

Title 14—AERONAUTICS AND SPACE

Chapter I—Federal Aviation Agency
[Docket No. 6486; Amdts. 25-8; 121-15; 37-5]

PART 25—AIRWORTHINESS STANDARDS: TRANSPORT CATEGORY AIRPLANES

PART 37—TECHNICAL STANDARD ORDER AUTHORIZATIONS

PART 121—CERTIFICATION AND OPERATIONS: DOMESTIC, FLAG, AND SUPPLEMENTAL AIR CARRIERS AND COMMERCIAL OPERATORS OF LARGE AIRCRAFT

Installation Requirements and Revised Minimum Performance Standards for Flight Recorders

The purpose of these amendments is to establish installation requirements for flight records on transport category airplanes and to revise the minimum performance standards for the manufacture of flight recorders. These amendments are designed to increase the accuracy of recorded information and to improve the "crash survivability" of this information.

There are presently no Federal Aviation Regulations governing the installation of flight recorders in airplanes. In the past, flight recorders were installed in accordance with policy guidelines set forth in CAM 4b.606-2. In Notice 65-4, published in 30 F.R. 2468 on February 25, 1965, the Agency proposed to update the policy material and to incorporate it into Part 25. The proposed requirements generally followed the installation requirements for cockpit voice recorders.

The amendments set forth herein after are based on, and reflect the pertinent comments concerning, Notice 65-4. Except as modified by the following discussion, the reasons for these amendments are those contained in the notice.

1. Amendments to Part 25: In connection with the foregoing, the proposed rule has been changed in response to comments received, to permit the first pilot's compass system to be used as a recorder data source. Moreover, the proposal has been revised to make it clear that it is the data obtained from "sources other than the first pilot's instrument system" that must meet the specified accuracy requirements rather than the recorded data. In addition, the regulation has been changed to permit the flight recorder to be connected to the same central air data systems (CADS) as the first pilot's instrument system, notwithstanding the provisions of § 25.1333. The Agency is aware that the accuracy of recorder information would be improved if the recorder used the CADS for data input.

Certain of the comments received regarding the vertical acceleration sensor requirement were concerned with the

necessity of making the required relocation on existing installations within the compliance time specified in the proposed amendment to § 121.343. However, as discussed in more detail hereinafter, the June 1, 1966, compliance date has been substantially extended, therefore the affected operators should have sufficient time to make the necessary change. Moreover, the Agency is aware that with respect to at least one flight recorder, the manufacturer has issued a service bulletin containing the necessary design data for a remote "g" sensor modification. The Agency is aware of the expense involved in the relocation of a "g" sensor. However, the Agency is also aware that the true vertical acceleration of the airplane can only be measured directly when the sensor for the acceleration is located within the center of gravity (c.g.) range of the airplane. The extent of the "g" error for other sensor locations is great enough to warrant a direct measurement requirement, notwithstanding the expense involved.

In response to comments concerning the scope of the preflight recorder check required in this amendment, the Agency has revised the proposal to make it clear that a means for a preflight check of the recorder for proper tape movement is all that is required.

Numerous comments were received concerning the proposed requirement for recorder location. In this connection, the comments pointed out that locating the recorder aft of the fuselage pressure bulkhead would adversely affect the recorder system accuracy and would be an undue burden because of the expense involved. Other comments were concerned with the fact that not enough space would be provided for a practical recorder installation beyond the pressure envelope, that such a location would be difficult with respect to "swing tail" airplanes, and that hydraulic fluid vapors which are sometimes present in the unpressurized areas, may seriously affect recorder operation. Finally, it was pointed out that the proposed location for flight recorders was inconsistent with the voice recorder location requirements.

While the Agency generally agrees with the comments concerning the requirement to locate the flight recorder aft of the pressurized compartment, it does not believe that recorder accuracy would suffer from such a location. However, the additional expense in locating the recorder within the unpressurized area together with the problem of limited space, the problem associated with "swing tail" airplanes, and the possible adverse effects of hydraulic fluid vapors on the recorder, provide a valid argument against such a location. Therefore, the Agency considers it appropriate to relax the proposed requirement and apply standards consistent with the location requirements applicable to cockpit voice recorders.

In addition to the foregoing, comments were received which stated that recorder

survivability may worsen if recorders are located in the aft fuselage and suggesting that the rule permit the installation in radio racks of flight recorders designed for installation in such racks. The Agency is aware, however, of the severe damage incurred by recorders located in the fuselage center section, and forward, of airplanes involved in accidents, while on the other hand, accidents have occurred in which only the aft fuselage and tail section escaped substantial damage. As indicated in Notice 65-4, experience has shown that a nonejectable record container stands the best chance of surviving crash impact forces if it is installed in the aft fuselage area.

In response to the comments from various operators objecting to the correlation test requirement as proposed, the final rule has been expanded in an effort to more clearly state the scope of the tests required. Moreover, based on correlation tests conducted by the Agency in flight and on the ground, the final rule expressly permits the correlation tests to be conducted on the ground. Some of the comments objected to the proposed correlation tests as being too expensive. However, it appears that these comments were made in the belief that the correlation tests had to be conducted in flight. Now, since the tests may be conducted on the ground, with effective programming they could be accomplished during the down-periods of the airplanes.

With respect to the proposed requirement that correlation data be included in the Airplane Flight Manual, the Agency now considers that in view of the nature of this data and since it is subject to change, it should not be incorporated in the Airplane Flight Manual. However, since this data is necessary for the proper interpretation of the flight-recorded information in the event of an airplane accident, it should be retained by the operators.

2. Amendments to Part 121: As previously referred to in the discussions concerning the amendments to Part 25, in the light of the numerous comments received concerning the proposed amendment to § 121.343, the Agency has determined that the proposed compliance date of June 1, 1966, is not realistic. However, the Agency does not agree with the opinion expressed by some of the commentators that 3 years should be allowed for compliance. After a thorough consideration of all the comments, views, and arguments presented concerning this matter, the Agency considers that a compliance date of December 15, 1967, allows the operators a reasonable period of time in which to make the required modifications.

In addition to the changes in the proposed amendment to § 121.343 previously discussed, the final rule requires the operators to retain the most recent flight recorder calibration, including the medium containing such calibration, and the recorder correlations. Consistent with Notice 65-4, under the amendments

contained herein, the Part 121 operators as well as the airplane manufacturers would be required to correlate flight recorder readings of airspeed, altitude, and headings, with the corresponding readings (taking into account correction factors) of the first pilot's instruments. Such a correlation can only be accomplished after the flight recorder and the pilot's instruments have been calibrated. Thus, in order to conduct the correlations required in the amendments to Parts 25 and 121, both the manufacturers of new production airplanes and the operators must make the necessary calibrations. It was proposed that this information be incorporated in the Airplane Flight Manual. However, for the reasons set forth in the discussion concerning the amendments to Part 25, it has been determined that this information should be retained by the operators. This should impose no additional burden on any operator since it merely requires them to retain data that they must, in any event, prepare for their existing airplanes, and to retain data which has already been prepared by the airplane manufacturer on new production airplanes rather than incorporate such data in the Airplane Flight Manual. The Agency is aware that the air carriers currently retain their calibration data.

3. Amendments to Part 37: One of the comments received concerning the proposed change to the minimum performance standards for flight recorders under the Technical Standard Order system recommended that the impact tests for type III recorders include a height of drop or velocity of impact requirement. In this connection, it was recommended that type III recorders be subjected to a 50-foot drop. However, the recommended drop test has not been incorporated in the final amendment. In the first place, Notice 65-4 proposed only to amend the impact requirements for types I and II recorders. Moreover, the comment did not submit data to support the proposed arbitrary values and the present standard permits the applicant to perform rational tests taking into consideration the features of his device, including airplane attitude, which could result in impact velocities greatly different from a single arbitrary value.

There was also comment to the effect that the proposed impact shear force test requirements for flight recorders should provide more detail test procedures. The Agency considers that the proposal is adequate but that the test is really a test of penetration resistance rather than impact shear. The title to the proposed section 7.8.3 has been appropriately changed. Furthermore, in order to advise manufacturers of the purpose of the tests, the Agency has incorporated a clarifying Note in the final standard.

In response to comments received, the Agency has investigated the prospects of installing a gamma radiation source in, or on, a flight recorder to assist in locating it after a crash. However, it appears that an impracticable and unsafe level of radioactivity would be required to overcome energy loss and permit detection through the amount of earth or water likely to surround the recorder.

There was also comment recommending that only ejectable and floatable recorders provided with a radio homing beacon be specified. This comment advocates the mandatory use of type III recorders only. However, there are no type III recorders fully developed and approved for use on air carrier aircraft as yet. Furthermore, the type I and type II recorders have provided useful information in a majority of accidents. With improved crash resistance, they should be even more successful. With respect to the inclusion of a radio beacon device, the Agency considers that such a beacon might be appropriate for type III recorders but not for the nonejectable types. However, the Agency considers that the intent of the proposal has merit and warrants further consideration.

A comment concerning the proposed performance standards suggested that the requirement for a breakaway mounting designed to yield or sever at applied loads be considered. It is assumed that this comment refers to the possible alleviating effect of a failure of the recorder mounting fixture allowing separation from the aircraft structure when the recorder case is subjected to a large external force or blow. This appears reasonable and the proposed test does not preclude testing the unit as installed in its external mountings.

It was also suggested that the proposed revisions to sections 7.8.3 and 7.8.4 should be changed to make it clear that the standards apply only to types I and II recorders. This is, of course, what the Agency intended and the sections have been clarified as suggested. Moreover, the provisions of section 7.8.3 have been clarified to specify the exact area of test bar contact. As now written, the standard would permit the use of other than a cylindrical bar.

Finally, the performance standards have been amended to require the manufacturer of the recorders to finish the exterior of the recorders in a bright orange or bright yellow color. While not covered in Notice 65-4, this should impose no additional burden on the recorder manufacturers since a bright yellow or orange color is already an installation requirement in Part 25.

The amendment to § 37.150 as contained herein sets forth the entire minimum performance standard for aircraft flight recorders revised as proposed in Notice 65-4 and as discussed in this preamble.

(Secs. 313(a), 601, 603, 604, 605, and 607, Federal Aviation Act of 1958; 49 U.S.C. 1354, 1421, 1423, 1424, 1425, and 1427)

In consideration of the foregoing, Chapter I of Title 14 of the Code of Federal Regulations is amended as herein-after set forth effective February 5, 1966.

Issued in Washington, D.C., on December 29, 1965.

WILLIAM F. McKEE,
Administrator.

1. Part 25 is amended by adding a new § 25.1459 to read as follows:

§ 25.1459 Flight recorders.

(a) Each flight recorder required by the operating rules of this chapter must be installed so that—

(1) It is supplied with airspeed and altitude data obtained from sources other than the first pilot's flight instrument systems except that, notwithstanding the requirements of § 25.1333(b), the flight recorder may be connected to the same air data computer as the first pilot's flight instruments. The sources from which the data are obtained must meet the accuracy requirements of §§ 25.1323, 25.1325, 25.1327, as appropriate;

(2) The vertical acceleration sensor is rigidly attached, and located longitudinally either within the approved center of gravity limits of the airplane, or at a distance forward or aft of these limits that does not exceed 25 percent of the airplane's mean aerodynamic chord;

(3) It receives its electrical power from the bus that provides the maximum reliability for operation of the flight recorder without jeopardizing service to essential or emergency loads; and

(4) There is an aural or visual means for preflight checking of the recorder for proper recorder tape movement.

(b) Each nonejectable record container must be located and mounted so as to minimize the probability of container rupture resulting from crash impact and subsequent damage to the record from fire. In meeting this requirement the record container must be located as far aft as practicable, but need not be aft of the pressurized compartment, and may not be where aft-mounted engines may crush the container upon impact.

(c) A correlation must be established between the flight recorder readings of airspeed, altitude, and heading and the corresponding readings (taking into account correction factors) of the first pilot's instruments. The correlation must cover the airspeed range over which the airplane is to be operated, the range of altitude to which the airplane is limited, and 360 degrees of heading. Correlation may be established on the ground as appropriate.

(d) Each recorder container must be either bright orange or bright yellow.

2. Section 121.343 of Part 121 is amended by adding a paragraph (d) reading as follows:

§ 121.343 Flight recorders.

(d) After December 15, 1967, each flight recorder must be installed in accordance with the requirements of § 25.1459 of Part 25 of this chapter. The most recent instrument calibration, including the recording medium from which this calibration is derived, and the recorder correlation, must be retained by the certificate holder.

3. Section 37.150 of Part 37 is amended to read as follows:

§ 37.150 Aircraft flight recorder—TSO-C51a.

(a) *Applicability.* This technical standard order prescribes minimum performance standards that aircraft flight recorders must meet in order to be identified with the applicable TSO marking. New models of flight recorders that are to be identified and that are manufactured on or after the effective date of this section must meet the Minimum Performance Standard for

Aircraft Flight Recorders set forth at the end of this section.

(b) **Marking.** In addition to the markings required by § 37.7, the rating (nominal voltage and wattage) must also be marked on the recorder.

(c) **Data requirements.** The manufacturer must furnish the Chief, Engineering and Manufacturing Branch (in the case of the Western Region, the Chief, Aircraft Engineering Division), Flight Standards Division, Federal Aviation Agency, in the region where the manufacturer is located, the following technical data:

(1) Six copies of the manufacturer's operating instructions, equipment limitations, and installation procedures.

(2) One copy of the manufacturer's test report.

MINIMUM PERFORMANCE STANDARD FOR AIRCRAFT FLIGHT RECORDER

1. **Purpose.** To establish minimum requirements for approved Aircraft Flight Recorders to be used in aircraft primarily for accident analysis, the operation of which may subject the recorder to environmental conditions specified in section 3.

2. **Scope.** This standard covers three basic types of aircraft flight recorders for recording time, air speed, altitude, vertical acceleration, and heading. The intelligence received by the record medium can be from direct and/or remote sensors.

2.1 **Definition of the types.** Type I—Non-ejectable; Type II—Non-ejectable, restricted to any location more than one-half of the wing root chord from the main wing structure through the fuselage and from any fuel tanks; Type III—Ejectable, unrestricted location.

3. **General requirements.**

3.1 **Environmental conditions.** The following conditions have been established as design requirements only. Tests shall be conducted as specified in sections 5, 6, and 7.

3.1.1 **Temperature.** When installed in accordance with the instrument manufacturer's instructions, the recorder shall function over the range of ambient temperature shown in column A below and shall not be adversely affected by exposure to the range of temperature shown in column B below:

Instrument location	A	B
Heated areas (temperature controlled).....	-30 to 50C	-65 to 70C
Unheated areas (temperature uncontrolled).....	-55 to 70C	-65 to 70C

3.1.2 **Humidity.** The recorder shall function and shall not be adversely affected when exposed to any relative humidity in the range from 0 to 95 percent at a temperature of approximately 32° C.

3.1.3 **Vibration.** When installed in accordance with the instrument manufacturer's instructions, the recorder shall function properly and shall not be adversely affected when subjected to vibrations of the following characteristics:

Recorder location in airframe	Cycles per sec.	Max. double amplitude (inches)	Max. acceleration
Airframe structure mounted.....	5-500	0.036	10g

3.1.4 **Altitude.** The recorder shall function and shall not be adversely affected when subjected to a pressure and temperature range equivalent to -1,000 to 50,000 feet

standard altitude, per NACA Report No. 1235, except as limited by the application of paragraph 3.1.1. The recorder shall not be adversely affected following exposure to extremes in ambient pressures of 50 and 3 in. Hg. absolute.

3.1.5 **Radio interference.** The recorder shall not be the source of objectionable interference, under operating conditions at any frequencies used on aircraft, either by radiation or feedback, in electronic equipment installed in the same aircraft as the recorder.

3.1.6 **Magnetic effect.** The magnetic effect of the recorder shall not adversely affect the operation of the other instruments installed in the same aircraft.

4. **Detail requirements.**

4.1 **Recording medium.** The record medium shall conform to the following requirements:

a. The recording medium of recorders employing mechanical inscribed markings shall advance at a rate of not less than 6 inches per hour, and that of recorders employing other means of recording shall advance at a rate sufficient to permit resolution within the accuracy prescribed in section 4.3.

b. The recording medium shall provide a recording of the required data for at least the total elapsed operating time of a flight for which the aircraft might be used.

c. The recording medium shall not be subject to deterioration or distortion of the recorded data within the limits specified herein.

4.2 **Recording intervals and ranges.**

a. Time: The time lapse shall be recorded at intervals of not more than 1 minute.

b. Pressure altitude: -1,000 to 50,000 feet of standard atmosphere pressures, and shall be recorded at intervals of not more than one second.

c. Vertical acceleration: +6 to -3g, and shall be recorded at intervals of not more than 1/10 of 1 second, or at intervals of 1 second in which peak accelerations are recorded.

d. Air speed: 100 to 450 knots IAS, and shall be recorded at intervals of not more than one second.

e. Heading: 360 degrees azimuth, and shall be recorded at intervals of not more than one second.

4.3 **Record resolution.** The record resolution shall be such that the data can be analyzed with the accuracy specified in section 6.

4.4 **Record protection.** The recorder shall be of such design that the recorded data will be protected against damage by fire, impact, and water within the limits specified herein.

4.5 **Pressure altitude.** The terms of pressure altitude shall conform to tables I and II.

4.6 **Air speed.** The terms of air speed shall conform to table III.

4.7 **Power variations.** All units shall properly function with +10 percent to -20 percent variation in DC voltage and/or ±10 percent variation in a.c. voltage and ±5 percent in frequency, provided the a.c. voltage and frequency vary in the same direction. The recorder shall not be damaged when subjected to lower voltages.

4.8 **Power malfunction indication.** A means shall be provided for indicating when adequate power is not being received by the recorder for proper operation.

4.9 **Automatic ejection.** The automatic ejection provision of Type III recorders, including the structure holding the ejectable portion, shall be capable of operating when subjected to inertia loads corresponding to an acceleration of 6g's acting in any direction.

5. **Test conditions.**

5.1 **Atmospheric conditions.** Unless otherwise specified all tests required by this standard shall be conducted at an atmospheric pressure of approximately 29.92 inches of mercury and at an ambient temperature

of approximately 25° C. When tests are conducted with the atmospheric pressure or the temperature substantially different from these values, allowance shall be made for the variation from the specified conditions.

5.2 **Vibration (to minimize friction).** Unless otherwise specified all tests for performance may be made with the recorder subjected to a vibration of 0.002 to 0.005 inch double amplitude at a frequency of 1,500 to 2,000 cycles per minute. The term double amplitude as used herein indicates total displacement from positive maximum to negative maximum.

5.3 **Vibration equipment.** Vibration equipment shall be used which will provide frequencies and amplitudes consistent with the requirements of section 3.1.3 with the following characteristics:

5.3.1 **Linear motion vibration.** Vibration equipment for testing airframe structure-mounted recorders of portions thereof shall be such as to allow vibration to be applied along each of three mutually perpendicular axes of the test specimen.

5.3.2 **Circular motion vibration.** Vibration equipment for testing shock-mounted recorders of portions thereof shall be such that a point on the case will describe, in a plane inclined 45 degrees to the horizontal plane, a circle, the diameter of which is equal to the double amplitude.

5.4 **Position.** All tests shall be conducted with the recorder mounted in its normal operating position.

5.5 **Test voltage.** All tests for performance shall be conducted at the voltage rating recommended by the manufacturer.

5.6 **Power conditions.** All tests for performance shall be conducted at the power rating recommended by the manufacturer.

6. **Allowable record errors.**

6.1 **Altitude record error.** The recorder shall be tested for allowable error at the test points specified in table I on decreasing and increasing pressure. The rate of change in pressure during this test shall not be less than 3,000 feet per minute. On decreasing pressure, the pressure shall be brought down to, but shall not exceed, the specified test point. On increasing pressure, the pressure shall be brought up to, but shall not exceed, the specified test point. Within 1 minute after applying the specified pressure, the error in the record shall not exceed the tolerance values indicated in table I for each test point.

6.2 **Acceleration record error.** The acceleration error shall not exceed plus or minus 0.2G in a stabilized condition, and the total error in following a single, triangular, acceleration pulse of one-half second duration or greater, shall be no more than 10 percent of the acceleration. (An analytical evaluation is considered acceptable.)

6.3 **Time scale record error.** The time lapse error shall not exceed plus or minus 1.0 percent during an 8-hour period.

6.4 **Air speed record error.** The recorder shall be tested for allowable error at the test points specified in table III on increasing and decreasing speeds. The allowable error shall not exceed the tolerance value specified in table III.

6.5 **Heading record error.** The heading record error shall not exceed plus or minus 2 degrees when measured at 15 degree intervals over 360 degrees in azimuth. This error is the difference between the sensor and the recorder.

7. **Performance tests.** The following tests, in addition to any others deemed necessary by the manufacturer, shall be the basis for determining compliance with the performance requirements of this standard.

7.1 **Room temperature.** The recorder shall be tested at room temperature to determine compliance with the requirements under section 6.

7.2 **Low temperature.** The recorder shall be subjected to an ambient temperature of minus 55° C. for 5 hours and while still ex-

posed to this temperature it shall be tested to determine compliance with the requirements under section 6.

7.3 *High temperature.* The recorder shall be subjected to an ambient temperature of 50° C. for 5 hours and while still exposed to this temperature it shall be tested to determine compliance with the room temperature accuracies under section 6.

7.4 *Extreme temperature exposure.* The recorder, after exposure to an ambient temperature of 70° C. for 24 hours followed by exposure to -65° C. for 24 hours followed immediately by exposure to room temperature for not more than 3 hours, shall meet the requirements of section 7.1. There shall be no evidence of damage as a result of exposure to the extreme temperatures.

7.5 *Hysteresis.* Not more than 15 minutes after the altitude sensor has been first subjected to the pressure corresponding to standard altitude of 50,000 feet, the pressure shall be increased at a rate corresponding to a decrease in altitude of not less than 3,000 feet per minute until the pressure corresponding to 25,000 is reached. Within 10 seconds the error shall not exceed the room temperature error at this test point by more than 100 feet. The altitude sensor shall remain at this pressure for not more than 10 minutes before the test to determine compliance with table II is made. The pressure shall be further increased at the above rate until atmospheric pressure is reached.

7.6 *After effect.* Not more than 5 minutes after the completion of the hysteresis test, the altitude record shall have returned to its original recording, corrected for any change in atmospheric pressure, within the tolerance shown in table II.

7.7 *Vibration.*

7.7.1 *Resonance.* The recorder, while operating, shall be subjected to a resonant frequency survey of the appropriate range specified in section 3.1.3 in order to determine if there exists any resonant frequencies of the parts. The amplitude used may be any convenient value that does not exceed the maximum double amplitude and the maximum acceleration specified in section 3.1.3.

The recorder shall then be subjected to a vibration at the appropriate maximum double amplitude or maximum acceleration specified in section 3.1.3 at the resonant frequency for a period of 1 hour in each axis or with circular motion vibration, whichever is applicable. When more than one resonant frequency is encountered with vibration applied along any one axis, a test period may be accomplished at the most severe resonance, or the period may be divided among the resonant frequencies, whichever shall be considered most likely to produce failure. The test period shall not be less than one-half hour at any resonant mode. When resonant frequencies are not apparent within the specified frequency range, the recorder shall be vibrated for 2 hours in accordance with the vibration requirements of section 3.1.3 at the maximum double amplitude and the frequency to provide the maximum acceleration.

7.7.2 *Cycling.* The recorder, while operating, shall be tested with the frequency cycled between limits specified in section 3.1.3 in 15-minute cycles for a period of 1 hour in each axis at an applied double am-

plitude specified in section 3.1.3 or an acceleration specified in section 3.1.3, whichever is the limiting value. After the completion of this vibration test, no damage shall be evident and the recorder shall meet the requirements of section 6.

7.8 *Humidity, water, impact, penetration resistance, static crush, and fire protection tests.* The humidity, impact, penetration resistance, static crush, and fire protection tests shall be made in the following sequence on the same recorder without the need for repairs.

7.8.1 *Humidity.* The recorder shall be mounted in a chamber maintained at a temperature of 70±2° C. and a relative humidity of 95±5 percent for a period of 6 hours. After this period the heat should be shut off and the recorder should be allowed to cool for a period of 18 hours in this atmosphere in which the humidity rises to 100 percent as the temperature decreases to not more than 38° C. This complete cycle should be conducted fifteen (15) times. Immediately after cycling, the recorder shall be subjected to the Record Error Tests of section 6.

7.8.2 *Impact.* The intelligence on the record medium shall be capable of being analyzed after the recorder has been subjected to the following impact shock: Types I and II—Half sine wave impact shocks applied to each of the three main orthogonal axes and having a peak acceleration magnitude of 1,000 g with a time duration of at least 5 milliseconds. Type III—Acceleration not less than the shocks developed on contact with a horizontal rock surface, considering the direction of ejection and any provisions for alleviation of shock. With regard to the former, the aircraft shall be assumed to be tilted at least 30 degrees from horizontal in the most critical direction.

7.8.3 *Penetration resistance (Type I and II recorders only).* The intelligence on the record medium shall be capable of being analyzed after the recorder has been subjected to an impact force equal to a 500-pound steel bar which is dropped from a height of 10 feet to strike each side of the enclosure in the most critical plane. The point of contact of the bar shall have an area that is no greater than 0.05 square inches. The longitudinal axis of the bar shall be vertical at the time of impact. Note: The objective of this test is to achieve protection of the record medium from possible damage caused by airframe structural members striking the recorder case during crash impact.

7.8.4 *Static crush (Type I and II recorders only).* The intelligence on the record medium shall be capable of being analyzed after the recorder has been subjected to a static crush force of 5,000 pounds applied continuously, but not simultaneously to each of the three main orthogonal axes for a test period of 5 minutes.

7.8.5 *Fire protection.* The record medium shall remain intact so that the intelligence can be analyzed after the recorder is exposed to flames of 1100° C. enveloping at least 50 percent of the outside area of the case for the following periods of time: Type I—30 minutes; Type II—15 minutes; Type III—1.5 minutes.

7.8.6 *Water protection.* The intelligence on the record medium shall be capable of remaining permanent and reproducible after the record medium has been immersed in seawater for 36 hours.

7.9 *Position error.* The recorder shall meet the following requirements when turned from its normal operating position through 90° forward and back, and left and right

where applicable:

- a. Time: Section 6.3.
- b. Altitude: Section 6.1, except that the tolerance may be increased by 25 feet.
- c. Acceleration: Section 6.2.
- d. Air speed: Section 6.4.
- e. Heading: Section 6.5.

7.10 *Dielectric.* The insulation shall be subjected to a dielectric test with an RMS voltage at a commercial frequency applied for a period of 5 seconds, equivalent to five times normal circuit operating voltage, except where circuits include components for which such a test would be inappropriate, the test voltage shall be 1.25 times normal circuit operating voltage. The insulation resistance shall not be less than 20 megohms at that voltage.

7.11 *Automatic ejection means.* The automatic ejection means for Type III recorders shall be tested to demonstrate that it is capable of ejecting the recorder from its mounting when subjected to forward acting inertia loads of 5g's to 6g's.

8.0 *Recorder color.* The exterior surface of the recorder must be finished in either a bright orange or a bright yellow color.

TABLE I—ALTITUDE RECORD ERROR TABLE

Standard altitude (feet)	Equivalent pressure mercury		Tolerance, feet plus or minus	
	MM	IN. HG	Room temp. sec. 6.1	Low temp. sec. 7.1
-1,000	787.9	31.02	100	150
-500	773.8	30.47	100	150
0	760.0	29.92	100	150
500	746.4	29.39	100	150
1,000	732.9	28.86	100	150
1,500	719.7	28.33	100	150
2,000	706.6	27.82	100	150
3,000	681.1	26.81	125	150
4,000	656.3	25.84	150	210
6,000	609.0	23.98	150	250
8,000	564.4	22.22	150	300
10,000	522.6	20.58	150	350
12,000	483.3	19.03	180	350
14,000	446.4	17.57	210	350
16,000	411.8	16.21	240	350
18,000	379.4	14.94	270	450
20,000	349.1	13.75	300	450
22,000	320.8	12.68	335	450
25,000	281.6	11.10	375	550
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	800

TABLE II—ALTITUDE TEST TABLE

Tests	Reference section	Tolerance in feet
Hysteresis:	7.4	90
First test point 25,000.....		90
Second test point 20,000.....		90
After effect test.....	7.5	50

*In excess of the room temperature error.

TABLE III—AIRSPEED RECORD ERROR TABLE

Standard airspeed (knots)	Tolerance, knots plus or minus	
	Room temp. sec. 6.1	Low temp. Sec. 7.1
100	10	12
150	10	12
200	10	12
250	10	12
300	10	12
350	10	12
400	10	12
450	10	12