



## ACCEPTABLE ARRANGEMENTS FOR FLIGHT RECORDERS

**Purpose**— This advisory circular provides guidance to support the RCAR requirements for installation and performance of flight recorders.

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- Advisory Circulars are intended to provide advice and guidance to illustrate a means, but not necessarily the only means, of complying with the Regulations, or to explain certain regulatory requirements by providing informative, interpretative and explanatory material.
- Where an AC is referred to in a 'Note' below the regulation, the AC remains as guidance material,
- ACs should always be read in conjunction with the referenced regulations.

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## SECTION 1 GENERAL

### 1.1 STATUS OF THIS ADVISORY CIRCULAR

This AC is an original issuance.

## 1.2 BACKGROUND

- A. Properly installed and functioning flight recorders are critical to accident investigations and identification of contributing factors in accidents and major incidents.
- B. The aftermath of a major accident is a demanding time for any State's investigation authority. One of the immediate items requiring a decision is where to have the flight recorders read out and analyzed.
- C. It is essential that the flight recorders be read out as early as possible after an accident. Early identification of problem areas can affect the investigation at the accident site where evidence is sometimes transient.
- D. Early identification of problem areas may also result in urgent safety recommendations which may be necessary to prevent a similar occurrence.

## 1.3 APPLICABILITY

This advisory circular is applicable to the operators and flight crews of all Rwanda-registered aircraft and all aircraft operated by holders of AOC issued by the RCAA.

## 1.4 RELATED REGULATIONS

The following regulations are directly applicable to the guidance contained in this advisory circular—

- RCAR Part 6, Instruments & Equipment
- RCAR Part 10, Operations of Aircraft

## 1.5 RELATED READING MATERIAL

- A. International Civil Aviation Organization (ICAO)
  - Annex 6, Part 1, International Operations of Commercial Air Transport; Appendix 8
  - Annex 6, Part 2, International Operations of General Aviation Aeroplanes; Appendix 3.1
  - Annex 6, Part 12, International Operations of Helicopters; Appendix 5
- B. European Aviation Safety
  - EUROCAE ED-112 – Minimum Operational Performance Specification (MOPS) for Crash Protected Airborne Recorder Systems
  - EUROCAE ED-155, *Minimum Operational Performance Specification (MOPS) for Lightweight Flight Recording Systems*
- C. Industry specification for documentation of flight recorder parameters
  - ARINC 647A, Flight Recorder Electronic Documentation

This advisory circular and copies of these documents may be obtained from the RCAA Flight Safety Services.

## 1.6 DEFINITIONS

For purposes of this advisory circular, these terms are defined as follows—

- 1) **Flight recorder.** Any type of recorder installed in the aircraft for the purpose of complementing accident/incident investigation.

## 1.7 ACRONYMS & ABBREVIATIONS

The following acronyms and abbreviations are used in this advisory circular—

- 1) **AC** – Advisory Circular
- 2) **AIR** – Airborne Image Recorder
- 3) **RCAR** – Rwanda Aviation Safety Regulation
- 4) **RCAA** – Rwanda Civil Aviation Authority
- 5) **CARS** – Cockpit Audio Recording System
- 6) **CVR** – Cockpit Voice Recorder
- 7) **DLR** – Data Link Recorder
- 8) **FDR** – Flight Data Recorder
- 9) **MOPS** – Minimum Operational Performance Specification
- 10) **TSO** – Technical Standard Order

## SECTION 2 GENERAL REQUIREMENTS

### 2.1 FLIGHT RECORDER SYSTEMS

A. Crash protected flight recorders comprise four systems—

- 1) Flight data recorder (FDR)
- 2) Cockpit voice recorder (CVR);
- 3) Airborne image recorder (AIR); and
- 4) Data link recorder (DLR); and

Image and data link information may be recorded on either the CVR or the FDR.

B. Lightweight flight recorders comprise four systems—

- 1) An aircraft data recording system (ADRS);
- 2) A cockpit audio recording system (CARS);
- 3) An airborne image recording system (AIRS); and
- 4) A data link recording system (DLRS).

Image and data link information may be recorded on either the CARS or the ADRS.

### 2.2 CONTAINERS & INSTALLATION

A. The flight recorder systems containers shall—

- 1) Be painted a distinctive orange or yellow color
- 2) Carry reflective material to facilitate their location; and
- 3) Have securely attached an automatically activated underwater locating device.

B. The flight recorder systems shall be installed so that—

- 1) The probability of damage to the recordings is minimized;
- 2) They receive electrical power from a bus that provides the maximum reliability for operation of the flight recorder systems without jeopardizing service to essential or emergency loads;
- 3) There is an aural or visual means for pre-flight checking that the flight recorder systems are operating properly; and

- 4) If the flight recorder systems have a bulk erasure device, the installation shall be designed to prevent operation of the device during flight time or crash impact.

### 2.3 TESTING & VERIFICATION

- A. 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.
- B. Means shall be provided for an accurate time correlation between the flight recorder systems recordings.
- C. The manufacturer shall provide the appropriate certifying authority with the following information in respect of the flight recording systems—
  - 1) Manufacturer's operating instructions, equipment limitations and installation procedures;
  - 2) Parameter origin or source and equations which relate counts to units of measurement; and
  - 3) Manufacturer's test reports.

## SECTION 3 FLIGHT DATA RECORDER (FDR)

The flight data recorder 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.

### 3.1 PARAMETERS TO BE RECORDED

- A. Flight data recorders shall be classified, depending upon the number of parameters to be recorded and the duration required for retention of the recorded information, as—
  - For aeroplanes: Type I, Type IA, Type II and Type IIA
  - For helicopters: Type IV, IVA and V
- B. The parameters that satisfy the requirements for FDRs are listed in this advisory circular.
  - The number of parameters to be recorded shall depend on aeroplane complexity.
  - Other parameters may be substituted with due regard to the aeroplane type and the characteristics of the recording equipment.
- C. Parameter guidance for range, sampling, accuracy and resolution are as contained in the EUROCAE ED-112, Minimum Operational Performance Specification (MOPS) for Crash Protected Airborne Recorder Systems, or equivalent documents issued by States of Design.

- See Appendix A (Aeroplanes) and C (Helicopters) for a listing of the parameters.
- See Appendix B (Aeroplanes) and D (Helicopters) for guidance re parameter measurements.

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

The range, sampling, accuracy or resolution guidance in Appendices B and D are intended for aircraft issued an individual certificate of airworthiness after 1 January 2016.

## 3.2 TYPES OF RECORDERS

### 3.2.1 TYPE IA FDR: AEROPLANES

This FDR shall be capable of recording, as appropriate to the aeroplane, at least the 78 parameters in Appendix B.

### 3.2.2 TYPE I FDR: AEROPLANES

This FDR shall be capable of recording, as appropriate to the aeroplane, at least the first 32 parameters in Appendix B.

### 3.2.3 TYPES II & IIA FDR: AEROPLANES

These FDRs shall be capable of recording, as appropriate to the aeroplane, at least the first 16 parameters in Appendix B.

A Type IIA FDR, in addition to a 30-minute recording duration, shall retain sufficient information from the preceding take-off for calibration purposes.

### 3.2.4 TYPE IVA FDR: HELICOPTERS

This FDR will be capable of recording, as appropriate to the helicopter, at least the 48 parameters in Appendix C.

### 3.2.5 TYPE IV FDR: HELICOPTERS

This FDR shall be capable of recording, as appropriate to the helicopter, at least the first 30 parameters in Appendix C.

### 3.2.6 TYPE V FDR: HELICOPTERS

This FDR shall be capable of recording, as appropriate to the helicopter, at least the first 15 parameters in Appendix C.

## 3.3 ADDITIONAL RECORDING CAPABILITY

- A. If further recording capacity is available, recording of
- B. For aeroplanes, if further recording capacity is available, recording of the following additional information should be considered—
  - 1) 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:
    - (a) 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;
    - (b) Display system selection/status, e.g. SECTOR, PLAN, ROSE, NAV, WXR, COMPOSITE, COPY, ETC.;
    - (c) Warnings and alerts;
    - (d) The identity of displayed pages for emergency procedures and checklists; and
  - 2) Retardation information including brake application for use in the investigation of landing overruns and rejected take-offs.
- C. For helicopters, the following additional information should be considered—
  - 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

- Additional engine parameters (EPR, N1, fuel flow, etc.).

### 3.4 PERFORMANCE & VERIFICATION

- A. FDR performance requirements are as contained in the EUROCAE ED-112, *Minimum Operational Performance Specification (MOPS) for Crash Protected Airborne Recorder Systems*, or equivalent documents.
- B. The measurement range, recording interval and accuracy of parameters on installed equipment shall be verified by methods approved by the RCAA.
- C. 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.

## SECTION 4 COCKPIT VOICE RECORDER (CVR) & COCKPIT AUDIO RECORDING SYSTEM (CARS)

### 4.1 SIGNALS TO BE RECORDED

- A. The CVR and 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.
- B. In addition, depending on the availability of electrical power, the CVR and 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.
- C. The CVR shall record on four separate channels, or more, at least the following—
  - 1) Voice communication transmitted from or received in the aeroplane by radio;
  - 2) Aural environment on the flight deck;
  - 3) Voice communication of flight crew members on the flight deck using the aeroplane's interphone system, if installed;
  - 4) Voice or audio signals identifying navigation or approach aids introduced in the headset or speaker; and
  - 5) Voice communication of flight crew members using the passenger address system, if installed
- D. The CARS shall record on two separate channels, or more, at least the following—
  - 1) Voice communication transmitted from or received in the aeroplane by radio;
  - 2) Aural environment on the flight deck; and
  - 3) Voice communication of flight crew members on the flight deck using the aeroplane's interphone system, if installed.
- E. The CVR shall be capable of recording on at least four channels simultaneously.
  - On a tape-based CVR, to ensure accurate time correlation between channels, the CVR is to record in an in-line format.
  - If a bi-directional configuration is used, the in-line format and channel allocation shall be retained in both directions.

F. The preferred channel allocation shall be as follows:

- Channel 1: Co-pilot headphones and live boom microphone
- Channel 2: Pilot headphones and live boom microphone
- Channel 3: Area microphone
- Channel 4: Time reference plus the third and fourth crew members' headphone and live microphone, if applicable. Additional requirements for helicopters include main rotor speed or the flight deck vibration environment

Channel 1 is located closest to the base of the recording head

- The preferred channel allocation presumes use of current conventional magnetic tape transport mechanisms, and is specified because the outer edges of the tape have a higher risk of damage than the middle.
- It is not intended to preclude use of alternative recording media where such constraints may not apply

## 4.2 PERFORMANCE REQUIREMENTS

- A. CVR performance requirements are as contained in the EUROCAE ED-112, *Minimum Operational Performance Specification (MOPS) for Crash Protected Airborne Recorder Systems*, or equivalent documents.
- B. CARS performance requirements are as contained in the EUROCAE ED-155, *Minimum Operational Performance Specification (MOPS) for Lightweight Flight Recording Systems*, or equivalent documents.

## SECTION 5 AIRBORNE IMAGE RECORDER (AIR)

### 5.1 CLASSES

- A. Class A AIR captures the general cockpit area in order to provide data supplemental to conventional flight recorders.
- B. A Class B AIR captures data link message displays.
- C. A Class C AIR captures instruments and control panels.

A Class C AIR 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.

- 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.
- There are no provisions for Class A AIRs in this RCAR at the issuance of this advisory circular.

### 5.2 OPERATION

- A. The AIR must 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.
- B. In addition, depending on the availability of electrical power, the AIR must 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.

### 5.3 PERFORMANCE

AIR performance requirements are as contained in the EUROCAE ED-112, *Minimum Operational Performance Specification (MOPS) for Crash Protected Airborne Recorder Systems*, or equivalent documents.



## SECTION 6 DATA LINK RECORDER (DLR)

### 6.1 APPLICATIONS TO BE RECORDED

- A. 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.
- B. As far as practicable, the time the messages were displayed to the flight crew and the time of the responses shall be recorded.
- C. Messages applying to the applications listed below 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.
  - Data link initiation capability
  - Controller–pilot data link communications
  - Data link – flight information services
  - Automatic dependent surveillance – contract
  - Automatic dependent surveillance – broadcast\*
  - Aeronautical operational control\*.
- D. Descriptions of the applications are contained in Appendix E.

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.

### 6.2 PERFORMANCE

Data link recorders performance requirements are as contained in the EUROCAE ED-112, *Minimum Operational Performance Specifications (MOPS) for Crash Protected Airborne Recorder Systems*, or equivalent documents.

## SECTION 7 AIRCRAFT DATA RECORDING SYSTEMS (ADRS)

### 7.1 PARAMETERS TO BE RECORDED

ADRS shall be capable of recording, as appropriate to the aeroplane, at least the essential (E) parameters in Appendix F.

### 7.2 PERFORMANCE

ADRS performance requirements are contained in EUROCAE ED-155, *Minimum Operational Performance Specifications (MOPS) for Lightweight Flight Recording Systems*, or equivalent document.

### 7.3 ADDITIONAL INFORMATION

- A. The measurement range, recording interval and accuracy of parameters on installed equipment is usually verified by methods approved by the appropriate certifying authority.
- B. 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.

## SECTION 8 INSPECTIONS OF FLIGHT RECORDER SYSTEMS

- A. 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.
- B. Annual inspections shall be carried out as follows—
- 1) An analysis of the recorded data from the flight recorders shall ensure that the recorder operates correctly for the nominal duration of the recording;
  - 2) The analysis of the FDR shall evaluate the quality of the recorded data to determine if the bit error rate (including those errors introduced by recorder, the acquisition unit, the source of the data on the aeroplane and by the tools used to extract the data from the recorder) is within acceptable limits and to determine the nature and distribution of the errors;
  - 3) A complete flight from the FDR 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.
    - ◆ Parameters taken from the aircraft's electrical bus system need not be checked if their serviceability can be detected by other aircraft systems;
  - 4) 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;
  - 5) An annual examination of the recorded signal on the CVR shall be carried out by replay of the CVR recording. While installed in the aircraft, the CVR shall record test signals from each aircraft source and from relevant external sources to ensure that all required signals meet intelligibility standards;
  - 6) Where practicable, during the annual examination, a sample of in-flight recordings of the CVR shall be examined for evidence that the intelligibility of the signal is acceptable; and
  - 7) An annual examination of the recorded images on the AIR shall be carried out by replay of the AIR recording.
    - ◆ While installed in the aircraft, the AIR shall record test images from each aircraft source and from relevant external sources to ensure that all required images meet recording quality standards.
- C. Flight recorder systems 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.
- D. A report of the annual inspection shall be made available on request to regulatory authorities for monitoring purposes.
- E. Calibration of the FDR system—
- 1) For those parameters which have sensors dedicated only to the FDR and are not checked by other means, recalibration shall be carried out at least every five years or in accordance with the recommendations of the sensor manufacturer to 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
  - 2) When the parameters of altitude and airspeed are provided by sensors that are dedicated to the FDR system, there shall be a recalibration performed as recommended by the sensor manufacturer, or at least every two years

*Appendix(es) Follow*

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## APPENDIX A

### Parameters to be Recorded: Aeroplanes

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Mandatory and voluntary parameters are designated in the following manner—

- The parameters without an asterisk (\*) are mandatory parameters which shall be recorded regardless of aeroplane complexity.
- 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

#### 1. Flight Path & Speed: Aeroplanes

The following parameters shall satisfy the requirements for flight path and speed—

- Pressure altitude
- Indicated airspeed or calibrated airspeed
- Air-ground status and each landing gear air-ground sensor when practicable
- Total or outside air temperature
- Heading (primary flight crew reference)
- Normal acceleration
- Lateral acceleration
- Longitudinal acceleration (body axis)
- Time or relative time count
- Navigation data\*: drift angle, wind speed, wind direction, latitude/longitude
- Groundspeed\*
- Radio altitude\*

#### 2. Attitude: Aeroplanes

The following parameters shall satisfy the requirements for attitude—

- Pitch attitude
- Roll attitude
- Yaw or sideslip angle\*
- Angle of attack\*

#### 3. Engine Power: Aeroplanes

The following parameters shall satisfy the requirements for engine power—

- Engine thrust/power: propulsive thrust/power on each engine, cockpit thrust/power lever position
- Thrust reverse status\*
- Engine thrust command\*
- Engine thrust target\*
- Engine bleed valve position\*
- Additional engine parameters\*: EPR, N1, indicated vibration level, N2, EGT, TLA, fuel flow, fuel cut-off lever position, N3

#### 4. Configuration: Aeroplanes

The following parameters shall satisfy the requirements for configuration—

- Pitch trim surface position
  - Flaps\*: trailing edge flap position, cockpit control selection
  - Slats\*: leading edge flap (slat) position, cockpit control selection
  - Landing gear\*: landing gear, gear selector position
  - Yaw trim surface position\*
  - Roll trim surface position\*
-

- Cockpit trim control input position pitch\*
- Cockpit trim control input position roll\*
- Cockpit trim control input position yaw\*
- Ground spoiler and speed brake\*: Ground spoiler position, ground spoiler selection, speed brake position, speed brake selection
- De-icing and/or anti-icing systems selection\*
- Hydraulic pressure (each system)\*
- Fuel quantity in CG trim tank \*
- AC electrical bus status\*
- DC electrical bus status
- APU bleed valve position\*
- Computed centre of gravity\*

## 5. Operation: Aeroplanes

The following parameters shall satisfy the requirements for operation—

- Warnings
- Primary flight control surface and primary flight control pilot input: pitch axis, roll axis, yaw axis
- Marker beacon passage
- Each navigation receiver frequency selection
- Manual radio transmission keying and CVR/FDR synchronization reference
- Autopilot/autothrottle/AFCS mode and engagement status\*
- Selected barometric setting\*: pilot, first officer
- Selected altitude (all pilot selectable modes of operation)\*
- Selected speed (all pilot selectable modes of operation)\*
- Selected Mach (all pilot selectable modes of operation)\*
- Selected vertical speed (all pilot selectable modes of operation)\*
- Selected heading (all pilot selectable modes of operation)\*
- Selected flight path (all pilot selectable modes of operation)\*: course/DSTRK, path angle
- Selected decision height\*
- EFIS display format\*: pilot, first officer
- Multi-function/engine/alerts display format\*
- GPWS/TAWS/GCAS status\*: selection of terrain display mode including pop-up display status, terrain alerts, both cautions and warnings, and advisories, on/off switch position
- Low pressure warning\*: hydraulic pressure, pneumatic pressure — Computer failure\*
- Loss of cabin pressure\*
- TCAS/ACAS (traffic alert and collision avoidance system/airborne collision avoidance system)\*
- Ice detection\*
- Engine warning each engine vibration\*
- Engine warning each engine over temperature\* — Engine warning each engine oil pressure low\*
- Engine warning each engine over speed\*
- Wind shear warning\*
- Operational stall protection, stick shaker and pusher activation\*
- All cockpit flight control input forces\*: control wheel, control column, rudder pedal cockpit input forces
- Vertical deviation\*: ILS glide path, MLS elevation, GNSS approach path
- Horizontal deviation\*: ILS localizer, MLS azimuth, GNSS approach path
- DME 1 and 2 distances\*
- Primary navigation system reference\*: GNSS, INS, VOR/DME, MLS, Loran C, ILS
- Brakes\*: left and right brake pressure, left and right brake pedal position
- Date\*
- Event marker\*
- Head up display in use\*
- Para visual display on\*

## APPENDIX B

### FDR Parameter Guidance: Aeroplanes

Serial number	Parameter	Measurement range	Maximum sampling and recording interval (seconds)	Accuracy limits (sensor input compared to FDR read-out)	Recording resolution
1	Time (UTC when available, otherwise relative time count or GPS time sync)	24 hours	4	±0.125% per hour	1 second
2	Pressure-altitude	-300 m (-1 000 ft) to maximum certified 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 $V_{Lo}$ (Note 1) $V_{Lo}$ to 1.2 $V_{Lo}$ (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 3)	-3 g to +6 g	0.125	±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		
9	Power on each engine (Note 4)	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/A/PCS mode and engagement status	A suitable combination of discrete	1		
16	Longitudinal acceleration (Note 3)	±1 g	0.25	±0.015 g excluding a datum error of ±0.05 g	0.004 g
<i>Note.—The preceding 16 parameters satisfy the requirements for a Type II FDR.</i>					
17	Lateral acceleration (Note 3)	±1 g	0.25	±0.015 g excluding a datum error of ±0.05 g	0.004 g

## FDR Parameter Guidance - Aeroplanes (Continued)

Serial number	Parameter	Measurement range	Maximum sampling and recording interval (seconds)	Accuracy limits (sensor input compared to FDR read-out)	Recording resolution
18	Pilot input and/or control surface position—primary controls (pitch, roll, yaw) (Note 3) (Note 6)	Full range	0.25	±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 ±3% 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/CP/CLS glide path, MLS elevation, IRNAV/IAN vertical deviation)	Signal range	1	±3%	0.3% of full range
22*	Horizontal beam deviation (ILS/CP/CLS 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 7)	Full range	4	As installed	
26*	DME 1 and 2 distance (includes Distance to runway threshold (CHS) and Distance to missed approach point (IRNAV/IAN)) (Notes 7 and 8)	0 – 370 km (0 – 200 NM)	4	As installed	1 852 m (1 NM)
27	Air/ground status	Discrete	1		
28*	GPWS/TAWS/QCAS 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 3)	As installed	1	As installed	
32*	Landing gear and gear selector position	Discrete	4	As installed	

Note.— The preceding 32 parameters satisfy the requirements for a Type I FDR.

## FDR Parameter Guidance - Aeroplanes (Continued)

Serial number	Parameter	Measurement range	Maximum sampling and recording interval (seconds)	Accuracy limits (sensor input compared to FDR read-out)	Recording resolution
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, discrete or full range)	1	±5%	2% of full range
35*	Additional engine parameters (EPR, $N_1$ , indicated vibration level, $N_2$ , EGT, fuel flow, fuel cut-off lever position, $N_3$ )	As installed	Each engine each second	As installed	2% of full range
36*	TCAS/ACAS (traffic alert and collision avoidance system)	Discrete	1	As installed	
37*	Windshear 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/DETRK, path angle, final approach path (DGN/VLAN))	As installed	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	
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

## FDR Parameter Guidance - Aeroplanes (Continued)

Serial number	Parameter	Measurement range	Maximum sampling and recording interval (seconds)	Accuracy limits (sensor input compared to FDR read-out)	Recording resolution
56*	Fuel quantity in CO <sub>2</sub> trim tank	As installed	64	As installed	1% of full range
57*	Head up display in use	As installed	4	As installed	
58*	Pan 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 (DME, 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
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	±3%	0.5°
69*	De-icing and/or anti-icing systems selection	Discrete(s)	4		
70*	Hydraulic pressure (each system)	Full range	2	±3%	100 psi
71*	Loss of cabin pressure	Discrete	1		
72*	Cockpit trim control input position, Pitch	Full range	1	±3%	0.2% of full range or as installed
73*	Cockpit trim control input position, Roll	Full range	1	±3%	0.2% of full range or as installed
74*	Cockpit trim control input position, Yaw	Full range	1	±3%	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	±3%	0.2% of full range or as installed
76*	Event marker	Discrete	1		
77*	Date	365 days	64		
78*	ANP or EFP or EPU	As installed	4	As installed	

*Note.— The preceding 78 parameters satisfy the requirements for a Type LA FDR.*

Notes relating to this appendix—

- 1) Vso stalling speed or minimum steady flight speed in the landing configuration is in Section “Abbreviations and Symbols”.



- 2) Vd design diving speed.
- 3) Increased recording requirements are specified for 2016.
- 4) Record sufficient inputs to determine power.
- 5) 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.
- 6) Increased recording requirements are specified for 2016.
- 7) If signal available in digital form.
- 8) Recording of latitude and longitude from INS or other navigation system is a preferred alternative.
- 3) If signals readily available.

*End of Appendix B*

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## APPENDIX C

### Parameters to be Recorded: Helicopters

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Mandatory and voluntary parameters are designated in the following manner—

- The parameters without an asterisk (\*) are mandatory parameters which shall be recorded regardless of helicopter complexity.
- 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.

#### 1. Flight Path & Speed: Helicopters

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. Attitude: Helicopters

The following parameters shall satisfy the requirements for attitude—

- Pitch attitude
- Roll attitude
- Yaw rate.

#### 3. Engine Power: Helicopters

The following parameters shall satisfy the requirements for engine power—

- Power on each engine: free power turbine speed (Nf), engine torque, engine gas generator speed (Ng), cockpit power control position
- Rotor: main rotor speed, rotor brake
- Main gearbox oil pressure\*
- Gearbox oil temperature\*: main gearbox oil temperature, intermediate gearbox oil temperature, tail rotor gearbox oil temperature
- Engine exhaust gas temperature (T4)\*
- Turbine inlet temperature (TIT)\*.

#### 4. Operation: Helicopters

The following parameters shall satisfy the requirements for operation—

- Hydraulics low pressure
  - Warnings
  - Primary flight controls: pilot input and/or control output position: collective pitch, longitudinal cyclic pitch, lateral cyclic pitch, tail rotor pedal, controllable stabilator, hydraulic selection
  - Marker beacon passage
  - Each navigation receiver frequency selection
  - AFCS mode and engagement status\*
  - Stability augmentation system engagement\*
-

- Indicated sling load force\*
- Vertical deviation\*: ILS glide path, MLS elevation, GNSS approach path
- Horizontal deviation\*: ILS localizer, MLS azimuth, GNSS approach path
- DME 1 and 2 distances\*
- Altitude rate\*
- Ice detector liquid water content\*
- Helicopter health and usage monitor system (HUMS)\*: engine data, chip detectors, channel timing, exceedance discretions, broadband average engine vibration.

## 5. Configuration: Helicopters

The following parameters shall satisfy the requirements for configuration—

- Landing gear or gear selector position\*
- Fuel contents\*
- Ice detector liquid water content\*.

*End of Appendix C*

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## APPENDIX D

### FDR Parameter Guidance: Helicopters

Serial number	Parameter	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 GPS time sync)	24 hours	4	±0.125% per hour	1 s
2	Pressure altitude	-300 m (-1 000 ft) to maximum certified 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	As the installed pilot display measuring system	1	±3%	1 kt
4	Heading	360°	1	±2°	0.5°
5	Normal acceleration	-3 g to +6 g	0.125	±0.09 g excluding a datum error of ±0.045 g	0.004 g
6	Pitch attitude	±75° or 100% of usable range whichever is greater	0.5	±2°	0.5°
7	Roll attitude	±180°	0.5	±2°	0.5°
8	Radio transmission keying	On-off (one discrete)	1	—	—
9	Power on each engine	Full range	1 (per engine)	±2%	0.1% of full range
10	Main rotor:				
	Main rotor speed	50-130%	0.51	±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)	±2% unless higher accuracy uniquely required	0.5% of operating range
12	Hydraulics, each system (line pressure and selection)	Discrete	1	—	—
13	Outside air temperature	Sensor range	2	±2°C	0.3°C
14*	Autopilot/ autothrottle/APCS mode and engagement status	A suitable combination of discrete	1	—	—
15*	Stability augmentation system engagement	Discrete	1	—	—
<i>Note.— The preceding 15 parameters satisfy the requirements for a Type V FDR.</i>					
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

## FDR Parameter Guidance - Helicopters (Continued)

Serial number	Parameter	Measurement range	Maximum sampling and recording interval (seconds)	Accuracy limits (sensor input compared to FDR readout)	Recording resolution
18	Yaw rate	$\pm 400^\circ/\text{second}$	0.25	$\pm 1.5\%$ maximum range excluding datum error of $\pm 5\%$	$\pm 2^\circ/\text{s}$
19*	Sling load force	0 to 200% of certified load	0.5	$\pm 3\%$ of maximum range	0.5% for maximum certified load
20	Longitudinal acceleration	$\pm 1\text{ g}$	0.25	$\pm 0.015\text{ g}$ excluding a datum error of $\pm 0.05\text{ g}$	0.004 g
21	Lateral acceleration	$\pm 1\text{ g}$	0.25	$\pm 0.015\text{ g}$ excluding a datum error of $\pm 0.05\text{ g}$	0.004 g
22*	Radio altitude	-6 m to 750 m (-20 ft to 2 500 ft)	1	$\pm 0.6\text{ m}$ ( $\pm 2\text{ ft}$ ) or $\pm 3\%$ whichever is greater below 150 m (500 ft) and $\pm 5\%$ 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	$\pm 3\%$	0.3% of full range
24*	Horizontal beam deviation	Signal range	1	$\pm 3\%$	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)
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	—	—
<i>Note.— The preceding 30 parameters satisfy the requirements for a Type IV FDR.</i>					
31*	Engine exhaust gas temperature ( $T_{EGT}$ )	As installed	1	As installed	
32*	Turbine inlet temperature (TIT/TTT)	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)

## FDR Parameter Guidance - Helicopters (Continued)

Serial number	Parameter	Measurement range	Maximum sampling and recording interval (seconds)	Accuracy limits (sensor input compared to FDR readout)	Recording resolution
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)	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	—	—

Note.— The remaining 48 parameters satisfy the requirements for a Type I/II FDR.

*End of Appendix D*

## APPENDIX E

### Description of Application for Data Link Recorders

#### Recording Content Legend—

- C = Complete contents recorded.
- M = Information that enables correlations to any associated records stored separately from the aircraft.
- \* = Applications to be recorded only as far as is practicable given the architecture of the system

Item No.	Application type	Application description	Recording content
1	Data link Initiation	This includes any applications used to logon 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 (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, D-METAR, D-ATIS, D-NOTAM and other textual data link services.	C
5	Aircraft Broadcast Surveillance	This includes Elementary and Enhanced Surveillance Systems, as well as ADS-B output data. Where parametric data sent by the aircraft 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 AOC purposes (per the ICAO definition of AOC).	M *

*End of Appendix E*

## APPENDIX F

### Parameter Guidance: Aircraft Data Recording Systems

#### Parameter Category Abbreviations

- E = Essential parameters
- R = Recommended parameters

No.	Parameter name	Parameter category	Minimum recording range	Maximum recording interval in seconds	Minimum recording accuracy	Minimum recording resolution	Remarks
1	Heading (Magnetic or True)	R*	±180 degrees	1	±2 degrees	0.5 degree	* If not available, record rate
2	Pitch attitude	E*	±90 degrees	0.25	±2 degrees	0.5 degree	* If not available, record rate
3	Roll attitude	E*	±180 degrees	0.25	±2 degrees	0.5 degree	* If not available, record rate
4	Yaw rate	E*	±300 degrees/s	0.25	±1% + drift of 360°/hr	2 degrees/s	* Essential if no heading available
5	Pitch rate	E*	±300 degrees/s	0.25	±1% + drift of 360°/hr	2 degrees/s	* Essential if no pitch attitude available
6	Roll rate	E*	±300 degrees/s	0.25	±1% + drift of 360°/hr	2 degrees/s	* Essential if no roll attitude available
7	Positioning system : latitude/longitude	E	Latitude:±90 degrees Longitude:±180 degrees	2 (1 if available)	As installed (0.00015 degree recommended)	0.00005 degree	
8	Positioning system estimated error	E*	Available range	2 (1 if available)	As installed	As installed	* If available
9	Positioning system : altitude	E	-300 m (-1 000 ft) to maximum certified altitude of aeroplane +1 500 m (5 000 ft)	2 (1 if available)	As installed (±15 m (±50 ft) recommended)	1.5 m (5 ft)	
10	Positioning system : time*	E	24 hours	1	±0.5 second	0.1 second	* UTC time preferred where available.
11	Positioning system : ground speed	E	0-1 000 kt	2 (1 if available)	As installed (±5 kt recommended)	1 kt	
12	Positioning system : channel	E	0-360 degrees	2 (1 if available)	As installed (±2 degrees recommended)	0.5 degrees	
13	Normal acceleration	E	-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	
14	Longitudinal acceleration	E	±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	
15	Lateral acceleration	E	±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	



## Parameter Guidance - Aircraft Data Recording Systems (Continued)

No.	Parameter name	Parameter category	Minimum recording range	Maximum recording interval in seconds	Minimum recording accuracy	Minimum recording resolution	Remarks
16	External static pressure (or pressure altitude)	R	34.4 mb (3.44 in-Hg) to 310.2 mb (31.02 in-Hg) or available sensor range	1	As installed ( $\pm 1$ mb (0.1 in-Hg) or $\pm 30$ m ( $\pm 100$ ft) to $\pm 210$ m ( $\pm 700$ ft) recommended)	0.1 mb (0.01 in-Hg) or 1.5 m (5 ft)	
17	Outside air temperature (or total air temperature)	R	-50° to +90°C or available sensor range	2	As installed ( $\pm 2^\circ\text{C}$ recommended)	1°C	
18	Indicated air speed	R	As the installed pilot display measuring system or available sensor range	1	As installed ( $\pm 3\%$ recommended)	1 kt (0.5 kt recommended)	
19	Engine RPM	R	Full range including overspeed condition	Each engine each second	As installed	0.2% of full range	
20	Engine oil pressure	R	Full range	Each engine each second	As installed (5% of full range recommended)	2% of full range	
21	Engine oil temperature	R	Full range	Each engine each second	As installed (5% of full range recommended)	2% of full range	
22	Fuel flow or pressure	R	Full range	Each engine each second	As installed	2% of full range	
23	Manifold pressure	R	Full range	Each engine each second	As installed	0.2% of full range	
24	Engine thrust/power/torque parameters required to determine propulsive thrust/power*	R	Full range	Each engine each second	As installed	0.1% of full range	* Sufficient parameters e.g. EPR/AN1 or torque/HP 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.
25	Engine gas generator speed (Ng)	R	0-150%	Each engine each second	As installed	0.2% of full range	
26	Free power turbine speed (Nf)	R	0-150%	Each engine each second	As installed	0.2% of full range	
27	Coolant temperature	R	Full range	1	As installed ( $\pm 5^\circ\text{C}$ recommended)	1 degree Celsius	
28	Main voltage	R	Full range	Each engine each second	As installed	1 Volt	
29	Cylinder head temperature	R	Full range	Each cylinder each second	As installed	2% of full range	
30	Flaps position	R	Full range or each discrete position	2	As installed	0.5 degree	

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

*End of Advisory Circular*

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