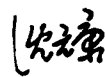
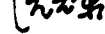


技术标准规定
航空器飞行数据记录器
(CTSO—C51a)

中国民用航空局



中国民用航空局

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批 准 人: 

技术标准规定

本技术标准规定根据中国民用航空规章《技术标准规定》(CCAR37)颁发。每份技术标准规定是对用于民用航空器上的航空材料、零部件和机载设备接受适航审查时,必须遵守的准则。

航空器飞行数据记录器

1. 适用性

本技术标准规定指明航空器的飞行数据记录器为取得有关 CTSO 标记所必须满足的最低性能标准。要取得这种标记和在本标准规定的有效日期或在此以后制造的新型飞行数据记录器,必须符合本标准规定的航空器飞行数据记录器的最低性能标准。

2. 标记

除 CCAR—21 部第八十四条(四)要求的标记外,记录器还应标记额定电压和额定功率。

3. 资料要求:

制造人应向民航局提交下列资料:

(1)六份制造人的使用说明书,使用限制和安装限制,安装规程。

(2)一份制造人的试验报告。

1992 年 6 月 1 日发布

航空器飞行数据记录器的最低性能标准

1 主题内容和适用范围

1.1 主题内容

本标准规定了主要提供航空器的飞行情况和飞行事故分析用的航空飞行数据记录器(以下简称记录器)必须满足产品的最低性能标准。记录器就能在本标准3条规定的环境条件下正常工作。

1.2 适用范围

本标准主要适用于三种基本类型的至少能记录时间,高度,空速,垂直加速度,航向等5个参数的记录器。

2. 分类

记录器分为如下三种基本类型:

I 型—非弹射型记录器

II 型—非弹射性记录器,装机位置应限定在离开穿过机身的主翼结构和远离任一燃油箱处的距离大于翼根弦长的1/2的任一位置上。

III 型—可弹射型记录器,装机位置不受限制。

3. 一般要求

3.1 环境条件

下列环境条件只作为设计要求。诸项试验则应按本标准第5、第6、和第7条的规定进行。

3.1.1 温度

当按照记录器制造人的《产品使用说明书》中规定的要

求进行安装时,记录器在如表 1 中 A 栏所列的环境温度范围内应能正常工作,而且当被暴露在如表 1 中 B 栏所列的温度范围内时,记录器不应受到不利影响。

3.1.2 湿度

当记录器被暴露在温度约为 32℃,相对湿度为 0~95%范围内的任一相对湿度条件时,记录器应能正常工作,而且不应受到不利影响。

3.1.3 振动

当按照记录器制造人的《产品使用说明书》中规定的要求进行安装时,记录器在经受到如表 2 所列振动特性的情况下应能正常工作,而且不应受到不利影响。

3.1.4 高度

当记录器在经受相当于 -305~15240m (-1000~50000ft)标称高度范围的等效压力和温度(按附录 A《标准大气数据简表》)时,除了应用本标准第 3.1.1 条而受到限制以外,记录器应能正常工作,而且不应受到不利影响。

当记录器在经受绝对环境压力为 169.319Kpa(50inHg)和 10.159Kpa(3inHg)这两个极端的情况下,记录器不应受到不利影响。

3.1.5 无线电干扰

记录器在任何飞机所用频率的条件下工作时,对安装在同一架飞机上的电子设备,记录器应不是有害的干扰源(无论是以发射的形式或是反馈的形式)。

3.1.6 磁影响

记录器的磁效应对安装在同一架飞机上的其它设备的工作应不产生不利影响。

4. 详细要求

4.1 记录介质

记录介质应符合下列要求：

- a. 采用机械划痕的记录器的记录装置应以不小于每小时 6 英寸的速度前进,而采用其它记录方式的记录器,其记录方式应按本标准第 4.3 条规定的分辨精度使用一种足以分辨清晰的速率运行。
- b. 记录介质应能够提供飞机至少一次飞行的整个航程工作时间所需数据的记录。
- c. 记录介质在本标准规定的极限内不应受到变质或记录数据失真。

4.2 记录间隔和记录范围

a. 时间

记录的时间间隔应不超过 1min。

b. 压力高度

在标准大气压条件下,记录范围为-305~15240m(-1000~50000ft)。记录的时间间隔不超过 1s。

c. 空速

记录范围为 185~833.4Km/h(100~450Kn,仪表指示空速)。

d. 垂直加速度

记录范围为 $58.8 \sim 29.4 \text{ m/s}^2 (+6 \sim -3g)$ 。

记录的时间间隔应不超过 0.1s,或者以 1s 的时间间隔记录峰值加速度。

e. 航向

记录范围为 360°方位角。

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记录的时间间隔应不超过 1s。

4.3 记录分辨率

记录分辨率应使所记录的数据能够进行分析,且具有本标准第 6 条规定的精度。

4.4 记录保护

在本标准所规定的极限范围内,记录器的设计应使所记录的数据能得到完好的保护,以防止由于火烧、冲击和海水浸泡引起的任何损坏。

4.5 压力高度

应符合本标准中表 3 和表 4 规定的要求。

4.6 空速

应符合本标准中表 5 规定的要求。

4.7 电源变化

当直流电压在 $+10\% \sim -20\%$ 的范围内变化或交流电压在 10% 之间变化,频率在 $\pm 5\%$ 之间变化,且交流电压和频率的变化为同一个方向时,所有的部件都应能正常工作。当在较低电压下工作时,记录器就不致于被损坏。

4.8 电源故障显示

当电源出现异常情况下不能保证记录器正常工作时,应能提供“电源故障显示”。

4.9 自动弹射

Ⅲ型记录器的自动弹射装置,包括固定可弹射部分的结构,当在任何方向上受到对应 58.8 m/s^2 (等于 6g)加速的惯性载荷的作用时,应能够自动弹射。

5. 试验条件

5.1 大气条件

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除非另有规定,本标准要求的所有试验都应在大气压力为 101.325Kpa(约等于 29.92inHg),环境温度约为 25℃的条件下进行。如果试验时的大气压力或温度与上述规定值有显著差异时,应当给出偏离规定条件的修正量。

5.2 振动(应使阻尼减为最小)

除非另有规定,所有性能试验都可以在使记录器经受振动频率为 25~33Hz(1500~2000C/min),“双幅值”为 0.050~0.127mm(0.20~0.15in)的振动条件下完成。

注:此处使用的术语“双振幅”是指从正的最大振幅值到负的最大振幅值的总位移。

5.3 振动试验设备

所选用的振动设备应能提供符合本标准第 3.1.3 规定的振动频率和振幅值,并且有下列振动特性。

5.3.1 线性运动振动

振动设备(用于测试飞机机身构架上安装的记录器或其各部分)应能沿该试验样品的三个相互垂直的每个轴向施加振动。

5.3.2 圆周运动振动

振动设备(用于测试在减震座架上安装的记录器或其各部分)应能使记录器外壳上的某一点在与水平倾斜 45°的斜面上作直径为双幅值的圆周运动。

5.4 位置

所有的试验都应使记录器安装在正常工作位置上进行。

5.5 试验电压

所有的性能试验都应在记录器制造厂推荐的额定电压条件下进行。

5.6 功率条件

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所有的性能试验都应在记录器制造厂推荐的额定功率条件下进行。

6. 允许记录误差

6.1 高度记录误差

记录器应按表 3 规定的试验点,以减压和增压的方式进行“允许误差测试”。在这一试验过程中,其压力的变化速率应不低于 914.4m/min (3000ft/min)。在减压时,其压力应下降到表 3 规定的试验点的值,但不应超过该值;在增压时,其压力应上升到表 3 规定的试验点的值,但不应超过该值。在每个试验点上施加了规定的压力之后的 1min 之内,其记录误差应不超过表 3 中规定的每一个试验点的容差值。

6.2 加速度记录误差

在稳定条件下的加速度记录误差应不超过 $\pm 0.2\text{g}$,在跟随一个 0.5 秒或更大持续时间的单个的、三角形的加速度脉冲时,其总的记录误差应不大于加速度值的 10% (用分析评估的方法也可以被接受)。

6.3 时标记录误差

在 8 小时内,时间间隔记录误差应不超过 $\pm 1\%$ 。

6.4 空速记录误差

记录器应按表 5 规定的试验点,以增加速度和减少速度的方式进行允许误差测试,其允许误差应不超过表 5 中规定的容差值。

6.5 航向记录误差

在 360° 方位角的范围内,以每 15° 的间隔进行测试时,航向记录误差应不超过 $\pm 2^\circ$ 。在传感器和记录器之间这个误差是不同的。

7. 性能试验

除记录器制造厂认为必要的任何其它试验以外,下列诸项试验应作为确定记录器是否符合本标准规定性能要求的依据。

7.1 室温试验

记录器在室温条件下进行测试,必须符合本标准第 6 条规定的要求。

7.2 低温试验

记录器应能经受环境温度为一55℃、持续时间达 5 小时的低温。并在此低温条件下进行测试,记录器应符合本标准第 6 条规定的要求。

7.3 高温试验

记录器应能经受环境温度为 55℃,持续时间达 5 小时的高温。并在此高温条件下进行测试,记录器应符合本标准第 6 条规定的要求。

7.4 极限温度暴露试验

使记录器暴露在 70℃ 的高温极限环境条件下保持 24 小时之后,紧接着暴露在一65℃的低温极限环境条件下保持 24 小时之后,随即又暴露在室温条件下不超过 3 小时,记录器能满足本标准第 7.1 条规定的要求,而且不应有由于暴露在极限温度下所导致损坏的痕迹。

7.5 迟滞试验

首先让高度传感器承受相当于 15240m(50000ft)标称高度的等效压力 11.639Kpa(3.44inHg)不大于 15 分钟之后,压力应以相当于每分钟高度降低不小于 914.4m(3000ft/min)的速率增加,直至压力达到相当于 7620m

(25000ft)高度的等效压力 37.583Kpa(11.1inHg)。10 秒之内,其误差应不超过该试验点的室温下允许误差(见表 3),再加 30.48m(100ft)。高度传感器在该压力下保持时间不超过 15 分钟。然后进行测试,应符合表 4 规定的要求。再此以后,压力应进一步以上述速率增加,直至达到相当于 6096m(20000ft)高度的等效压力 46.543Kpa(13.75inHg)。高度传感器在该压力下保持时间不超过 10 分钟,然后进行测试,应符合表 4 规定的要求。让压力再进一步以上述速率增压,直至达到大气压力为止。

7.6 后效试验

在迟滞性试验进行完毕之后不超过 5 分钟时间内,高度记录应恢复到它的初始记录状态(按当地当时的大气压进行校正),并且在表 4 的容差范围之内。

7.7 振动试验

7.7.1 谐振试验

为了确定记录器的零部件中是否存在有任何谐振频率,对处于工作状态的记录器应按照本标准 3.1.1 条规定的适当范围内进行谐振频率检查,所使用的振幅可以是不超过本标准第 3.1.3 条规定的最大双幅值和最大加速度的任一方便的值。

然后,应让记录器经受在每一轴向上施加的试验周期为 1 小时,频率为谐振频率,振动幅度为本标准第 3.1.3 条规定的相应的最大双幅值或最大加速度值的振动,或者施以圆周运动振动,以适用者为准。当沿着任一轴向施加的振动出现多于一个谐振频率时,可以在最剧烈的谐振状态下完成一个试验周期,或者把试验在各个谐振频率之间进行分配,以何者应被认为最可以使记录器导致损坏为准。无论以任何谐

振频率进行试验,其试验周期应不小于 0.5 小时。

当在规定的频率范围内,谐振频率不太明显时,应使记录器按本标准第 3.1.3 条规定的振动要求以最大双振幅和能产生最大加速度的振频经受 2 小时的振动。

7.7.2 振动循环试验

对于处于工作状态的记录器,应当在其每个轴向上施加本标准第 3.1.3 条规定的最大双幅值或最大加速度值(以任一个达到极限值为准)的情况下,采用本标准第 3.1.3 条规定的极限范围内循环的振动频率进行试验,在 1 小时的试验周期内进行四次循环,每次循环 15 分钟。在完成整个振动试验后,记录器应无明显损坏,而且应仍能满足本标准第 6 条规定的要求。

7.8 湿度试验、冲击试验、抗穿透试验、静态挤压试验、火烧防护试验、耐海水浸泡试验。

湿度试验、冲击试验、抗穿透试验、静态挤压试验、火烧防护试验应按下列各条规定的顺序和要求在同一部记录器上进行,而且不需要修复。

7.8.1 湿度试验

记录器放在试验箱内,箱内温度应保持在 $70 \pm 2^{\circ}\text{C}$,相对湿度保持在 $95\% \pm 5\%$,试验时间为 6 小时。经过 6 小时之后应停止加热,使试验箱温度下降到 38°C 以下而湿度上升到 100%,记录器在该大气环境条件下冷却 18 小时。上述这样完整的试验周期应进行 15 次循环。

在湿度循环试验完成之后,应立即对记录器进行符合本标准第 6 条规定所要求的记录误差测试。

7.8.2 冲击试验

当记录器受到下列冲击之后,记录介质上所记录的数据

信号应仍能被分析。

I 型和 II 型记录器—在记录器的三个正交轴的每个轴方向上施加半个正弦波的冲击,其加速度峰值为 9806.65m/s^2 (1000g),持续时间至少为 5 毫秒。

II 型记录器—考虑到弹射方向和为减轻冲击而采取的措施,它受到的冲击加速度应不小于与水平振动面碰撞时所产生的冲击。对于弹射方向,是假定飞机在最关键要害的方向上与水平方向至少倾斜 30° 。

7.8.3 抗穿透试验(仅适用于 I 型和 II 型记录器)

记录器应承受一个撞击力,这个撞击力相当于一根质量为 226.8kg(500lb)的钢棒,从 3.05m(10ft)高处竖直掉落撞击在记录器外壳表面的最关键的面上。撞击时钢棒的纵轴方向应该是垂直的,钢棒碰触点的面积应不大于 32.3mm^2 (0.5in^2)当记录器在承受抗穿透试验之后,记录介质上所记录的数据信号应能被分析。

注:本试验的目的是为了防止记录介质在飞机发生坠毁冲击时,由于机身结构的零部件撞击记录器外壳而可能引起的损坏。

7.8.4 静态挤压试验(仅适用于 I 型和 II 型记录器)

应使记录器在其三个相互垂直的正交主轴的每个轴向上连续分别承受一个 2268kgf(5000ibf)静态压力,每个轴向试验的时间为 5 分钟。经过静态挤压试验之后,记录介质上所记录的数据信号仍能被分析。

7.8.5 火烧防护试验

记录器被置于 1100°C 火焰中,其壳体外表面至少有 50%被火焰所包围,试验时间为:

I 型记录器—经受 30 分钟

Ⅱ型记录器—经受 15 分钟

Ⅲ型记录器—经受 1.5 分钟

试验之后,记录介质应保持完整无损坏,所记录的数据信号仍能被分析。

7.8.6 耐海水浸泡试验

当记录介质在海水中浸泡 36 小时以后,记录介质上所记录的数据信号应能保持不变并能提供复制。

7.9 位置误差

把记录器从它的正常位置向前、向后、向左、向右各翻转 90°时,记录器应满足下列要求:

- a. 时间:应符合本标准第 6.3 条的规定
- b. 高度:应符合本标准第 6.1 条的规定,但“容差值”可以增加 7.62m(25ft)
- c. 加速度:应符合本标准第 6.2 条的规定。
- d. 空速:应符合本标准第 6.4 条的规定。
- e. 航向:应符合本标准第 6.5 条的规定。

7.10 电绝缘试验

绝缘体应经受电绝缘试验,此试验是采用工业用电频率下的“均方根值”(RMS)电压(等效于正常电路工作电压的 5 倍),施加时间 5 秒。此外,对不适宜做上述试验电压的电路部分(包括元器件和零部件在内)其试验电压应是正常电路工作电压的 1.25 倍。在此电压下,其绝缘电阻应不小于 20mΩ。

7.11 自动弹射装置

对Ⅲ型记录器的自动弹射应进行自动弹射试验,用以证明当记录器受到 $49 \sim 58.8 \text{ m/s}^2$ ($5 \sim 6\text{g}$) 向前的惯性载荷时,确实能够从它的安装架上自动弹射出去。

8. 记录器的颜色

记录器外表面所涂的颜色,必须是鲜橙色或鲜黄色。

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表 1 环境温度范围表

℃

记录器位置	A	B
受热区域(控制温度)	—30~50	—65~70
非受热区域(不控制温度)	—55~70	—65~70

表 2 振动特性

记录器在飞机机身内的位置	振动频率	振动幅度	振动加速度
安装在机身构架内	5—500Hz	最大双幅值 0.9mm (0.036in)	最大加速度值 98m/s ² (10g)

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表 3 高度记录误差表

标称高度		等效大气压力			高度容差			
					室温条件下		低温条件下	
					(见本标准第 6.2 条和第 7.1 条)		(见本标准第 6.2 条和第 7.2 条)	
m	(ft)	kPa	(minHg)	(inHg)	m	(ft)	m	(ft)
15240	50000	11.639	87.3	3.44	±213.36	±700	—	—
12192	40000	18.758	140.7	5.54	±182.88	±600	±243.84	±800
10668	35000	23.825	178.7	7.04	±160.02	±525	±222.50	±730
9144	30000	30.077	225.6	8.88	±137.16	±450	±182.88	±600
7620	25000	37.583	281.9	11.10	±114.30	±375	±170.69	±560
6706	22000	42.770	320.8	12.63	±102.11	±335	—	—
6096	20000	46.543	349.1	13.75	±91.44	±300	—	—
5486	18000	50.582	379.4	14.94	±82.30	±270	±137.16	±450
4877	16000	54.902	411.8	16.21	±73.15	±240	—	—
4267	14000	59.515	446.4	17.57	±64.01	±210	—	—
3658	12000	64.435	483.3	19.03	±54.86	±180	±106.68	±350
3048	10000	69.874	522.6	20.58	±45.72	±150	—	—
2438	8000	75.247	564.1	22.22	±45.72	±150	—	—
1829	6000	81.193	609.0	23.98	±45.72	±150	±76.20	±250
1219	4000	87.409	656.3	25.84	±45.72	±150	±64.01	±210
914	3000	90.806	681.1	26.81	±38.01	±125	—	—
610	2000	94.205	706.6	27.82	±30.48	±100	—	—
457	1500	95.952	719.7	28.33	±30.48	±100	—	—
305	1000	97.712	732.9	28.86	±30.48	±100	—	—
152	500	99.512	746.4	29.39	±30.48	±100	—	—
0	0	101.325	760.0	29.92	±30.48	±100	±45.72	±150
—152	—500	103.165	773.8	30.47	±30.48	±100	—	—
—305	—1000	105.044	787.9	31.02	±30.48	±100	±45.72	±150

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表 4 高度试验表

试验项目	参见标准条文	试 验 点	容 差
迟滞性试验	第 7.5 条	第一次试验点:7620m(25000ft)	27.43m(90ft) ¹⁾
		第二次试验点:6069m(20000ft)	27.43m(90ft) ¹⁾
后效试验	第 7.6 条		15.24m(50ft)

注: 1)超过室温误差

表 5 空速记录误差表

标 定 空 速		容 差			
		室温条件下		低温条件下	
		(见本标准第 6.4 条和 7.1 条)		(见本标准第 6.4 条和 7.2 条)	
km/h	kn	km/h	kn	km/h	kn
833.4	450	±18.5	±10	±22.2	±12
740.8	400	±18.5	±10	±22.2	±12
648.2	350	±18.5	±10	±22.2	±12
555.6	300	±18.5	±10	±22.2	±12
463.0	250	±18.5	±10	±22.2	±12
370.4	200	±18.5	±10	±22.2	±12
277.8	150	±18.5	±10	±22.2	±12
185.2	100	±18.5	±10	±22.2	±12

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附录 A

标准大气数据简表

本附录给出 22km 以下标准大气数据简表(见表 A1),供参考使用。

表 A1 22km 以下标准大气数据简表

高 度	大 气 温 度	大 气 压 力	
m	C	kPa	mmHg
22000	—54.576	4.048	30.36
21400	—55.172	4.443	33.33
21300	—55.271	4.513	33.85
21000	—55.569	4.729	33.47
20000	—56.500	5.529	41.47
16200	—56.500	10.033	75.25
16100	—56.500	10.191	76.44
15300	—56.500	11.554	86.67
15200	—56.500	11.737	88.04
15000	—56.500	12.111	90.85
12200	—56.500	18.799	141.00
12100	—56.500	19.097	143.23
12000	—56.500	19.399	145.50
11000	—56.376	22.699	170.26
10800	—55.081	23.422	175.68
10700	—54.433	23.790	178.44
10650	—54.109	23.975	179.83
10000	—49.898	26.499	198.76
9150	—44.390	30.121	225.93
9100	—44.065	30.346	227.61
9000	—43.417	30.800	231.02

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高 度	大 气 温 度	大 气 压 力	
m	C	kPa	mmHg
8000	—36.935	35.651	267.40
7650	—34.665	37.489	281.19
7600	—34.341	37.757	283.20
7000	—30.450	41.105	308.31
6950	—30.126	41.394	310.48
6900	—29.801	41.685	312.67
6750	—28.828	42.569	319.29
6700	—28.504	42.867	321.53
6100	—24.612	46.575	340.34
6050	—24.288	46.895	351.74
6000	—23.963	47.217	354.16
5500	—20.719	50.539	379.07
5450	—20.395	50.881	381.64
5000	—17.474	54.048	405.39
4900	—16.825	54.773	410.83
4850	—16.501	55.138	413.57
4300	—12.931	59.290	444.71
4250	—12.607	59.680	447.64
4000	—10.984	61.660	462.49
3700	—9.036	64.106	480.83
3650	—8.711	64.521	483.95
3050	—4.815	69.676	522.61
3000	—4.491	70.121	525.95
2450	—0.919	75.161	563.75

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高 度	大 气 温 度	大 气 压 力	
		kPa	mmHg
2400	—0.594	75.634	567.30
2350	—0.269	76.109	570.86
2300	0.055	76.586	574.44
2000	2.004	79.510	596.30
1850	2.978	80.992	607.49
1800	3.303	81.494	611.25
1250	6.877	87.185	653.94
1200	7.201	87.717	657.93
1000	8.501	89.876	674.12
950	8.826	90.422	678.22
900	9.151	90.971	682.34
650	10.775	93.756	703.23
600	11.100	94.322	707.47
500	11.750	95.461	716.01
450	12.075	96.034	720.32
350	12.725	97.190	728.98
300	13.050	97.772	733.35
200	13.700	98.945	742.15
150	14.025	99.535	746.58
100	14.350	100.120	751.03
50	14.675	100.720	755.00
0	15.000	101.325	760.00
—50	15.325	101.920	764.51
—100	15.650	102.530	769.05

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高 度	大 气 温 度	大 气 压 力	
m	C	kPa	mmHg
—150	15.975	103.140	773.61
—200	16.300	103.750	778.19
—300	16.950	104.980	787.42
—350	17.275	105.600	792.07
—1500	24.752	120.690	905.29
—1550	25.077	121.3880	910.49
—2600	31.907	136.730	1025.50
—2650	32.232	137.490	1031.30
—3500	37.763	151.090	1133.30
—3550	38.088	151.930	1139.50
—3800	39.715	156.150	1171.20
—3850	40.040	157.000	1177.60
—4000	41.016	159.590	1197.00
—4500	44.271	168.480	1263.70
—4550	44.596	169.390	1270.50
—5000	47.526	177.760	1333.30

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Chinese Technical Standard Order

Aircraft Flight Recorder

(CTSO—C51a)

CIVIL AVIATION ADMINISTRATION OF CHINA

**Technical Standard Order Aircraft Flight Recorder
(CTSO—C51a)**

1. **Applicability**

This Technical Standard Order prescribes minimum performance standards that aircraft flight recorders must meet in order to be identified with the applicable CTSO marking. New models of flight recorders that are to be identified and that are manufactured on or after the effective date of this CTSO must meet the Minimum Performance Standard for Aircraft Flight Recorders set forth in this CTSO.

2. **Marking**

In addition to the markings required by 21. 84 (d) of CCAR Part 21, the rating (nominal voltage and wattage) must also be marked on the recorder.

3. **Data requirements**

The manufacturer must furnish to CAAC the following technical data:

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

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

Minimum Performance Standard for Aircraft Flight Recorder

1. Subject Content and Scope of Applicability.

1.1 Subject Content

This Standard prescribes minimum performance standard requirements that aircraft flight recorders used primarily for accident analysis (hereinafter simply called “recorder”) must meet. Recorder should be able to work normally subject to environmental conditions specified in section 3 of this CTSO.

1.2 Scope of Applicability

This Standard is applicable to three basic types of aircraft flight records for recording at least 5 parameters, namely time, air speed, altitude, vertical acceleration and heading.

2. Definition of The Types.

The recorders can be divided into three types as following:

Type I—Non-ejectable recorder,

Type II—Non-ejectable, restricted to any location more than $\frac{1}{2}$ 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 50°C —65	—65° to 70°C
Unheated Areas (Temperature Uncontrolled)	—55° to 70°C	—65° to 70°C

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% at a temperature of approximately 32°.

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	Cycles	Max Double	Max
in Airframe	Per Sec.	Amplitude	Acceleration
Airframe Structure Mounted	5—500Hz	0.9mm(0.036 In)	98m/s ² (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—305~15240 meters(—1000 to 50,000 feet) standard altitude, per appended Table A “Simplified Table of Standard Atmosphere Data”, 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 169. 319 kpa(1270mm or 50 in. Hg.)and 10. 159 kpa(76. 2mm or 3 in. Hg.)absolute.

3. 1. 5 Radio Interference; The recorder shall not be the source of objectionable interference, under operation conditions at any frequencies used on aircraft, either by radiation or feed-back, 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 magnetic recording means or 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 one minute.

b. Pressure Altitude: $-305 \sim 15240$ meters (-1000 to $50,000$ feet) of standard atmosphere pressures, and shall be recorded at intervals of not more than one second.

c. Air Speed; $185 \sim 833$. 4km/hr. (100 to 450 knots) IAS. and shall be recorded at intervals of not more than one second.

d. Vertical Acceleration: $+58.8$ to -29.4 m/s² ($+6$ to $-3g$.) and shall be recorded at intervals of not more than 1/10 of one second, or at intervals of one second in which peak accelerations are recorded.

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 $+10\%$ to -20% variation in DC

voltage and or $\pm 10\%$ variation in AC voltage and $\pm 5\%$ in frequency, provided the AC 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 $58.8 \text{ m/s}^2 (6g's)$ 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 101.325 kpa (760mm or 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 other wise specified all tests for performance may be made with the recorder subjected to a vibration of $0.050 \sim 0.127\text{mm}$ (0.002 to 0.005 inch) double amplitude at a frequency of $25 \sim 33\text{Hz}$ (1500 to 2000 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 or 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 or 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 posi-

tion.

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 Time Scale Record Error; The time lapse error shall not exceed plus or minus 1.0% during an eight hour period.

6.2 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 914.4 meters (3000 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 one 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.

6.3 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 values specified in Table III.

6.4 Acceleration Record Error; The acceleration error shall not exceed plus or minus 1.96m/s^2 (0.2G) in a stabilized condition, and the total error in following a single, triangular, acceleration pulse of $\frac{1}{2}$ second duration or greater, shall be no more than 10% of the acceleration. (An analytical evaluation is considered acceptable).

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 five hours and while still exposed 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 55°C for five 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 hour followed by exposure to -65°C for 24 hour followed immediately by exposure to room temperature for not more than three 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 11.639kpa (87.3mm or 3.44in. Hg.) corresponding to standard altitude of 15240 meters (50,000 feet), the pressure shall be increased at a rate corresponding to a decrease in altitude of not less than 914.4 meters (3,000 feet) per minute until the pressure 37.583kpa (281.9mm or 11.1 in. Hg.) corresponding to 7620 meters (25,000 feet) is reached. Within 10 seconds the error shall not exceed the room temperature error (see Table I) at this test point by more than 30.48 meters (100 feet). The altitude sensor shall remain at this pressure for not more than 15 minutes before the test to determine compliance with Table II is made, after which the pressure shall be further increased at the above rate (i.e. 914.4 meters/minute) until the pressure 46.543kpa (349.1mm or 13.75in. Hg.) corresponding to 6096 meters (20,000 feet) is reached. The altitude sensor shall remain at this pressure for not more than ten minutes before the test to determine compliance with Table II is made. The pressure shall be further increased at the above rate (i.e. 914.4 meters/minute) until atmospheric pressure 101.325kpa (760mm or 29.92 in. Hg.) is reached.

7.6 After Effect; Not more than five 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 one 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 two 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 one hour in each axis at an applied double amplitude 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 $70 \pm 2^\circ\text{C}$ and a relative humidity of $95 \pm 5\%$ 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% 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 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 $980665 \text{ meters/sec}^2 (1,000 \text{ g})$ with a time

duration of at least five milliseconds. Type III—Acceleration not less than the shocks developed on contact with a horizontal rock surface, considering the direction of 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 226. 8kg. (500-pound) steel bar which is dropped from a height of 3. 05 meters (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 32. 3mm²(0. 05 square inches). The longitudinal axis of the bar shall be vertical at the time of impact.

Note; The object 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 22226 Newtons(2268kg or 5,000 pounds) applied continuously, but not simultaneously to each of the three main orthogonal axes for a test period of five 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

Table 1—Altitude Record Error Table

Standard Altitude		Equivalent Pressure			Tolerance, Feet Plus or Minus			
					Room Temp. (See 6. 2 and 7. 1)		Low Temp (See 6. 2 and 7. 2)	
m	(ft)	kpa	(mmhg)	mhg	m	(ft)	m	(ft)
15240	50000	11. 639	87. 3	3. 44	±213. 36	±700	—	—
12192	40000	18. 758	140. 7	5. 54	±182. 88	±600	±243. 84	±800
10688	35000	23. 825	178. 7	7. 04	±160. 02	±525	±222. 50	±730
9144	30000	30. 077	225. 5	8. 88	±137. 16	±450	±182. 88	±600
7620	25000	37. 583	281. 9	11. 10	±114. 30	±375	±170. 69	±560
6706	22000	42. 770	320. 8	12. 63	±102. 11	±335	—	—
6096	20000	46. 543	349. 1	13. 75	±91. 44	±300	—	—
5486	18000	50. 582	379. 4	14. 94	±82. 30	±270	±137. 16	±450
4877	16000	54. 902	411. 8	16. 21	±73. 15	±240	—	—
4267	14000	59. 515	446. 4	17. 57	±64. 01	±210	—	—
3658	12000	64. 435	183. 3	19. 03	±54. 86	±180	±106. 68	±350
3048	10000	69. 674	522. 6	20. 58	±45. 72	±150	—	—
2438	8000	75. 247	364. 1	22. 22	±45. 72	±150	—	—
1329	6000	81. 193	609. 0	23. 98	±45. 72	±150	±76. 20	±250
1219	4000	87. 499	656. 3	25. 84	±45. 72	±150	±64. 01	±210
914	3000	90. 806	681. 1	26. 81	±38. 10	±125	—	—
610	2000	94. 205	706. 6	27. 82	±30. 48	±100	—	—
457	1500	95. 952	719. 7	28. 33	±30. 48	±100	—	—
305	1000	97. 712	732. 9	28. 86	±30. 48	±100	—	—
152	500	99. 512	746. 4	29. 39	±30. 48	±100	—	—
0	0	101. 325	760. 0	29. 92	±30. 48	±100	±45. 72	±150
—152	—500	103. 165	773. 8	30. 47	±30. 48	±100	—	—
—305	—1000	105. 044	787. 9	31. 02	±30. 48	±100	±45. 72	±150

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 6.1
- b. Altitude; Section 6.2 except that the tolerance may be increased by 7.62 meters (25 feet)
- c. Airspeed; Section 6.3
- d. Acceleration; 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 five 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 49~58.8 meters/sec² (5g's to 6g's).

8. Recorder Color; The exterior surface of the recorder must be finished in either a bright orange or a bright yellow color.

Table II — Altitude test Table

tests	Reference Section	test Point	Tolerance
Hysteresis	7.5	Frist test point 7620 meters (25000 feet)	27.43 meters (90 feet)
		Second test point 6096 meters (20000 feet)	27.43 meters (90 feet)
After Effect test	7.6		15.24 meters (50 feet)

1) In excess of the room temperature Error

Table III — Airspeed Record Error Table

Standard Airspeed		Tolerance, Plus or Minus			
		Room Temperature (See 6. 3 and 7. 1)		Low Temperature (See 6. 3 and 7. 2)	
km/h	kn	km/h	kn	km/h	kn
833. 4	450	±18. 5	±10	±22. 2	±12
740. 8	400	±18. 5	±10	±22. 2	±12
648. 2	350	±18. 5	±10	±22. 2	±12
555. 6	300	±18. 5	±10	±22. 2	±12
463. 0	250	±18. 5	±10	±22. 2	±12
370. 4	200	±18. 5	±10	±22. 2	±12
277. 8	150	±18. 5	±10	±22. 2	±12
185. 2	100	±18. 5	±10	±22. 2	±12

Appendix A

Simplified Table of Standard Atmosphere Data (Rebesence material)

A simplified Table of standard atmosphere data up to 22,000 meter altitude is given as Table A for reference.

Table A **Simplified Table of Standard Atmosphere**
Data up to 22, meter altitude

Altitude	Air Temperature	Air Pressure	
		kPa	mmHg
m	℃		
22000	—54.576	4.048	30.36
21400	—55.172	4.443	33.33
21300	—55.271	4.513	33.85
21000	—55.569	4.729	35.47
20000	—56.500	5.529	41.47
16200	—56.500	10.033	75.25
16100	—56.500	10.191	76.44
15300	—56.500	11.554	86.67
15200	—56.500	11.737	88.04
15000	—56.500	12.111	90.85
12200	—56.500	18.799	141.00
12100	—56.500	19.097	143.23
12000	—56.500	19.399	145.50
11000	—56.376	22.699	170.26
10800	—55.081	23.422	175.68
10700	—55.433	23.790	178.44
10650	—54.109	23.975	179.83
10000	—49.898	26.499	198.76
9150	—44.390	30.121	225.93
9100	—44.065	30.346	227.61
9000	—43.417	30.800	231.02
8000	—36.935	35.651	267.40
7650	—34.665	37.489	281.19
7600	—34.341	37.757	283.20

Table A (Continued)

Altitude	Air Temperature	Air Pressure	
		kPa	mmHg
m	°C		
7000	−30.450	41.105	308.31
6950	−30.126	41.394	310.48
6900	−29.801	41.685	312.67
6750	−28.828	42.569	319.29
6700	−28.504	42.867	321.53
6100	−24.612	46.575	340.34
6050	−24.288	46.895	351.74
6000	−23.963	47.217	354.16
5500	−20.719	50.539	379.07
5450	−20.395	50.881	381.64
5000	−17.474	54.048	405.39
4900	−16.825	54.773	410.83
4850	−16.501	55.138	413.57
4300	−12.931	59.290	444.71
4250	−12.607	59.680	447.64
4000	−10.984	61.660	462.49
3700	−9.036	64.106	480.83
3650	−8.711	64.521	483.95
3050	−4.815	69.676	522.61
3000	−4.491	70.121	525.95
2450	−0.919	75.161	563.75
2400	−0.594	75.634	567.30
2350	−0.269	76.109	570.86
2300	0.055	76.586	574.44
2000	2.004	79.501	596.30

Table A(Continued)

Altitude	Air Temperature	Air Pressure	
		kPa	mmHg
1850	2.978	80.992	607.49
1800	3.303	81.494	611.25
1250	6.877	87.185	653.94
1200	7.201	87.717	657.93
1000	8.501	89.876	674.12
950	8.826	90.422	678.22
900	9.151	90.971	682.34
650	10.775	93.756	703.23
600	11.100	94.322	707.47
500	11.750	95.461	716.01
450	12.075	96.034	720.32
350	12.725	97.190	728.98
300	13.050	97.772	733.35
200	13.700	98.945	742.15
150	14.025	99.535	746.58
100	14.350	100.120	751.03
50	14.675	100.720	755.50
0	15.000	101.325	760.00
—50	15.325	101.920	764.51
—100	15.650	102.530	769.05
—150	15.975	103.140	773.61
—200	16.300	103.750	778.19
—300	16.950	104.980	787.42
—350	17.275	105.600	792.07
—1500	24.752	120.690	905.29

Table A (Continued)

Altitude	Air Temperature	Air Pressure	
		kPa	mmHg
m	℃		
—1550	25.077	121.380	910.49
—2600	31.907	136.730	1025.50
—2650	32.232	137.490	1031.30
—3500	37.763	151.090	1133.30
—3550	38.088	151.930	1139.50
—3800	39.715	156.150	1171.20
—3850	40.040	157.000	1177.60
—4000	41.016	159.590	1197.00
—4500	44.271	168.480	1263.70
—4550	44.596	169.390	1270.50
—5000	47.526	177.760	1333.30

Note: This Table is adopted from China's National Standards GB1920-80 "Standard Atmosphere" which is completely identical to the corresponding parts of the ICAO standard (ICAO, DOC 7486/2, 1964), the ISO standard (ISO 253—1973), the World Meteorological Organization WMO standard and the American Standard Atmosphere (1976).