APPENDIX M TO PART 121—AIRPLANE FLIGHT RECORDER SPECIFICATIONS

The recorded values must meet the designated range, resolution, and accuracy requirements during dynamic and static conditions. All data recorded must be correlated in time to within one second.

Parameters	Range	Accuracy (sensor input)	Seconds per sampling interval	Resolution	Remarks
1. Time or Relative Times Counts.[1].	24 Hrs, 0 to 4095.	±0.125% Per Hour.	4	1 sec	UTC time preferred when available. Count increments each 4 second of system operation.
2. Pressure Altitude.	−1000 ft to max certificated altitude of aircraft. +5000 ft.	±100 to ±700 ft (see table, TSO C124a or TSO C51a).	1	5′ to 35′	Data should be obtained from the air data computer when practicable.
3. Indicated airspeed or Calibrated airspeed.	50 KIAS or minimum value to Max V_{so} to 1.2 V. D.	±5% and ±3%	1	1 kt	Data should be obtained from the air data computer when practicable.
4. Heading (Primary flight crew reference).	0–360° and Discrete “true” or “mag”.	±2°	1	0.5°	When true or magnetic heading can be selected as the primary heading reference, a discrete indicating selection must be recorded.
5. Normal acceleration (vertical) [9].	−3g to +6g	±1% of max range excluding datum error of ±5%.	0.125	0.004g.	
6. Pitch Attitude	±75°	±2°	1 or 0.25 for airplanes operated under §121.344(f).	0.5°	A sampling rate of 0.25 is recommended.
7. Roll attitude [2]	±180°	±2°	1 or 0.5 for airplanes operated under §121.344(f).	0.5	A sampling rate of 0.5 is recommended.
8. Manual Radio Transmitter Keying or CVR/DFDR synchronization reference.	On-Off (Discrete) None		1		Preferably each crew member but one discrete acceptable for all transmission provided the CVR/FDR system complies with TSO C124a CVR synchronization requirements (paragraph 4.2.1 ED–55).
9. Thrust/power on each engine—primary flight crew reference.	Full range forward.	±2%	1 (per engine)	0.3% of full range.	Sufficient parameters (e.g. EPR, N1 or Torque, NP) as appropriate to the particular engine being recorded to determine power in forward and reverse thrust, including potential overspeed condition.
10. Autopilot Engagement.	Discrete “on” or “off”.		1		
11. Longitudinal Acceleration.	±1g	±1.5% max. range excluding datum error of ±5%.	0.25	0.004g	
12a. Pitch Control(s) position (non-fly-by-wire systems).	Full Range	±2° Unless Higher Accuracy Uniquely Required.	0.5 or 0.25 for airplanes operated under §121.344(f).	0.5% of full range.	For airplanes that have a flight control break away capability that allows either pilot to operate the controls independently, record both control inputs. The control inputs may be sampled alternately once per second to produce the sampling interval of 0.5 or 0.25, as applicable.
12b. Pitch Control(s) position (fly-by-wire systems).[3].	Full Range	±2° Unless Higher Accuracy Uniquely Required..	0.5 or 0.25 for airplanes operated under §121.344(f)..	0.2% of full range.	

The recorded values must meet the designated range, resolution, and accuracy requirements during dynamic and static conditions. All data recorded must be correlated in time to within one second.

Parameters	Range	Accuracy (sensor input)	Seconds per sampling interval	Resolution	Remarks
13a. Lateral Control position(s) (non-fly-by-wire).	Full Range	±2° Unless Higher Accuracy Uniquely Required.	0.5 or 0.25 for airplanes operated under § 121.344(f).	0.2% of full range.	For airplanes that have a flight control break away capability that allows either pilot to operate the controls independently, record both control inputs. The control inputs may be sampled alternately once per second to produce the sampling interval of 0.5 or 0.25, as applicable.
13b. Lateral Control position(s) (fly-by-wire).[4].	Full Range	±2° Unless Higher Accuracy Uniquely Required.	0.5 or 0.25 for airplanes operated under § 121.344(f).	0.2% of full range.	
14a. Yaw control position(s) (non-fly-by-wire)[5].	Full range	±2° Unless higher accuracy uniquely required.	0.5	0.3% of full range.	For airplanes that have a flight control break away capability that allows either pilot to operate the controls independently, record both control inputs. The control inputs may be sampled alternately once per second to produce the sampling interval of 0.5.
14b. Yaw Control position(s) (fly-by-wire).	Full Range	±2° Unless Higher Accuracy Uniquely Required.	0.5	0.2% of full range.	
15. Pitch Control Surface(s) Position.[6].	Full Range	±2° Unless Higher Accuracy Uniquely Required..	0.5 or 0.25 for airplanes operated under § 121.344(f)..	0.3% of full range..	For airplanes fitted with multiple or split surfaces, a suitable combination of inputs is acceptable in lieu of recording each surface separately. The control surfaces may be sampled alternately to produce the sampling interval of 0.5 or 0.25.
16. Lateral control surface(s) position[7].	Full range	±2° Unless higher accuracy uniquely required.	0.5 or 0.25 for airplanes operated under § 121.344(f).	0.3% of full range.	A suitable combination of surface position sensors is acceptable in lieu of recording each surface separately. The control surfaces may be sampled alternately to produce the sampling interval of 0.5 or 0.25.
17. Yaw Control Surface(s) Position.[8].	Full Range	±2° Unless Higher Accuracy Uniquely Required.	0.5	0.2% of full range.	For airplanes with multiple or split surfaces, a suitable combination of surface position sensors is acceptable in lieu of recording each surface separately. The control surfaces may be sampled alternately to produce the sapling interval of 0.5.
18. Lateral Acceleration.	±1g	±1.5% max. range excluding datum error of ±5%.	0.25	0.004g	
19. Pitch Trim Surface Position.	Full Range	±3° Unless Higher Accuracy Uniquely Required.	1	0.6% of full range.	

The recorded values must meet the designated range, resolution, and accuracy requirements during dynamic and static conditions. All data recorded must be correlated in time to within one second.

Parameters	Range	Accuracy (sensor input)	Seconds per sampling interval	Resolution	Remarks
20. Trailing Edge Flap or Cockpit Control Selection.[10].	Full Range or Each Position (discrete).	±3° or as Pilot's indicator.	2	0.5% of full range.	Flap position and cockpit control may each be sampled at 4 second intervals, to give a data point every 2 seconds.
21. Leading Edge Flap or Cockpit Control Selection.[11].	Full Range or Each Discrete Position.	±3° or as Pilot's indicator and sufficient to determine each discrete position.	2	0.5% of full range.	Left and right sides, or flap position and cockpit control may each be sampled at 4 second intervals, so as to give a data point every 2 seconds.
22. Each Thrust Reverser Position (or equivalent for propeller airplane).	Stowed, In Transit, and Reverse (Discrete).		1 (per engine)		Turbo-jet—2 discretes enable the 3 states to be determined. Turbo-prop—discrete.
23. Ground spoiler position or brake selection[12].	Full range or each position (discrete).	±2° Unless higher accuracy uniquely required.	1 or 0.5 for airplanes operated under §121.344(f).	0.5% of full range.	
24. Outside Air Temperature or Total Air Temperature.[13].	−50 °C to +90 °C.	±2 °C	2	0.3 °C	
25. Autopilot/ Autothrottle/ AFCS Mode and Engagement Status.	A suitable combination of discretes.		1		Discretes should show which systems are engaged and which primary modes are controlling the flight path and speed of the aircraft.
26. Radio Altitude[14].	−20 ft to 2,500 ft.	±2 ft or ±3% whichever is greater below 500 ft and ±5% above 500 ft.	1	1 ft +5% above 500 ft.	For autoland/category 3 operations. Each radio altimeter should be recorded, but arranged so that at least one is recorded each second.
27. Localizer Deviation, MLS Azimuth, or GPS Latitude Deviation.	±400 Microamps or available sensor range as installed. ±62°	As installed ±3% recommended.	1	0.3% of full range.	For autoland/category 3 operations. Each system should be recorded but arranged so that at least one is recorded each second. It is not necessary to record ILS and MLS at the same time, only the approach aid in use need be recorded.
28. Glideslope Deviation, MLS Elevation, or GPS Vertical Deviation.	±400 Microamps or available sensor range as installed 0.9 to +30°	As installed +/ 3−3% recommended.	1	0.3% of full range.	For autoland/category 3 operations. Each system should be recorded but arranged so that at least one is recorded each second. It is not necessary to record ILS and MLS at the same time, only the approach aid in use need be recorded.
29. Marker Beacon Passage.	Discrete "on" or "off".		1		A single discrete is acceptable for all markers.
30. Master Warning.	Discrete		1		Record the master warning and record each "red" warning that cannot be determined from other parameters or from the cockpit voice recorder.
31. Air/ground sensor (primary airplane system reference nose or main gear).	Discrete "air" or "ground".		1 (0.25 recommended).		

The recorded values must meet the designated range, resolution, and accuracy requirements during dynamic and static conditions. All data recorded must be correlated in time to within one second.

Parameters	Range	Accuracy (sensor input)	Seconds per sampling interval	Resolution	Remarks
32. Angle of Attack (If measured directly).	As installed	As installed	2 or 0.5 for airplanes operated under §121.344(f).	0.3% of full range.	If left and right sensors are available, each may be recorded at 4 or 1 second intervals, as appropriate, so as to give a data point at 2 seconds or 0.5 second, as required.
33. Hydraulic Pressure Low, Each System.	Discrete or available sensor range, ''low'' or ''normal''.	±5%	2	0.5% of full range.	
34. Groundspeed	As Installed	Most Accurate Systems Installed.	1	0.2% of full range.	
35. GPWS (ground proximity warning system).	Discrete ''warning'' or ''off''.		1		A suitable combination of discretes unless recorder capacity is limited in which case a single discrete for all modes is acceptable.
36. Landing Gear Position or Landing gear cockpit control selection.	Discrete		4		A suitable combination of discretes should be recorded.
37. Drift Angle.[15]	As installed	As installed	4	0.1°	
38. Wind Speed and Direction.	As installed	As installed	4	1 knot, and 1.0°.	
39. Latitude and Longitude.	As installed	As installed	4	0.002°, or as installed.	Provided by the Primary Navigation System Reference. Where capacity permits Latitude/longitude resolution should be 0.0002°.
40. Stick shaker and pusher activation.	Discrete(s) ''on'' or ''off''.		1		A suitable combination of discretes to determine activation.
41. Windshear Detection.	Discrete ''warning'' or ''off''.		1.		
42. Throttle/power Leverl position.[16].	Full Range	±2%	1 for each lever	2% of full range	For airplanes with non-mechanically linked cockpit engine controls.
43. Additional Engine Parameters.	As installed	As installed	Each engine each second.	2% of full range	Where capacity permits, the preferred priority is indicated vibration level, N2, EGT, Fuel Flow, Fuel Cutoff lever position and N3, unless engine manufacturer recommends otherwise.
44. Traffic Alert and Collision Avoidance System (TCAS).	Discretes	As installed	1		A suitable combination of discretes should be recorded to determine the status of—Combined Control, Vertical Control, Up Advisory, and Down Advisory. (ref. ARINC Characteristic 735 Attachment 6E, TCAS VERTICAL RA DATA OUTPUT WORD.)
45. DME 1 and 2 Distance.	0–200 NM	As installed	4	1 NM	1 mile
46. Nav 1 and 2 Selected Frequency.	Full Range	As installed	4		Sufficient to determine selected frequency
47. Selected barometric setting.	Full Range	±5%	(1 per 64 sec.)	0.2% of full range	
48. Selected Altitude.	Full Range	±5%	1	100 ft	
49. Selected speed.	Full Range	±5%	1	1 knot	

The recorded values must meet the designated range, resolution, and accuracy requirements during dynamic and static conditions. All data recorded must be correlated in time to within one second.

Parameters	Range	Accuracy (sensor input)	Seconds per sampling interval	Resolution	Remarks
50. Selected Mach.	Full Range	±5%	1	.01	
51. Selected vertical speed.	Full Range	±5%	1	100 ft/min	
52. Selected heading.	Full Range	±5%	1	1°	
53. Selected flight path.	Full Range	±5%	1	1°	
54. Selected decision height.	Full Range	±5%	64	1 ft	
55. EFIS display format.	Discrete(s)		4		Discretes should show the display system status (e.g., off, normal, fail, composite, sector, plan, nav aids, weather radar, range, copy.
56. Multi-function/ Engine Alerts Display format.	Discrete(s)		4		Discretes should show the display system status (e.g., off, normal, fail, and the identity of display pages for emergency procedures, need not be recorded.
57. Thrust command.[17].	Full Range	±2%	2	2% of full range.	
58. Thrust target	Full Range	±2%	4	2% of full range	
59. Fuel quantity in CG trim tank.	Full Range	±5%	(1 per 64 sec.)	1% of full range	
60. Primary Navigation System Reference.	Discrete GPS, INS, VOR/ DME, MLS, Loran C, Omega, Localizer Glideslope.		4		A suitable combination of discretes to determine the Primary Navigation System reference.
61. Ice Detection	Discrete ''ice'' or ''no ice''.		4		
62. Engine warning each engine vibration.	Discrete		1		
63. Engine warning each engine over temp.	Discrete		1		
64. Engine warning each engine oil pressure low.	Discrete		1		
65. Engine warning each engine over speed.	Discrete		1		
66. Yaw Trim Surface Position.	Full Range	±3% Unless Higher Accuracy Uniquely Required.	2	0.3% of full range.	
67. Roll Trim Surface Position.	Full Range	±3% Unless Higher Accuracy Uniquely Required.	2	0.3% of full range.	
68. Brake Pressure (left and right).	As installed	±5%	1		To determine braking effort applied by pilots or by autobrakes.
69. Brake Pedal Application (left and right).	Discrete or Analog ''applied'' or ''off''.	±5% (Analog)	1		To determine braking applied by pilots.
70. Yaw or sideslip angle.	Full Range	±5%	1	0.5°	
71. Engine bleed valve position.	Discrete ''open'' or ''closed''.		4		
72. De-icing or anti-icing system selection.	Discrete ''on'' or ''off''.		4		
73. Computed center of gravity.	Full Range	±5%	(1 per 64 sec.)	1% of full range	

The recorded values must meet the designated range, resolution, and accuracy requirements during dynamic and static conditions. All data recorded must be correlated in time to within one second.

Parameters	Range	Accuracy (sensor input)	Seconds per sampling interval	Resolution	Remarks
74. AC electrical bus status.	Discrete ''power'' or ''off''.	.....	4	.....	Each bus.
75. DC electrical bus status.	Discrete ''power'' or ''off''.	.....	4	.....	Each bus.
76 APU bleed valve position.	Discrete ''open'' or ''closed''.	.....	4		
77. Hydraulic Pressure (each system).	Full range	±5%	2	100 psi	
78. Loss of cabin pressure.	Discrete ''loss'' or ''normal''.	.....	1.		
79. Computer failure (critical flight and engine control systems).	Discrete ''fail'' or ''normal''.	.....	4.		
80. Heads-up display (when an information source is installed).	Discrete(s) ''on'' or ''off''.	.....	4		
81. Para-visual display (when an information source is installed).	Discrete(s) ''on'' or ''off''.				
82. Cockpit trim control input position—pitch.	Full Range	±5%	1	0.2% of full range.	Where mechanical means for control inputs are not available, cockpit display trim positions should be recorded.
83. Cockpit trim control input position—roll.	Full Range	±5%	1	0.7% of full range.	Where mechanical means for control inputs are not available, cockpit display trim position should be recorded.
84. Cockpit trim control input position—yaw.	Full range	±5%	1	0.3% of full range.	Where mechanical means for control input are not available, cockpit display trim positions should be recorded.
85. Trailing edge flap and cockpit flap control position.	Full Range	±5%	2	0.5% of full range.	Trailing edge flaps and cockpit flap control position may each be sampled alternately at 4 second intervals to provide a sample each 0.5 second.
86. Leading edge flap and cockpit flap control position.	Full Range or Discrete.	±5%	1	0.5% of full range	
87. Ground spoiler position and speed brake selection.	Full range or discrete.	±5%	0.5	0.3% of full range.	

The recorded values must meet the designated range, resolution, and accuracy requirements during dynamic and static conditions. All data recorded must be correlated in time to within one second.

Parameters	Range	Accuracy (sensor input)	Seconds per sampling interval	Resolution	Remarks
88. All cockpit flight control input forces (control wheel, control column, rudder pedal).	Full range control wheel ±70 lb control column ±85 rudder pedal ±165.	±5%	1	0.3% full range ..	For fly-by-wire flight control systems, where flight control surface position is a function of the displacement of the control input device only, it is not necessary to record this parameter. For airplanes that have a flight control break away). capability that allows either pilot to operate the control independently, record both control force inputs. The control force inputs may be sampled alternately once per 2 seconds to produce the sampling interval of 1.

[1] For A300 B2/B4 airplanes, resolution=6 seconds.
[2] For A330/A340 series airplanes, resolution=0.703°.
[3] For A318/A319/A320/A321 series airplanes, resolution=0.275% (0.088°>0.064°).
For A330/A340 series airplanes, resolution=2.20%(0.703°>0.064°).
[4] For A318/A319/A320/A321 series airplanes, resolution=0.22% (0.088°>0.080°).
For A330/A340 series airplanes, resolution=1.76% (0.703°>0.080°).
[5] For A330/A340 series airplanes, resolution = 1.18% (0.703°>0.120°).
[6] For A330/A340 series airplanes, resolution=0.783% (0.352°>0.090°).
[7] For A330/A340 series airplanes, aileron resolution = 0.704% (0.352°>0.100°). For A330/A340 series airplanes, spoiler resolution = 1.406% (0.703°>0.100°).
[8] For A330/A340 series airplanes, resolution=0.30% (0.176°>0.12°).
For A330/A340 series airplanes, seconds per sampling interval=1.
[9] For B–717 series airplanes, resolution = .005g. For Dassault F900C/F900EX airplanes, resolution = .007g.
[10] For A330/A340 series airplanes, resolution=1.05% (0.250°>0.120°).
[11] For A330/A340 series airplanes, resolution = 1.05% (0.250°>0.120°). For A300 B2/B4 series airplanes, resolution = 0.92% (0.230°>0.125°).
[12] For A330/A340 series airplanes, spoiler resolution = 1.406% (0.703°>0.100°).
[13] For A330/A340 series airplanes, resolution=0.5°C.
[14] For Dassault F900C/F900EX airplanes, Radio altitude resolution = 1.25 ft.
[15] For A330/A340 series airplanes, resolution = 0.352 degrees.
[16] For A318/A319/A320/A321 series airplanes, resolution = 4.32%. For A330/A340 series airplanes, resolution is 3.27% of full range for throttle lever angle (TLA); for reverse thrust, reverse throttle lever angle (RLA) resolution is nonlinear over the active reverse thrust range, which is 51.54 degrees to 96.14 degrees. The resolved element is 2.8 degrees uniformly over the entire active reverse thrust range, or 2.9% of the full range value of 96.14 degrees.
[17] For A318/A319/A320/A321 series airplanes, with IAE engines, resolution = 2.58%.

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APPENDIX N TO PART 121 [RESERVED]

APPENDIX O—HAZARDOUS MATERIALS TRAINING REQUIREMENTS FOR CERTIFICATE HOLDERS

This appendix prescribes the requirements for hazardous materials training under part 121, subpart Z, and part 135, subpart K of this chapter. The training requirements for various categories of persons are defined by job function or responsibility. An ''X'' in a box under a category of persons indicates that the specified category must receive the noted training. All training requirements apply to direct supervisors as well as to persons actually performing the job function. Training requirements for certificate holders authorized in their operations specifications to transport hazardous materials (will-carry) are prescribed in Table 1. Those certificate holders with a prohibition in their operations specifications against carrying or handling hazardous materials (will-not-carry) must follow the curriculum prescribed in Table 2. The method of delivering the training will be determined by the certificate holder. The certificate holder is responsible for providing a method (may include email, telecommunication, etc.) to answer all questions prior to testing regardless of the method of instruction. The certificate holder must certify that a test has been completed satisfactorily to verify understanding of the regulations and requirements.