



## AERONAUTICAL CIRCULAR CIVIL AVIATION AUTHORITY – MACAO, CHINA

### SUBJECT:

#### Flight Recorders

### EFFECTIVE DATE:

03 November 2022

### CANCELLATION:

This Aeronautical Circular (AC) supersedes AC no. AC/AW/023R08 dated 15 December 2020.

### GENERAL:

The President of Civil Aviation Authority, in exercise of his power under article 35 of the Statutes of Civil Aviation Authority approved by the Decree-Law 10/91/M and paragraph 89 of the Air Navigation Regulation of Macao (ANRM), established this Aeronautical Circular.

#### 1. Introduction

- 1.1. Pursuant to paragraph 38, and paragraphs 4(1)(k)(i), 4(1)(q), 4(2)(l), 4(2)(s) and Scale P of the Fifth Schedule of the ANRM, this AC prescribes the requirements of flight recorders.
- 1.2. Following the adoption of amendment 47 to the Annex 6 Part I, amendment 40 to Annex 6 Part II and amendment 24 to Annex 6 Part III to the Convention on International Civil Aviation by the International Civil Aviation Organization (ICAO) updating the provision related to flight recorders, this AC is revised to effect promulgation of the relevant requirements.
- 1.3. The operator, or the registered owner of the aircraft as the case may be, of a Macao registered aircraft shall ensure that the aircraft is equipped with the flight recorders in accordance with the requirements specified in ANRM and this AC.
- 1.4. The operator, or the registered owner of the aircraft as the case may be, of a Macao registered aircraft shall ensure that the flight recorders installed on the aircraft are maintained and operated in accordance with the requirements specified in the ANRM and this AC.

#### 2. Requirements for aeroplanes flying for the purpose of commercial air transport

*Note 1: Crash-protected flight recorders comprise one or more of the following systems:*

- a flight data recorder (FDR),

- a cockpit voice recorder (CVR),
- an airborne image recorder (AIR),
- a data link recorder (DLR).

*As per Appendix 1 of this AC, image and data link information may be recorded on either the CVR or the FDR.*

*Note 2: Lightweight flight recorders comprise one or more of the following systems:*

- an aircraft data recording system (ADRS),
- a cockpit audio recording system (CARS),
- an airborne image recording system (AIRS),
- a data link recording system (DLRS).

*As per Appendix 1 of this AC, image and data link information may be recorded on either the CARS or the ADRS.*

*Note 3: Detailed requirements on flight recorders for aeroplanes flying for the purpose of commercial air transport are contained in Appendix 1 of this AC.*

*Note 4: For aeroplanes for which the application for type certification is submitted to a Contracting State before 1 January 2016, specifications applicable to crash-protected flight recorders may be found in EUROCAE ED-112, ED-56A, ED-55, Minimum Operational Performance Specifications (MOPS), or earlier equivalent documents.*

*Note 5: For aeroplanes for which the application for type certification is submitted to a Contracting State on or after 1 January 2016, specifications applicable to crash-protected flight recorders may be found in EUROCAE ED-112A, Minimum Operational Performance Specification (MOPS), or equivalent documents.*

*Note 6: Specifications applicable to lightweight flight recorders may be found in EUROCAE ED 155, Minimum Operational Performance Specification (MOPS), or equivalent documents.*

*Note 7: “The application for type certification is submitted to a Contracting State” refers to the date of application of the original “Type Certificate” for the aeroplane type, not the date of certification of particular aeroplane variants or derivative models.*

## 2.1. Flight data recorders (FDR) and aircraft data recording systems (ADRS)

*Note: Parameters to be recorded are listed in Tables A1-1 and A1-3 of Appendix 1 of this AC.*

### 2.1.1. Applicability

- (a) All turbine-engined aeroplanes of a maximum certificated take-off mass of 5,700kg or less for which the individual certificate of airworthiness is first issued on or after 1 January 2016, shall be equipped with:
  - (1) an FDR which shall record at least the first 16 parameters listed in Table A1-1 of Appendix 1 of this AC; or
  - (2) a Class C AIR or AIRS which shall record at least the flight path and speed parameters displayed to the pilot(s), as defined in paragraph 2.2.3 of Appendix 1 of this AC; or

- (3) an ADRS which shall record at least the first 7 parameters listed in Table A1-3 of Appendix 1 of this AC.

*Note: AIR or AIRS classification is defined in 6.2 of Appendix 1 of this AC.*

- (b) 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 1989 shall be equipped with an FDR which shall record at least the first 32 parameters listed in Table A1-1 of Appendix 1 of this AC.
- (c) All aeroplanes of a maximum certificated take-off mass of over 5,700 kg, up to and including 27,000 kg, for which the individual certificate of airworthiness is first issued on or after 1 January 1989, shall be equipped with an FDR which shall record at least the first 16 parameters listed in Table A1-1 of Appendix 1 of this AC.
- (d) All multi-engined turbine-engined aeroplanes of a maximum certificated take-off mass of 5,700 kg or less for which the individual certificate of airworthiness is first issued on or after 1 January 1990 shall be equipped with an FDR which shall record at least the first 16 parameters listed in Table A1-1 of Appendix 1 of this AC.
- (e) All turbine-engined aeroplanes, for which the individual certificate of airworthiness was first issued before 1 January 1989, with a maximum certificated take-off mass of over 5,700 kg, except those in paragraph 2.1.1 (g) of this AC, shall be equipped with an FDR which shall record at least the first 5 parameters listed in Table A1-1 of Appendix 1 of this AC.
- (f) All turbine-engined aeroplanes, for which the individual certificate of airworthiness was first issued on or after 1 January 1987 but before 1 January 1989, with a maximum certificated take-off mass of over 5,700 kg, except those in 2.1.1 (g) of this AC, shall be equipped with an FDR which shall record at least the first 9 parameters listed in Table A1-1 of Appendix 1 of this AC.
- (g) All turbine-engined aeroplanes, for which the individual certificate of airworthiness was first issued on or after 1 January 1987 but before 1 January 1989, with a maximum certificated take-off mass of over 27,000 kg that are of types of which the prototype was certificated by the appropriate national authority after 30 September 1969 shall be equipped with an FDR which shall record at least the first 16 parameters listed in Table A1-1 of Appendix 1 of this AC.
- (h) All turbine-engined aeroplanes, for which the individual certificate of airworthiness was first issued before 1 January 1987, with a maximum certificated take-off mass of over 27,000 kg that are of types of which the prototype was certificated by the appropriate national authority after 30 September 1969 shall be equipped with an FDR which shall record, in addition to the first 5 parameters listed in Table A1-1 of Appendix 1 of this AC, such additional parameters as are necessary to meet the objectives of determining:

- (1) the attitude of the aeroplane in achieving its flight path; and
  - (2) the basic forces acting upon the aeroplane resulting in the achieved flight path and the origin of such basic forces.
- (i) All aeroplanes of a maximum certificated take-off mass of over 5,700 kg for which the individual certificate of airworthiness is first issued after 1 January 2005 shall be equipped with an FDR which shall record at least the first 78 parameters listed in Table A1-1 of Appendix 1 of this AC.
  - (j) 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 2023 shall be equipped with an FDR capable of recording at least the 82 parameters listed in Table A1-1 of Appendix 1 of this AC.

#### 2.1.2. Recording technology

FDRs or ADRS shall not use engraving metal foil, frequency modulation (FM), photographic film or magnetic tape.

#### 2.1.3. Duration

All FDRs shall retain the information recorded during at least the last 25 hours of their operation, with the exception of those installed on aeroplanes referenced in paragraph 2.1.1 (d) of this AC for which the FDR shall retain the information recorded during at least the last 30 minutes of its operation, and, in addition, sufficient information from the preceding take-off for calibration purposes.

### 2.2. Cockpit voice recorders (CVR) and cockpit audio recording systems (CARS)

#### 2.2.1. Applicability

- (a) All turbine-engined aeroplanes of a maximum certificated take-off mass of 5,700 kg or less for which the individual certificate of airworthiness is first issued on or after 1 January 2016 and required to be operated by more than one pilot shall be equipped with either a CVR or a CARS.
- (b) 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 1987 shall be equipped with a CVR.
- (c) All turbine-engined aeroplanes, for which the individual certificate of airworthiness was first issued before 1 January 1987, with a maximum certificated take-off mass of over 27,000 kg that are of types of which the prototype was certificated by the appropriate national authority after 30 September 1969 shall be equipped with a CVR.

- (d) All turbine-engined aeroplanes, for which the individual certificate of airworthiness was first issued before 1 January 1987, with a maximum certificated take-off mass of over 5,700 kg up to and including 27,000 kg that are of types of which the prototype was certificated by the appropriate national authority after 30 September 1969 shall be equipped with a CVR.

#### 2.2.2. Recording technology

CVRs and CARS shall not use magnetic tape or wire.

#### 2.2.3. Duration

- (a) All CVRs shall be capable of retaining the information recorded during at least the last 2 hours of their operation.
- (b) 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 2022 shall be equipped with a CVR which shall retain the information recorded during at least the last 25 hours of its operation.
- (c) All aeroplanes that are required to be equipped with CARS, and for which the individual certificate of airworthiness is first issued on or after 1 January 2025, shall be equipped with a CARS which shall retain the information recorded during at least the last two hours of their operation.

#### 2.2.4. Cockpit voice recorder alternate power source

- (a) An alternate power source shall automatically engage and provide 10 minutes, plus or minus one minute, of operation whenever aeroplane power to the recorder ceases, either by normal shutdown or by any other loss of power. The alternate power source shall power the CVR and its associated cockpit area microphone components. The CVR shall be located as close as practicable to the alternate power source.

*Note 1: "Alternate" means separate from the power source that normally provides power to the CVR. The use of aeroplane batteries or other power sources is acceptable provided that the requirements above are met and electrical power to essential and critical loads is not compromised.*

*Note 2: When the CVR function is combined with other recording functions within the same unit, powering the other functions is allowed.*

- (b) 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 2018 shall be provided with an alternate power source, as defined in paragraph 2.2.4 (a), that powers at least one CVR.

## 2.3. Data link recorders (DLR)

### 2.3.1. Applicability

- (a) All aeroplanes for which the individual certificate of airworthiness is first issued on or after 1 January 2016, which use any of the data link communications applications referred to in paragraph 5.1.2 of Appendix 1 of this AC and are required to carry a CVR, shall record the data link communications message on a crash-protected flight recorder.
- (b) All aeroplanes for which the individual certificate of airworthiness was first issued before 1 January 2016, that are required to carry a CVR and are modified on or after 1 January 2016 to use any of the data link communications applications referred to in paragraph 5.1.2 of Appendix 1 of this AC, shall record the data link communications message on a crash-protected flight recorder unless the installed data link communications equipment is compliant with a type certificate issued or aircraft modification first approved prior to 1 January 2016.

*Note 1: A Class B AIR could be a means for recording data link communications applications messages to and from the aeroplanes where it is not practical or is prohibitively expensive to record those data link communications applications messages on FDR or CVR.*

*Note 2: The “aircraft modifications” refer to modifications to install the data link communications equipment on the aircraft (e.g. structural, wiring).*

### 2.3.2. Duration

The minimum recording duration of data link recording shall be equal to the duration of the CVR.

### 2.3.3. Correlation

Data link recording shall be able to be correlated to the recorded cockpit audio.

## 2.4. Flight crew-machine interface recordings

### 2.4.1. Applicability

All aeroplanes of a maximum take-off mass of over 5,700 kg for which the application for type certification is submitted to a Contracting State on or after 1 January 2023 shall be equipped with a crash-protected flight recorder which shall record the information displayed to the flight crew from electronic displays, as well as the operation of switches and selectors by the flight crew as defined in Appendix 1 of this AC.

#### 2.4.2. Duration

The minimum flight crew-machine interface recording duration shall be at least for the last 2 hours.

#### 2.4.3. Correlation

Flight crew-machine interface recordings shall be able to be correlated to the recorded cockpit audio.

#### 2.5. Combination recorders

- (a) All aeroplanes of a maximum certificated take-off mass of over 5,700 kg up to and including 15,000 kg for which the application for type certification is submitted to a Contracting State on or after 1 January 2016, and which are required to be equipped with both a CVR and an FDR, shall be equipped with two combination recorders (FDR/CVR).
- (b) All aeroplanes of a maximum certificated take-off mass of over 15,000 kg for which the application for type certification is submitted to a Contracting State on or after 1 January 2016 and which are required to be equipped with both a CVR and an FDR, shall be equipped with two combination recorders (FDR/CVR). One recorder shall be located as close to the cockpit as practicable and the other recorder located as far aft as practicable.
- (c) All aeroplanes of a maximum certificated take-off mass over 5,700 kg, or which the application for type certification is submitted to a Contracting State before 1 January 2016, required to be equipped with an FDR and a CVR, may alternatively be equipped with two combination recorders (FDR/CVR).
- (d) All multi-engined turbine-powered aeroplanes of a maximum certificated take-off mass of 5,700 kg or less, required to be equipped with an FDR and/or a CVR, may alternatively be equipped with one combination recorder (FDR/CVR).

*Note: The requirement of 2.5 may be satisfied by equipping the aeroplanes with two combination recorders (one forward and one aft) or separate devices.*

#### 2.6. Flight recorder data recovery

- (a) 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 means approved by the AACM, to recover flight recorder data and make it available in a timely manner.
- (b) The following shall be taken into account when designing the means to make flight recorder data available in a timely manner:



- (1) the capabilities of the operator;
- (2) overall capability of the aeroplane and its systems as certified by the State of Design;
- (3) the reliability of the means to recover the appropriate CVR channels and appropriate FDR data; and
- (4) specific mitigation measures.

### 3. Requirements for aeroplanes flying for purpose other than commercial air transport

*Note 1: Crash-protected flight recorders comprise one or more of the following:*

- a flight data recorder (FDR),
- a cockpit voice recorder (CVR),
- an airborne image recorder (AIR),
- a data link recorder (DLR).

*As per Appendix 2 of this AC, image and data link information may be recorded on either the CVR or the FDR.*

*Note 2: Lightweight flight recorders comprise one or more of the following:*

- an aircraft data recording system (ADRS),
- a cockpit audio recording system (CARS),
- an airborne image recording system (AIRS),
- a data link recording system (DLRS).

*As per Appendix 2 of this AC, image and data link information may be recorded on either the CARS or the ADRS.*

*Note 3: “The application for type certification is submitted to a Contracting State” refers to the date of application of the original “Type Certificate” for the aeroplane type, not the date of certification of particular aeroplane variants or derivative models.*

*Note 4: Detailed requirements on flight recorders for aeroplane flying for purpose other than commercial air transport are contained in Appendix 2 of this AC.*

*Note 5: For aeroplanes for which the application for type certification is submitted to a Contracting State before 1 January 2016, specifications applicable to crash-protected flight recorders may be found in EUROCAE ED-112, ED-56A, ED-55, Minimum Operational Performance Specifications (MOPS), or earlier equivalent documents.*

*Note 6: For aeroplanes for which the application for type certification is submitted to a Contracting State on or after 1 January 2016, specifications applicable to crash-protected flight recorders may be found in EUROCAE ED-112A, Minimum Operational Performance Specification (MOPS), or equivalent documents.*

*Note 7: Specifications applicable to lightweight flight recorders may be found in EUROCAE ED 155, Minimum Operational Performance Specification (MOPS), or equivalent documents.*

#### 3.1. Flight data recorders (FDR) and aircraft data recording systems (ADRS)

*Note: Parameters to be recorded are listed in Tables A2-1 and A2-3 of Appendix 2 of this AC.*



### 3.1.1. Applicability

- (a) All turbine-engined aeroplanes of a maximum certificated take-off mass of 5,700 kg or less for which the individual certificate of airworthiness is first issued on or after 1 January 2016 shall be equipped with:
- (1) an FDR which shall record at least the first 16 parameters in Tables A2-1 of Appendix 2 of this AC; or
  - (2) a Class C AIR or AIRS which shall record at least the flight path and speed parameters displayed to the pilot(s), as defined in 2.2.2 of Appendix 2 of this AC; or
  - (3) an ADRS capable of recording the essential parameters defined in Table A2-3 of Appendix 2.3 of ICAO Annex 6 Part II.

*Note: AIR or AIRS classification is defined in 4.1 of Appendix 2 of this AC.*

- (b) 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 2023 shall be equipped with an FDR capable of recording at least the 82 parameters listed in Table A2-1 of Appendix 2 of this AC.
- (c) 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 2005 shall be equipped with an FDR which shall record at least 78 parameters listed in Table A2-1 of Appendix 2 of this AC.
- (d) 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 1989 shall be equipped with an FDR which shall record at least the first 32 parameters listed in Table A2-1 of Appendix 2 of this AC.
- (e) All aeroplanes of a maximum certificated take-off mass of over 5,700 kg, up to and including 27,000 kg, for which the individual certificate of airworthiness is first issued on or after 1 January 1989 shall be equipped with an FDR which shall record at least the first 16 parameters listed in Table A2-1 of Appendix 2 of this AC.

### 3.1.2. Recording technology

FDRs, ADRS, AIRs or AIRS shall not use engraving metal foil, frequency modulation (FM), photographic film or magnetic tape.

### 3.1.3. Duration

All FDRs shall retain the information recorded during at least the last 25 hours of their operation.

## 3.2. Cockpit voice recorders (CVR) and cockpit audio recording systems (CARS)

### 3.2.1. Applicability

- (a) All turbine-engined aeroplanes with a seating configuration of more than five passenger seats and of a maximum certificated take-off mass of 5 700 kg or less for which the individual certificate of airworthiness is first issued on or after 1 January 2016 and required to be operated by more than one pilot shall be equipped with either a CVR or a CARS.
- (b) All turbine-engined aeroplanes of a maximum certificated take-off mass of over 5,700 kg for which the application for type certification is submitted to a Contracting State on or after 1 January 2016 and required to be operated by more than one pilot shall be equipped with a CVR.
- (c) 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 1987, shall be equipped with a CVR.

### 3.2.2. Recording technology

CVRs and CARs shall not use magnetic tape or wire.

### 3.2.3. Duration

- (a) All CVRs shall be capable of retaining the information recorded during at least the last 2 hours of their operation.
- (b) 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 2022 shall be equipped with a CVR capable of retaining the information recorded during at least the last 25 hours of its operation.
- (c) All aeroplanes that are required to be equipped with CARS, and for which the individual certificate of airworthiness is first issued on or after 1 January 2025, shall be equipped with a CARS which shall retain the information recorded during at least the last two hours of their operation.

### 3.3. Data link recorders (DLR)

#### 3.3.1. Applicability

- (a) All aeroplanes for which the individual certificate of airworthiness is first issued on or after 1 January 2016, which use any of the data link communications applications referred to in paragraph 5.1.2 of Appendix 2 of this AC and are required to carry a CVR, shall record the data link communications message on a crash-protected flight recorder.
- (b) All aeroplanes for which the individual certificate of airworthiness was first issued before 1 January 2016, that are required to carry a CVR and are modified on or after 1 January 2016 to install and use any of the data link communications applications referred to in paragraph 5.1.2 of Appendix 2 of this AC, shall record the data link communications messages on a crash-protected flight recorder unless the installed data link communications equipment is compliant with a type certificate issued or aircraft modification first approved prior to 1 January 2016.

*Note 1: A Class B AIR could be a means for recording data link communications applications messages to and from the aeroplanes where it is not practical or is prohibitively expensive to record those data link communications applications messages on FDR or CVR.*

*Note 2: The “aircraft modifications” refer to modifications to install the data link communications equipment on the aircraft (e.g. structural, wiring).*

#### 3.3.2. Duration

The minimum recording duration of data link recording shall be equal to the duration of the CVR.

#### 3.3.3. Correlation

Data link recording shall be able to be correlated to the recorded cockpit audio.

### 3.4. Combination recorders

All aeroplanes of a maximum certificated take-off mass over 5,700 kg, required to be equipped with an FDR and a CVR, may alternatively be equipped with two combination recorders (FDR/CVR).

## 4. Requirements for helicopters flying for the purpose of commercial air transport

*Note 1: Crash-protected flight recorders comprise one or more of the following:*

- a flight data recorder (FDR),
- a cockpit voice recorder (CVR),
- an airborne image recorder (AIR),
- a data link recorder (DLR).

*As per Appendix 3 of this AC, image and data link information may be recorded on either the CVR or the FDR.*

*Note 2: Combination recorders (FDR/CVR) may be used to meet the flight recorder equipage requirements in paragraph 4 of this AC.*

*Note 3: Detailed requirements on flight recorders for helicopters are contained in Appendix 3 of this AC.*

*Note 4: Lightweight flight recorders comprise one or more of the following:*

- an aircraft data recording system (ADRS),*
- a cockpit audio recording system (CARS),*
- an airborne image recording system (AIRS),*
- a data link recording system (DLRS).*

*As per Appendix 3 of this AC, image and data link information may be recorded on either the CARS or the ADRS.*

*Note 5: For helicopters for which the application for type certification is submitted to a Contracting State before 1 January 2016, specifications applicable to crash-protected flight recorders may be found in EUROCAE ED-112, ED-56A, ED-55, Minimum Operational Performance Specifications (MOPS), or earlier equivalent documents.*

*Note 6: For helicopters for which the application for type certification is submitted to a Contracting State on or after 1 January 2016, specifications applicable to crash-protected flight recorders may be found in EUROCAE ED-112A, Minimum Operational Performance Specification (MOPS), or equivalent documents.*

*Note 7: Specification applicable to lightweight flight recorders may be found in the EUROCAE ED-155, Minimum Operational Performance Specification (MOPS), or equivalent documents.*

*Note 8: “The application for type certification is submitted to a Contracting State” refers to the date of application of the original “Type Certificate” for the helicopter type, not the date of certification of particular helicopter variants or derivative models.*

#### 4.1. Flight data recorders (FDR) and aircraft data recording systems (ADRS)

*Note: Parameters to be recorded are listed in Table A3-1 of Appendix 3 of this AC.*

##### 4.1.1. Applicability

- (a) All helicopters of a maximum certificated take-off mass of over 3,175 kg for which the individual certificate of airworthiness is first issued on or after 1 January 2016 shall be equipped with an FDR which shall record at least the first 48 parameters listed in Table A3-1 of Appendix 3 of this AC.
- (b) All helicopters of a maximum certificated take-off mass of over 7,000 kg, or having a passenger seating configuration of more than nineteen, for which the individual certificate of airworthiness is first issued on or after 1 January 1989 shall be equipped with an FDR which shall record at least the first 30 parameters listed in Table A3-1 of Appendix 3 of this AC.

- (c) All helicopters of a maximum certificated take-off mass of over 3,175 kg, up to and including 7,000 kg, for which the individual certificate of airworthiness is first issued on or after 1 January 1989, shall be equipped with an FDR which shall record at least the first 15 parameters listed in Table A3-1 of Appendix 3 of this AC.
- (d) All helicopters of a maximum certificated take-off mass of 3,175 kg or less for which the individual certificate of airworthiness is first issued on or after 1 January 2018 shall be equipped with:
  - (1) an FDR which shall record at least the first 48 parameters listed in Table A3-1 of Appendix 3 of this AC; or
  - (2) a Class C AIR or AIRS which shall record at least the flight path and speed parameters displayed to the pilot(s), as defined in Appendix 3 of this AC; or
  - (3) an ADRS which shall record the first 7 parameters listed in Table A3-3 of Appendix 3 of this AC.

*Note: AIR or AIRS classification is defined in 4.1 of Appendix 3 of this AC.*

- (e) All helicopters of a maximum certificated take-off mass of over 3,175 kg for which the individual certificate of airworthiness is first issued on or after 1 January 2023 shall be equipped with an FDR capable of recording at least the first 53 parameters listed in Table A3-1 of Appendix 3 of this AC.

#### 4.1.2. Recording technology

FDRs, ADRS, AIRs or AIRS shall not use engraving metal foil, frequency modulation (FM), photographic film or magnetic tape.

#### 4.1.3. Duration

All FDRs shall retain the information recorded during at least the last 10 hours of their operation.

### 4.2. Cockpit voice recorders (CVR)

#### 4.2.1. Applicability

- (a) All helicopters of a maximum certificated take-off mass of over 7,000 kg shall be equipped with a CVR. For helicopters not equipped with an FDR, at least main rotor speed shall be recorded on the CVR.
- (b) All helicopters of a maximum certificated take-off mass of over 3,175 kg, up to and including 7,000 kg for which the individual certificate of airworthiness is first issued on

or after 1 January 1987 shall be equipped with a CVR. For helicopters not equipped with an FDR, at least main rotor speed shall be recorded on the CVR.

#### 4.2.2. Recording technology

CVRs and CARS shall not use magnetic tape or wire.

#### 4.2.3. Duration

All helicopters required to be equipped with a CVR shall be equipped with a CVR which shall retain the information recorded during the last 2 hours of its operation.

### 4.3. Data link recorders (DLR)

#### 4.3.1. Applicability

- (a) All helicopters for which the individual certificate of airworthiness is first issued on or after 1 January 2016, which use any of the data link communications applications referred to in paragraph 5.1.2 of Appendix 3 of this AC and are required to carry a CVR, shall record the data link communications messages on a crash-protected flight recorder.
- (b) All helicopters for which the individual certificate of airworthiness was first issued before 1 January 2016, that are required to carry a CVR and are modified on or after 1 January 2016 to install and use any of the data link communications applications referred to in paragraph 5.1.2 of Appendix 3 of this AC, shall record the data link communications messages on a crash-protected flight recorder unless the installed data link communications equipment is compliant with a type design or aircraft modification first approved prior to 1 January 2016.

*Note 1: A Class B AIR could be a means for recording data link communications applications messages to and from the helicopters where it is not practical or is prohibitively expensive to record those data link communications applications messages on FDR or CVR.*

*Note 2: The “aircraft modifications” refer to modifications to install the data link communications equipment on the aircraft (e.g. structural, wiring).*

#### 4.3.2. Duration

The minimum recording duration of data link recording shall be equal to the duration of the CVR.

#### 4.3.3. Correlation

Data link recording shall be able to be correlated to the recorded cockpit audio.

## 5. Requirements for helicopters flying for purpose other than commercial air transport

*Note 1: Crash-protected flight recorders comprise one or more of the following:*

- a flight data recorder (FDR),
- a cockpit voice recorder (CVR),
- an airborne image recorder (AIR),
- a data link recorder (DLR).

*As per Appendix 3 of this AC, image and data link information may be recorded on either the CVR or the FDR.*

*Note 2: Combination recorders (FDR/CVR) may be used to meet the flight recorder equipage requirements in paragraph 5 of this AC.*

*Note 3: Detailed requirements on flight recorders for helicopters are contained in Appendix 3 of this AC.*

*Note 4: Lightweight flight recorders comprise one or more of the following:*

- an aircraft data recording system (ADRS),
- a cockpit audio recording system (CARS),
- an airborne image recording system (AIRS),
- a data link recording system (DLRS).

*As per Appendix 3 of this AC, image and data link information may be recorded on either the CARS or the ADRS.*

*Note 5: For helicopters for which the application for type certification is submitted to a Contracting State before 1 January 2016, specifications applicable to crash-protected flight recorders may be found in EUROCAE ED-112, ED-56A, ED-55, Minimum Operational Performance Specifications (MOPS), or earlier equivalent documents.*

*Note 6: For helicopters for which the application for type certification is submitted to a Contracting State on or after 1 January 2016, specifications applicable to crash-protected flight recorders may be found in EUROCAE ED-112A, Minimum Operational Performance Specification (MOPS), or equivalent documents.*

*Note 7: Specification applicable to lightweight flight recorders may be found in the EUROCAE ED-155, Minimum Operational Performance Specification (MOPS), or equivalent documents.*

*Note 8: “The application for type certification is submitted to a Contracting State” refers to the date of application of the original “Type Certificate” for the helicopter type, not the date of certification of particular helicopter variants or derivative models.*

### 5.1. Flight data recorders (FDR) and aircraft data recording systems (ADRS)

*Note: Parameters to be recorded are listed in Table A3-1 of Appendix 3 of this AC.*

#### 5.1.1. Applicability

- (a) All helicopters of a maximum certificated take-off mass of over 3,175 kg for which the individual certificate of airworthiness is first issued on or after 1 January 2016 shall be equipped with an FDR which shall record at least the first 48 parameters listed in Table A3-1 of Appendix 3 of this AC.



- (b) All helicopters of a maximum certificated take-off mass of over 7,000 kg, or having a passenger seating configuration of more than nineteen, for which the individual certificate of airworthiness is first issued on or after 1 January 1989 shall be equipped with an FDR which shall record at least the first 30 parameters listed in Table A3-1 of Appendix 4 of Appendix 3 of this AC.
- (c) All helicopters of a maximum certificated take-off mass of over 3,175 kg, up to and including 7,000 kg, for which the individual certificate of airworthiness is first issued on or after 1 January 1989, shall be equipped with an FDR which shall record at least the first 15 parameters listed in Table A3-1 of Appendix 3 of this AC.

#### 5.1.2. Recording technology

FDRs shall not use engraving metal foil, frequency modulation (FM), photographic film or magnetic tape.

#### 5.1.3. Duration

All FDRs shall retain the information recorded during at least the last 10 hours of their operation.

### 5.2. Cockpit voice recorders (CVR) and cockpit audio recording systems (CARS)

#### 5.2.1. Applicability

- (a) All helicopters of a maximum certificated take-off mass of over 7,000 kg shall be equipped with a CVR. For helicopters not equipped with an FDR, at least main rotor speed shall be recorded on the CVR.
- (b) All helicopters of a maximum certificated take-off mass of over 3,175 kg, up to and including 7,000 kg, for which the individual certificate of airworthiness is first issued on or after 1 January 1987 shall be equipped with a CVR. For helicopters not equipped with an FDR, at least main rotor speed shall be recorded on the CVR.

#### 5.2.2. Recording technology

CVRs shall not use magnetic tape or wire.

#### 5.2.3. Duration

All helicopters required to be equipped with a CVR shall be equipped with a CVR which shall retain the information recorded during at least the last 2 hours of its operation.

### 5.3. Data link recorders (DLR)

#### 5.3.1. Applicability

- (a) All helicopters for which the individual certificate of airworthiness is first issued on or after 1 January 2016, which use any of the data link communications applications referred to in 5.1.2 of Appendix 3 of this AC and are required to carry a CVR, shall record the data link communications messages on a crash-protected flight recorder.
- (b) All helicopters for which the individual certificate of airworthiness was first issued before 1 January 2016, that are required to carry a CVR and are modified on or after 1 January 2016 to install and use any of the data link communications applications referred to in 5.1.2 of Appendix 3 of this AC and are required to carry a CVR, shall record the data link communications messages on a crash-protected flight recorder unless the data link communications equipment is compliant with a type design or aircraft modification first approved prior to 1 January 2016.

*Note 1: A Class B AIR could be a means for recording data link communications applications messages to and from the helicopters where it is not practical or is prohibitively expensive to record those data link communications applications messages on FDR or CVR.*

*Note 2: The “aircraft modifications” refer to modifications to install the data link communications equipment on the aircraft (e.g. structural, wiring).*

#### 5.3.2. Duration

The minimum recording duration shall be equal to the duration of the CVR.

#### 5.3.3. Correlation

Data link recording shall be able to be correlated to the recorded cockpit audio.

## 6. General requirements for flight recorders

### 6.1. Construction and installation

Flight recorders shall be constructed, located and installed so as to provide maximum practical protection for the recordings in order that the recorded information may be preserved, recovered and transcribed. Flight recorders shall meet the prescribed crashworthiness and fire protection specifications.

### 6.2. Flight recorder electronic documentation

- 6.2.1. The operator, or the registered owner of the aircraft as the case may be, of an aircraft shall provide the documentation requirement concerning FDR parameters and/or ADRS parameters,

as applicable, to the AACM, within 14 days after the aircraft being registered in Macao. Such documentation shall be in electronic format and take account of industry specifications.

*Note: Industry specification for documentation concerning flight recorder parameters may be found in the ARINC 647A, Flight Recorder Electronic Documentation, or equivalent document.*

- 6.2.2. If there is change to the abovementioned documentation, the operator, or the owner as the case may be, shall provide the updated documentation to the AACM, within 14 days after the change becomes effective on the aircraft.

## **7. Inspections of flight recorder systems**

- 7.1. 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.
- 7.2. FDR systems or ADRS, CVR systems or CARS and AIR systems or AIRS shall have recording inspection intervals of one year. DLR systems or DLRS shall have recording system inspection intervals of two years.
- 7.3. Recording inspections shall be carried out as follows:
- (a) an analysis of the recorded data from the flight recorders shall ensure that the recorder operates correctly for the nominal duration of the recording;
  - (b) a complete flight from the FDR or the ADRS recording from a complete flight shall be examined in engineering units to evaluate the validity of all recorded parameters. Particular attention shall be given to parameters from sensors dedicated to the FDR or the ADRS. Parameters taken from the aircraft's electrical bus system need not be checked if their serviceability can be detected by other aircraft systems;
  - (c) the readout facility shall have the necessary software to accurately convert the recorded values to engineering units and to determine the status of discrete signals;
  - (d) an examination of the recorded signal on the CVR or the CARS shall be carried out by replay of the CVR or CARS recording. While installed in the aircraft, the CVR or CARS shall record test signals from each aircraft source and from relevant external sources to ensure that all required signals meet intelligibility standards;
  - (e) where practicable, during the examination, a sample of in-flight recordings of the CVR or CARS shall be examined for evidence that the intelligibility of the signal is acceptable; and
  - (f) an examination of the recorded images on the AIR or AIRS shall be carried out by replay of the AIR or AIRS recording. While installed in the aircraft, the AIR or AIRS shall record

test images from each aircraft source and from relevant external sources to ensure that all required images meet recording quality standards.

- (g) an examination of the recorded messages on the DLR or DLRS shall be carried out by replay of the DLR or DLRS recording.

7.4. A flight recorder system shall be considered unserviceable if there is a significant period of poor quality data, unintelligible signals, or if one or more of the mandatory parameters is not recorded correctly.

7.5. A report of the recording system inspection shall be made available on request to AACM for monitoring purposes.

7.6. Calibration of the FDR system

- (a) for those parameters which have sensors dedicated only to the FDR and are not checked by other means, recalibration shall be carried out at an interval determined by the continuing airworthiness information for the FDR system. In the absence of such information, a recalibration shall be carried out at least every five years. The recalibration shall determine any discrepancies in the engineering conversion routines for the mandatory parameters and to ensure that parameters are being recorded within the calibration tolerances; and
- (b) when the parameters of altitude and airspeed are provided by sensors that are dedicated to the FDR system, there shall be a recalibration performed at an interval determined by the continuing airworthiness information for the FDR system. In the absence of such information, a recalibration shall be carried out at least every two years.

- END -

## **Appendix 1 Detailed requirements on flight recorders for aeroplanes flying for the purpose of commercial air transport**

The material in this Appendix concerns flight recorders intended for installation in aeroplanes flying for the purpose of commercial air transport.

Crash-protected flight recorders comprise one or more of the following:

- a flight data recorder (FDR),
- a cockpit voice recorder (CVR),
- an airborne image recorder (AIR),
- a data link recorder (DLR).

When image or data link information is required to be recorded on a crash-protected flight recorder, it is permissible to record it on either the CVR or the FDR.

Lightweight flight recorders comprise one or more of the following systems:

- an aircraft data recording system (ADRS),
- a cockpit audio recording system (CARS),
- an airborne image recording system (AIRS),
- a data link recording system (DLRS).

When image or data link information is required to be recorded on a lightweight flight recorder, it is permissible to record it on either the CARS or the ADRS.

### **1. General requirements**

1.1. Non-deployable flight recorder containers shall be painted a distinctive orange colour.

1.2. Non-deployable crash-protected flight recorder containers shall:

- (a) carry reflective material to facilitate their location; and
- (b) 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.

1.3. Automatic deployable flight recorder containers shall:

- (a) be painted a distinctive orange colour, however the surface visible from outside the aircraft may be of another colour;
- (b) carry reflective material to facilitate their location; and
- (c) have an integrated automatically activated ELT.

1.4. The flight recorder systems shall be installed so that:

- (a) the probability of damage to the recordings is minimized;
- (b) there is an aural or visual means for pre-flight checking that the flight recorder systems are operating properly; and
- (c) if the flight recorder systems have an erasure device, the installation shall be designed to prevent operation of the device during flight time or crash impact; and
- (d) for aeroplanes for which the individual certificate of airworthiness is first issued on or after 1 January 2023, a flight crew-operated erase function shall be provided on the flight deck which, when activated, modifies the recording of a CVR and AIR so that it cannot be retrieved using normal replay or copying techniques. The installation shall be designed to prevent activation during flight. In addition, the probability of an inadvertent activation of an erase function during an accident shall also be minimized.

*Note: The erase function is intended to prevent access to CVR and AIR recordings by normal replay or copying means, but would not prevent accident investigation authorities access to such recordings by specialized replay or copying techniques.*

- 1.5. The crash-protected flight recorders shall be installed so that they receive electrical power from a bus that provides the maximum reliability for operation of the flight recorders without jeopardizing service to essential or emergency loads.
- 1.6. The lightweight flight recorders shall be connected to a power source having the characteristics which ensure proper and reliable recording in the operational environment.
- 1.7. The flight recorder systems, when tested by methods approved by the appropriate certifying authority, shall be demonstrated to be suitable for the environmental extremes over which they are designed to operate.
- 1.8. Means shall be provided for an accurate time correlation between the flight recorder systems recordings.
- 1.9. The flight recorder system manufacturer shall provide the appropriate certifying authority with the following information in respect of the flight recorder systems:
- (a) manufacturer's operating instructions, equipment limitations and installation procedures;
  - (b) parameter origin or source and equations which relate counts to units of measurement;
  - (c) manufacturer's test reports; and
  - (d) detailed information to ensure the continued serviceability of the flight recorder system.

- 1.10. The holder of the airworthiness approval for the installation design of the flight recorder system shall make available the relevant continuing airworthiness information to the operator of the aeroplane to be incorporated in the continuing airworthiness maintenance programme. This continuing airworthiness information shall cover in detail all the tasks required to ensure the continued serviceability of the flight recorder system.

*Note 1: The flight recorder system is composed of the flight recorder as well as any dedicated sensors, hardware and software that provide information required per this Appendix.*

*Note 2: Conditions related to the continued serviceability of a flight recorder system are defined in paragraph 7 of this AC. The Manual on Flight Recorder System Maintenance (FRSM) (Doc 10104) provides guidance on maintenance tasks associated with flight recorder systems.*

## **2. Flight data recorder (FDR) and aircraft data recording systems (ADRS)**

### **2.1. Start and stop logic**

The FDR or ADRS shall start to record prior to the aeroplane moving under its own power and record continuously until the termination of the flight when the aeroplane is no longer capable of moving under its own power.

### **2.2. Parameters to be recorded**

*Note: In previous revision of AC no. AC/AW/023, types of recorders were defined to capture the first evolutions of FDRs.*

- 2.2.1. The parameters that satisfy the requirements for FDRs are listed in Table A1-1 of this Appendix. The number of parameters to be recorded shall depend on aeroplane complexity. The parameters without an asterisk (\*) are mandatory parameters which shall be recorded regardless of aeroplane complexity. In addition, the parameters designated by an asterisk (\*) shall be recorded if an information data source for the parameter is used by aeroplane systems or the flight crew to operate the aeroplane. However, other parameters may be substituted with due regard to the aeroplane type and the characteristics of the recording equipment.

- 2.2.2. If further FDR recording capacity is available, recording of the following additional information shall be considered:

(a) operational information from electronic display systems, such as electronic flight instrument systems (EFIS), electronic centralized aircraft monitor (ECAM) and engine indication and crew alerting system (EICAS). Use the following order of priority:

- (1) parameters selected by the flight crew relating to the desired flight path, e.g. barometric pressure setting, selected altitude, selected airspeed, decision height, and autoflight system engagement and mode indications if not recorded from another source;



- (2) display system selection/status, e.g. SECTOR, PLAN, ROSE, NAV, WXR, COMPOSITE, COPY, ETC.;
  - (3) warnings and alerts; and
  - (4) the identity of displayed pages for emergency procedures and checklists; and
- (b) retardation information including brake application for use in the investigation of landing overruns and rejected take-offs.

2.2.3. The parameters that satisfy the requirements for flight path and speed as displayed to the pilot(s) are listed below. The parameters without an (\*) are mandatory parameters which shall be recorded. In addition, the parameters designated by an (\*) shall be recorded if an information source for the parameter is displayed to the pilot and is practicable to record:

- Pressure altitude
- Indicated airspeed or calibrated airspeed
- Heading (primary flight crew reference)
- Pitch attitude
- Roll attitude
- Engine thrust/power
- Landing-gear status\*
- Total or outside air temperature\*
- Time\*
- Navigation data\*: drift angle, wind speed, wind direction, latitude/longitude
- Radio altitude\*

2.2.4. The parameters that satisfy the requirements for ADRS are the first 7 parameters listed in Table A1-3 of this Appendix.

2.2.5. If further ADRS recording capacity is available, the recording of any parameters from 8 onwards defined in Table A1-3 shall be considered.

### 2.3. Additional information

2.3.1. The measurement range, recording interval and accuracy of parameters on installed equipment shall be verified by methods approved by the appropriate certificating authority.

2.3.2. Documentation concerning parameter allocation, conversion equations, periodic calibration and other serviceability/maintenance information shall be maintained by the operator. The documentation needs to be sufficient to ensure that accident investigation authorities have the necessary information to read out the data in engineering units.

### **3. Cockpit voice recorder (CVR) and cockpit audio recording system (CARS)**

#### **3.1. Start and stop logic**

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

#### **3.2. Signals to be recorded**

##### **3.2.1. The CVR shall record simultaneously on four separate channels, or more, at least the following:**

- (a) voice communication transmitted from or received in the aeroplane by radio;
- (b) aural environment on the flight deck;
- (c) voice communication of flight crew members on the flight deck using the aeroplane's interphone system, if installed;
- (d) voice or audio signals identifying navigation or approach aids introduced in the headset or speaker; and
- (e) voice communication of flight crew members using the passenger address system, if installed.

##### **3.2.2. The preferred CVR audio allocation should be as follows:**

- (a) pilot-in-command audio panel;
- (b) co-pilot audio panel;
- (c) additional flight crew positions and time reference; and
- (d) cockpit area microphone.

##### **3.2.3. The CARS shall record simultaneously on two separate channels, or more, at least the following:**

- (a) voice communication transmitted from or received in the aeroplane by radio;
- (b) aural environment on the flight deck; and

- (c) voice communication of flight crew members on the flight deck using the aeroplane's interphone system, if installed.

3.2.4. The preferred CARS audio allocation should be as follows:

- (a) voice communication; and
- (b) aural environment on the flight deck.

#### **4. Automatic deployable flight recorder (ADFR)**

##### **4.1. Operation**

The following requirements shall apply to an ADFR:

- (a) deployment shall take place when the aeroplane structure has been significantly deformed;
- (b) deployment shall take place when an aeroplane sinks in water;
- (c) ADFR shall not be capable of manual deployment;
- (d) the ADFR shall be able to float on water;
- (e) the ADFR deployment shall not compromise the safe continuation of the flight;
- (f) the ADFR deployment shall not significantly reduce the chance of survival of the recorder and of successful transmission by its ELT;
- (g) the ADFR deployment shall not release more than one piece;
- (h) an alert shall be made to the flight crew when the ADFR is no longer captive to the aircraft;
- (i) the flight crew shall have no means to disable ADFR deployment when the aircraft is airborne;
- (j) 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
- (k) 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.

## 5. Data link recorder (DLR)

### 5.1. Applications to be recorded

- 5.1.1. Where the aircraft flight path is authorized or controlled through the use of data link messages, all data link messages, both uplinks (to the aircraft) and downlinks (from the aircraft), shall be recorded on the aircraft. As far as practicable, the time the messages were displayed to the flight crew and the time of the responses shall be recorded.

*Note: Sufficient information to derive the content of the data link communications message and the time the messages were displayed to the flight crew is needed to determine an accurate sequence of events on board the aircraft.*

- 5.1.2. Messages applying to the applications listed in Table A1-2 shall be recorded. Applications without the asterisk (\*) are mandatory applications which shall be recorded regardless of the system complexity. Applications with an (\*) shall be recorded only as far as is practicable given the architecture of the system.

## 6. Flight crew-machine interface recordings

### 6.1. Start and stop logic

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

### 6.2. Classes

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

*Note 1: To respect crew privacy, the cockpit area view may be designed as far as practical to exclude the head and shoulders of crew members whilst seated in their normal operating position.*

*Note 2: There are no provisions for Class A AIR or AIRS in this document.*

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

- 6.2.3. 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 an ADRS, or where an FDR is not required.*

### 6.3. Applications to be recorded

- 6.3.1. The operation of switches and selectors and the information displayed to the flight crew from electronic displays shall be captured by sensors or other electronic means.
- 6.3.2. The recording of operation of switches and selectors by the flight crew shall include the following:
- (a) any switch or selector that will affect the operation and the navigation of the aircraft; and
  - (b) selection of normal and alternate systems.
- 6.3.3. The recording of the information displayed to the flight crew from electronic displays shall include the following:
- (a) primary flight and navigation displays;
  - (b) aircraft system monitoring displays;
  - (c) engine indication displays;
  - (d) traffic, terrain, and weather displays;
  - (e) crew alerting systems displays;
  - (f) stand-by instruments; and
  - (g) installed EFB to the extent it is practical.
- 6.3.4. If image sensors are used, the recording of such images shall not capture the head and shoulders of the flight crew members while seated in their normal operating position.

Table A1-1 Parameter characteristics for flight data recorders  
for aeroplanes flying for the purpose of commercial air transport

Serial number	Parameter	Applicability	Measurement range	Maximum sampling and recording interval (seconds)	Accuracy limits (sensor input compared to FDR readout)	Recording resolution
1	Time (UTC when available, otherwise relative time count or -GNSS time sync)		24 hours	4	±0.125%/h	1 s
2	Pressure-altitude		−300 m (−1 000 ft) to maximum certificated altitude of aircraft +1 500 m (+5 000 ft)	1	±30 m to ±200 m (±100 ft to ±700 ft)	1.5 m (5 ft)
3	Indicated airspeed or calibrated airspeed		95 km/h (50 kt) to max $V_{SO}$ (Note 1) $V_{SO}$ to 1.2 $V_D$ (Note 2)	1	±5% ±3%	1 kt (0.5 kt recommended)
4	Heading (primary flight crew reference)		360°	1	±2°	0.5°
5	Normal acceleration (Note 8)	Application for type certification is submitted to a Contracting State before 1 January 2016	−3 g to +6 g	0.125	±1% of maximum range excluding datum error of ±5%	0.004 g
		Application for type certification is submitted to a Contracting State on or after 1 January 2016	−3 g to +6 g	0.0625	±1% of maximum range excluding datum error of ±5%	0.004 g
6	Pitch attitude		±75° or usable range whichever is greater	0.25	±2°	0.5°
7	Roll attitude		±180°	0.25	±2°	0.5°
8	Radio transmission keying		On-off (one discrete)	1		

Table A1-1 Parameter characteristics for flight data recorders  
for aeroplanes flying for the purpose of commercial air transport (cont')

Serial number	Parameter	Applicability	Measurement range	Maximum sampling and recording interval (seconds)	Accuracy limits (sensor input compared to FDR readout)	Recording resolution
9	Power on each engine (Note 3)		Full range	1 (per engine)	±2%	0.2% of full range or the resolution required to operate the aircraft
10*	Trailing edge flap and cockpit control selection		Full range or each discrete position	2	±5% or as pilot's indicator	0.5% of full range or the resolution required to operate the aircraft
11*	Leading edge flap and cockpit control selection		Full range or each discrete position	2	±5% or as pilot's indicator	0.5% of full range or the resolution required to operate the aircraft
12*	Thrust reverser position		Stowed, in transit, and reverse	1 (per engine)		
13*	Ground spoiler/speed brake selection (selection and position)		Full range or each discrete position	1	±2% unless higher accuracy uniquely required	0.2% of full range
14	Outside air temperature		Sensor range	2	±2°C	0.3°C
15*	Autopilot/auto throttle/AFCS mode and engagement status		A suitable combination of discretes	1		
16	Longitudinal acceleration (Note 8)	Application for type certification submitted to a Contracting State before 1 January 2016	±1 g	0.25	±0.015 g excluding a datum error of ±0.05 g	0.004 g
		Application for type certification submitted to a Contracting State on or after 1 January 2016	±1 g	0.0625	±0.015 g excluding a datum error of ±0.05 g	0.004 g
17	Lateral acceleration (Note 8)	Application for type certification submitted to a Contracting State before 1 January 2016	±1 g	0.25	±0.015 g excluding a datum error of ±0.05 g	0.004 g
		Application for type certification submitted to a Contracting State on or after 1 January 2016	±1 g	0.0625	±0.015 g excluding a datum error of ±0.05 g	0.004 g



Table A1-1 Parameter characteristics for flight data recorders  
for aeroplanes flying for the purpose of commercial air transport (cont')

Serial number	Parameter	Applicability	Measurement range	Maximum sampling and recording interval (seconds)	Accuracy limits (sensor input compared to FDR readout)	Recording resolution
18	Pilot input and/or control surface position-primary controls (pitch, roll, yaw) (Notes 4 and 8)	Application for type certification submitted to a Contracting State before 1 January 2016	Full range	0.25	±2° unless higher accuracy uniquely required	0.2% of full range or as installed
		Application for type certification submitted to a Contracting State on or after 1 January 2016	Full range	0.125	±2° unless higher accuracy uniquely required	0.2% of full range or as installed
19	Pitch trim position		Full range	1	±3% unless higher accuracy uniquely required	0.3% of full range or as installed
20*	Radio altitude		-6 m to 750 m (-20 ft to 2 500 ft)	1	±0.6 m (±2 ft) or ±3% whichever is greater below 150 m (500 ft) and ±5% above 150 m (500 ft)	0.3 m (1 ft) below 150 m (500 ft) 0.3 m (1 ft) + 0.5% of full range above 150 m (500 ft)
21*	Vertical beam deviation (ILS/GNSS/GLS glide path, MLS elevation, IRNAV/IAN vertical deviation)		Signal range	1	±3%	0.3% of full range
22*	Horizontal beam deviation (ILS/GNSS/GLS localizer, MLS azimuth, IRNAV/IAN lateral deviation)		Signal range	1	±3%	0.3% of full range
23	Marker beacon passage		Discrete	1		
24	Master warning		Discrete	1		
25	Each NAV receiver frequency selection (Note 5)		Full range	4	As installed	

Table A1-1 Parameter characteristics for flight data recorders  
for aeroplanes flying for the purpose of commercial air transport (cont')

Serial number	Parameter	Applicability	Measurement range	Maximum sampling and recording interval (seconds)	Accuracy limits (sensor input compared to FDR readout)	Recording resolution
26*	DME 1 and 2 distance (includes Distance to runway threshold (GLS) and Distance to missed approach point (IRNAV/IAN)) (Notes 5 and 6)		0 – 370 km (0 – 200 NM)	4	As installed	1 852 m (1 NM)
27	Air/ground status		Discrete	1		
28*	GPWS/TAWS/GCAS status (selection of terrain display mode including pop-up display status) and (terrain alerts, both cautions and warnings, and advisories) and (on/off switch position)		Discrete	1		
29*	Angle of attack		Full range	0.5	As installed	0.3 % of full range
30*	Hydraulics, each system (low pressure)		Discrete	2		0.5% of full range
31*	Navigation data (latitude/longitude, ground speed and drift angle) (Note 7)		As installed	1	As installed	
32*	Landing gear and gear selector position		Discrete	4	As installed	
33*	Groundspeed		As installed	1	Data should be obtained from the most accurate system	1 kt
34	Brakes (left and right brake pressure, left and right brake pedal position)		(Maximum metered brake range, discretes or full range)	1	±5%	2% of full range

Table A1-1 Parameter characteristics for flight data recorders  
for aeroplanes flying for the purpose of commercial air transport (cont')

Serial number	Parameter	Applicability	Measurement range	Maximum sampling and recording interval (seconds)	Accuracy limits (sensor input compared to FDR readout)	Recording resolution
35*	Additional engine parameters (EPR, $N_1$ , indicated vibration level, $N_2$ , EGT, fuel flow, fuel cut-off lever position, $N_3$ , engine fuel metering valve position)	Engine fuel metering valve position: Application for type certification is submitted to a Contracting State on or after 1 January 2023	As installed	Each engine each second	As installed	2% of full range
36*	TCAS/ACAS (traffic alert and collision avoidance system)		Discretes	1	As installed	
37*	Wind shear warning		Discrete	1	As installed	
38*	Selected barometric setting (pilot, co-pilot)		As installed	64	As installed	0.1 mb (0.01 in-Hg)
39*	Selected altitude (all pilot selectable modes of operation)		As installed	1	As installed	Sufficient to determine crew selection
40*	Selected speed (all pilot selectable modes of operation)		As installed	1	As installed	Sufficient to determine crew selection
41*	Selected Mach (all pilot selectable modes of operation)		As installed	1	As installed	Sufficient to determine crew selection
42*	Selected vertical speed (all pilot selectable modes of operation)		As installed	1	As installed	Sufficient to determine crew selection
43*	Selected heading (all pilot selectable modes of operation)		As installed	1	As installed	Sufficient to determine crew selection
44*	Selected flight path (all pilot selectable modes of operation) (course/DSTRK, path angle, final approach path (IRNAV/IAN))			1	As installed	
45*	Selected decision height		As installed	64	As installed	Sufficient to determine crew selection
46*	EFIS display format (pilot, co-pilot)		Discrete(s)	4	As installed	
47*	Multi-function/engine/alerts display format		Discrete(s)	4	As installed	
48*	AC electrical bus status		Discrete(s)	4	As installed	

Table A1-1 Parameter characteristics for flight data recorders  
for aeroplanes flying for the purpose of commercial air transport (cont')

Serial number	Parameter	Applicability	Measurement range	Maximum sampling and recording interval (seconds)	Accuracy limits (sensor input compared to FDR readout)	Recording resolution
49*	DC electrical bus status		Discrete(s)	4	As installed	
50*	Engine bleed valve position		Discrete(s)	4	As installed	
51*	APU bleed valve position		Discrete(s)	4	As installed	
52*	Computer failure		Discrete(s)	4	As installed	
53*	Engine thrust command		As installed	2	As installed	
54*	Engine thrust target		As installed	4	As installed	2% of full range
55*	Computed centre of gravity		As installed	64	As installed	1% of full range
56*	Fuel quantity in CG trim tank		As installed	64	As installed	1% of full range
57*	Head up display in use		As installed	4	As installed	
58*	Para visual display on/off		As installed	1	As installed	
59*	Operational stall protection, stick shaker and pusher activation		As installed	1	As installed	
60*	Primary navigation system reference (GNSS, INS, VOR/DME, MLS, Loran C, localizer glideslope)		As installed	4	As installed	
61*	Ice detection		As installed	4	As installed	
62*	Engine warning each engine vibration		As installed	1	As installed	
63*	Engine warning each engine over temperature		As installed	1	As installed	
64*	Engine warning each engine oil pressure low		As installed	1	As installed	
65*	Engine warning each engine over speed		As installed	1	As installed	
66*	Yaw trim surface position		Full range	2	±3% unless higher accuracy uniquely required	0.3% of full range

Table A1-1 Parameter characteristics for flight data recorders  
for aeroplanes flying for the purpose of commercial air transport (cont')

Serial number	Parameter	Applicability	Measurement range	Maximum sampling and recording interval (seconds)	Accuracy limits (sensor input compared to FDR readout)	Recording resolution
67*	Roll trim surface position		Full range	2	±3% unless higher accuracy uniquely required	0.3% of full range
68*	Yaw or sideslip angle		Full range	1	±5%	0.5°
69*	De-icing and/or anti-icing systems selection		Discrete(s)	4		
70*	Hydraulic pressure (each system)		Full range	2	±5%	100 psi
71*	Loss of cabin pressure		Discrete	1		
72*	Cockpit trim control input position, Pitch		Full range	1	±5%	0.2% of full range or as installed
73*	Cockpit trim control input position, Roll		Full range	1	±5%	0.2% of full range or as installed
74*	Cockpit trim control input position, Yaw		Full range	1	±5%	0.2% of full range or as installed
75*	All cockpit flight control input forces (control wheel, control column, rudder pedal)		Full range (±311 N (±70 lbf), ± 378 N (±85 lbf), ± 734 N (±165 lbf))	1	±5%	0.2% of full range or as installed
76*	Event marker		Discrete	1		
77*	Date		365 days	64		
78*	ANP or EPE or EPU		As installed	4	As installed	
79*	Cabin pressure altitude	Application for type certification submitted to a Contracting State on or after 1 January 2023	As installed (0 ft to 40 000 ft recommended)	1	As installed	100 ft
80*	Aeroplane computed weight	Application for type certification submitted to a Contracting State on or after 1 January 2023	As installed	64	As installed	1% of full range
81*	Flight director command	Application for type certification submitted to a Contracting State on or after 1 January 2023	Full range	1	± 2°	0.5°
82*	Vertical speed	Application for type certification submitted to a Contracting State on or after 1 January 2023	As installed	0.25	As installed (32 ft/min recommended)	16 ft/min

### Notes to Table A1-1:

1.  $V_{S0}$  stalling speed or minimum steady flight speed in the landing configuration is in Section “Abbreviations and Symbols”.
2.  $V_D$  design diving speed.
3. Record sufficient inputs to determine power.
4. For aeroplanes with control systems in which movement of a control surface will back drive the pilot's control, “or” applies. For aeroplanes with control systems in which movement of a control surface will not back drive the pilot's control, “and” applies. In aeroplanes with split surfaces, a suitable combination of inputs is acceptable in lieu of recording each surface separately. In aeroplanes with independent pilot input on primary controls, each pilot input on primary controls needs to be recorded separately.
5. If signal available in digital form.
6. Recording of latitude and longitude from INS or other navigation system is a preferred alternative.
7. If signals readily available.
8. It is not intended that aeroplanes issued with an individual certificate of airworthiness before 1 January 2016 be modified to meet the measurement range, maximum sampling and recording interval, accuracy limits or recording resolution description detailed in this Appendix.

**Table A1-2 Description of applications for data link recorders for aeroplanes flying for the purpose of commercial air transport**

Item No.	Application type	Application description	Recording content
1	Data link initiation	This includes any applications used to log on to or initiate data link service. In FANS-1/A and ATN, these are ATS facilities notification (AFN) and context management (CM) respectively.	C
2	Controller/pilot communication	This includes any application used to exchange requests, clearances, instructions and reports between the flight crew and controllers on the ground. In FANS-1/A and ATN, this includes the CPDLC application. It also includes applications used for the exchange of oceanic (OCL) and departure clearances (DCL) as well as data link delivery of taxi clearances.	C
3	Addressed surveillance	This includes any surveillance application in which the ground sets up contracts for delivery of surveillance data. In FANS-1/A and ATN, this includes the automatic dependent surveillance — contract (ADS-C) application. Where parametric data are reported within the message they shall be recorded unless data from the same source are recorded on the FDR.	C
4	Flight information	This includes any service used for delivery of flight information to specific aircraft. This includes, for example, data link aviation weather report service (D-METAR), data link-automatic terminal service (D-ATIS), digital Notice to Airmen (D-NOTAM) and other textual data link services.	C
5	Aircraft broadcast surveillance	This includes elementary and enhanced surveillance systems, as well as automatic dependent surveillance — broadcast (ADS-B) output data. Where parametric data sent by the aeroplane are reported within the message they shall be recorded unless data from the same source are recorded on the FDR.	M*
6	Aeronautical operational control data	This includes any application transmitting or receiving data used for aeronautical operational control purposes (per the ICAO definition of operational control).	M*

**Key:**

C: Complete contents recorded.

M: Information that enables correlation to any associated records stored separately from the aeroplane.

\*: Applications to be recorded only as far as is practicable given the architecture of the system.



Table A1-3 Parameter characteristics for aircraft data recording systems  
for aeroplanes flying for the purpose of commercial air transport

No.	Parameter name	Minimum recording range	Maximum recording interval in seconds	Minimum recording accuracy	Minimum recording resolution	Remarks
1	Heading					
	a) Heading (Magnetic or True)	$\pm 180^\circ$	1	$\pm 2^\circ$	$0.5^\circ$	Heading is preferred, if not available, yaw rate shall be recorded
	b) Yaw rate	$\pm 300^\circ/\text{s}$	0.25	$\pm 1\% + \text{drift of } 360^\circ/\text{h}$	$2^\circ/\text{s}$	
2	Pitch					
	a) Pitch attitude	$\pm 90^\circ$	0.25	$\pm 2^\circ$	$0.5^\circ$	Pitch attitude is preferred, if not available, pitch rate shall be recorded
	b) Pitch rate	$\pm 300^\circ/\text{s}$	0.25	$\pm 1\% + \text{drift of } 360^\circ/\text{h}$	$2^\circ/\text{s}$	
3	Roll					
	a) Roll attitude	$\pm 180^\circ$	0.25	$\pm 2^\circ$	$0.5^\circ$	Roll attitude is preferred, if not available, roll rate shall be recorded
	b) Roll rate	$\pm 300^\circ/\text{s}$	0.25	$\pm 1\% + \text{drift of } 360^\circ/\text{h}$	$2^\circ/\text{s}$	
4	Positioning system:					
	a) Time	24 hours	1	$\pm 0.5 \text{ s}$	0.1 s	UTC time preferred where available.
	b) Latitude/longitude	Latitude: $\pm 90^\circ$ Longitude: $\pm 180^\circ$	2 (1 if available)	As installed (0.00015° recommended)	0.00005°	
	c) Altitude	-300 m (-1 000 ft) to maximum certificated altitude of aeroplane +1 500 m (5 000 ft)	2 (1 if available)	As installed ( $\pm 15 \text{ m}$ ( $\pm 50 \text{ ft}$ ) recommended)	1.5 m (5 ft)	
	d) Ground speed	0–1 000 kt	2 (1 if available)	As installed ( $\pm 5 \text{ kt}$ recommended)	1 kt	
	e) Track	0–360°	2 (1 if available)	As installed ( $\pm 2^\circ$ recommended)	$0.5^\circ$	
	f) Estimated error	Available range	2 (1 if available)	As installed	As installed	Shall be recorded if readily available
5	Normal acceleration	-3 g to + 6 g (*)	0.25 (0.125 if available)	As installed ( $\pm 0.09 \text{ g}$ excluding a datum error of $\pm 0.45 \text{ g}$ recommended)	0.004 g	
6	Longitudinal acceleration	$\pm 1 \text{ g}$ (*)	0.25 (0.125 if available)	As installed ( $\pm 0.015 \text{ g}$ excluding a datum error of $\pm 0.05 \text{ g}$ recommended)	0.004 g	

**Table A1-3 Parameter Characteristics for aircraft data recording systems for aeroplanes flying for the purpose of commercial air transport (Cont')**

No.	Parameter name	Minimum recording range	Maximum recording interval in seconds	Minimum recording accuracy	Minimum recording resolution	Remarks
7	Lateral acceleration	±1 g (*)	0.25 (0.125 if available)	As installed (±0.015 g excluding a datum error of ±0.05 g recommended)	0.004 g	
8	External static pressure (or pressure altitude)	34.4 mb (3.44 in-Hg) to 310.2 mb (31.02 in-Hg) or available sensor range	1	As installed (±1 mb (0.1 in-Hg) or ±30 m (±100 ft) to ±210 m (±700 ft) recommended)	0.1 mb (0.01 in-Hg) or 1.5 m (5 ft)	
9	Outside air temperature (or total air temperature)	-50° to +90°C or available sensor range	2	As installed (±2°C recommended)	1°C	
10	Indicated air speed	As the installed pilot display measuring system or available sensor range	1	As installed (±3 % recommended)	1 kt (0.5 kt recommended)	
11	Engine RPM	Full range including overspeed condition	Each engine each second	As installed	0.2% of full range	
12	Engine oil pressure	Full range	Each engine each second	As installed (5% of full range recommended)	2% of full range	
13	Engine oil temperature	Full range	Each engine each second	As installed (5% of full range recommended)	2% of full range	
14	Fuel flow or pressure	Full range	Each engine each second	As installed	2% of full range	
15	Manifold pressure	Full range	Each engine each second	As installed	0.2% of full range	
16	Engine thrust/power/torque parameters required to determine propulsive thrust/power*	Full range	Each engine each second	As installed	0.1% of full range	* Sufficient parameters e.g. EPR/N1 or torque/Np as appropriate to the particular engine shall be recorded to determine power in both normal and reverse thrust. A margin for possible overspeed should be provided.
17	Engine gas generator speed (Ng)	0-150%	Each engine each second	As installed	0.2% of full range	
18	Free power turbine speed (Nf)	0-150%	Each engine each second	As installed	0.2% of full range	
19	Coolant temperature	Full range	1	As installed (±5°C recommended)	1°C	
20	Main voltage	Full range	Each engine each second	As installed	1 Volt	
21	Cylinder head temperature	Full range	Each cylinder each second	As installed	2% of full range	
22	Flaps position	Full range or each discrete position	2	As installed	0.5°	

**Table A1-3 Parameter Characteristics for aircraft data recording systems for aeroplanes flying for the purpose of commercial air transport (Cont')**

No.	Parameter name	Minimum recording range	Maximum recording interval in seconds	Minimum recording accuracy	Minimum recording resolution	Remarks
23	Primary flight control surface position	Full range	0.25	As installed	0.2 % of full range	
24	Fuel quantity	Full range	4	As installed	1% of full range	
25	Exhaust gas temperature	Full range	Each engine each second	As installed	2% of full range	
26	Emergency voltage	Full range	Each engine each second	As installed	1 Volt	
27	Trim surface position	Full range or each discrete position	1	As installed	0.3% of full range	
28	Landing gear position	Each discrete position*	Each gear every two seconds	As installed		* Where available, record up-and- locked and down-and-locked position
29	Novel/unique aircraft features	As required	As required	As required	As required	

## **Appendix 2 Detailed requirements on flight recorders for aeroplanes flying for purpose other than commercial air transport**

The material in this Appendix concerns flight recorders intended for installation in aeroplanes flying for purpose other than commercial air transport.

Crash-protected flight recorders comprise one or more of the following systems:

- a flight data recorder (FDR),
- a cockpit voice recorder (CVR),
- an airborne image recorder (AIR),
- a data link recorder (DLR).

When image or data link information is required to be recorded on a crash-protected flight recorder, it is permissible to record it on either the CVR or the FDR.

Lightweight flight recorders comprise one or more of the following systems:

- an aircraft data recording system (ADRS),
- a cockpit audio recording system (CARS),
- an airborne image recording system (AIRS),
- a data link recording system (DLRS).

When image or data link information is required to be recorded on a lightweight flight recorder, it is permissible to record it on either the CARS or the ADRS.

### **1. General requirements**

1.1. Non-deployable flight recorder containers shall be painted a distinctive orange colour.

1.2. Non-deployable crash-protected flight recorder containers shall:

- (a) carry reflective material to facilitate their location; and
- (b) have securely attached an automatically activated underwater locating device operating at a frequency of 37.5 kilohertz (kHz). At the earliest practical date, but not later than 1 January 2018, this device shall operate for a minimum of 90 days.

1.3. Automatic deployable flight recorder containers shall:

- (a) be painted a distinctive orange colour, however the surface visible from outside the aircraft may be of another colour;
- (b) carry reflective material to facilitate their location; and
- (c) have an integrated automatically activated ELT.

1.4. The flight recorder systems shall be installed so that:

- (a) the probability of damage to the recordings is minimized;
- (b) there is an aural or visual means for pre-flight checking that the flight recorder systems are operating properly; and
- (c) if the flight recorder systems have an erasure device, the installation shall be designed to prevent operation of the device during flight time or crash impact; and
- (d) aeroplanes for which the individual certificate of airworthiness is first issued on or after 1 January 2023, a flight crew-operated erase function shall be provided on the flight deck which, when activated, modifies the recording of a CVR and AIR so that it cannot be retrieved using normal replay or copying techniques. The installation shall be designed to prevent activation during flight. In addition, the probability of an inadvertent activation of an erase function during an accident shall also be minimized.

*Note: The erase function is intended to prevent access to CVR and AIR recordings by normal replay or copying means, but would not prevent accident investigation authorities access to such recordings by specialized replay or copying techniques.*

- 1.5. The crash-protected flight recorders shall be installed so that they receive electrical power from a bus that provides the maximum reliability for operation of the flight recorders without jeopardizing service to essential or emergency loads.
- 1.6. The lightweight flight recorders shall be connected to a power source having the characteristics which ensure proper and reliable recording in the operational environment.
- 1.7. The flight recorder systems, when tested by methods approved by the appropriate certifying authority, shall be demonstrated to be suitable for the environmental extremes over which they are designed to operate.
- 1.8. Means shall be provided for an accurate time correlation between the recorder systems recordings.
- 1.9. The flight recorder system manufacturer shall provide the appropriate certifying authority with the following information in respect of the flight recorder systems:
  - (a) manufacturer's operating instructions, equipment limitations and installation procedures;
  - (b) parameter origin or source and equations which relate counts to units of measurement;
  - (c) manufacturer's test reports; and
  - (d) detailed information to ensure the continued serviceability of the flight recorder system.

- 1.10. The holder of the airworthiness approval for the installation design of the flight recorder system shall make available the relevant continuing airworthiness information to the operator of the aeroplane to be incorporated in the continuing airworthiness maintenance programme. This continuing airworthiness information shall cover in detail all the tasks required to ensure the continued serviceability of the flight recorder system.

*Note 1: The flight recorder system is composed of the flight recorder as well as any dedicated sensors, hardware and software that provide information required per this Appendix.*

*Note 2: Conditions related to the continued serviceability of a flight recorder system are defined in paragraph 7 of this AC. The Manual on Flight Recorder System Maintenance (FRSM) (Doc 10104) provides guidance on maintenance tasks associated with flight recorder systems.*

## **2. Flight data recorder (FDR) and aircraft data recording system (ADRS)**

### **2.1. Start and stop logic**

The FDR or ADRS shall start to record prior to the aeroplane moving under its own power and record continuously until the termination of the flight when the aeroplane is no longer capable of moving under its own power.

### **2.2. Parameters to be recorded**

*Note: In previous editions of Annex 6, Part II, types of recorders were defined to capture the first evolutions of FDRs.*

- 2.2.1. The parameters that satisfy the requirements for FDRs are listed in Table A2-1. The number of parameters to be recorded shall depend on aeroplane complexity. The parameters without an asterisk (\*) are mandatory parameters which shall be recorded regardless of aeroplane complexity. In addition, the parameters designated by an asterisk (\*) shall be recorded if an information data source for the parameter is used by aeroplane systems or the flight crew to operate the aeroplane. However, other parameters may be substituted with due regard to the aeroplane type and the characteristics of the recording equipment.

- 2.2.2. If further FDR recording capacity is available, recording of the following additional information should be considered:

(a) operational information from electronic display systems, such as electronic flight instrument systems (EFIS), electronic centralized aircraft monitor (ECAM) and engine indication and crew alerting system (EICAS). Use the following order of priority:

- (1) parameters selected by the flight crew relating to the desired flight path, e.g. barometric pressure setting, selected altitude, selected airspeed, decision height, and autoflight system engagement and mode indications if not recorded from another source;

(2) display system selection/status, e.g. SECTOR, PLAN, ROSE, NAV, WXR, COMPOSITE, COPY;

(3) warnings and alerts; and

(4) the identity of displayed pages for emergency procedures and checklists;

(b) retardation information including brake application for use in the investigation of landing overruns and rejected take-offs.

2.2.3. The parameters that satisfy the recommendations for flight path and speed as displayed to the pilot(s) are listed below. The parameters without an (\*) are mandatory parameters which shall be recorded. In addition, the parameters designated by an (\*) are to be recorded if an information source for the parameter is displayed to the pilot and is practicable to record:

- Pressure altitude
- Indicated airspeed or calibrated airspeed
- Heading (primary flight crew reference)
- Pitch attitude
- Roll attitude
- Engine thrust/power
- Landing gear status\*
- Total or outside air temperature\*
- Time\*
- Navigation data\*: Drift angle, wind speed, wind direction, latitude/ longitude
- Radio altitude\*

2.2.4. The parameters that satisfy the requirements for ADRS are the first 7 parameters listed in Table A2-3 of this Appendix.

2.2.5. If further ADRS recording capacity is available, the recording of any parameters from 8 onwards defined in Table A2.3 shall be considered.

### 2.3. Additional information

2.3.1. The measurement range, recording interval and accuracy of parameters on installed equipment shall be verified by methods approved by the appropriate certificating authority.

2.3.2. Documentation concerning parameter allocation, conversion equations, periodic calibration and other serviceability/maintenance information shall be maintained by the operator/owner. The documentation shall be sufficient to ensure that accident investigation authorities have the necessary information to read out the data in engineering units.

### 3. Cockpit voice recorder (CVR) and cockpit audio recording system (CARS)

#### 3.1. Start and stop logic

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

#### 3.2. Signals to be recorded

##### 3.2.1. The CVR shall record simultaneously on four separate channels, or more, at least the following:

- (a) voice communication transmitted from or received in the aeroplane by radio;
- (b) aural environment on the flight deck;
- (c) voice communication of flight crew members on the flight deck using the aeroplane's interphone system, if installed;
- (d) voice or audio signals identifying navigation or approach aids introduced in the headset or speaker; and
- (e) digital communications with ATS, unless recorded by the FDR.

##### 3.2.2. The preferred CVR audio allocation should be as follows:

- (a) pilot-in-command audio panel;
- (b) co-pilot audio panel;
- (c) additional flight crew positions and time reference; and
- (d) cockpit area microphone.

##### 3.2.3. The CARS shall record simultaneously on two separate channels, or more, at least the following:

- (a) voice communication transmitted from or received in the aeroplane by radio;
- (b) aural environment on the flight deck; and
- (c) voice communication of flight crew members on the flight deck using the aeroplane's interphone system, if installed.



3.2.4. The preferred CARS audio allocation should be as follows:

- (a) voice communication; and
- (b) aural environment on the flight deck.

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

##### **4.1. Start and stop logic**

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

##### **4.2. Classes**

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

*Note 1: To respect crew privacy, the cockpit area view may be designed as far as practical to exclude the head and shoulders of crew members whilst seated in their normal operating position.*

*Note 2: There are no provisions for Class A AIR or AIRS in this document.*

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

4.2.3. 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 an ADRS, or where an FDR is not required.*

#### **5. Data link recorder (DLR)**

##### **5.1. Applications to be recorded**

5.1.1. Where the aircraft flight path is authorized or controlled through the use of data link messages, all data link messages, both uplinks (to the aircraft) and downlinks (from the aircraft), shall be recorded on the aircraft. As far as practicable, the time the messages were displayed to the flight crew and the time of the responses shall be recorded.

*Note: Sufficient information to derive the content of the data link communications message and the time the messages were displayed to the flight crew is needed to determine an accurate sequence of events on board the aircraft.*

5.1.2. Messages applying to the applications listed in Table A2-2 shall be recorded. Applications without the asterisk (\*) are mandatory applications which shall be recorded regardless of the system complexity. Applications with an (\*) shall be recorded only as far as is practicable given the architecture of the system.

Table A2-1 Parameter characteristics for flight data recorders  
for aeroplanes flying for purpose other than commercial air transport

Serial number	Parameter	Applicability	Measurement range	Maximum sampling and recording interval (seconds)	Accuracy limits (sensor input compared to FDR readout)	Recording resolution
1	Time (UTC when available, otherwise relative time count or GNSS time sync)		24 hours	4	$\pm 0.125\%/h$	1 s
2	Pressure altitude		-300 m (-1 000 ft) to maximum certificated altitude of aircraft +1 500 m (+5 000 ft)	1	$\pm 30$ m to $\pm 200$ m ( $\pm 100$ ft to $\pm 700$ ft)	1.5 m (5 ft)
3	Indicated airspeed or calibrated airspeed		95 km/h (50 kt) to max $V_{s_0}$ (Note 1) $V_{s_0}$ to 1.2 $V_D$ (Note 2)	1	$\pm 5\%$ $\pm 3\%$	1 kt (0.5 kt recommended)
4	Heading (primary flight crew reference)		$360^\circ$	1	$\pm 2^\circ$	$0.5^\circ$
5	Normal acceleration		-3 g to +6 g	0.125	$\pm 1\%$ of maximum range excluding datum error of $\pm 5\%$	0.004 g
6	Pitch attitude		$\pm 75^\circ$ or usable range whichever is greater	0.25	$\pm 2^\circ$	$0.5^\circ$
7	Roll attitude		$\pm 180^\circ$	0.25	$\pm 2^\circ$	$0.5^\circ$
8	Radio transmission keying		On-off (one discrete)	1		
9	Power on each engine (Note 3)		Full range	1 (per engine)	$\pm 2\%$	0.2% of full range or the resolution required to operate the aircraft
10*	Trailing edge flap and cockpit control selection		Full range or each discrete position	2	$\pm 5\%$ or as pilot's indicator	0.5% of full range or the resolution required to operate the aircraft

Table A2-1 Parameter characteristics for flight data recorders  
for aeroplanes flying for purpose other than commercial air transport (Cont')

Serial number	Parameter	Applicability	Measurement range	Maximum sampling and recording interval (seconds)	Accuracy limits (sensor input compared to FDR readout)	Recording resolution
11 <sup>**</sup>	Leading edge flap and cockpit control selection		Full range or each discrete position	2	±5% or as pilot's indicator	0.5% of full range or the resolution required to operate the aircraft
12 <sup>**</sup>	Thrust reverser position		Stowed, in transit, and reverse	1 (per engine)		
13 <sup>**</sup>	Ground spoiler/speed brake selection (selection and position)		Full range or each discrete position	1	±2% unless higher accuracy uniquely required	0.2% of full range
14	Outside air temperature		Sensor range	2	±2°C	0.3°C
15 <sup>**</sup>	Autopilot/auto throttle/AFCS mode and engagement status		A suitable combination of discretes	1		
16	Longitudinal acceleration		±1 g	0.25	±0.015 g excluding a datum error of ±0.05 g	0.004 g
17	Lateral acceleration (Note 3)		±1 g	0.25	±0.015 g excluding a datum error of ±0.05 g	0.004 g
18	Pilot input and/or control surface position-primary controls (pitch, roll, yaw) (Notes 4 and 8)	Application for type certification submitted to a Contracting State before 1 January 2016	Full range	0.25	±2° unless higher accuracy uniquely required	0.2% of full range or as installed
		Application for type certification submitted to a Contracting State on or after 1 January 2016	Full range	0.125	±2° unless higher accuracy uniquely required	0.2% of full range or as installed
19	Pitch trim position		Full range	1	±3% unless higher accuracy uniquely required	0.3% of full range or as installed
20 <sup>**</sup>	Radio altitude		-6 m to 750 m (-20 ft to 2 500 ft)	1	±0.6 m (±2 ft) or ±3% whichever is greater below 150 m (500 ft) and ±5% above 150 m (500 ft)	0.3 m (1 ft) below 150 m (500 ft) 0.3 m (1 ft) + 0.5% of full range above 150 m (500 ft)

Table A2-1 Parameter characteristics for flight data recorders  
for aeroplanes flying for purpose other than commercial air transport (Cont')

Serial number	Parameter	Applicability	Measurement range	Maximum sampling and recording interval (seconds)	Accuracy limits (sensor input compared to FDR readout)	Recording resolution
21*	Vertical beam deviation (ILS/GNSS/GLS glide path MLS elevation, IRNAV/IAN vertical deviation)		Signal range	1	±3%	0.3% of full range
22*	Horizontal beam deviation (ILS/GNSS/GLS localizer, MLS azimuth, IRNAV/IAN lateral deviation)		Signal range	1	±3%	0.3% of full range
23	Marker beacon passage		Discrete	1		
24	Master warning		Discrete	1		
25	Each NAV receiver frequency selection (Note 5)		Full range	4	As installed	
26*	DME 1 and 2 distance (includes distance to runway threshold (GLS) and distance to missed approach point (IRNAV/IAN) (Notes 5 and 6)		0–370 km (0–200 NM)	4	As installed	1 852 m (1 NM)
27	Air/ground status		Discrete	1		
28*	GPWS/TAWS/GCAS status (selection of terrain display mode including pop-up display status) and (terrain alerts, both cautions and warnings, and advisories) and (on/off switch position)		Discrete	1		
29*	Angle of attack		Full range	0.5	As installed	0.3% of full range
30*	Hydraulics, each system (low pressure)		Discrete	2		0.5% of full range

Table A2-1 Parameter characteristics for flight data recorders  
for aeroplanes flying for purpose other than commercial air transport (Cont')

Serial number	Parameter	Applicability	Measurement range	Maximum sampling and recording interval (seconds)	Accuracy limits (sensor input compared to FDR readout)	Recording resolution
31*	Navigation data (latitude/longitude, ground speed and drift angle) (Note 7)		As installed	1	As installed	
32*	Landing gear and gear selector position		Discrete	4	As installed	
33*	Groundspeed		As installed	1	Data should be obtained from the most accurate system	1 kt
34	Brakes (left and right brake pressure, left and right brake pedal position)		(Maximum metered brake range, discretes or full range)	1	±5%	2% of full range
35*	Additional engine parameters (EPR, N <sub>1</sub> , indicated vibration level, N <sub>2</sub> , EGT, fuel flow, fuel cut-off lever position, N <sub>3</sub> engine fuel metering valve position)	Engine fuel metering valve position: Application for type certification is submitted to a Contracting State on or after 1 January 2023	As installed	Each engine each second	As installed	2% of full range
36*	TCAS/ACAS (traffic alert and collision avoidance system)		Discrete(s)	1	As installed	
37*	Wind shear warning		Discrete	1	As installed	
38*	Selected barometric setting (pilot, co-pilot)		As installed	64	As installed	0.1 mb (0.01 in-Hg)
39*	Selected altitude (all pilot selectable modes of operation)		As installed	1	As installed	Sufficient to determine crew selection
40*	Selected speed (all pilot selectable modes of operation)		As installed	1	As installed	Sufficient to determine crew selection
41*	Selected Mach (all pilot selectable modes of operation)		As installed	1	As installed	Sufficient to determine crew selection
42*	Selected vertical speed (all pilot selectable modes of operation)		As installed	1	As installed	Sufficient to determine crew selection
43*	Selected heading (all pilot selectable modes of operation)		As installed	1	As installed	Sufficient to determine crew selection

Table A2-1 Parameter characteristics for flight data recorders  
for aeroplanes flying for purpose other than commercial air transport (Cont')

Serial number	Parameter	Applicability	Measurement range	Maximum sampling and recording interval (seconds)	Accuracy limits (sensor input compared to FDR readout)	Recording resolution
44*	Selected flight path (all pilot selectable modes of operation) (course/DSTRK, path angle, final approach path (IRNAV/IAN))			1	As installed	As installed
45*	Selected decision height		As installed	64	As installed	Sufficient to determine crew selection
46*	EFIS display format (pilot, co-pilot)		Discrete(s)	4	As installed	
47*	Multi-function/engine/alerts display format		Discrete(s)	4	As installed	
48*	AC electrical bus status		Discrete(s)	4	As installed	
49*	DC electrical bus status		Discrete(s)	4	As installed	
50*	Engine bleed valve position		Discrete(s)	4	As installed	
51*	APU bleed valve position		Discrete(s)	4	As installed	
52*	Computer failure		Discrete(s)	4	As installed	
53*	Engine thrust command		As installed	2	As installed	2% of full range
54*	Engine thrust target		As installed	4	As installed	2% of full range
55*	Computed centre of gravity		As installed	64	As installed	1% of full range
56*	Fuel quantity in CG trim tank		As installed	64	As installed	1% of full range
57*	Head-up display in use		As installed	4	As installed	
58*	Para-visual display on/off		As installed	1	As installed	
59*	Operational stall protection, stick shaker and pusher activation		As installed	1	As installed	
60*	Primary navigation system reference (GNSS, INS, VOR/DME, MLS, Loran C, localizer glide slope)		As installed	4	As installed	
61*	Ice detection		As installed	4	As installed	

Table A2-1 Parameter characteristics for flight data recorders  
for aeroplanes flying for purpose other than commercial air transport (Cont')

Serial number	Parameter	Applicability	Measurement range	Maximum sampling and recording interval (seconds)	Accuracy limits (sensor input compared to FDR readout)	Recording resolution
62*	Engine warning each engine vibration		As installed	1	As installed	
63*	Engine warning each engine over temperature		As installed	1	As installed	
64*	Engine warning each engine oil pressure low		As installed	1	As installed	
65*	Engine warning each engine over speed		As installed	1	As installed	
66*	Yaw trim surface position		Full range	2	±3% unless higher accuracy uniquely required	0.3% of full range
67*	Roll trim surface position		Full range	2	±3% unless higher accuracy uniquely required	0.3% of full range
68*	Yaw or sideslip angle		Full range	1	±5%	0.5°
69*	De-icing and/or anti-icing systems selection		Discrete(s)	4		
70*	Hydraulic pressure (each system)		Full range	2	±5%	100 psi
71*	Loss of cabin pressure		Discrete	1		
72*	Cockpit trim control input position, Pitch		Full range	1	±5%	0.2% of full range or as installed
73*	Cockpit trim control input position, Roll		Full range	1	±5%	0.2% of full range or as installed
74*	Cockpit trim control input position, Yaw		Full range	1	±5%	0.2% of full range or as installed
75	All cockpit flight control input forces (control wheel, control column, rudder pedal)		Full range (±311 N (±70 lbf), ±378 N (±85 lbf), ±734 N (±165 lbf))	1	±5%	0.2% of full range or as installed
76*	Event marker		Discrete	1		
77*	Date		365 days	64		
78*	Actual navigation performance or estimated position error or estimated position uncertainty		As installed	4	As installed	



Table A2-1 Parameter characteristics for flight data recorders  
for aeroplanes flying for purpose other than commercial air transport (Cont')

Serial number	Parameter	Applicability	Measurement range	Maximum sampling and recording interval (seconds)	Accuracy limits (sensor input compared to FDR readout)	Recording resolution
79*	Cabin pressure altitude	Application for type certification submitted to a Contracting State on or after 1 January 2023	As installed (0 ft to 40 000 ft recommended)	1	As installed	100 ft
80*	Aeroplane computed weight	Application for type certification submitted to a Contracting State on or after 1 January 2023	As installed	64	As installed	1% of full range
81*	Flight director command (left flight director pitch command, left flight director roll command, right flight director pitch command, right flight director roll command)	Application for type certification submitted to a Contracting State on or after 1 January 2023	Full range	1	$\pm 2^\circ$	$0.5^\circ$
82*	Vertical speed	Application for type certification submitted to a Contracting State on or after 1 January 2023	As installed	0.25	As installed (32 ft/min recommended)	16 ft/min

Notes.—

1.  $V_{s_0}$  stalling speed or minimum steady flight speed in the landing configuration is in Section "Abbreviations and Symbols".
2.  $V_D$  design diving speed.
3. Record sufficient inputs to determine power.
4. For aeroplanes with control systems in which movement of a control surface will back drive the pilot's control, "or" applies. For aeroplanes with control systems in which movement of a control surface will not back drive the pilot's control, "and" applies. In aeroplanes with split surfaces, a suitable combination of inputs is acceptable in lieu of recording each surface separately. In aeroplanes with independent pilot input on primary controls, each pilot input on primary controls needs to be recorded separately.
5. If signal available in digital form.
6. Recording of latitude and longitude from INS or other navigation system is a preferred alternative.
7. If signals readily available.
8. It is not intended that aeroplanes issued with an individual certificate of airworthiness before 1 January 2016 be modified to meet the measurement range, maximum sampling and recording intervals, accuracy limits or recording resolution guidance description detailed in this Appendix.

Table A2-2 Description of applications for data link recorders  
for aeroplanes flying for purpose other than commercial air transport

Item No.	Application type	Application description	Recording content
1	Data link initiation	This includes any applications used to log on to or initiate data link service. In FANS-1/A and ATN, these are ATS facilities notification (AFN) and context management (CM), respectively.	C
2	Controller-pilot communication	This includes any application used to exchange requests, clearances, instructions and reports between the flight crew and controllers on the ground. In FANS-1/A and ATN, this includes the CPDLC application. It also includes applications used for the exchange of oceanic (OCL) and departure clearances (DCL) as well as data link delivery of taxi clearances.	C
3	Addressed surveillance	This includes any surveillance application in which the ground sets up contracts for delivery of surveillance data. In FANS-1/A and ATN, this includes the automatic dependent surveillance — contract (ADS-C) application. Where parametric data are reported within the message they shall be recorded unless data from the same source are recorded on the FDR.	C
4	Flight information	This includes any service used for delivery of flight information to specific aircraft. This includes, for example, data link aviation weather report service (D-METAR), data link-automatic terminal service (D-ATIS), digital Notice to Airmen (D-NOTAM) and other textual data link services.	C
5	Aircraft broadcast surveillance	This includes elementary and enhanced surveillance systems, as well as automatic dependent surveillance — broadcast (ADS-B) output data. Where parametric data sent by the aeroplane are reported within the message they shall be recorded unless data from the same source are recorded on the FDR.	M*
6	Aeronautical operational control data	This includes any application transmitting or receiving data used for aeronautical operational control purposes (per the ICAO definition of operational control).	M*

Key:

C: Complete contents recorded.

M: Information that enables correlation to any associated records stored separately from the aeroplane.

\*: Applications that are to be recorded only as far as is practicable given the architecture of the system.

Table A2-3. Parameter characteristics for aircraft data recording systems for aeroplanes flying for purpose other than commercial air transport

No.	Parameter name	Minimum recording range	Maximum recording interval in seconds	Minimum recording accuracy	Minimum recording resolution	Remarks
1	Heading:					
	a) Heading (Magnetic or True)	$\pm 180^\circ$	1	$\pm 2^\circ$	$0.5^\circ$	* Heading is preferred, if not available, yaw rate shall be recorded
	b) Yaw rate	$\pm 300^\circ/\text{s}$	0.25	$\pm 1\% + \text{drift of } 360^\circ/\text{h}$	$2^\circ/\text{s}$	
2	Pitch:					
	a) Pitch attitude	$\pm 90^\circ$	0.25	$\pm 2^\circ$	$0.5^\circ$	* Pitch altitude is preferred, if not available, pitch rate shall be recorded
	b) Pitch rate	$300^\circ/\text{s}$	0.25	$\pm 1\% + \text{drift of } 360^\circ/\text{h}$	$2^\circ/\text{s}$	
3	Roll:					
	a) Roll attitude	$\pm 180^\circ$	0.25	$\pm 2^\circ$	$0.5^\circ$	* If not available, roll rate shall be recorded
	b) Roll rate	$300^\circ/\text{s}$	0.25	$\pm 1\% + \text{drift of } 360^\circ/\text{h}$	$2^\circ/\text{s}$	
4	Positioning system:					
	a) Time	24 hours	1	$\pm 0.5 \text{ s}$	0.1 s	UTC time preferred where available
	b) Latitude/longitude	Latitude: $\pm 90^\circ$ Longitude: $\pm 180^\circ$	2 (1 if available)	As installed ( $0.00015^\circ$ recommended)	0.00005°	
	c) Altitude	-300 m (-1 000 ft) to maximum certificated altitude of aircraft + 1 500 m (5 000 ft)	2 (1 if available)	As installed ( $\pm 15 \text{ m}$ ( $\pm 50 \text{ ft}$ ) recommended)	1.5 m (5 ft)	
	d) Ground speed	0-1 000 kt	2 (1 if available)	As installed ( $\pm 5 \text{ kt}$ recommended)	1 kt	

Table A2-3. Parameter characteristics for aircraft data recording systems for aeroplanes flying for purpose other than commercial air transport (Cont')

No.	Parameter name	Minimum recording range	Maximum recording interval in seconds	Minimum recording accuracy	Minimum recording resolution	Remarks
	e) Track	0-360°	2 (1 if available)	As installed (±2° recommended)	0.5°	
	f) Estimated error	Available range	2 (1 if available)	As installed	As installed	Shall be recorded if readily available
5	Normal acceleration	-3 g to +6 g (*)	0.25 (0.125 if available)	As installed (±0.09 g excluding a datum error of ±0.45 g recommended)	0.004 g	
6	Longitudinal acceleration	±1 g (*)	0.25 (0.125 if available)	As installed (±0.015 g excluding a datum error of ±0.05 g recommended)	0.004 g	
7	Lateral acceleration	±1 g (*)	0.25 (0.125 if available)	As installed (±0.015 g excluding a datum error of ±0.05 g recommended)	0.004 g	
8	External static pressure (or pressure altitude)	34.4 mb (3.44 in-Hg) to 310.2 mb (31.02 in-Hg) or available sensor range	1	As installed (±1 mb (0.1 in-Hg) or ±30 m (±100 ft) to ±210 m (±700 ft) recommended)	0.1 mb (0.01 in-Hg) or 1.5 m (5 ft)	
9	Outside air temperature (or total air temperature)	-50° to +90°C or available sensor range	2	As installed (±2°C recommended)	1°C	
10	Indicated air speed	As the installed pilot display measuring system or available sensor range	1	As installed (±3% recommended)	1 kt (0.5 kt recommended)	
11	Engine RPM	Full range including overspeed condition	Each engine each second	As installed	0.2% of full range	
12	Engine oil pressure	Full range	Each engine each second	As installed (5% of full range)	2% of full range	

Table A2-3. Parameter characteristics for aircraft data recording systems for aeroplanes flying for purpose other than commercial air transport (Cont')

No.	Parameter name	Minimum recording range	Maximum recording interval in seconds	Minimum recording accuracy	Minimum recording resolution	Remarks
13	Engine oil temperature	Full range	Each engine each second	As installed (5% of full range recommended)	2% of full range	
14	Fuel flow or pressure	Full range	Each engine each second	As installed	2% of full range	
15	Manifold pressure	Full range	Each engine each second	As installed	0.2% of full range	
16	Engine thrust/power/torque parameters required to determine propulsive thrust/power*	Full range	Each engine each second	As installed	0.1% of full range	* Sufficient parameters e.g. EPR/N <sub>1</sub> or torque/N <sub>p</sub> as appropriate to the particular engine shall be recorded to determine power in both normal and reverse thrust. A margin for possible overspeed should be provided.
17	Engine gas generator speed (Ng)	0–150%	Each engine each second	As installed	0.2% of full range	
18	Free power turbine speed (Nf)	0–150%	Each engine each second	As installed	0.2% of full range	
19	Coolant temperature	Full range	1	As installed (±5°C recommended)	1°C	
20	Main voltage	Full range	Each engine each second	As installed	1 Volt	
21	Cylinder head temperature	Full range	Each cylinder each second	As installed	2% of full range	
22	Flaps position	Full range or each discrete position	2	As installed	0.5°	
23	Primary flight control surface position	Full range	0.25	As installed	0.2% of full range	
24	Fuel quantity	Full range	4	As installed	1% of full range	
25	Exhaust gas temperature	Full range	Each engine each second	As installed	2% of full range	

Table A2-3. Parameter characteristics for aircraft data recording systems for aeroplanes flying for purpose other than commercial air transport (Cont')

No.	Parameter name	Minimum recording range	Maximum recording interval in seconds	Minimum recording accuracy	Minimum recording resolution	Remarks
26	Emergency voltage	Full range	Each engine each second	As installed	1 Volt	
27	Trim surface position	Full range or each discrete position	1	As installed	0.3% of full range	
28	Landing gear position	Each discrete position*	Each gear every two seconds	As installed		* Where available, record up-and-locked and down-and-locked position
29	Novel/unique aircraft features	As required	As required	As required	As required	

### Appendix 3 Detailed requirements on flight recorders for helicopters

The material in this Appendix concerns flight recorders intended for installation in helicopters.

Crash-protected flight recorders comprise one or more of the following systems:

- a flight data recorder (FDR),
- a cockpit voice recorder (CVR),
- an airborne image recorder (AIR),
- a data link recorder (DLR).

When image or data link information is required to be recorded on a crash-protected flight recorder, it is permissible to record it on either the CVR or the FDR.

Lightweight flight recorders comprise one or more of the following systems:

- an aircraft data recording system (ADRS),
- a cockpit audio recording system (CARS),
- an airborne image recording system (AIRS),
- a data link recording system (DLRS).

When image or data link information is required to be recorded on a crash-protected flight recorder, it is permissible to record it on either the CARS or the ADRS.

#### 1. General requirements

1.1. Non-deployable flight recorder containers shall be painted a distinctive orange colour.

1.2. Non-deployable crash-protected flight recorder containers shall:

- (a) carry reflective material to facilitate their location; and
- (b) have securely attached an automatically activated underwater locating device operating at a frequency of 37.5 kHz. At the earliest practical date, but not later than 1 January 2018, this device shall operate for a minimum of 90 days.

1.3. Automatic deployable flight recorder containers shall:

- (a) be painted a distinctive orange colour, however the surface visible from outside the helicopter may be of another colour;
- (b) carry reflective material to facilitate their location; and
- (c) have an integrated automatically activated ELT.

1.4. The flight recorder systems shall be installed so that:

- (a) the probability of damage to the recordings is minimized;

- (b) there is an aural or visual means for preflight checking that the flight recorder systems are operating properly; and
- (c) if the flight recorder systems have an erasure device, the installation shall be designed to prevent operation of the device during flight time or crash impact; and
- (d) helicopters for which the individual certificate of airworthiness is first issued on or after 1 January 2023, a flight crew-operated erase function shall be provided on the flight deck which, when activated, modifies the recording of a CVR and AIR so that it cannot be retrieved using normal replay or copying techniques. The installation shall be designed to prevent activation during flight. In addition, the probability of an inadvertent activation of an erase function during an accident shall also be minimized.

*Note: The erase function is intended to prevent access to CVR and AIR recordings by normal replay or copying means, but would not prevent accident investigation authorities access to such recordings by specialized replay or copying techniques.*

- 1.5. The crash-protected flight recorders shall be installed so that they receive electrical power from a bus that provides the maximum reliability for operation of the flight recorders without jeopardizing service to essential or emergency loads.
- 1.6. The lightweight flight recorders shall be connected to a power source having the characteristics which ensure proper and reliable recording in the operational environment.
- 1.7. The flight recorder systems, when tested by methods approved by the appropriate certifying authority, shall be demonstrated to be suitable for the environmental extremes over which they are designed to operate.
- 1.8. Means shall be provided for an accurate time correlation between the flight recorder systems functions.
- 1.9. The flight recorder system manufacturer shall provide the appropriate certifying authority with the following information in respect of the flight recorder systems:
  - (a) manufacturer's operating instructions, equipment limitations and installation procedures;
  - (b) parameter origin or source and equations which relate counts to units of measurement;
  - (c) manufacturer's test reports; and
  - (d) detailed information to ensure the continued serviceability of the flight recorder system.
- 1.10. The holder of the airworthiness approval for the installation design of the flight recorder system shall make available the relevant continuing airworthiness information to the operator of the helicopter to be incorporated in the continuing airworthiness maintenance programme. This



continuing airworthiness information shall cover in detail all the tasks required to ensure the continued serviceability of the flight recorder system.

*Note 1: The flight recorder system is composed of the flight recorder as well as any dedicated sensors, hardware and software that provide information required per this Appendix.*

*Note 2: Conditions related to the continued serviceability of a flight recorder system are defined in paragraph 7 of this AC. The Manual on Flight Recorder System Maintenance (FRSM) (Doc 10104) provides guidance on maintenance tasks associated with flight recorder systems.*

## **2. Flight data recorder (FDR) and aircraft data recording system (ADRS)**

### **2.1. Start and stop logic**

The FDR or ADRS shall 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.

### **2.2. Parameters to be recorded**

*Note: In previous editions of Annex 6, Part III, types of recorders were defined to capture the first evolutions of FDRs.*

2.2.1. The parameters that satisfy the requirements for FDRs, are listed in Table A3-1. The number of parameters to be recorded shall depend on helicopter complexity. The parameters without an asterisk (\*) are mandatory parameters which shall be recorded regardless of helicopter complexity. In addition, the parameters designated by an asterisk (\*) shall be recorded if an information data source for the parameter is used by helicopter systems or the flight crew to operate the helicopter. However, other parameters may be substituted with due regard to the helicopter type and the characteristics of the recording equipment.

2.2.2. The following parameters shall satisfy the requirements for flight path and speed:

- pressure altitude
- indicated airspeed
- outside air temperature
- heading
- normal acceleration
- lateral acceleration
- longitudinal acceleration (body axis)
- time or relative time count
- navigation data\*: drift angle, wind speed, wind direction, latitude/longitude
- radio altitude\*

2.2.3. If further FDR recording capacity is available, recording of the following additional information shall be considered:

(a) additional operational information from electronic displays, such as electronic flight instrument systems (EFIS), electronic centralized aircraft monitor (ECAM) and engine indication and crew alerting system (EICAS); and

(b) additional engine parameters (EPR,  $N_1$ , fuel flow, etc.).

2.2.4. The parameters that satisfy the requirements for ADRS are the first 7 parameters listed in Table A3-3 of this Appendix.

2.2.5. If further ADRS recording capacity is available, the recording of any parameters from 8 onwards defined in Table A3-3 shall be considered.

### 2.3. Additional information

2.3.1. The measurement range, recording interval and accuracy of parameters on installed equipment is usually verified by methods approved by the appropriate certificating authority.

2.3.2. Documentation concerning parameter allocation, conversion equations, periodic calibration and other serviceability/maintenance information shall be maintained by the operator/owner. The documentation shall be sufficient to ensure that accident investigation authorities have the necessary information to read out the data in engineering units.

## 3. Cockpit voice recorder (CVR) and cockpit audio recording system (CARS)

### 3.1. Start and stop logic

The CVR or CARS shall 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 CVR or CARS 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.

### 3.2. Signals to be recorded

3.2.1. The CVR shall record simultaneously on four separate channels, or more, at least the following:

- (a) voice communication transmitted from or received in the aircraft by radio;
- (b) aural environment on the flight deck;
- (c) voice communication of flight crew members on the flight deck using the interphone system, if installed;
- (d) voice or audio signals identifying navigation or approach aids introduced in the headset or speaker; and

- (e) voice communication of flight crew members using the passenger address system, if installed.

3.2.2. The preferred CVR audio allocation should be as follows:

- (a) pilot-in-command audio panel;
- (b) co-pilot audio panel;
- (c) additional flight crew positions and time reference; and
- (d) cockpit area microphone.

3.2.3. The CARS shall record simultaneously on two separate channels, or more, at least the following:

- (a) voice communication transmitted from or received in the helicopter by radio;
- (b) aural environment on the flight deck; and
- (c) voice communication of flight crew members on the flight deck using the helicopter's interphone system, if installed.

3.2.4. The preferred CARS audio allocation should be as follows:

- (a) voice communication; and
- (b) aural environment on the flight deck.

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

##### **4.1. Start and stop logic**

The AIR or AIRS shall 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 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.

##### **4.2. Classes**

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

*Note 1: To respect crew privacy, the cockpit area view may be designed as far as practical to exclude the head and shoulders of crew members whilst seated in their normal operating position.*

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

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

4.2.3. 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.*

## **5. Data link recorder (DLR)**

### **5.1. Applications to be recorded**

5.1.1. Where the helicopter flight path is authorized or controlled through the use of data link messages, all data link messages, both uplinks (to the helicopter) and downlinks (from the helicopter), shall be recorded on the helicopter. As far as practicable, the time the messages were displayed to the flight crew and the time of the responses shall to be recorded.

*Note: Sufficient information to derive the content of the data link communications message and the time the messages were displayed to the flight crew is needed to determine an accurate sequence of events on board the aircraft.*

5.1.2. Messages applying to the applications listed in Table A3-2 shall be recorded. Applications without the asterisk (\*) are mandatory applications which shall be recorded regardless of the system complexity. Applications with an (\*) are to be recorded only as far as is practicable given the architecture of the system.

Table A3-1 Parameter Characteristics for flight data recorders for helicopters

Serial number	Parameter	Applicability	Measurement range	Maximum sampling and recording interval (seconds)	Accuracy limits (sensor input compared to FDR readout)	Recording resolution
1	Time (UTC when available, otherwise relative time count or GNSS time sync)		24 hours	4	$\pm 0.125\%$ /h	1 s
2	Pressure altitude		-300 m (-1 000 ft) to maximum certificated altitude of aircraft +1 500 m (+5 000 ft)	1	$\pm 30$ m to $\pm 200$ m ( $\pm 100$ ft to $\pm 700$ ft)	1.5 m (5 ft)
3	Indicated airspeed		As the installed pilot display measuring system	1	$\pm 3\%$	1 kt
4	Heading		360°	1	$\pm 2^\circ$	0.5°
5	Normal acceleration		-3 g to +6 g	0.125	$\pm 0.09$ g excluding a datum error of $\pm 0.045$ g	0.004 g
6	Pitch attitude		$\pm 75^\circ$ or 100% of useable range whichever is greater	0.5	$\pm 2^\circ$	0.5°
7	Roll attitude		$\pm 180^\circ$	0.5	$\pm 2^\circ$	0.5°
8	Radio transmission keying		On-off (one discrete)	1	—	—
9	Power on each engine		Full range	1 (per engine)	$\pm 2\%$	0.1% of full range
10	Main rotor:					
	Main rotor speed		50–130%	0.51	$\pm 2\%$	0.3% of full range
	Rotor brake		Discrete		—	—
11	Pilot input and/or control surface position — primary controls (collective pitch, longitudinal cyclic pitch, lateral cyclic pitch, tail rotor pedal)		Full range	0.5 (0.25 recommended)	$\pm 2\%$ unless higher accuracy uniquely required	0.5% of operating range
12	Hydraulics, each system (low pressure and selection)		Discrete	1	—	—
13	Outside air temperature		Sensor range	2	$\pm 2^\circ\text{C}$	0.3°C

Table A3-1 Parameter Characteristics for flight data recorders for helicopters (Cont')

Serial number	Parameter	Applicability	Measurement range	Maximum sampling and recording interval (seconds)	Accuracy limits (sensor input compared to FDR readout)	Recording resolution
14*	Autopilot/ autothrottle/AFCs mode and engagement status		A suitable combination of discretes	1	—	—
15*	Stability augmentation system engagement		Discrete	1	—	—
16*	Main gearbox oil pressure		As installed	1	As installed	6.895 kN/m <sup>2</sup> (1 psi)
17*	Main gearbox oil temperature		As installed	2	As installed	1°C
18	Yaw rate		±400°/second	0.25	±1.5% maximum range excluding datum error of ±5%	±2°/s
19*	Sling load force		0 to 200% of certified load	0.5	±3% of maximum range	0.5% for maximum certified load
20	Longitudinal acceleration		±1 g	0.25	±0.015 g excluding a datum error of ±0.05 g	0.004 g
21	Lateral acceleration		±1 g	0.25	±0.015 g excluding a datum error of ±0.05 g	0.004 g
22*	Radio altitude		−6 m to 750 m (−20 ft to 2 500 ft)	1	±0.6 m (±2 ft) or ±3% whichever is greater below 150 m (500 ft) and ±5% above 150 m (500 ft)	0.3 m (1 ft) below 150 m (500 ft), 0.3 m (1 ft) + 0.5% of full range above 150 m (500 ft)
23*	Vertical beam deviation		Signal range	1	±3%	0.3% of full range
24*	Horizontal beam deviation		Signal range	1	±3%	0.3% of full range
25	Marker beacon passage		Discrete	1	—	—
26	Warnings		Discrete(s)	1	—	—
27	Each navigation receiver frequency selection		Sufficient to determine selected frequency	4	As installed	—
28*	DME 1 and 2 distances		0–370 km (0–200 NM)	4	As installed	1 852 m (1 NM)

Table A3-1 Parameter Characteristics for flight data recorders for helicopters (Cont')

Serial number	Parameter	Applicability	Measurement range	Maximum sampling and recording interval (seconds)	Accuracy limits (sensor input compared to FDR readout)	Recording resolution
29*	Navigation data (latitude/longitude, ground speed, drift angle, wind speed, wind direction)		As installed	2	As installed	As installed
30*	Landing gear and gear selector position		Discrete	4	—	—
31*	Engine exhaust gas temperature (T <sub>4</sub> )		As installed	1	As installed	
32*	Turbine inlet temperature (TIT/ITT)		As installed	1	As installed	
33*	Fuel contents		As installed	4	As installed	
34*	Altitude rate		As installed	1	As installed	
35*	Ice detection		As installed	4	As installed	
36*	Helicopter health and usage monitor system		As installed	—	As installed	—
37	Engine control modes		Discrete	1	—	—
38*	Selected barometric setting (pilot and co-pilot)		As installed	64 (4 recommended)	As installed	0.1 mb (0.01 in Hg)
39*	Selected altitude (all pilot selectable modes of operation)		As installed	1	As installed	Sufficient to determine crew selection
40*	Selected speed (all pilot selectable modes of operation)		As installed	1	As installed	Sufficient to determine crew selection
41*	Selected Mach (all pilot selectable modes of operation)		As installed	1	As installed	Sufficient to determine crew selection
42*	Selected vertical speed (all pilot selectable modes of operation)		As installed	1	As installed	Sufficient to determine crew selection
43*	Selected heading (all pilot selectable modes of operation)		As installed	1	As installed	Sufficient to determine crew selection

Table A3-1 Parameter Characteristics for flight data recorders for helicopters (Cont')

Serial number	Parameter	Applicability	Measurement range	Maximum sampling and recording interval (seconds)	Accuracy limits (sensor input compared to FDR readout)	Recording resolution
44*	Selected flight path (all pilot selectable modes of operation)		As installed	1	As installed	Sufficient to determine crew selection
45*	Selected decision height		As installed	4	As installed	Sufficient to determine crew selection
46*	EFIS display format (pilot and co-pilot)		Discrete(s)	4	—	—
47*	Multi-function/engine/alerts display format		Discrete(s)	4	—	—
48*	Event marker		Discrete	1	—	—
49*	GPWS/TAWS/GCAS status (selection of terrain display mode including pop-up display status) and (terrain alerts, both cautions and warnings, and advisories) and (on/off switch position) and (operational status)	Application for type certification is submitted to a Contracting State on or after 1 January 2023	Discrete(s)	1	As installed	
50*	TCAS/ACAS (traffic alert and collision avoidance system) and (operational status)	Application for type certification is submitted to a Contracting State on or after 1 January 2023	Discrete(s)	1	As installed	
51*	Primary flight controls – pilot input forces	Application for type certification is submitted to a Contracting State on or after 1 January 2023	Full range	0.125 (0.0625 recommended)	± 3% unless higher accuracy is uniquely required	0.5% of operating range



Table A3-1 Parameter Characteristics for flight data recorders for helicopters (Cont')

Serial number	Parameter	Applicability	Measurement range	Maximum sampling and recording interval (seconds)	Accuracy limits (sensor input compared to FDR readout)	Recording resolution
52*	Computed centre of gravity	Application for type certification is submitted to a Contracting State on or after 1 January 2023	As installed	64	As installed	1% of full range
53*	Helicopter computed weight	Application for type certification is submitted to a Contracting State on or after 1 January 2023	As installed	64	As installed	1% of full range

Table A3-2 Description of applications for data link recorders for helicopters

Item No.	Application type	Application description	Recording content
1	Data link initiation	This includes any applications used to log on to or initiate data link service. In FANS-1/A and ATN, these are ATS facilities notification (AFN) and context management (CM) respectively.	C
2	Controller/pilot communication	This includes any application used to exchange requests, clearances, instructions and reports between the flight crew and controllers on the ground. In FANS-1/A and ATN, this includes the CPDLC application. It also includes applications used for the exchange of oceanic (OCL) and departure clearances (DCL) as well as data link delivery of taxi clearances.	C
3	Addressed surveillance	This includes any surveillance application in which the ground sets up contracts for delivery of surveillance data. In FANS-1/A and ATN, this includes the automatic dependent surveillance — contract (ADS-C) application. Where parametric data are reported within the message they shall be recorded unless data from the same source are recorded on the FDR.	C
4	Flight information	This includes any service used for delivery of flight information to specific aircraft. This includes, for example, data link aviation weather report service (D-METAR), data link-automatic terminal service (D-ATIS), digital Notice to Airmen (D-NOTAM) and other textual data link services.	C
5	Aircraft broadcast surveillance	This includes elementary and enhanced surveillance systems, as well as automatic dependent surveillance — broadcast (ADS-B) output data. Where parametric data sent by the helicopter are reported within the message they shall be recorded unless data from the same source are recorded on the FDR.	M*
6	Aeronautical operational control data	This includes any application transmitting or receiving data used for aeronautical operational control purposes (per the ICAO definition of operational control).	M*

## Key:

C: Complete contents recorded.

M: Information that enables correlation to any associated records stored separately from the helicopter.

\*: Applications that are to be recorded only as far as is practicable given the architecture of the system.

Table A3-3 Parameter characteristics for aircraft data recording systems for helicopters

N°	Parameter name	Minimum recording range	Maximum recording interval in seconds	Minimum recording accuracy	Minimum recording resolution	Remarks
1	Heading:					
	a) Heading (Magnetic or True)	±180°	1	±2°	0.5°	*Heading is preferred, if not available, yaw rate shall be recorded
	b) Yaw rate	±300°/s	0.25	±1% + drift of 360°/h	2°/s	
2	Pitch:					
	a) Pitch attitude	±90°	0.25	±2°	0.5°	*Pitch attitude is preferred, if not available, pitch rate shall be recorded
	b) Pitch rate	±300°/s	0.25	±1% + drift of 360°/h	2°/s	
3	Roll:					
	a) Roll attitude	±180°	0.25	±2°	0.5°	*Roll attitude is preferred, if not available, roll rate shall be recorded
	b) Roll rate	±300°/s	0.25	±1% + drift of 360°/h	2°/s	
4	Positioning system:					
	a) Time	24 hours	1	±0.5°	0.1°	UTC time preferred where available
	b) Latitude/longitude	Latitude:±90° Longitude:±180°	2 (1 if available)	As installed (0.00015° recommended)	0.00005°	
	c) Altitude	−300 m (−1 000 ft) to maximum certified altitude of aircraft +1 500 m (5 000 ft)	2 (1 if available)	As installed (±15 m (±50 ft) recommended)	1.5 m (5 ft)	
	d) Ground speed	0–1 000 kt	2 (1 if available)	As installed (±5 kt recommended)	1 kt	
	e) Track	0–360°	2 (1 if available)	As installed (± 2° recommended)	0.5°	
	f) Estimated error	Available range	2 (1 if available)	As installed	As installed	Shall be recorded if readily available

Table A3-3 Parameter characteristics for aircraft data recording systems for helicopters (Con't)

N°	Parameter name	Minimum recording range	Maximum recording interval in seconds	Minimum recording accuracy	Minimum recording resolution	Remarks
5	Normal acceleration	-3 g to + 6 g	0.25 (0.125 if available)	As installed ( $\pm 0.09$ g excluding a datum error of $\pm 0.05$ g recommended)	0.004 g	
6	Longitudinal acceleration	$\pm 1$ g	0.25 (0.125 if available)	As installed ( $\pm 0.015$ g excluding a datum error of $\pm 0.05$ g recommended)	0.004 g	
7	Lateral acceleration	$\pm 1$ g	0.25 (0.125 if available)	As installed ( $\pm 0.015$ g excluding a datum error of $\pm 0.05$ g recommended)	0.004 g	
8	External static pressure (or pressure altitude)	34.4 hPa (1.02 in-Hg) to 310.2 hPa (9.16 in-Hg) or available sensor range	1	As installed ( $\pm 1$ hPa (0.3 in-Hg) or $\pm 30$ m ( $\pm 100$ ft) to $\pm 210$ m ( $\pm 700$ ft) recommended)	0.1 hPa (0.03 in-Hg) or 1.5 m (5 ft)	
9	Outside air temperature (or total air temperature)	-50° to +90°C or available sensor range	2	As installed ( $\pm 2^\circ\text{C}$ recommended)	1°C	
10	Indicated air speed	As the installed pilot display measuring system or available sensor range	1	As installed ( $\pm 3\%$ recommended)	1 kt (0.5 kt recommended)	
11	Main rotor speed (Nr)	50% to 130% or available sensor range	0.5	As installed	0.3% of full range	
12	Engine RPM (*)	Full range including overspeed condition	Each engine each second	As installed	0.2% of full range	*For piston- engined helicopters
13	Engine oil pressure	Full range	Each engine each second	As installed (5% of full range recommended)	2% of full range	
14	Engine oil temperature	Full range	Each engine each second	As installed (5% of full range recommended)	2% of full range	
15	Fuel flow or pressure	Full range	Each engine each second	As installed	2% of full range	
16	Manifold pressure (*)	Full range	Each engine each second	As installed	0.2% of full range	*For piston- engined helicopters

Table A3-3 Parameter characteristics for aircraft data recording systems for helicopters

N°	Parameter name	Minimum recording range	Maximum recording interval in seconds	Minimum recording accuracy	Minimum recording resolution	Remarks
17	Engine thrust/power/torque parameters required to determine propulsive thrust/power*	Full range	Each engine each second	As installed	0.1% of full range	*Sufficient parameters e.g. EPR/N1 or torque/Np as appropriate to the particular engine shall be recorded to determine power. A margin for possible overspeed should be provided. Only for turbine-engined helicopters.
18	Engine gas generator speed (Ng) (*)	0–150%	Each engine each second	As installed	0.2% of full range	*Only for turbine-engined helicopters
19	Free power turbine speed (Nf) (*)	0–150%	Each engine each second	As installed	0.2% of full range	*Only for turbine-engined helicopters
20	Collective pitch	Full range	0.5	As installed	0.1% of full range	
21	Coolant temperature (*)	Full range	1	As installed (±5°C recommended)	1° C	*Only for piston-engined helicopters
22	Main voltage	Full range	Each engine each second	As installed	1 Volt	
23	Cylinder head temperature (*)	Full range	Each cylinder each second	As installed	2% of full range	*Only for piston-engined helicopters
24	Fuel quantity	Full range	4	As installed	1% of full range	
25	Exhaust gas temperature	Full range	Each engine each second	As installed	2% of full range	
26	Emergency voltage	Full range	Each engine each second	As installed	1 Volt	
27	Trim surface position	Full range or each discrete position	1	As installed	0.3% of full range	
28	Landing gear position	Each discrete position*	Each gear every two seconds	As installed		*Where available, record up-and-locked and down-and-locked position
29	Novel/unique aircraft features	As required	As required	As required	As required	