International Civil Aviation Organization | Organisation de l'aviation civile internationale | Organización de Aviación Civil Internacional | Международная организация гражданской авиации | منظمة الطيران المدني الدولي | 国际民用航空组织

Tel.: +1 514-954-8219 ext. 6260

Ref.: SP 55/4-15/15

15 May 2015

Subject: Proposals for the amendment to Annex 6, Parts I, II and III relating to carriage requirements of flight recorders

Action required: Comments to reach Montréal by 14 August 2015

Sir/Madam,

1. I have the honour to inform you that the Air Navigation Commission, at the third meeting of its 198th Session held on 29 January 2015, considered proposals developed by the Secretariat with the assistance of the seventh meeting of the Flight Recorder Panel (FLIRECP/7) to amend the Standards and Recommended Practices (SARPs) in Annex 6 — *Operation of Aircraft*, Part I — *International Commercial Air Transport — Aeroplanes*, Part II — *International General Aviation — Aeroplanes* and Part III — *International Operations — Helicopters*, relating to flight recorders, and authorized their transmission to Contracting States and appropriate international organizations for comments.

2. The proposed amendments are aligned with the Global Aeronautical Distress and Safety System (GADSS) concept of operations. Additional background information concerning the proposals is provided in Attachment A. The GADSS report is available as HLSC/15-WP/2 on the HLSC 2015 website (http://www.icao.int/Meetings/HLSC2015/Pages/WorkingPapers.aspx).

3. The proposed amendments, contained in Attachments B, C and D herein, introduce new Standards and Recommended Practices on automatic deployable flight recorders (ADFR), extended duration of cockpit voice recordings (CVR) and location of an aeroplane in distress.

4. In examining the proposed amendments, you should not feel obliged to comment on editorial aspects as such matters will be addressed by the ANC during its final review of the draft amendments.

5. May I request that any comments you wish to make on the amendment proposals be dispatched to reach me not later than 14 August 2015. The Air Navigation Commission has asked me to specifically indicate that comments received after the due date may not be considered by the Commission

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and the Council. In this connection, should you anticipate a delay in the receipt of your reply, please let me know in advance of the due date.

6. For your information, the proposed amendments to Annex 6, Parts I, II and III are envisaged for applicability on 10 November 2016. Any comments you may have thereon would be appreciated.

7. The subsequent work of the ANC and the Council would be greatly facilitated by specific statements on the acceptability or otherwise of the proposals. Please note that for the review of your comments by the ANC and the Council, replies are normally classified as "agreement with or without comments", "disagreement with or without comments" or "no indication of position". If in your reply the expressions "no objections" or "no comments" are used, they will be taken to mean "agreement without comment" and "no indication of position", respectively. In order to facilitate proper classification of your response, a form has been included in Attachment F which may be completed and returned together with your comments, if any, on the proposals in Attachments B, C and D.

Accept, Sir/Madam, the assurances of my highest consideration.

Raymond Benjamin
Secretary General

Enclosures:

A — Background
B — Proposed amendment to Annex 6, Part I
C — Proposed amendment to Annex 6, Part II
D — Proposed amendment to Annex 6, Part III
E — Draft EUROCAE ED-237
F — Response form

ATTACHMENT A to State letter SP 55/4-15/15

BACKGROUND

1. The seventh meeting of the Flight Recorder Panel (FLIRECP/7) reconsidered automatic deployable flight recorders, extended duration of cockpit voice recorder recordings and the location of accident site proposals. At the request of the Air Navigation Commission (ANC), the Secretariat, supported by an ad-hoc working group of flight recorder and aircraft systems experts, developed additional proposals for performance-based ADFR provisions.

2. The proposed amendments, as modified by the discussions of the Commission, are contained in Attachments B, C and D. The amendment proposals to Annex 6 introduce:

a) **automatic deployable flight recorders (ADFRs)**: to provide a definition for ADFRs and provisions for the carriage of ADFRs. The amendment proposal includes a performance-based alternative for the carriage of ADFRs. Guidance material is included in Attachment XX on flight data recovery to assist States approve equipage variations for performance-based alternate means of compliance;

b) **extended duration cockpit voice recordings**: to provide provisions to extend the duration of CVR recordings to twenty-five hours to increase the availability of CVR recordings for accident and incident investigations; and

c) **location of an aeroplane in distress**: to include performance-based provisions in Annex 6, Part I for means to locate an aeroplane in distress. The proposal includes an amendment to the provisions for emergency locator transmitters (ELT) and guidance material (Attachment YY refers) for the implementation of the location of an aeroplane in distress. Additionally, with reference to Table XX-1 on events that activate the autonomous transmission of position information in Appendix XX, a current draft of the EUROCAE Minimum Aviation System Performance Specification (MASPS) ED-237, being developed by EUROCAE WG-98, is provided in English as Attachment E to the electronic version of this State letter.

3. These issues were considered in the light of recent accidents, including the disappearance of Malaysia Airlines flight MH370. Considering ADFRs and location of an aeroplane in distress, a multidisciplinary ad-hoc working group was tasked to develop a draft concept of operations on flight tracking with a clear definition of the objectives of flight tracking, ensuring that information is provided in a timely fashion to the correct persons to support search and rescue, recovery and accident investigation activities. The concept should also include the roles and responsibilities of all stakeholders. As a result, the Global Aeronautical Distress and Safety System (GADSS) was developed.

4. Some costs may be incurred by aircraft operators/owners as they may have to equip new aircraft with updated flight recorder or other systems. However, these costs will be off-set by search and rescue (SAR) costs.

5. The proposals are followed by rationales supporting the amendments and are intended to facilitate their consideration by States and international organizations.

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ATTACHMENT B to State letter SP 55/4-15/15

PROPOSED AMENDMENT TO ANNEX 6, PART I

NOTES ON THE PRESENTATION OF THE PROPOSED AMENDMENT

The text of the amendment is arranged to show deleted text with a line through it and new text highlighted with grey shading, as shown below:

1.	~~Text to be deleted is shown with a line through it.~~	text to be deleted
2.	New text to be inserted is highlighted with grey shading.	new text to be inserted
3.	~~Text to be deleted is shown with a line through it~~ followed by the replacement text which is highlighted with grey shading.	new text to replace existing text

PROPOSED AMENDMENT TO

INTERNATIONAL STANDARDS
AND RECOMMENDED PRACTICES

OPERATION OF AIRCRAFT

ANNEX 6
TO THE CONVENTION ON INTERNATIONAL CIVIL AVIATION

PART I
INTERNATIONAL COMMERCIAL AIR TRANSPORT — AEROPLANES

CHAPTER 1. DEFINITIONS

. . .

Flight recorder. Any type of recorder installed in the aircraft for the purposes of complementing accident/incident investigation.

Automatic deployable flight recorder (ADFR). A flight recorder installed on the aircraft which is capable of automatically deploying from the aircraft.

. . .

CHAPTER 6. AEROPLANE INSTRUMENTS, EQUIPMENT AND FLIGHT DOCUMENTS

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6.3 Flight recorders

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6.3.2 Cockpit voice recorders and cockpit audio recording systems

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6.3.2.3 *Duration*

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6.3.2.3.4 All aeroplanes of a maximum certificated take-off mass of over 27 000 kg for which the individual certificate of airworthiness is first issued on or after 1 January 2021 shall be equipped with a CVR capable of retaining the information recorded during at least the last twenty-five hours of its operation.

. . .

Origin:	**Rationale:**
FLIRECP/7	The value of CVR recordings for the analysis of human factors and different sounds cannot be emphasized enough and the technology exists to increase the

	duration of recordings. Several safety recommendations have been addressed to ICAO to extend the duration of CVRs beyond the present two-hour duration. An incident might occur during take-off but due to the flight being longer than two hours, the CVR recordings would not cover the take-off phase, which would be a valuable tool for the investigations. A robust solution would be to extend the CVR recording duration to twenty-five hours, which would include a long-haul flight, its pre-flight and post-flight crew activities. It is expected that long-haul flights may extend to nineteen hours. It was estimated that a CVR with a recording duration of twenty-five hours would cover all flights in the foreseeable future, including the pre-flight activities and post-flight activities. Furthermore, the proposed amendment allows for harmonization with FDR duration requirements.

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6.3.4 Flight recorders — general

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6.3.4.5 *Combination recorders*

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6.3.4.5.3 All aeroplanes of a maximum certificated take-off mass of over 27 000 kg and authorized to carry more than nineteen passengers for which the application for type certification is submitted to a Contracting State on or after 1 January 2021, shall be equipped with a combination recorder as close to the cockpit as practicable and an automatic deployable flight recorder (ADFR) located as far aft as practicable in accordance with Appendix 8.

Note 1.— A combination recorder that includes a FDR meets the requirements of 6.3.1.

Note 2.— A combination recorder that includes a CVR meets the requirements of 6.3.2.

6.3.4.5.4 **Recommendation.—** *All aeroplanes of a maximum certificated take-off mass of over 27 000 kg and authorized to carry more than nineteen passengers for which the individual certificate of airworthiness is first issued on or after 7 November 2019, should be equipped with a combination recorder as close to the cockpit as practicable and an automatic deployable flight recorder (ADFR) located as far aft as practicable in accordance with Appendix 8.*

6.3.4.5.5 Notwithstanding the provisions in 6.3.4.5.3 and 6.3.4.5.4, the State of the Operator may, based on the results of a specific performance assessment conducted by the operator which demonstrates how an equivalent level of performance will be maintained, specifically approve equipage variations to recover, at a minimum, CVR and mandatory FDR data for the mandated duration in a timely manner. The specific performance assessment shall include at least the following:

a) the capabilities of the operator;

b) overall capability of the aeroplane and its systems;

c) the reliability of the means to recover the appropriate CVR channels and FDR data in a timely manner and avoiding the need for underwater retrieval;

d) the capability to establish the location where an aircraft terminates controlled flight;

e) the ability to contribute with finding the location of an accident site; and

f) specific mitigation measures.

Note 3.— Guidance on the specific performance assessment, appropriate CVR data and FDR parameters, duration of recordings and timely recovery of CVR and FDR data is contained in Attachment XX.

Note 4.— The specific approval for an equipment variation should be included in the Operation Specification template contained in Appendix 6 under "Other".

Editorial note: *Renumber* subsequent paragraphs and *Note*.

. . .

6.17 Emergency locator transmitter (ELT)

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6.17.3 All aeroplanes authorized to carry more than 19 passengers for which the individual certificate of airworthiness is first issued after 1 July 2008 shall be equipped with at least two ELTs, one of which shall be automatic, unless the aeroplane meets the requirements of 6.18.

. . .

Editorial note.— Insert new paragraph 6.18 as follows:

6.18 Location of an aeroplane in distress

6.18.1 All aeroplanes of a maximum certificated take-off mass of over 27 000 kg for which the individual certificate of airworthiness is first issued on or after 1 January 2021, shall autonomously transmit information from which a position can be determined by the operator at least once every minute, when in distress, in accordance with Appendix XX.

6.18.2 **Recommendation.**— *All aeroplanes of a maximum certificated take-off mass of over 5 700 kg for which the individual certificate of airworthiness is first issued on or after 1 January 2021, should autonomously transmit information from which a position can be determined at least once every minute, when in distress, in accordance with Appendix XX.*

6.18.3 The operator shall make position information of a flight in distress available to the appropriate organizations, as established by the State of the Operator.

Note.— Refer to 4.2.1.3.1 for operator responsibilities when using third parties.

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APPENDIX 8. FLIGHT RECORDERS

(Note — See Chapter 6, 6.3, 6.18)

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4. Automatic deployable flight recorder (ADFR)

4.1 Operation

The following requirements shall apply to an ADFR:

- deployment shall take place when the aeroplane structure has been significantly deformed;
- deployment shall take place when an aeroplane sinks in water;
- ADFR shall not be capable of manual deployment;
- the ADFR shall be able to float on water;
- the ADFR shall contain an integrated ELT, which shall activate automatically during the deployment sequence. Such ELT may be of a type that is activated in-flight and provides information from which a position can be determined; and
- the integrated ELT of an ADFR shall satisfy the same requirements as an ELT required to be installed on an aeroplane. The integrated ELT shall at least have the same performance as the fixed ELT to maximize detection of the transmitted signal.

Note.— Refer to Attachment XX for more information on ADFR.

Editorial note: *Renumber* subsequent paragraphs.

. . .

Origin:	**Rationale:**
FLIRECP/7	Since 1996 until 2009, thirty-eight accidents involving large aeroplanes occurred over water. Currently, eight recorders have not yet been recovered. From 2009, thirteen accidents have occurred over water. In studies undertaken during the Air France 447 investigation (the Flight Data Recovery Working Group and the Triggered Transmission of Flight Data Working Group reports accessible at http://www.bea.aero/en/enquetes/flight.af.447/reports.php), cost/benefit was considered and it was determined that ADFR is one of the effective methods of recovery of flight data after an accident. The cost for these type of recoveries on the average is approximately one to two million dollars. A multidisciplinary Ad-Hoc Working Group (AHWG) was formed after Malaysia 370 went missing in May 2014. The AHWG considered a global aeronautical distress and safety system (GADSS) and produced a concept of operations (CONOPS) which refers to emergency flight tracking with the last element being the ADFR. In the GADSS, the ADFR was included to provide for redundancy to determine the location of the accident site and that flight data would be quickly available for investigation purposes. An automatic deployable flight recorder (ADFR) is a combination recorder fitted into a crash-protected container that would deploy from an aircraft during

	significant deformation of the aircraft in an accident scenario. Considering the design and deployment features of a deployable recorder, the recorder is usually fitted externally, flush with the outer skin towards the tail of the aircraft. To find a deployed ADFR, an emergency locator transmitter (ELT) is integrated in the ADFR. This ELT has the added advantage to assist in locating the accident site and facilitate search and rescue efforts. In the case of a new generation ELT being fitted, the ELT will provide emergency tracking data before the impact. Furthermore, if the wreckage becomes submerged in water, the traditional ELT signal will be undetectable, but with the deployable recorder being floatable, the ELT signal would still be detectable and the deployable recorder would be recovered quicker. As the ADFR is floatable, there is no requirement for an underwater locating device. In terms of cost benefit, if the ADFR installation can be included into a newly designed aircraft, it would be approximately cost neutral in the sense that one of the two combination recorders would be a deployable recorder. Having an integral ELT, one less ELT may be installed with the associated cost saving of an ELT mounting bracket. A further benefit would be the availability of critical flight data soon after the accident to direct the accident investigation and initiate safety actions. This could have large saving implications in terms of not calling for maintenance inspections when the safety of the aircraft systems is suspected and having the data available to put these suspicions to rest. The specifications for ADFRs are contained in the EUROCAE ED-112A MOPS that was revised after the AF447 accident. The specifications include the robustness of the ADFR attachment and define that the overall quantitative probability (per flight hour) of the failure event "non-commanded deployment" shall be less than 10^{-7}. Provisions for the container of ADFRs were included in Amendment 38 of Annex 6, Part I, which became applicable on 13 November 2014. In this working paper, a definition of an ADFR and a recommendation for the carriage of ADFRs on large aeroplanes is proposed for Annex 6, Part I. Due to the ADFR being a special type of combination recorder, the recommendation for the carriage of ADFRs is proposed to be included in 6.3.4.5 of the provisions for flight recorders and has no retrofit implications, only forward fit.

Editorial note.— Insert new Appendix XX and new Attachment XX as follows:

APPENDIX XX. LOCATION OF AN AEROPLANE IN DISTRESS

(Note — See Chapter 6, 6.18)

1. Purpose and scope

Location of an aeroplane in distress aims at establishing, to a reasonable extent, the location of an accident site within a 6 NM radius.

2. Operation

2.1 An aeroplane in distress shall automatically activate the transmission of information from which its position can be determined by the operator and the position information shall contain a time stamp. It shall also be possible for this transmission to be activated manually. The system used for the autonomous transmission of position information shall be capable to transmit that information in the event of aircraft electrical power loss, at least for the expected duration of the entire flight.

2.2 Autonomous transmission of position information shall be activated automatically when events in Table XX-1 occur. The initial transmission of position information shall commence immediately or no later than five seconds after the detection of the activation event.

2.3 **Recommendation.—** *Autonomous transmission of position information should be able to be activated manually from the ground (e.g. ATSU, operator).*

2.4 When an aircraft operator or an Air Traffic Service Unit (ATSU) has reason to believe that an aircraft is in distress, coordination shall be established between the ATSU and the aircraft operator.

2.5 The State of the Operator shall identify the organizations that will require the position information of an aircraft in an emergency phase. These shall include, as a minimum:

a) Air Traffic Service Unit(s) (ATSU); and

b) SAR Rescue Coordination Centre (s) (RCC) and sub-centres.

Note 1.— Refer to Annex 11 for emergency phase criteria.

Note 2.— Refer to Annex 12 for required notifications in the event of an emergency phase.

Table XX-1. Events that activate the autonomous transmission of position information

Event
Urgency or distress code in transponder, ADS-B or ADS-C
Activation of an ELT
Aircraft behaviour events such as unusual attitudes, unusual speed conditions, loss of power on all engines and ground proximity warnings.

Note 3.— Triggering criteria for aircraft behaviour events are detailed in the EUROCAE Minimum Aviation System Performance Specification (MASPS) ED –XX.

2.6 When autonomous transmission of position information has been activated, it shall only be able to be de-activated using the same mechanism that activated it or, in any case, from the ground (e.g. ATSU, Operator).

2.7 The accuracy of position information shall, as a minimum, meet the position accuracy requirements established for ELTs.

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ATTACHMENT XX. FLIGHT DATA RECOVERY

Supplementary to Chapter 6, 6.3.4.5.5

Guidance for flight data recovery

1. Purpose and scope

1.1 As indicated in Standard 6.3, crash protected flight recorders may include one or more of the following systems: a FDR, CVR, AIR and/or DLR. A combination recorder includes at least a CVR and FDR and any combination of other systems in a single flight recorder. The flight recorder provisions aim at improving the overall probability of timely recovery of flight data needed for accident investigation. The systems and related procedures should significantly improve the overall probability of recovering flight data when compared to conventional flight recorders with 30 day underwater location device (ULD) batteries.

1.2 Standard 6.3.4.5.2 requires two combination recorders (FDR/CVR) to be included in the design specifications when the application for type certification is submitted after 1 January 2016. Additionally, to address the timely recovery of flight data, a Standard and Recommendation applicable in 2021 and 2019, 6.3.4.5.3 and 6.3.4.5.4 respectively, require/recommend replacing the rear combination recorder with an automatic deployable flight recorder (ADFR). An ADFR as defined in Appendix 8, Section 4, is a technology that is believed to provide the desired level of increased probability of recovering flight data and can contribute to locating an accident site.

1.3 Standard 6.3.4.5.5 is a performance base alternative to the prescriptive Standards described in 1.2 above. Scenarios for maintaining an equivalent level of performance when applying 6.3.4.5.5 may be the following:

On an aeroplane that is required to have a combination recorder (FDR/CVR) and an ADFR, the ADFR could be substituted by:

a) A means of making the full dataset available, as it would be recorded on a combination recorder, in a timely manner after an accident, as what would have been the case with an ADFR. The aeroplane would also need to be equipped with a means of contributing to the location of an accident site such as a system for locating an aeroplane in distress.

b) Having two combination recorders (FDR/CVR), a system for locating an aeroplane in distress and a means of making a set of flight data available in a timely manner after an accident, as what would have been the case with an ADFR. The dataset could be limited to a subset of FDR and CVR data because the full dataset will be available from at least one of the two combination recorders when recovered.

1.4 Other technologies may be brought to bear to meet the performance improvement goal . This Attachment provides guidance to aid in the evaluation of systems and procedures intended to support this means of flight data recovery.

2. Background

2.1 When an accident occurs over water it is beneficial for the investigation to recover critical flight data in a timely manner. Once recovered, flight recorders have been highly reliable. However, there have been instances in which the search for recorders has been very long, flight data has never been recovered or where data were lost due to damage from exposure to severe fire or underwater conditions. Examples of these scenarios may be found in the GADSS CONOPS, Appendix C: Concept Scenario.

2.2 When an aeroplane has an accident in water and becomes submerged, deployable recorders are a technology that can be used to recover flight data without the delay of a long underwater recovery. However, in many cases an underwater search and recovery of wreckage may still be required to determine the cause of an accident. Also, ADFR, if installed will complement a fixed combination recorder (FDR/CVR) to improve the probability that at least one recorder is recovered successfully.

2.3 Other technologies based on transmission of flight data, prior to an accident may be useful to recover some CVR and FDR data quickly without any search required. Furthermore, such data streamed from an aircraft in a distress situation or streamed continuously throughout the flight may enable near real time trend analysis on the ground that could potentially allow early detection and mitigation of factors that might lead to an accident. Such streaming technology is evolving and already exists to some degree on some airframes. As the performance of datalink technology improves, these practices are expected to be more widely adopted due to the potential economic and safety benefits that result from the availability of near real time flight data.

2.4 The CVR/FDR data required for timely flight data availability depends on the configuration and the impact on the overall probability of meeting the needs of accident investigation in a timely manner. In the scenario where the ADFR replaces one of two combination recorders (FDR/CVR), the ADFR should meet all the requirements for data recording as defined in Standards 6.3.1 and 6.3.2 (i.e. the full dataset). For flight data systems that stream data and operate in addition to two installed combination recorders (FDR/CVR), a subset of the required parameters over a specified duration may be provided as described in the following sections. The objective is to provide flight data that allows a timely determination of the cause of the accident to the extent possible. In many cases the ultimate root cause of an accident can only be definitively determined after physical examination of the wreckage.

2.5 The requirements for CVR information are detailed in Standard 6.3.2. Systems that provide timely flight data recovery in addition to two combination recorders, should at a minimum include CVR recorded data from the time the airplane enters the distress phase (refer to table for distress events as per Table XX-1 in Appendix XX) to the end of the flight. To the extent possible historical data prior to the declaration of distress should also be provided. In cruise the crew is not wearing the headset with the microphones and in such case most of the time all useable audio data from the CVR is contained on the Cockpit Area Microphone (CAM) Channel. The subset data from a CVR then could be limited to the audio from the CAM channel. Data streaming in support of timely flight data recovery may also support accident site location and consequently shorten the duration of any subsequent underwater search and recovery that may be required.

2.6 The list of mandatory FDR parameters depends on the date of individual certificate of airworthiness of each aircraft and are listed in Standard 6.3.1 "Flight data recorders and aircraft data recording systems". Systems for the timely recovery of flight data in addition to two combination recorders should at a minimum provide all the mandatory parameters from the time the airplane enters the distress phase to the end of the flight. A subset of parameters may be used if that subset is shown to provide a high likelihood of supporting initial accident investigation needs with respect to identifying the cause of the accident. Also to the extent possible, historical data prior to the time the flight enters the distress phase should be provided. The availability of a subset parameters soon after an accident, with enough information to provide an indication of malfunctions that may have led to the accident, could support immediate safety recommendations. For example, soon after one of the major accidents over the ocean, aircraft monitoring parameters provided enough information to introduce recommendations that led to maintenance actions and training actions well in advance of recovery of the aircraft's recorders. The following is the subset of parameters that should be transmitted during the distress phase of flight:

- Time;
- Altitude (pressure or radio);
- Airspeed (indicated or calibrated);
- Heading (primary flight crew reference);
- Acceleration (normal, lateral and longitudinal);
- Attitude (pitch, roll, yaw or sideslip angle);
- Manual radio transmission keying (for CVR/FDR synchronization reference);
- Engine thrust/power on each engine;
- Autopilot/auto throttle/AFCS mode or engagement status;
- Primary flight control surface position and/or primary flight control pilot input (pitch, roll, yaw);
- Red or master warnings; and
- Angle of attack (if available).

2.7 In accordance with Annex 13, the operator collecting CVR and FDR data via data streaming for the purpose of an investigation should make the data available to the appropriate accident investigation authorities without delay. Procedures for retrieval, packaging and transmission of data to the appropriate authorities should be established in advance with due consideration for data security, confidentiality and authenticity.

3. Performance Assessments

3.1 As stated in Standard 6.3.4.5.5, a specific performance assessment must be conducted to demonstrate that the system maintains an equivalent level of performance. The specific performance assessment should consider the entire system including operational procedures, airborne equipment and ground based infrastructure. The assessment must include at least the following elements which are discussed in the following sections:

a) *Capabilities of the operator*: The assessment should take into account the capabilities of the operator or an agent thereof to collect, archive, protect, and disseminate CVR/FDR data collected from an airplane that was involved in an accident. The assessment should include an evaluation of the operators total use of datalink for near real time collection of maintenance data, or other relevant operational data. The overall sophistication of the operator with respect to tracking of aircraft under normal and distress situations should be included in the assessment as well as the operators established processes and procedures for handling data streamed from aircraft.

b) *Capability of the aeroplane and its systems*: The assessment should include the total airplane equipage with respect to:

1) **Number and location of FDRs/CVRs and their historical reliability.** At a minimum, two combination recorders (FDR/CVR) should be installed where one may optionally be of a deployable type. The historical reliability can be derived based on in-service use of similar devices. Consideration should be given to the history or aircraft accidents where similar equipment was deployed in order to determine the probability of recovery of at least one working combination recorder (FDR/CVR);
2) **Number and location of Underwater Location Devices (ULD).** At a minimum an ULD should be attached to each fixed combination recorder (FDR/CVR). Additionally a third ULD operating at 8.8 kHz may be included to increase the probability of finding the wreckage underwater;
3) **Overall Communication and Navigation Capabilities.** The assessment should take into account the complete suite of navigation and communications capabilities that are available for aircraft tracking under normal, abnormal or distress situations. The operator's Standard Operational Procedures (SOP) for aircraft tracking should be considered;
4) **ELT Transmitters:** Type, availability and performance of ELT transmitters that may improve accident site location. The historical reliability can be derived based on in-service use of similar devices. Consideration should be given to the history of aircraft accidents where similar equipment is used in order to determine the probability of recovery of at least one operational combination recorder (FDR/CVR); and
5) **System to locate an aeroplane in distress:** Type, availability and performance of the system to locate an aeroplane in distress that may improve accident site location. Consideration should be given to the solution reliability and any interdependencies with the data streaming capabilities.

c) *Reliability of the means to recover the appropriate CVR channels and FDR data in a timely manner and avoiding the need for underwater retrieval:* The assessment should

include an evaluation of the reliability of each component of the system to provide timely flight data recovery. For example, the reliability of any satcom link used to transmit data should be evaluated including the joint reliability of multiple datalinks. The reliability of various datalinks under the condition of unusual aircraft attitudes or aircraft power outages should be considered. Ultimately, the joint reliability of all datalinks used for data streaming, the reliability of ULD and reliability or each fixed combination recorder (FDR/CVR) should be assessed.

d) *The capability to establish the location where an aircraft terminates controlled flight:* The assessment should include all aeroplane systems and other systems that may be used to locate an accident site. For example, the role that space based ADS-B may someday play in accident site location should be considered as well as the potential for ATS surveillance. The expected performance of any installed system to locate an aeroplane in distress should be included in the analysis.

e) *The ability of the data recovery mechanism to contribute to finding the location of an accident site:* When flight data is streamed during a distress situation, the data may include aeroplane position information at a relatively high rate. This data may lead to even more accurate accident site location than would be provided by any ELT or a system to locate an aeroplane in distress . The ability of such improved accuracy of accident site location to reduce the duration of an underwater search should be considered.

f) *Other specific mitigation measures:* Where streaming of flight data is used in a system to do trend monitoring that may reduce the probability of an accident, this capability should also be included in the evaluation.

3.2 Overall performance evaluations should be a combination of quantitative and qualitative criteria. A quantitative analysis which aims to show the overall improvement in the probability of recovering flight data should be included. However, some value may also be given to qualitative criteria such as relative improvements in overall safety that may be achieved through the implementation of timely flight data recovery systems

4. Example Performance Assessments

4.1 **Quantitative assessments**: Quantitative assessments may be instructive in that they illustrate the relative improvement afforded by elements used to achieve timely flight data recovery. However, accurate quantitative assessments are problematic because reliabilities and probabilities of certain types of events can only be estimated based on historical experience from operational use of similar equipment. The number of accidents where FDR/CVR data was not recovered are few and therefore, statistical uncertainty in the implied probability of occurrence is quite high. The following sections provide an example of a quantitative assessment for ADFR. The quantitative assessment is based on a fault tree analysis aimed at quantifying the top level probability of recovering the flight data.

4.2 No validated baseline quantitative performance assessment for ADFR currently exists. The example below is based on current expectations of the performance of ADFR in civil applications. As no operational experience in civil applications exists, the inputs to this analysis are based on experience with military applications of ADFR.

4.3 A Fault Tree Analysis used to derive the overall probability of recovering flight data for an aeroplane that includes ADFR is illustrated in Figure XX-1. Note that the overall probability of successfully recovering the CVR/FDR data is the combined probability of recovering the data without an underwater search (i.e. ADFR is successfully deployed, recovered and is readable) and the probability of recovering the data with an underwater search (i.e. assuming ADFR fails somehow, but accident site location and a search for ULDs is successful). In turn each event is broken down into the other constituent events as needed until the model has inputs that can be quantified based on specifications or inferred from historical operational experience.

Note.— The figures employed in Figure XX-1 are for illustration purposes only and do not represent any validated assessment of the probabilities for individual events.

(See Figure XX-1 on next page)

4.4 **Qualitative Assessment**: As noted above, strict quantitative assessment of options for recovery of flight data are difficult due to uncertainties in the probability of certain kinds of events. Other more qualitative considerations should be included in the assessment such as:

- Cost effectiveness of an option
- Potential unintended consequences or safety implications of the options (e.g. risks due to deployment of additional lithium batteries)
- Privacy and data security issues
- Practicality of solutions for deployment in retrofit or forward fit vs. integration during development of a new type design
- Sustainability and scalability of solutions

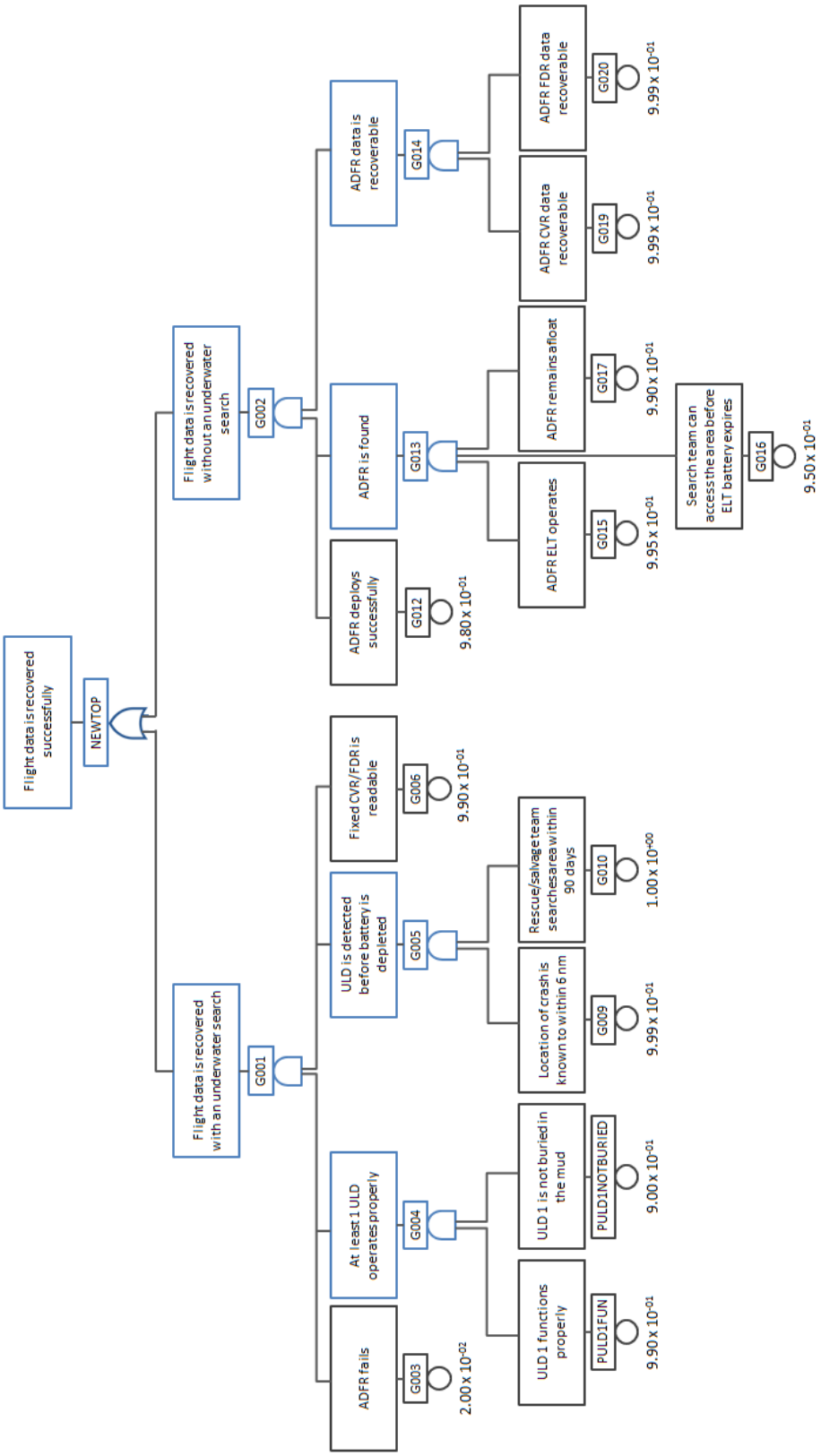

Figure XX-1. Example of Fault Tree Analysis for overall probability of data recovery for a system that includes ADFR

ATTACHMENT YY. LOCATION OF AN AEROPLANE IN DISTRESS

Supplementary to Chapter 6, 6.18

Guidance for Location of an Aeroplane in Distress

1. Introduction

1.1 The following material provides guidance on locating an aeroplane in distress. The Triggered Transmission of Flight Data Working Group (TTFDWG) reviewed 42 accidents to determine an indication of the distance from a last known aeroplane position to the location of an accident site. The report concluded that in approximately 95 per cent of the cases, when the aircraft position was known one minute prior to the accident, the accident site location was within a 6 NM radius of that position. (The TTFDWG Report is accessible at http://www.bea.aero/en/enquetes/flight.af.447/reports.php).

1.2 When an aeroplane has an accident into water and becomes submerged, the location of the accident site within a 6 NM radius on the surface becomes more important. Starting the initial search area beyond a 6 NM radius reduces the amount of time available to search for and locate the aeroplane. At current estimated underwater search capabilities of 100 km^2/day, an area with a 6 NM radius could be searched in 4 days. Allowing for naval assets to reach the search area and conduct the search, it is estimated that an area of 2 300 km^2, equivalent to a radius of 14 NM, will be able to be searched before the ULB battery degrades. Starting at an area of more than 6 NM radius reduces the probability of a successful location during an initial search, whilst extending the location requirement beyond 6 NM radius reduces the time available to search with no appreciable gain in the probability of recovery.

2. Clarification of purpose of equipment

2.1 Information from which a position can be determined: Information from an aircraft system which, when automatically or manually activated, can provide position information which includes a time stamp. This is a performance-based requirement which is not system specific and may also bring operational benefits.

2.2 Emergency locator transmitter (ELT): The current generation of ELTs were designed to provide the position of impact for a survivable accident. The next generation of ELTs may have the capability to activate a transmission in flight when any of the conditions detailed in Table XX-1 are met. When an ELT sinks below the surface of water, its signal is not detectable.

2.3 Automatic deployable flight recorder (ADFR): The purpose of an ADFR is to have flight data available soon after an accident, in particular for accident over water. The integrated ELT provides for both locating the accident site for accident investigation and search and rescue purposes. Being floatable, it will assist locating the accident site by providing an ELT signal when the wreckage sinks below the surface of the water. It also ensures redundancy for one ELT.

2.4 Underwater locator beacon (ULB): A low frequency ULB is attached to the airframe to locate aeroplane wreckage below the surface of water when an ELT signal is not possible to detect. The high frequency ULBs are used for locating the flight recorders under water.

3. Equipage compliance

3.1 The advent of technology has made it possible to meet the equipage requirements by different means. Table YY-1 below provides examples of compliance. In such potential installations, the cost will be minimized and the effectiveness of the current installation improved.

Table YY-1. Examples of compliance

Current	**After 7 November 2019**	**After 1 January 2021**
In-service	**Individual certificate of airworthiness is first issued**	**Application for type certification is submitted to a Contracting State**
Two ELTs Two fixed recorders	Example: A system from which a position can be determined and one ELT and two fixed recorders or one fixed combined recorder and one ADFR with an integrated ELT of a type that is activated in flight and provides information from which a position can be determined and one ELT	Example: A system from which a position can be determined; and one ADFR with an integrated ELT; and one combined recorder or A system from which a position can be determined and one ELT and two fixed recorders and an additional means to retrieve flight data in timely manner

Note.— A system from which a position can be determined (e.g. ADFR with integrated ELT or an ELT of a type that is activated in flight and provides information from which a position can be determined) used to comply with 6.18, may replace one of the ELTs required by 6.17.

Origin:	Rationale:
FLIRECP/7	Locating an aeroplane in distress is essential to determine whether the distress situation has been resolved, or in the case of an accident, to facilitate the location of the wreckage and possible survivors; for accident investigation purposes, to recover flight data. The flight data becomes available by either finding the flight recorders or, in the case of an ADFR, recovering it using the integrated ELT's signal as a means to locate it. During the Air France 447 (AF447) investigation, the Triggered Transmission of Flight Data Working Group (TTFDWG), consisting of more than 150 international experts, studied the viability of locating an accident site by means of transmission of a basic package of flight data which contains positional elements (TTFDWG Report is accessible at http://www.bea.aero/en/enquetes/flight.af.447/reports.php). The data of forty-two accidents were considered and it was determined that, if the rate of position information is transmitted once per minute, the accident site could be located in

	approximately 95 per cent of the cases within a 6 NM radius. This was calculated for current sub-sonic aircraft. Furthermore, the first signal should be transmitted within five seconds from the activation of the distress tracking system. In cases where the accident happened over water, locating the accident site within a 6 NM radius on the surface of the water was essential for the search operation to reach the low-frequency underwater locator beacon in time. After MH370, a multi-disciplinary meeting was held so as to assess flight tracking possibilities. An Ad-Hoc Working Group (AHWG) was tasked to develop a concept of operations (CONOPS) for a Global Aeronautical Distress and Safety System (GADSS). The main system components identified were: aircraft tracking systems (normal and abnormal operations); autonomous distress tracking system; and automatic deployable flight recorders. The autonomous distress tracking contains triggers for activation, autonomy and failure-mode capability and reception of data on the ground. Currently, approximately sixty per cent of aircraft crossing the Atlantic are equipped to transmit enough information to determine their location should they enter a distress situation. In some cases, a software modification may be required to include the system triggering criteria and to include position information in messages that are currently transmitted. The position information of an aeroplane, at a specific time and at a certain accuracy, is important. To be performance-based, the provision for the location of the aeroplane in distress, should refer to an accuracy level and rate of providing the position. During the emergency phase, the aircraft systems are used to provide the information, but in the distress phase the autonomous system is needed, according to the CONOPS. The reference to "location of an aeroplane in distress" was preferred as opposed to "autonomous distress tracking" so that the aeroplane systems may be used to trigger the distress tracking system and to keep providing position information. If the distress tracking system needs to be fully autonomous, then the system needs to operate independently of the aircraft systems and to incorporate such functions as power supply, navigation, transmission and triggering, all of which have a cost implication. In the case where the aircraft has suffered an electrical power failure, the system will need power for, in some cases, an extended flight. Triggering the distress tracking system needs to be automatic but may also be manual. It is proposed to have the triggering criteria contained in the appendix to this provision. The triggering criteria would best be in a EUROCAE Minimum Aviation System Performance Specifications (MASPS) and reference needs to be made to such MASPS in Table XX-1 of the proposed Appendix XX to address this issue. Concurrent to this amendment proposal, EUROCAE are working on Minimum Aviation System Performance Specification (MASPS) ED–XX which will be available prior to the adoption of the proposed provisions. The contents of the table will be inserted as soon as the EUROCAE MASPS is published, which is scheduled for January 2016. The operator shall make position information available to search coordination centres. Reference is made to Annex 11 — *Air Traffic Services* regarding the definition of an aircraft being in distress. It also makes reference to information

	flow and ground-based facilities. The current automatic fixed ELTs are not considered to be an acceptable means in locating a wreckage, mainly due to their design to operate after a survivable accident when lives need to be saved. On the other hand, should the aircraft sink below the water surface, the ELT's signal is unable to be received. In the case of manual deployment of a deployable ELT, by experience, it was found that in some cases the ELT was manually deployed and the wreckage located some distance away.

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ATTACHMENT C to State letter SP 55/4-15/15

PROPOSED AMENDMENT TO ANNEX 6, PART II

NOTES ON THE PRESENTATION OF THE PROPOSED AMENDMENT

The text of the amendment is arranged to show deleted text with a line through it and new text highlighted with grey shading, as shown below:

1.	~~Text to be deleted is shown with a line through it.~~	text to be deleted
2.	New text to be inserted is highlighted with grey shading.	new text to be inserted
3.	~~Text to be deleted is shown with a line through it~~ followed by the replacement text which is highlighted with grey shading.	new text to replace existing text

PROPOSED AMENDMENT TO

INTERNATIONAL STANDARDS AND RECOMMENDED PRACTICES

OPERATION OF AIRCRAFT

ANNEX 6
TO THE CONVENTION ON INTERNATIONAL CIVIL AVIATION

PART II
INTERNATIONAL GENERAL AVIATION — AEROPLANES

SECTION 3
LARGE AND TURBOJET AEROPLANES

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CHAPTER 3.6 AEROPLANE INSTRUMENTS, EQUIPMENT AND FLIGHT DOCUMENTS

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3.6.3.2.2 *Duration*

3.6.3.2.2.1 All aeroplanes of a maximum certificated take-off mass of over 27 000 kg for which the individual certificate of airworthiness is first issued on or after 1 January 2021 shall be equipped with a CVR capable of retaining the information recorded during at least the last twenty-five hours of its operation.

. . .

Origin:	**Rationale:**
FLIRECP/7	The value of CVR recordings for the analysis of human factors and different sounds cannot be emphasized enough and the technology exists to increase the duration of recordings. Several safety recommendations have been addressed to ICAO to extend the duration of CVRs beyond the present two-hour duration. An incident might occur during take-off but due to the flight being longer than two hours, the CVR recordings would not cover the take-off phase, which would be a valuable tool for the investigations. A robust solution would be to extend the CVR recording duration to twenty-five hours, which would include a long-haul flight, its pre-flight and post-flight crew activities. It is expected that long-haul flights may extend to nineteen hours. It was estimated that a CVR with a recording duration of twenty-five hours would cover all flights in the foreseeable future, including the pre-flight activities and post-flight activities. Furthermore, the proposed amendment allows for harmonization with FDR duration requirements.

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ATTACHMENT D to State letter SP 55/4-15/15

PROPOSED AMENDMENT TO ANNEX 6, PART III

NOTES ON THE PRESENTATION OF THE PROPOSED AMENDMENT

The text of the amendment is arranged to show deleted text with a line through it and new text highlighted with grey shading, as shown below:

1.	~~Text to be deleted is shown with a line through it.~~	text to be deleted
2.	New text to be inserted is highlighted with grey shading.	new text to be inserted
3.	~~Text to be deleted is shown with a line through it~~ followed by the replacement text which is highlighted with grey shading.	new text to replace existing text

PROPOSED AMENDMENT TO

INTERNATIONAL STANDARDS AND RECOMMENDED PRACTICES

OPERATION OF AIRCRAFT

ANNEX 6 TO THE CONVENTION ON INTERNATIONAL CIVIL AVIATION

PART III INTERNATIONAL OPERATIONS — HELICOPTERS

SECTION II INTERNATIONAL COMMERCIAL AIR TRANSPORT

APPENDIX 4. FLIGHT RECORDERS

. . .

4. Airborne image recorder (AIR) and airborne image recording system (AIRS)

4.1 Classes

4.1.1 A Class A AIR or AIRS captures the general cockpit area in order to provide data supplemental to conventional flight recorders.

. . .

Note 2.— There are no provisions for Class A AIRs or AIRS in this document.

4.1.2 A Class B AIR or AIRS captures data link message displays.

4.1.3 A Class C AIR or AIRS captures instruments and control panels.

Note.— A Class C AIR or AIRS may be considered as a means for recording flight data where it is not practical or is prohibitively expensive to record on an FDR, or where an FDR is not required.

4.2 Operation

The AIR or AIRS shall ~~will~~ start to record prior to the helicopter moving under its own power and record continuously until the termination of the flight when the helicopter is no longer capable of moving under its own power. In addition, depending on the availability of electrical power, the AIR or AIRS shall ~~will~~ 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.

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Origin:	**Rationale:**
FLIRECP/7	Amendment to Appendix 4, Section 4 is proposed in order to align the text with Parts I and II.

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