuming no change to the current OPS rules is made, there will be more accidents for which the Agency or an EASA Member State is involved (as State of Occurrence, State of

[32] Part CAT contains the OPS rules applicable to aircraft operated for commercial air transport. It is Annex IV to Commission Regulation (EU) No 965/2012.

Registry , State of Design, State of nationality of victims) and where locating the wreckage is very difficult. While accidents of large aeroplanes over very deep maritime areas are not frequent (6 accidents in the last 40 years), the consequences of not finding the wreckage can be very serious (see above)

5.1.2 Compared effectiveness of options 1 and 2

The extension of the transmission time of the crash-protected flight recorders ULDs to 90 days would already allow covering a large area. In addition, when the seafloor is very deep, a sensor towed by a vessel can be brought less than 1 300 m above the seafloor to allow for the detection of the 37.5 kHz signal. Such a sensor is usually called a towed pinger locator (TPL).

When comparing the area that could be covered by search means in the case of a 37.5 kHz, 90-day transmission time ULD and in the case of an 8.8 kHz ULD, it is important to take into account real-life circumstances that reduce the actual time left to detect a ULD signal:

— Searching for a ULD signal requires preparation and bringing a team with adequate detection means to the search area. Usually one or several ships will be needed to support the search operations. It frequently takes days to get underwater search operations ready to start.

— Nevertheless, historical data show that after most accidents of large aeroplanes over water, one or several navies had ships and aircraft in the accident areas within one day after the accident, to assist search and rescue operations and/or underwater search operations. 8.8 kHz is in the frequency range of navies' sonars and navies' sonobuoys but 37.5 kHz is not.

— The search operations can only be conducted if the sea surface is calm enough. Greater sea state values than 3 make underwater search operations more difficult[33]. Historical data show that adverse sea state conditions have often significantly delayed underwater search operations.

Therefore, it is not considered realistic to assume that the underwater search team will be able to take advantage of every hour of the theoretical transmission time of a ULD. It is proposed that 10 days are needed to get the search team on site and ready to work in the case of a 37.5 kHz ULD and only 2 days in the case of an 8.8 kHz ULD, as in the second case, one can assume that one or several navies will have deployed means in the area hours after the accident. It is also assumed that only every other day offers favourable sea surface conditions. Finally, it is assumed that underwater search operations are conducted round-the-clock in the remaining time.

With these assumptions, the time left to detect the signal would be:

— (30-2)/2= **14 days** in the case of an 8.8 kHz, 30-day transmission time ULD;

— (30-10)/2 = **10 days** in the case of a 37.5 kHz, 30-day transmission time ULD; and

— (90-10)/2= **40 days** in the case of a 37.5 kHz, 90-day transmission time ULD.

Annex C provides numerical examples for the area that can be covered by underwater search means during the transmission time of a 37.5 kHz ULD or an 8.8 kHz ULD. For comparison:

— The area covered in the case of a 37.5 kHz, 90-day transmission time ULD would be 13 578 km^2 if the height of the TPL above the sea floor is 500 m, and 7 185 km^2 if this height is 1 300 m (7 185 km^2 corresponds to a circular area with a radius of 48 km).

— The area covered in the case of an 8.8 kHz, 30-day transmission time ULD, would be 35 916 km^2 if the height of the TPL above the sea floor is 500 m, 35 689 km^2 if

[33] Sea state 3 corresponds to wave height from 0.5 m to 1.25 m.

this height is 1 300 m, and 29 770 km^2 if this height is 6 000 m (29 770 km^2 correspond to a circular area with a radius of 97 km).

Hence, in the case of an 8.8 kHz ULD, the height above the seafloor has limited influence on the area covered: there is only a 20 % difference in the area between the case of a height of 500 m and the case of a height of 6 000 m. In any case, the area is much larger than in the case of a 37.5 kHz, 90-day transmission time ULD.

In addition, when the seafloor is very deep, kilometres of cable need to be deployed to bring the TPL less than 1 300 metres above the seafloor[34]. A cable with a length of several kilometres takes hours to turn through 180 degrees for the TPL to be correctly aligned behind the tow vessel for the start of each track. Moreover, when the terrain is rugged with great variations in depth, it is difficult to maintain the TPL in an adequate range of height above the seafloor.

By comparison, in the case of an 8.8 kHz ULD, it would be sufficient to tow the detection means with a cable of a few tens of metres.

Hence, a 37.5 kHz, 90-day transmission time ULD is not as effective a solution as an 8.8 kHz ULD when the seafloor is deep and the search area is very large. However a 37.5 kHz, 90-day transmission time ULD would complement the 8.8 kHz ULD and facilitate the retrieval of the flight recorders.

Therefore, while Option 1 would have a positive impact on timely retrieval of the wreckage, Option 2 would be a significantly more robust and effective solution.

5.1.3. Conclusion

Table D.4: Comparative safety impact of options

	Option 0	**Option 1**	**Option 2**
Safety impact	**0** (does not address the safety issue)	**+** (slight improvement)	**+++** (significant improvement)

5.2. Environmental impact

Option 0

No impact.

Option 1:

No impact: the weight of a 90-day ULD is similar to the weight of a 30-day ULD, so that no increase in fuel consumption would be caused by the introduction of 90-day ULDs.

Option 2:

Two ULD manufacturers were surveyed during the drafting of SAE AS6254 on the weight and size factor they could achieve for the 8.8 kHz ULD. The ULD weight is expected to be in the range 0.7 kg to 3.7 kg. Adding the weight of the ULD mounting kit, the installed ULD would only add a few kilograms and, therefore, not increase sensibly the average aircraft fuel.

[34] There is approximately a 3 to 1 ratio between the cable length and the TPL depth.

Table D.5: Comparative environmental impact of options

	Option 0	Option 1	Option 2
Environmental impact	**0**	**0**	**0** (negligible increase in fuel consumption)

5.3. Social impact

No social impact is foreseen.

5.4. Economic impact

5.4.1. Option 0

The cost of underwater search operations depends on their duration, which in turn depends on the nature of the seafloor, the depth and the size of the area to explore (see section 2.1.1 and Table D.1.

For example, if only a ROV is appropriate to explore the seafloor, it cannot cover more than a few square kilometres per day, while its average daily cost is around EUR 130 000. (Source: BEA, based on 12 underwater search operations). In addition, such a vehicle needs to be operated from a ship equipped with dynamic positioning systems. The rental of such a ship is also very expensive.

For these reasons, underwater search operations over deep maritime areas may claim several millions of Euros to several tens of millions of Euros (for example in the case of AF 447) before the wreckage is located.

However, considering that only 6 accidents of large aeroplanes over deep maritime areas occurred in 40 years globally, they can be considered seldom events.

For instance assuming that such an accident occurs every 5 years and the cost of locating the wreckage is EUR 30 000 000 (average cost of the underwater search operations of AF 447, most of it being spent in looking for the wreckage), that’s an annual cost of EUR 6 000 000. Assuming that EASA Member States operators represent one quarter of flights performed over oceanic areas, the annual cost of the baseline option would then be **EUR 1 500 000.**

5.4.2. Option 1

The cost of Option 1 per individual aircraft is expected to be less than EUR 840. The total cost for the fleet would be **EUR 12 100 000** when considering all aircraft required to carry a flight recorder and EUR 7 400 000 when considering aeroplanes operated for commercial air transport, as computed for Option 2 and Option 3 of RIA C on transmission time of the flight recorder ULD.

Option 1 would not generate savings for underwater search operations compared to Option 0, as Option 1 does not provide for a faster localisation of the flight recorder signal, but only for a longer availability of this signal.

5.4.3. Option 2

5.4.3.1. ULD purchase price

8.8 kHz ULDs compliant with SAE AS6254 are under development. In order to get a price assessment, two equipment manufacturers developing models of 8.8 kHz ULD were asked to estimate a unit price (including the mounting kit and the battery) if it was to be produced in large quantities. Two assumptions were submitted to them:

(a) Between 250 and 400 units produced[35]: this range corresponds to the cumulated number of Airbus A330, A340, A380, Boeing B747, B777 and B787 operated by aircraft operators located in EASA Member States, and manufactured since 2000 (400 aeroplanes) or since 2005 (250 aeroplanes). These are the most common models of long-range aircraft.

(b) Between 2 800 and 3 800 units produced: this range corresponds to the number of aeroplanes with an MCTOM exceeding 27 000 kg and operated by operator located in EASA Member States, and manufactured since 2000 (3 800 aeroplanes) or since 2005 (2 800 aeroplanes) estimated in January 2013. Not all of these aeroplanes are used for performing transoceanic flights: a large proportion of them are used only for short-haul flights inside Europe or for flights to Africa or Asia. If they don't fly further than 180 nm from seashores they would not be required to be fitted with an 8.8 kHz ULD.

Table D.6 presents the rough unit price estimates made by these ULD manufacturers.

Table D.6: Rough unit price estimates for an 8.8 kHz, SAE (AS) 6254 compliant ULD (in Euros)

Number of units produced	Rough unit price estimate
Between 250 and 400 units	Between EUR 3 400 and EUR 4 000
Between 2 800 and 3 800 units	Between EUR 1 900 and EUR 3 000

5.4.3.2. Other costs

Non-recurring cost

In the case of a forward-fit, for the affected aircraft that are still in production, the non-recurring cost (design, documentation and certification) can be distributed over the aircraft manufactured over several years.

In the case of a retrofit, the change is developed only for the existing fleet. In case of a large fleet of the same aircraft model, the non-recurring costs are shared over this fleet and the situation is similar to the forward-fit case. However, for aircraft models with a small fleet, the non-recurring cost is distributed over a small number of aircraft and then the individual cost is higher. For example, assuming that only 10 aircraft of a given aircraft model are still operated, then 1/10 of the non-recurring cost is supported by each individual aircraft.

Recurring cost

The recurring cost is identical in the case of a retrofit and a forward-fit. The recurring cost encompasses:

— purchase cost of the unit and its mounting kit: this cost varies with the number of units produced;

— cost of physically performing the installation: this cost is expected to be limited, given that the 8.8 kHz ULD is a small, light and stand-alone piece of equipment. Not more than a few man-hours are expected to perform the installation;

— maintenance cost associated with replacing the ULD battery (periodicity of the order of 5 or 6 years) and checking the ULD serviceability; and

— increase in fuel consumption due to added weight. Given that the 8.8 kHz ULD is a light piece of equipment, the increase in fuel consumption is negligible.

[35] The source of fleet numbers in section 6.4.3.1 is Ascend aircraft and airlines data, year 2012.

5.4.3.3. Cost distribution

An example of distribution of cost is presented in Table D.7. Figures are not accurate, they should only be considered as cost order of magnitude.

In this example:

— The initial cost for every aircraft equipped can be split into:

- non-recurring cost (documentation and certification), amounting for 3 200 + 600 = EUR 3 800, to be divided by the number of aircraft sharing this cost; and
- equipment purchase and installation cost ranging from (1 900 +400) = EUR 2 300 to (4 000 + 400) = EUR 4 400, depending on the number of units produced.

— The maintenance and operation cost is considered negligible.

Hence, except in the case where the non-recurring cost is shared among very few aeroplanes of the same model, most of the initial cost corresponds to the ULD unit price. Given the average operating life of large aeroplanes (about 25 years), it can be assumed that aeroplanes of a model manufactured less than 10 years ago are for a large part still operated, so that the non-recurring cost could be shared over a fleet of several tens or hundreds of aeroplanes. For example, considering 40 aeroplanes of the same model, the non-recurring initial cost per individual aeroplanes would be 3 800/40 ≈ EUR 100.

With those assumptions, **the initial cost per individual aeroplane is expected to be between EUR 2 400 and EUR 4 500.**

In the most expensive case, the 8.8 kHz ULD is fitted on all aeroplanes with an MCTOM exceeding 27 000 kg, manufactured since 2005 and operated by operators located in EASA Member States and its unit price is EUR 3 000 (see Table D.6), so that the individual initial cost is 3 000 (unit price) + 400 (installation cost) + 100 (non-recurring cost) = EUR 3 500. The size of this fleet is assumed to be 2 800 aircraft on 1 January 2013. Assuming that the size of this fleet remains constant until 1 January 2019, **the total cost for retrofit would amount to 2 800 × 3 500 = EUR 9 800 000 for the period from 2015 to 2018.** Assuming the same unit cost, and that 200 new aeroplanes are added every year to this fleet, **the annual cost would amount to 200 × 3 500 = EUR 700 000 every year after 2018.**

It is expected that an 8.8 kHz ULD would make the localisation of the aircraft wreckage much faster, and, therefore, significantly decrease the cost of the first phase of the underwater search operations for the states involved. It is proposed to translate this benefit into a decrease of the annual search cost from EUR 1 500 000 to EUR 300 000 (five times less time and, therefore, cost for locating the aircraft wreckage). This corresponds to savings of EUR 1 200 000 for EASA Member States every year as of 1 January 2019.

Table D.7: Example of distribution of cost when fitting an aeroplane with an 8.8 kHz ULD

Cost line	Recurrence of cost	Order of cost	Comment
Design and documentation cost (Installation drawing, Installation Instructions, Maintenance Instructions, AFM)	Once per aircraft model	4 pages * EUR 800 (USD 1 000) = EUR 3 200	Assuming 4 pages of documentation
Certification fees (Minor Change)	Once per aircraft model	EUR 600	This would probably be a Minor Change. EASA Fees are 564 euros per Minor Change.
Equipment purchase (ULD, battery, mounting kit)	Once per individual aircraft	EUR 1 900 to EUR 4 000	Unit price range (the unit price being conditioned by the number produced)
Implementation of change (installation of ULD)	Once per individual aircraft	5 man-hours * EUR 80 (USD 100) = EUR 400	This operation is expected to be easy to perform, given the size and weight of an 8.8 kHz ULD. The aircraft immobilisation time is not taken into account, as it is assumed that this task could be performed during a heavy maintenance check.
Maintenance cost	Every year, for each individual aircraft	(EUR 230 for a battery + 1 man-hour * EUR 80 / 5 years = 60	Periodic change of the battery every 5 or 6 years
Fuel consumption cost	Every flight cycle, for each individual aircraft	Not quantified	The ULD (including battery and mounting kit) would weigh a few kilograms, and, therefore, it would not significantly impact the fuel consumption.

5.4.4. Conclusion

- The long-term cost of Option 0 is estimated of the order of EUR 1 500 000 per year. It is mainly supported by safety investigation authorities, which usually rely on national subsidies.
- The initial cost of Option 1 would be between EUR 420 and EUR 840 per individual aircraft and the total cost for the fleet would be EUR 12 100 000 in the most expensive case (cost supported by EASA Member State operators of aircraft carrying flight recorders, encompassing aeroplanes and helicopters alike, short-range and long-range).
- The initial cost of Option 2 would be between EUR 2 400 and EUR 4 500 per individual large aeroplane and in total EUR 9 800 000 in the most expensive case for the period 2015 to 2018, and EUR 700 000 after 2018 (cost supported by EASA Member State operators of large aeroplanes performing long-range overwater flights).
- The initial cost of Option 2 and Option 1 for an EASA Member State operator of large aeroplanes performing long-range overwater flights add up to an amount per

aeroplane comprised between 2 400 + 420 ≈ **EUR 2 800** and 4 500 + 840 ≈ **EUR 5 300**. The long-term cost would be very little.

— The long-term savings for EASA Member States on underwater search operations would be EUR 1 200 000.

Table D.8: Comparative economic impact of options

	Option 0	**Option 1**	**Option 2**
Overall economic impact (cost of equipment, no quantified benefits)	Supported by EASA Member States: Underwater search cost = 1 EUR 500 000 every year	Supported by aircraft operators: Total fleet cost for 2015-2018: up to EUR 12 100 000 (between EUR 420 and 840 per individual aircraft) After 2018: No saving compared to Option 0	Supported by aircraft operators: Total fleet cost for 2015-2018: EUR 9 800 000 (between EUR 2 400 and EUR 4 500 per individual aeroplane) Total fleet cost after 2018: EUR 700 000 per year Savings of EUR 1 200 000 on underwater search operations after 2018 for EASA Member States
Economic impact score	**0**	**–**	**–/+**

5.5. Proportionality issues

5.5.1. Option 0

No impact.

5.5.2. Option 1:

Given the limited cost of introducing 90-day ULDs, any option would have a limited impact on small operators and on general aviation. See RIA C on 'Transmission time of the flight recorder ULD'. The impact of Option 1 is, therefore, neutral.

5.5.3. Option 2:

The proposed installation of the 8.8 kHz ULD would only affect aeroplanes with an MCTOM over 27 000 kg and operated for commercial air transport. Lighter aeroplanes and helicopters that do not usually fly far away from land would not be affected.

Among the large aeroplanes, only those which operate on routes more than 180 nm away from land and are not equipped with a means to locate them in case of an accident within 6 nm accuracy would be required to be fitted with an 8.8 kHz ULD. To this date, there is none or very few equipped with a means to locate them within 6 nm accuracy in case of an accident.

Also, not all of those aeroplanes would need to be retrofitted. Only the aeroplanes first issued with an individual CofA after 2005 would be affected, because they are likely to be operated for a long time after an 8.8 kHz ULD is installed.

Hence, the impact on proportionality of Option 2 can be considered as positive.

5.5.4. Conclusion

Whichever the option, the impact on the proportionality issues would be negligible.

Table D.9: Comparative impact on proportionality issues

	Option 0	Option 1	Option 2
Proportionality issues	**0**	**0**	**+**

5.6. Impact on regulatory coordination and harmonisation

5.6.1. Foreseeable implementation issues

Option 0:

No impact.

Option 1:

Given the large number of aircraft potentially impacted, the supply of 90-day ULDs may not meet the demand if the timeframe for implementation is too short. Therefore, an interval of several years between the time of publication and the time of applicability is recommended.

See RIA C on 'Transmission time of the flight recorder ULD'.

Option 2:

At least two manufacturers intend to produce models compliant with ETSO-C200 in 2013 or 2014. Given that the 8.8 kHz ULD is expected to be a small, light and stand-alone piece of equipment, no particular difficulty with regard to installing it in the central section of a large aeroplane is expected.

However, as this task may require a few hours of work, it should be performed during a heavy maintenance check to avoid aircraft immobilisation cost. Therefore, the timeframe for performing the installation should take into account the usual cycles for heavy maintenance checks.

5.6.2. Risk of conflict with other legislation or national action

Whichever the option, it would not affect another regulation or legislation.

Option 1:

There is no danger of duplication at national level, as Commission Regulation (EU) No 965/2012 will have entered into force in all EASA Member States by 28 October 2014. Any mandatory replacement of 30-day ULDs by 90-day-ULDs would be effective after this date, i.e. when the new OPS rules are applicable in all EASA Member States.

See RIA C on 'Transmission time of the flight recorder ULD'.

Option 2:

There is no danger of duplication at national level, as Commission Regulation (EU) No 965/2012 will have entered into force in all EASA Member States by 28 October 2014. Any requirement to equip of large aeroplanes with an 8.8 kHz ULD would be effective after this date, i.e. when the new OPS rules are already applicable in all EASA Member States.

5.6.3. Impact on Member States' obligations towards ICAO

Options 0 and 1:

The EASA Member States will not be in compliance with Standard 6.5.3.1 c) of ICAO Annex 6 Part I.

Option 2:

The EASA Member States will not be fully compliant with Standard 6.5.3.1 c) of ICAO Annex 6 Part I, as the conditions on the distance to the seashore and on the date of applicability are different (see 2.3.3). However, the intent of this Standard will be met.

5.6.4. Conclusion

Options 1 and 2 create no implementation issue if an appropriate timeframe is elected for their application. Option 2 is the most satisfactory with regard to harmonisation with ICAO Standards.

Table D.10: Comparative impact on regulatory coordination and harmonisation

	Option 0	**Option 1**	**Option 2**
Impact on Regulatory coordination and harmonisation	**-** (ICAO Standard not transposed)	**-** (ICAO Standard not transposed)	**+** (not fully aligned with ICAO Standard, however, the intent is meant)

6. Conclusion and preferred option

A summary of the strengths and weaknesses of each option is presented in Table D.11.

Table D.11: Comparison of impacts between the various options ('+' means a positive impact, '-' a negative impact, '0' no significant impact)

Option	Option 0	Option 1	Option 2
Option description	Baseline option (No change in rules; risks remain as outlined in the issue analysis)	Mandate that the ULDs of crash-protected flight recorders fitting aeroplanes operated for commercial air transport have an underwater transmission time of 90 days by 1 January 2020	Mandate that aeroplanes that: — have an MCTOM in excess of 27 000 kg, — are operated for commercial air transport, — perform long-range overwater flights, — were first issued with an individual CofA on or after 1 January 2005, and — are not equipped with a reliable means to determine, in case of an accident, the location of the impact point with the Earth surface within 6 nm accuracy, are equipped by 1 January 2019 with an 8.8 kHz ULD.
Safety impact	**0** (does not address the safety issue)	**+** (slight improvement)	**+++** (significant improvement)
Environmental impact	**0**	**0**	**0** (negligible increase in fuel consumption)
Social impact	**0**	**0**	**0**
Economic impact	**0**	**-**	**+/-** (positive for States, negative for industry)
Proportionality issues	**0**	**0**	**+**(proportionality improved)
Impact on regulatory coordination and harmonisation	**0** (ICAO Standard not transposed)	**0** (ICAO Standard not transposed)	**+** (not fully aligned with ICAO Standard, however, the intent is meant)
Overall assessment	**0**	**0/+**	**+++**

It appears that only Option 2 would bring a significant improvement with regard to finding the aircraft wreckage. The economic impact of Option 2 is fully acceptable when considering commercial air transport and the volume of revenues generated by a large aeroplanes. After installation, the cost of a ULD is negligible. Option 2 would improve proportionality and harmonisation of the rules applicable in EASA Member States with ICAO Standards.

Therefore, Option 2 is the preferred option for addressing the issue of accidents over deep maritime areas and far away from seashores. This issue is specific to large aeroplanes performing long-range overwater flights. Option 1 (which corresponds to Option 3 of RIA C on 'Transmission time of the flight recorder ULD') is considered the best option to address another issue affecting all aircraft accidents over water, namely the insufficient transmission time of the 37.5 kHz ULD. Option 1 is applicable to all aircraft equipped with flight recorders. Option 1 is not sufficient for addressing the specific case of an accident over a deep maritime area.

When implementing Option 2, the following precautions should be taken:

— The time interval between the publication of the requirement and its date of application should be sufficient to allow for installing the ULD when heavy maintenance on the aircraft is scheduled. It is currently considered that setting the applicability on 1 January 2019 provides for sufficient notice, however, this could be adjusted to maintain at least 30 months (two and a half year) between the date of publication and the date of applicability;

— Alternate solutions to an 8.8 kHz ULD should be provided. In particular, a robust and reliable means to locate the accident within 6 nm accuracy, wherever on Earth and within a short timeframe, is an alternate solution. Indeed, with such pre-localisation means, the search area would be small enough and the 37.5 kHz ULDs would be sufficient to help locating the wreckage within 30 days. Examples of acceptable pre-localisation means should be provided, such as those listed in 1.3.2.3. For that purpose, acceptable means of compliance and guidance material should be developed.

7. Annexes

Annex A: Acronyms and definitions

AUV	Autonomous Underwater Vehicle
BEA	Bureau d'Enquêtes et d'Analyses (French safety investigation authority)
CVR	Cockpit Voice Recorder
CofA	Certificate of Airworthiness
EFRPG	European Flight Recorder Partnership Group
ETSO	European Technical Standard Order
FAA	Federal Aviation Administration of the United States
FDR	Flight Data Recorder
ICAO	International Civil Aviation Organization
MAPSC	Maximum Approved Passenger Seating Configuration
MCTOM	Maximum Certificated Take-Off mass
OPTIMI	Oceanic Position Tracking Improvement and Monitoring Initiative
TPL	Towed Pinger Locator
TSO	Technical Standard Order
ULB	Underwater Locator Beacon (other name for the ULD)
ULD	Underwater Locating Device

Annex B: References

— ICAO Annex 6 Part I, International Commercial Air Transport – Aeroplanes, Amendment 36.

— ICAO Annex 13, Aircraft Accident and Incident Investigation, Amendment 13.

— 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.

— Commission Regulation (EC) 859/2008 of 20 August 2008 amending Council Regulation (EEC) No 3922/91 as regards common technical requirements and administrative procedures applicable to commercial transportation by aeroplane.

— Opinion No 01/2012 of the European Aviation Safety Agency of 1 February 2012 for a Commission Regulation establishing Implementing Rules for air operations. Available under http://www.easa.europa.eu/agency-measures/opinions.php

— Opinion No 02/2012 of the European Aviation Safety Agency of 16 April 2012 for a Commission Regulation establishing Implementing Rules for air operations. Available under http://www.easa.europa.eu/agency-measures/opinions.php.

— Notice of Proposed Amendment (NPA) 2012-16, Draft Decision of the Executive Director of the European Aviation Safety Agency amending Decision 2003/10/RM of the Executive Director of the European Aviation Safety Agency of 24 October 2003 on certification specifications, including airworthiness codes and acceptable means of compliance, for European Technical Standard Orders (CS-ETSO) 'Systematic review and transposition of existing FAA TSO standards for parts and appliances into EASA ETSOs'.

— SAE Aerospace Standard 6254, Minimum Performance Standard for Low Frequency Underwater Locating Devices (Acoustic) (Self-Powered).

— Flight Data Recovery Working Group Report, available on the website of the French Bureau d'Enquêtes et d'Analyses under http://www.bea.aero/en/enquetes/flight.af.447/flight.data.recovery.working.group.final.report.pdf

- Triggered Flight Data Transmission working group, available on the website of the French Bureau d'Enquêtes et d'Analyses under

  http://www.bea.aero/en/enquetes/flight.af.447/triggered.transmission.of.flight.data.pdf

- OPTIMI Lot 1, Work Package 2 Report – Implementation feasibility analysis of the OPTIMI Flight Tracking Service (Deliverable L1-D6), September 2010

Annex C: Theoretical detection performance of ULD

Searching a signal means covering systematically the search area with a hydrophone. Usually, the vessel carrying the detection equipment will follow parallel lines at a distance from each other that is small enough to make sure that the ULD signal will not go undetected (line spacing). The narrower these parallel lines, the more distance the research vessel will have to cruise to cover the same area, the more time it will take, the greater the risk that the ULD ceases emitting before having completed the search area.

For example, assuming that a ULD has a detection range of *x* metres (m) and the sea floor depth is exactly *x* m, the signal can be only detected at the point on the sea surface located at the exact vertical of the ULD. It is in this case practically impossible to detect the ULD, because if the hydrophone does not pass at the exact vertical of the ULD, it will not detect it.

If the sea floor depth *d* is less than the ULD detection range *x*, then on the sea surface, the signal can be detected from the sea surface at any point of a circular area which has its centre at the vertical of the ULD and a radius *r* given by Pythagorean theorem[36]:

$$r = \sqrt{x^2 - d^2}$$

The distance between two parallel tracks followed by a vessel at the surface, or line spacing, must be less than twice this radius, in order to make sure that the signal will be detected when the hydrophone is brought to its vicinity. In addition, the scanned areas usually overlap to make sure that no sector of the seabed was missed. Assuming a *P*% overlapping, the useful scanning width is

$$w = 2 \times r \times \left(1 - \frac{P}{100}\right)$$

Knowing the vessel cruising speed *v*, it is then possible to assess the area covered in a given period *T*:

$$S = w \times v \times T$$

Note:

These formula can be applied to a towed pinger locator (TPL) or any other detection means overflying the seafloor, by substituting the height of the detection means above the seafloor to the seafloor depth. However, in that case, the cable deployment delay should be taken into account. There is approximately a 3 to 1 ratio between the cable length and the TPL depth. A cable with a length of several kilometres takes hours to deploy and hours to turn through 180 degrees for the TPL to be correctly aligned behind the tow vessel for the start of each track.

The detection range of a conventional 37.5 kHz ULD depends on several parameters, such as emission power, underwater propagation, background noise, hydrophone sensitivity, signal processing performance, etc. However, a conservative value of **1 500 m** has been

[36] In order to keep the computation simple, it is assumed here that the ULD signal is propagated in the sea water following straight lines.

elected to take account of environmental factors (this value is also consistent with historic underwater search operations).

For an 8.8 kHz ULD, a theoretical detection range of 5.8 nm i.e. **10 700 m** is assumed, as it is the most conservative range value of two results conducted independently by industry experts of companies that produce ULDs.

With regard to the actual time left to detect the ULD signal, the following values are assumed:

— 14 days in the case of an 8.8 kHz, 30-day transmission time ULD;

— 10 days in the case of a 37.5 kHz, 30-day transmission time ULD; and

— 40 days in the case of a 37.5 kHz, 90-day transmission time ULD.

Examples with a 37.5 kHz ULD and with an 8.8 kHz ULD, a vessel cruising speed of 3 kts and 10 % overlapping are given in Tables D.C.1 and D.C.2.

Table D.C.1: Example with a 37.5 kHz ULD, detection range of 1 500 m, vessel cruising at 3 kts, and 10 % overlapping

Seafloor depth	Radius of detection area at sea surface, in m	Area covered in one day , in square km	Area covered in 10 days of continuous operation , in square km	Area covered in 40 days of continuous operation , in square km
500	1 414	339	3 394	13 578
1 000	1 118	268	2 683	10 734
1 300	748	180	1 796	7 185
1 400	539	129	1 293	5 170
1 500	0	0	0	0

Table D.C.2: Example with an 8.8 kHz ULD, detection range of 5.8 nm (10 700 m), vessel cruising at 3 kts, and 10 % overlapping

seafloor depth	Radius of detection area at sea surface, in m	Area covered in one day , in square km	Area covered in 14 days of continuous operation , in square km
500	10688	2565	35916
1000	10653	2557	35798
1300	10621	2549	35689
1500	10594	2543	35600
2000	10511	2523	35321
2500	10404	2497	34960
3000	10271	2465	34513
3500	10111	2427	33977
4000	9924	2382	33348
4500	9708	2330	32621
5000	9460	2271	31788
5500	9178	2203	30841
6000	8859	2126	29770

<u>In the case of a 37.5 kHz ULD:</u>

- If the sea floor depth is 1 300 m, the area covered per day by a vessel is half the area covered in the same time assuming the sea floor depth is 500 m. With a sea floor depth of 1 400 m, the area that can be covered per day with the same vessel is divided by 3 compared to the case of a sea floor depth of 500 m. Beyond 1 500 m depth, the signal cannot be detected from the sea surface.
- Assuming 10 days of continuous operation (case of a 30-day transmission time ULD), the maximum area that can be covered is 3 394 km^2 if the sea floor depth is 500 m, and 1 796 km^2 if the sea floor depth is 1 300 m.
- Assuming 40 days of continuous operation (case of a 40-day transmission time ULD), the maximum area that can be covered is 13 578 km^2 if the sea floor depth is 500 m, and 7 185 km^2 if the sea floor depth is 1 300 m.

<u>In the case of an 8.8 kHz ULD:</u>

- The seafloor depth has limited influence on the area covered per day of operation: there is only a 20 % difference in area between the case of a seafloor depth of 500 m and the case of a seafloor depth of 6 000 m. Assuming 14 days of continuous operation, the maximum area that can be covered when the sea floor depth is 6 000 m is 29 770 km^2. 29 770 km^2 correspond to a circular area with a radius of 97 km, i.e. 53 nm.