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AEROSPACE STANDARD

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Minimum Performance Standard General Aviation Flight Recorder

NOTICE

Changes in this Revision are format/editorial only.

INTRODUCTION

The standards contained herein apply to recording equipment intended primarily for installation in multi-engine, turbine powered aircraft (fixed and rotary wing) for automatically recording flight data parameters and audio information. This standard is not intended for large aircraft operating under Code of Federal Regulations Title 14, Aeronautics & Space, part 121.

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1. SCOPE:

1.1 Basic Types of Flight Recorders:

This standard covers three (3) basic types of flight recorders as defined below:

TYPE I Cockpit Voice Recorder (only) - Records voice communication (among flight crew and radio communication to and from aircraft crew) and cockpit area sound.

TYPE II Flight Data Recorder (only) - Records aircraft flight data parameters.

TYPE III Cockpit Voice/Flight Data Recorder Combination - Records all TYPE I and TYPE II requirements in a composite unit.

All requirements specified in Sections 3, 4, 5, 6 and 7 of this standard shall be applicable to all recorder types unless otherwise noted.

1.2 Purpose:

This Aerospace Standard (AS) specifies minimum performance standards for recording automatically aircraft flight parameters and (or) aural communication between flight crew members, aural warning sounds, and communications to and from aircraft necessary for flight operations. It is the intent of this standard to allow for the use of individual Cockpit Voice Recorder (CVR) or Flight Data Recorder (FDR) equipment, or a combination CVR/FDR. These equipments have been identified as TYPE I, II and III, thereafter as identified by paragraph 1.1.

2. APPLICABLE DOCUMENTS:

The following documents shall form a part of this standard to the extent specified. In the event of conflict between these documents and this standard, the contents of this standard shall govern.

2.1 Code of Federal Regulations, Title 14:

Applicable as specified herein. Copies may be purchased from The Superintendent of Documents, U.S. Government Printing Office, Washington, D.C. 20402.

a. Title 14 - Code of Federal Regulations Aeronautics & Space

2.2 Industry Standards:

a. RS-232 Interface Between Data Terminal Equipment and Data Communication Equipment Employing Serial Binary Data Interchange

RS-422A Electrical Characteristics of Balanced Voltage Digital Interface Circuits

Copies may be purchased from Electronic Industries Association, Standard Sales Office, 2001 "I" Street, N.W. Washington, D.C. 20006.

b. Magnetic Tape Recording and Reproducing April 1965

Copies may be purchased from National Association of Broadcasters, 477 Madison Avenue, New York, N.Y.

c. IEEE STANDARD 488 - Standard Interface for Programmable Instrumentation (1978)

Copies may be purchased from Institute of Electrical and Electronic Engineers, Inc., 345 East 47th Street, New York, N.Y. 10017.

2.3 Military Specifications:

a. MIL-S-17526 - Sands, Molding

Copies may be purchased from Naval Publications and Forms Center, 5801 Tabor Avenue, Philadelphia, PA 19120.

2.4 SAE Documents:

Not applicable

2.5 RTCA Documents:

a. RTCA/DO-160A - Environmental Conditions and Test Procedures for Airborne Equipment, January 1980

Copies may be purchased from the Radio Technical Commission for Aeronautics Secretariat, 1425 "K" Street, N.W., Suite 500, Washington, D.C. 20005.

3. GENERAL REQUIREMENTS:

3.1 Material:

Material shall be of a quality which experience and/or tests have demonstrated to be suitable and dependable for use in aircraft.

3.2 Workmanship:

Workmanship shall be consistent with high grade aircraft manufacturing practices.

3.3 Compatibility:

If components are individually acceptable but require matching for proper operation, they shall be identified in a manner that will ensure performance to the requirements of this standard.

3.4 Interchangeability:

Components or systems which are identified with the same manufacturer part or model number shall be completely interchangeable.

3.5 Accessibility of Controls:

Controls which are not normally adjustable in flight shall not be readily accessible to flight personnel when the recorder is installed in accordance with the manufacturer's instructions.

3.6 Operation of Controls:

The design of the equipment shall be such that the controls intended for use during flight (if any) cannot be operated in any possible position, combinations or sequences that would result in a condition detrimental to the continued performance of the equipment or have any detrimental effect on associated equipments.

3.7 Fault Monitoring:

3.7.1 Fault Monitoring: Automatic means shall be provided to indicate malfunctions that cause loss of recorded audio or flight data. Means shall be provided for remote indication of a malfunction. Monitoring shall include as a minimum:

a. Presence of input power
b. Generation of a data stream
c. Data write/read function is operable
d. Audio channels are functioning

3.7.2 Monitoring Effects: The inclusion of self-test and fault monitoring shall not produce a condition detrimental to other aircraft systems or sensed signals to be recorded.

3.8 Input Circuit Protection:

Each signal input circuit shall include suitable circuitry to minimize the flight recorder system from inducing errors, malfunctions, and failures in the aircraft system being monitored. The circuitry shall protect the aircraft sensors, transducers or instrument system against all reasonably probable malfunctions including non-programmed multiplex switch closures. The protection shall continue to exist even in the event of any reasonably probable failure within the isolation circuitry itself and with power-off conditions.

3.9 Fire Hazard:

Except for small parts (such as knobs, fasteners, seals, grommets, and small electrical parts) that would not contribute significantly to the propagation of a fire, all external materials shall be self-extinguishing when tested in accordance with the requirements of The Code of Federal Regulations Title 14, Aeronautics & Space, Part 25, Appendix F, with the exception that materials tested may be configured in accordance with paragraph (d) of Appendix F or may be configured as used.

3.10 Marking:

The equipment shall be legibly and permanently marked, as specified in 14 CFR Part 45, and indicate:

3.10.1 The environmental categories for which it has been qualified to operate in accordance with RTCA/DO-160A.

3.10.2 Type of recorder (See SECTION NO. 1)

3.10.3 Nominal power input rating, (voltage, AC power and frequency or DC current).

3.10.4 External marking shall be applied to the unit containing the storage medium on two (2) places, as large as practical, with the following warning (second marking French or an alternate language):

FLIGHT RECORDER - - DO NOT OPEN
ENREGISTREUR DE VOL - - NE PAS OUVRIR

3.10.5 Application Marking: Each recorder shall be plainly identified or marked on its identification label to establish installation applicability for which a recorder is designed. The identification marking shall be one of the following for the applicable aircraft installation.

a. "Install on Fixed Wing Aircraft Only"
b. "Install on Rotary Wing Aircraft Only"
c. "Install on Fixed or Rotary Wing Aircraft"

The above marking selection shall be based on the recorder's ability to meet the applicable requirements of paragraph 3.10.1 and 4.1 with respect to environmental operations and parameters.

3.11 Documentation Requirements:

In accordance with 14 CFR Part 21, Paragraph 31 requirements, manufacturers shall furnish to the appropriate approving agencies the following technical data:

3.11.1 Operating Instructions

3.11.2 Equipment Limitations

3.11.3 Installation Procedures and Limitations

3.11.4 Schematic Drawings

3.11.5 Wiring Diagrams

3.11.6 Specifications

3.11.7 Recorder Calibration and Maintenance Procedures

3.11.8 Qualification Test Procedures and Report

3.11.9 Instructions and documentation, mathematics and logic required for data transcription for TYPE II and TYPE III recorders.

3.11.10 Readout information to demonstrate that the manufacturer has facilities capable of:

a. Retrieving recorded audio data from TYPES I and III recorders.
b. Producing a printout of all recorded parameters from TYPES II and III recorders.

3.11.11 Specification and schematics for special readout devices as may be required under Section 5, paragraph 5.4.4.

4. DESIGN CONSIDERATION:

4.1 Recording Channels:

TYPES I and III recorders shall be capable of recording simultaneously at least two channels of audio information. TYPES II and III recorders shall be capable of recording flight data information as given in Tables 1 or 2.

4.2 Recording Methods:

Any recording method which meets the standard test conditions and the environmental test conditions is acceptable. If an electromechanical system of recording is used, the mean recording speed shall not vary more than 2 percent from the design speed when the recorder is powered by a constant frequency source or within the supply voltage tolerance.

4.3 Bulk Erase:

The recorder(s) shall contain no provisions for bulk erase of the stored information.

4.4 Locating Requirements:

4.4.1 Non Ejectable Recorders: The recorder (unit containing the storage medium) color shall be international orange and shall have reflective material located on three (3) sides. Provision shall be made for an underwater locator beacon (ULB) to be attached to the crash protected container. The attachment shall be such that the ULB shall not become detached when subject to the shock test of 7.2.1.

4.4.2 Ejectable Recorders: After ejection, the ejectable package shall be capable of floatation and shall emit a suitable radio beacon signal on a standard distress frequency. The recorder ejectable package color shall be international orange with reflective material located on all sides except the side(s) exposed to the external environment when installed in the aircraft.

5. MINIMUM PERFORMANCE STANDARDS IN AMBIENT ENVIRONMENT:

5.1 Ambient Conditions:

Unless otherwise specified, all tests shall be made at ambient conditions specified in RTCA/DO-160A.

5.2 Automatic Operation:

5.2.1 When power is applied to the aircraft, TYPE I recorders shall record continuously in a manner as specified herein.

5.2.1.1 TYPE I recorders shall cease recording when the signal defined in 5.4.1-b is present.

5.2.2 When power is applied to the aircraft and self-powered motion of the aircraft has been established, TYPE II and III recorders shall start recording in a manner as specified herein.

5.3 Audio Recording:

The following requirements shall be applicable to TYPES I and III recorders utilizing replay equipment recommended by the manufacturer:

5.3.1 Recording Duration: Audio data shall be recorded for a total elapsed time of at least the last 15 minutes.

5.3.2 Audio Frequency Response: When the level of an audio input signal applied to any of the two required recording channel inputs is held constant at 10 dB below maximum recording level, and its frequency is varied over the range of 350 to at least 5000 Hertz, the level of the signal recorded on the recording medium shall not vary more than a total range of 6 dB.

5.3.3 Input Signal Level: The input signal used shall be:

0.7 VRMS	Intercom Systems (ICS) circuits shall produce a nominal recording level
85 dB (SPL) Sound Pressure Level	Shall produce a nominal recording level

5.3.4 Distortion: The total distortion of the audio data shall not exceed:

a. Ten percent, when the level of the input signal applied to any of the two required audio channels is equal to the maximum level for which the equipment is designed.

b. Six percent, when the level of the input signal is equal to 10% of the maximum level for which the equipment is designed. This standard shall be met at the audio frequency of 400 Hertz.

c. Ten percent, when the cockpit-mounted area microphone is exposed to a sound pressure source within the range of 60 to 120 dB above 0.0002 dyne per square centimeter at a frequency of 400 Hertz.

5.3.5 Audio Noise Level - Without Input Signal: With no input signal applied to any of the two required audio channel inputs, the level of the noise recorded on the recording medium shall be at least 35 dB below that level recorded on the recording medium when an input signal at the frequency of maximum response of the channel and having a level equal to the maximum level for which the equipment is designed is applied to the same recording channel input. This test shall be performed with the inputs open and shorted.

5.3.6 Wow and Flutter: When an input having an amplitude equal to the maximum for which the equipment is designed is applied to any of the two required audio channel inputs, the level of any wow and flutter frequency below 250 Hertz recorded on the recording medium shall not exceed 2 percent RMS using National Association of Broadcaster's standard measuring equipment and procedures.

5.3.7 Stray Magnetic Field: When the cockpit mounted area microphone assembly of the equipment is in an operating condition in an area free from local magnetic disturbances, the stray magnetic field of this microphone assembly shall cause not more than a 2-degree deflection of a magnetic compass when the closest edge of the microphone assembly is located at a distance of 12 inches from the compass.

5.3.8 Cockpit Area Microphone Assembly: If the cockpit area microphone assembly is supplied as a part of the cockpit voice recorder, it shall be compatible with the recorder so that the combination will meet the system requirements as specified in other paragraphs of this document.

a. If the microphone assembly is not furnished as a part of the system, the manufacturer shall specify the microphone assembly requirements so it will meet the system requirements.

b. Channels used for recording area microphone signals shall have sufficient gain to satisfactorily record voice communications between crew members and aural warnings when the cockpit area microphone is located as recommended by the recorder manufacturer.

5.4 Flight Data Recording:

The following requirements shall be applicable to TYPE II and III only:

5.4.1 Automatic Cessation of Recording:

a. Means shall be provided in TYPE II and III recorders to automatically prevent the recorder from continuing to record or destroy information when the aircraft conditions are such that continued unpowered flight or self-powered taxi is not possible. (For example: Airspeed below 50 knots, and altitude constant, and engine speed below 15%.) Continued recording is permissible beyond the above conditions, providing not more than the oldest 33% of the data in memory is destroyed.

b. TYPE II recorders shall provide a nominal +28 VDC, 0.01 Ampere continuous output signal when automatic cessation of recording exists.

5.4.2 Parameters:

5.4.2.1 Continuous Recording: As a minimum, the recorder shall record the parameters as specified in Table 1 or 2.

5.4.2.2 Data Compression Recording: As a minimum, the recorder shall sample the parameters at the intervals and record the parameters as specified in Table 1 or 2 (Reference Paragraph 5.4.5).

The sampling interval is not intended to mean the recording interval. The recording interval is dependent on the method of data compression.

TABLE 1 - SAE General Aviation Flight Recorder Minimum Flight Data Parameter List (for Fixed Wing Aircraft Only)

PARAMETERS	RANGE	INSTALLED SYSTEM*1 MINIMUM ACCURACY (TO RECOVERED DATA)	SAMPLING INTERVAL (PER SECOND)
Relative Time (From Power up)	8 hour minimum	±0.125% per hour	1
Airspeed	V_{SO} to V_D (KIAS)	±5% of indicated value or ±10 knots, whichever is greater. Resolution 2 knots below 175 KIAS	1
Altitude*2	-1000 ft to 1.2 times max. cert. alt. of A/C	±100 to ±700 ft (see Table 3)	1
Magnetic Heading	360°	±5°	1
Vertical Acceleration	-3 g to +6 g	±0.2 g in addition to ±0.3 g maximum offset	4*4
Pitch Attitude	±25° or 100% of usable range, whichever is greater	±2°	1
Roll Attitude	±60° or 100% of usable range, whichever is greater	±2°	1
Engine Power Each*5			
Fan or N1 Speed or EPR or Prop. Speed and Torque	Maximum range	±5%	1
Altitude Rate*2	±8000 fpm	±10% Resolution 250 fpm below 12,000 ft indicated	1

TABLE 1 - (Continued)

PARAMETERS	RANGE	INSTALLED SYSTEM*1 MINIMUM ACCURACY (TO RECOVERED DATA)	SAMPLING INTERVAL (PER SECOND)
Angle of Attack*2	-20° to +40° or 100% of usable range	±2°	1
Radio Transmitter Keying (Discrete)	On/Off	-	1
TE Flaps (Discrete or Analog)	Each discrete position (U, D, T/O, APP) or Analog 0-100% range	-	1
		±3°	1
LE Flaps*3 (Discrete or Analog)	Each discrete position (U, D, T/O, APP) or Analog 0-100% range	-	1
		±3°	1
Thrust Reverser*3 (Discrete)	Stowed or full reverse	-	1
Spoiler/Speedbrake*3 (Discrete)	Stowed or up	-	1
Autopilot*3 (Discrete)	Engaged	-	1

TABLE 2 - SAE General Aviation Flight Recorder Minimum Flight Data Parameter List (for Rotary Wing Aircraft Only)

PARAMETERS	RANGE	INSTALLED SYSTEM *1 MINIMUM ACCURACY (TO RECOVERED DATA)	SAMPLING INTERVAL (PER SECOND)
Relative Time (From Power up)	4 hour minimum	±0.125% per hour	1
Airspeed	V_{MIN} *6 to V_D (KIAS)	±5% of indicated value or ±10 knots, whichever is greater	1
Altitude	-1000 ft to 1.2 times max. certificated alt. of aircraft	±100 to ±700 ft (see Table 3)	1
Magnetic Heading	360°	±5°	1
Vertical Acceleration	-3 g to +6 g	±0.2 g in addition to ±0.3 g maximum offset	4*4
Pitch Attitude	100% of usable range	±2°	1
Roll Attitude	±60° or 100% of usable range, whichever is greater	±2°	1
Altitude Rate*3	±8,000 fpm	±10% Resolution 250 fpm below 12,000 ft indicated	1
Engine Power Each			
Rotor Speed*5	Maximum range	±5%	1
Engine Torque*5	Maximum range	±5%	1

TABLE 2 - (Continued)

PARAMETERS	RANGE	INSTALLED SYSTEM*1 MINIMUM ACCURACY (TO RECOVERED DATA)	SAMPLING INTERVAL (PER SECOND)
Flight Control Hydraulic Pressure			
Primary (Discrete)	High or Low	-	1
Secondary if*3 applicable (Discrete)		-	1
Radio Transmitter Keying (Discrete)	On/Off	-	1
Autopilot Mode*3 (Discrete)	Engaged	-	1
SAS Status Mode (Discrete)	Engaged	-	1
SAS Fault Status*3 (Discrete)	Fault	-	1
Flight Controls			
Collective	Full Range	±3%	2
Pedal Position	Full Range	±3%	2
Lat Cyclic	Full Range	±3%	2
Long Cyclic	Full Range	±3%	2
Controllable Stabilator Position*3	Full Range	±3%	2

TABLE 1 and 2 - (Continued)

NOTES: *1 The recording system shall contribute no more than 50% of the values shown except where sensors are supplied as part of the system.

*2 Either:

a. If altitude is recorded to minimum resolution of 25 ft, then it is not necessary to record altitude rate or angle of attack, or

b. The altitude encoding altimeter (100 ft resolution) may be used to record altitude if angle of attack is also recorded (it is then not necessary to record altitude rate), or

c. The altitude encoding altimeter (100 ft resolution) may be used to record altitude if altitude rate is also recorded (it is then not necessary to record angle of attack).

*3 The recorder shall have the capability of accepting these signal inputs as applicable, and when these parameters are available as signals in the aircraft.

*4 Vertical acceleration may be recorded at intervals of one second if peak acceleration referenced to 1 g is recorded.

*5 Or those thrust/power cockpit indication parameters used for aircraft certification. Propeller/rotor speed and torque shall each be sampled once per second as close together as practicable.

*6 Minimum Airspeed Signal (V_{MIN}) which can be obtained using the installed pitot static system.

COMMENTS: This standard encourages but does not require manufacturers to leave room for spare channels so that fault status monitoring and additional parameters can be added.

TABLE 3 - Altitude Record Error Table

STANDARD ALTITUDE (FEET)	EQUIVALENT PRESSURE MERCURY MM	IN HG	TOLERANCE (FEET) PLUS OR MINUS	LOW TEMPERATURE (FEET) PLUS OR MINUS
-1,000	787.9	31.02	100	150
- 500	773.8	30.47	100	
0	760.0	29.92	100	150
500	746.4	29.39	100	
1,000	732.9	28.86	100	
1,500	719.7	28.33	100	
2,000	706.6	27.82	100	
3,000	681.1	26.81	125	
4,000	656.3	25.84	150	210
6,000	609.0	23.98	150	250
8,000	564.4	22.22	150	
10,000	522.6	20.58	150	
12,000	483.3	19.03	180	350
14,000	446.4	17.47	210	
16,000	411.8	16.21	240	
18,000	379.4	14.94	270	450
20,000	349.1	13.74	300	
22,000	320.8	12.63	335	
25,000	281.9	11.10	375	560
30,000	225.6	8.88	450	600
35,000	178.7	7.04	525	730
40,000	140.7	5.54	600	800
50,000	87.3	3.44	700	

5.4.3 Error Rate:

5.4.3.1 Continuous Recording: The bit error rate which results in non-recoverable data shall be less than one in 10^5 bits.

5.4.3.2 Data Compression Recording: For the full contents of the recorder memory, the reconstituted data shall exhibit an error rate of less than one in 10^5 bits relative to the input data prior to compression.

5.4.4 FDR Data Readout Interface: The data readout signal shall conform with IEEE 488, RS 232, or RS 422A. The interface circuitry shall be either internal to the FDR or provided as part of a ground-based interface device. (See list of Applicable Documents.)

5.4.5 Recording Duration:

a. Continuous Recording - Aircraft data shall be available for a minimum time of the last 15 minutes. This does not include Baseline Data (reference paragraph 5.4.7).

b. Data Compression Recording - The oldest data in the recording medium compared to the most recent data in the recording medium shall be at least 15 minutes older for normal flight conditions, including both a takeoff and landing. This data shall be recorded in addition to the Baseline data of paragraph 5.4.7.

5.4.6 Retention of Recorded Information: Information (TYPES II and III) shall be recorded for the periods and conditions stated in paragraph 5.4.5, prior to shut-down of the recording function. Information can be erased or written over, based on the given conditions. When the equipment recording functions are shut down, the erasure or writeover function shall cease.

5.4.7 Baseline Data:

a. For data reduction reference purposes, all data parameters shall be sampled and stored at least once at or near each of the following conditions:

(1) Engine start

(2) Takeoff power

(3) Aircraft rotation (fixed wing only)

b. Two sets of each of the above stored data shall always be in the recording for a period of up to 8 operating hours or until written over by new baseline data. This is intended to insure that takeoff data from the flight prior to the presence flight is stored, as well as takeoff data from the present flight.

6. MINIMUM PERFORMANCE STANDARD IN SEVERE ENVIRONMENTS:

6.1 Environmental Conditions:

Unless otherwise specified below, the procedures to determine the performance of cockpit voice and flight data recorders defined as TYPES I, II and III under environmental conditions are stated in Radio Technical Commission for Aeronautics (RTCA) Document No. DO-160A, entitled "ENVIRONMENTAL CONDITIONS AND TEST PROCEDURES FOR AIRBORNE EQUIPMENT," dated January 1980. The order of testing shall conform with the paragraph entitled "Order of Tests" in RTCA/DO-160A.

6.1.1 Some of the environmental tests contained in this section do not have to be performed unless the manufacturer wishes to qualify the equipment for that particular environmental condition. It is recommended that the recorder be certified to its maximum capability even if its intended certification base does not require it.

6.2 Temperature and Altitude Tests:

The Recorder (TYPE I, II or III) shall be subjected to test requirements as specified in RTCA/DO-160A under the section entitled "Temperature and Altitude Tests" and meet all applicable performance requirements in Section 5 of this standard, where specified by the above testing.

6.3 Humidity Test:

The Recorder (TYPE I, II or III) shall be subjected to the test requirements as specified in RTCA/DO-160A under the section entitled "Humidity Test" and meet all applicable performance requirements in Section 5 of this standard, where specified by the above testing.

6.4 Shock Test:

The Recorder (TYPE I, II or III) shall be subjected to the test requirements as specified in RTCA/DO-160A under the section entitled "Shock Test" and meet all applicable performance requirements in Section 5 of this standard, when specified by the above testing.

6.5 Vibration Test:

The Recorder (TYPE I, II or III) shall be subjected to test requirements as specified in RTCA/DO-160A under the section entitled "Vibration Test" and meet all applicable performance requirements in Section 5 of this standard, where specified by the above testing.

6.6 Explosion Test:

The Recorder (TYPE I, II or III) shall be subjected to test requirements as specified in RTCA/DO-160A under the section entitled "Explosion Test" and meet all applicable acceptance criteria set forth within.