编　　号：CTSO-C62e
日　　期：
局长授权
批　　准：

中国民用航空技术标准规定

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

航空轮胎

1.目的

本技术标准规定（CTSO）适用于为航空轮胎申请 CTSO 批准书（CTSOA）的制造人。本 CTSO 规定了航空轮胎为获得批准和使用适用的 CTSO 标记进行标识所必须满足的最低性能标准。

2.适用范围

本 CTSO 适用于自其生效之日起新提交的申请。

a. 自本 CTSO 生效之日起，欲获得航空轮胎技术标准规定项目批准书（CTSOA）的申请人应按照本 CTSO 提交申请。但如果自本 CTSO 生效之日起六个月内，申请人能够向局方表明在新版本生效前一直按照以前版本的最低性能标准进行研制，可以按以前版本的 CTSO 提交申请。

b. 自本 CTSO 生效之日起，按以前版本 CTSO 获得技术标准规定项目批准书（CTSOA）的设备可以按批准时的规定继续制造。

c. 按本 CTSO 批准的设备，设计大改应按 CCAR-21 部第 21.310 条要求重新申请技术标准规定项目批准书（CTSOA）。

3.要求

a.在本 CTSO 生效之日或生效之后制造并欲使用本 CTSO 标记进行标识的航空轮胎应满足本标准附录 A 规定的最低性能标准要求。

b. 偏离

CAAC 可以提供符合本标准最低性能标准的替代试验或相应准则的条款。如果需要援引这些条款，必须出示设备保持相应安全水平的证明。在提交资料前参照 CCAR-21 部第 21.311 条提交偏离申请。

4.标记

每个航空轮胎至少应在一个主要部件上有永久清晰的标记，标记应包括 CCAR-21 第 21.312 条（四）规定的所有信息：

a.适用的 CTSO 编号；

b.平衡标识，红色圆点，在胎圈上方的胎侧区域，用来表征轮胎的轻点；

c.对其一致性负责的制造商名称、地址、商标或注册商标名称；

d.生产日期代码（可以包含在特定的序列号中）；

e.产品件号；

f.工厂代码（可以包含在特定的序列号中）；

g.层级，需符合国家标准 GB9745、美国轮胎轮辋协会（TRA）或欧洲轮胎轮辋技术组织（ETRTO）的相关规定。如果在轮胎上标识了层级，轮胎上标识的额定负荷必须与层级一致；

h.序列号，可包含工厂代码和生产日期代码；

i.规格和额定负荷，按最新版的 GB9745、TRA 或 ETRTO 航空轮胎和轮辋年鉴确定；

j.模型花纹沟深度，参照附录 A 的定义，以毫米或英寸表示，精确到最接近的 1/10 毫米或 1/100 英寸；

k.额定速度，参照附录 A 的 A4.b 条规定，以公里/小时或英里/小时表示，额定速度应小于或等于轮胎的鉴定速度；

l.轮胎类型，对有内胎的轮胎标识“Tube Type”字样；

m.不可翻新轮胎必须做出“不可翻新”的标识。

5.申请资料要求

申请人必须向局方提交相关技术资料以支持设计和生产批准。提交资料包括 CCAR-21 第 21.310 条（三）3 中规定的符合性声明和以下技术资料：

a. 规格；

b. 层级，如需要；

c. 轮胎额定速度；

d.额定负荷；

e.额定充气内压；

f.轮胎外直径尺寸；

g.轮胎断面宽尺寸；

h.模型花纹沟深度；

i.轮胎肩部直径和肩部断面宽尺寸；

j.额定负荷和额定内压下的名义负荷半径和允许公差；

k.额定负荷和额定内压下试验轮胎的使用负荷半径；

l.轮胎重量；

m.依据附录A4.c的胎体爆破压力；

n.轮胎静平衡差度；

o.轮辋规格尺寸；

p.产品件号；

q.额定内压下，1.5倍额定负荷时的负荷-下沉量曲线；

r.动力试验负荷-速度-时间参数曲线；

s.材料和工艺规范清单；

t.维护和保养说明：维护资料必须包括在役轮胎是否可用的判定标准。在采用特殊修补方法的维修信息中，应包括特殊的非破坏性检查手法和翻新程序。另外，根据CCAR-21第21.8条的规定，应向局方报告轮胎使用中影响航空安全的已知和潜在性问题。轮胎尺寸（外直径、肩部直径等）必须保持在GB9745、TRA、ETRTO规定的公差范围内；

u.限制：取得 CTSOA 的轮胎不能直接取得装机批准，需要进行更多的装机试验或分析才能取得装机批准。装机试验用来验证轮胎材料、设计和/或制造工艺更改后：

(1)轮胎基本力学性能的改变（如轮胎支撑路面的形式、轮胎印痕上的负荷分布以及扭矩和侧向力对起落架的传递），和

(2)对之前已确定的性能水平的影响（如操纵性和停机距离）；

v.包括下列声明的记录：

本设备取得 CTSOA 所需的条件和试验为最低性能标准。如欲将该设备安装于规定型号或类别的航空器上时，安装人有责任表明符合本 CTSO 标准的设备能够覆盖该航空器的使用情况。只有在获得局方的安装批准后，该设备方可装机。

6.制造人资料要求

除直接提交给局方的资料外，还应准备如下技术资料供适航部门评审：

a.鉴定样件符合 CTSO 标准的合格鉴定规范；

b.设备校准程序；

c.维护保养程序；

d.能显示轮胎断面关键特点的合适分辨率的示意图或照片；

e.材料和工艺规范。

7.随设备提交给用户的资料要求

如欲向一个机构（例如运营人或修理站）提交一件或多件按本CTSO 制造的设备，则应随设备提供本 CTSO 标准第 5.a、 b、 c、 d、e、 h、 j、 l、 o、 p 和 t 及 6.c 和 d 的资料副本，以及航空轮胎正确安装、使用和持续适航所必须的资料。

8.引用文件

a.GB9745 航空轮胎

b.TRA标准可以从以下地址邮购：

The Tire and Rim Association, Inc.

175 Montrose West Ave. ,Suite 150,Copley,Ohio 44321,USA

c. ETRTO标准可以从以下地址邮购：

The European Tyre and Rim Technical Organisation,

32/2, Avenue Brugmann B-1060 Brussels,Belgium

附录 A 航空轮胎的最低性能标准

A1. 目的

用于识别除尾轮轮胎外，符合CTSO-C62e标准的新的和重新鉴定的子午线轮胎和斜交轮胎的最低性能标准。

A2. 范围

最低性能标准适用于以额定速度和额定负荷作为轮胎试验速度和试验负荷的航空轮胎。

A3. 定义

斜交轮胎：胎体帘线由一个胎圈延伸到另一个胎圈、帘线与胎面中心线之间的角度大大地小于 90° 的充气轮胎，还有一种具有周向带束层的带束斜交胎。

子午线轮胎：胎体帘线由一个胎圈延伸到另一个胎圈，胎体帘线与胎面中心线之间的角度大体成 90° 、胎体用基本不伸张的周向带束层箍紧的充气轮胎。

额定负荷：规定充气内压条件下的最大允许静负荷。当为航空器选择适用的轮胎以及测试 CTSO 标准要求的性能时，使用额定充气内压下对应的额定负荷。

额定充气内压：以额定负荷将轮胎压向平板，轮胎下沉率达到规定静负荷半径时对应的无负荷充气内压。

静负荷半径（SLR）：轮胎充气至额定充气内压，将轮胎加载至额定负荷，其接地面到轮轴中心线之间的垂直距离。

层级：某一特定规格轮胎在额定充气内压和与该内压相应的最大额定负荷条件下的强度指数。

额定速度：按照 CTSO 标准规定进行试验时轮胎的最大地面速度。

模型花纹沟深度：在轮胎模型上测得的从轮胎胎面表面到最深的花纹沟底之间的距离。

A4. 设计和结构

a. 通用标准

为特定的航空器选择轮胎时必须通过本附录A5.a或A5.b规定的试验室模拟试验证明其适用性。按下列方法确定材料的适用性：

（1）温度

用试验或分析证明轮胎材料在不高于-40℃（－40℉）和不低于71℃（160℉）的温度下分别暴露至少24h后，其物理性能应不降级。

（2）轮辋生热

除低速轮胎和前轮轮胎按正常使用过程中预期出现的最高轮辋胎圈座温度条件进行试验或分析外，其余轮胎用适当的试验或分析证明在不低于 149℃（300℉）的轮辋-胎圈座温度条件下暴露至少 1h后，轮胎材料的物理性能不降级。

b. 额定速度

与最大地面起飞速度相对应的动力试验速度见表A1。

地面起飞速度大于394km/h(245mph)的轮胎，必须以最苛刻的负荷－速度－时间要求进行试验，并标出正确的额定速度。

表A1　动力试验速度

最大起飞速度，km/h(mph)		飞机和轮胎最大起飞速度，km/h(mph)	轮胎最小动力模拟试验速度，km/h(mph)（图A1、A2或A3）
大于	小于或等于		
0	193(120)	193(120)	193(120)
193(120)	257(160)	257(160)	257(160)
257(160)	306(190)	306(190)	306(190)
306(190)	338(210)	338(210)	338(210)

338(210)	362(225)	362(225)	362(225)
362(225)	378(235)	378(235)	378(235)
378(235)	394(245)	394(245)	394(245)

c．超压性能

轮胎必须在不少于 4 倍额定充气内压的水压下保持至少 3s 不爆破。

d．直升机轮胎

按本标准规定鉴定的轮胎可以用于直升机。当标准轮胎用于直升机时，最大额定静负荷可以增加到 1.5 倍，额定充气内压也相应地增加，而无需进行任何附加鉴定试验（负荷圆整至最接近的 0.5kN/10lbs，充气内压圆整至最接近的整数 10kPa/psi），这些指导原则不适用于预测滑行距离。标准轮胎用于直升机时，最大允许充气内压为标准轮胎额定充气内压的 1.8 倍。

e．尺寸

保持轮胎的尺寸（外直径、胎肩直径、断面宽和胎肩宽度）在规定的公差范围内。

（1）外直径、胎肩直径、断面宽和胎肩宽度

斜交轮胎的外直径和断面宽测量额定充气内压下膨胀 12h 后的最大值和最小值，胎肩直径和胎肩宽度测量额定充气内压下膨胀 12h 后的最大值。子午线轮胎只测定 A4.e.(3)（b）规定的静负荷半径对应的胀大尺寸。

（2）标准轮胎用于直升机时，由于允许充气内压增加，所以轮胎尺寸允许增大 4%。

（3）静负荷半径（SLR）：

（a）斜交轮胎

标准中给出名义静负荷半径。新胎的实际静负荷半径在额定充气内压下膨胀至少 12h 后的轮胎上测定。

（b）子午胎

标准中给出名义静负荷半径。子午胎的实际静负荷半径在额定充气内压下在经过 A5.a.(2)规定的 50 次起飞试验后的轮胎上测定。

（4）直升机轮胎

用于直升机的新轮胎最大尺寸比标准飞机轮胎的最大尺寸大 4%（计算最大外直径和胎肩直径乘以 4％的系数前，应先扣除轮辋直径）。

f. 气密性

轮胎充气至额定充气内压，经至少 12h 稳定后，再调整气压至额定充气内压，停放 24h，其充气内压下降率应不大于额定充气内压的 5％。应测定试验开始及结束时的环境温度，确保轮胎充气内压变化不是由环境温度变化引起的。

g. 平衡

所有轮胎应进行静平衡差度试验。平衡标志为红点，位于胎圈上部的胎侧，以指示轮胎的轻点部位；该标志应在轮胎的贮存保管期和原胎面寿命期内一直保留。

设计时应包括对每条轮胎进行静平衡差度测定的要求，以及必要时将静平衡差度修正至上述限度内的修正程序。

（1）辅助轮胎（非主轮或尾轮轮胎）

辅助轮胎的静平衡差度（静不平衡力矩）（M）应不超过公式（1）的计算值：

$$M＝0.00274\ D^2 \cdots\cdots\cdots\cdots\cdots\cdots\cdots\cdots\ (1)$$

式中：M——轮胎静平衡差度值，N·cm，向下圆整至临近的整数；

D——新轮胎的标准最大充气外直径，单位为 cm。

（用英制单位时，公式（1）为 $M＝0.025D^2$(in·oz) ）

（2)所有主轮胎及所有外直径大于或等于 1168mm(46in)的轮胎：

主轮胎的静平衡差度（M）应不超过公式（2）的计算值：

$$M=0.00383\ D^2 \quad (2)$$

式中：M——轮胎静平衡差度值，N·cm，向下圆整至临近的整数；

D——新轮胎的标准最大充气外直径，单位为cm。

（用英制单位时，公式（2）为 $M=0.035D^2$（in·oz））

A5. 轮胎试验要求

a. 用一条轮胎试样进行鉴定试验。

轮胎必须通过下列动力试验循环，除最后进行的超载起飞试验外(见 A5.a.(8)条规定)，轮胎不应出现除胎面正常磨耗以外的其他可见的损坏现象。

(1) 动力试验循环要求

所有的航空轮胎都必须完成 58 次动力试验循环，外加 3 次超载动力试验循环。58 次动力试验循环包括 A5.a.(2)规定的 50 次起飞循环和 A5.a.(7)规定的 8 次滑行循环。超载动力试验包括 A5.a.(7)规定的 2 次 1.2 倍额定负荷超载滑行循环和 A5.a.(8)规定的 1 次 1.5 倍额定负荷的超载起飞循环。试验顺序任选。如果超载起飞试验不放在最后，轮胎必须在超载起飞试验后不出现除正常胎面磨损外的其他可见损坏现象。

(2) 起飞试验

50 次起飞循环应真实地模拟飞机起飞重量、起飞速度和飞机重心达到最苛刻情况下在跑道上起飞时的轮胎性能。如有必要，确定上述试验条件时，必须对因高海拔和高环境温度引起的速度增加进行说明。应确定合适的轮胎试验曲线的负荷-速度-时间数据或参数。

试验曲线图见图 A1、图 A2 和图 A3。试验从速度为 0 时开始，对轮胎加载使之与试验飞轮接触。试验周期应当模拟图 A1、图 A2 或图 A3 规定的曲线之一。

图 A1 适用于额定速度为 193km/h(120mph)或 257 km/h (160 mph)的任意轮胎。

图 A2 适用于额定速度大于 257 km/h (160 mph)的任意轮胎。

图 A3 适用于由飞机给定最苛刻起飞负荷、速度和距离的任意额定速度的轮胎。

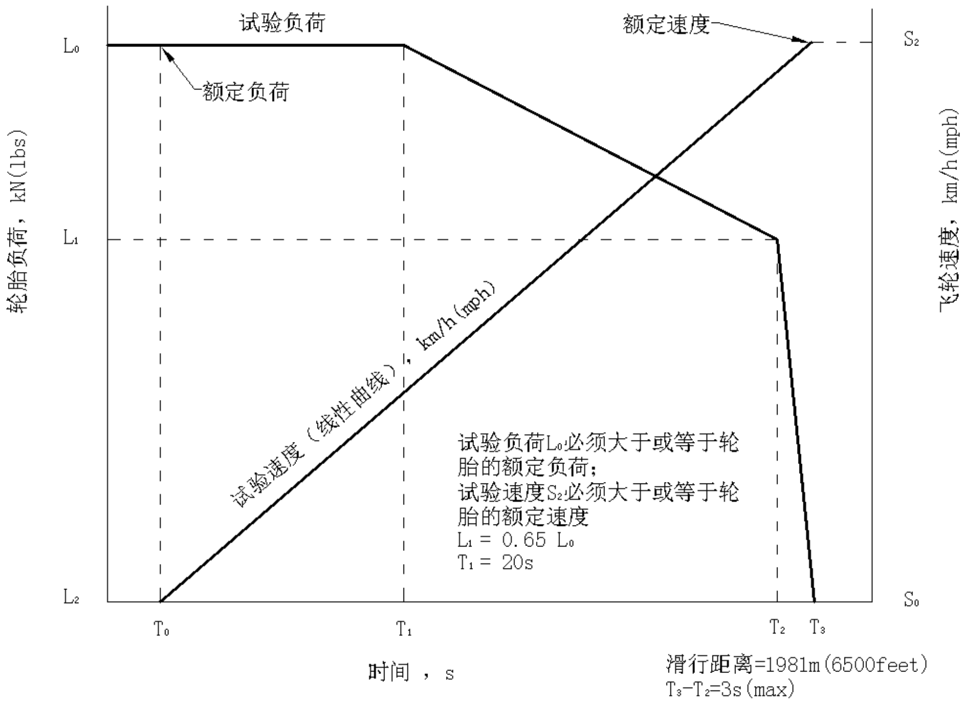


图 A1 通用负荷-速度-时间试验曲线图

（适用于额定速度为 193km/h(120mph)和 257 km/h (160 mph)的轮胎）

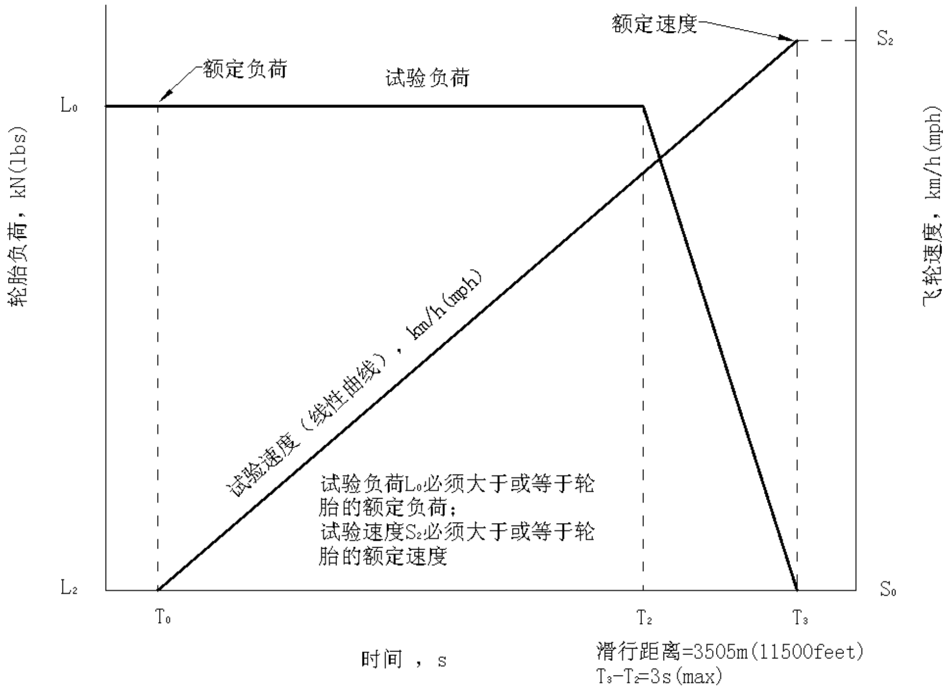


图 A2 通用负荷-速度-时间试验曲线图

（适用于额定速度大于 257 km/h (160 mph)的轮胎）

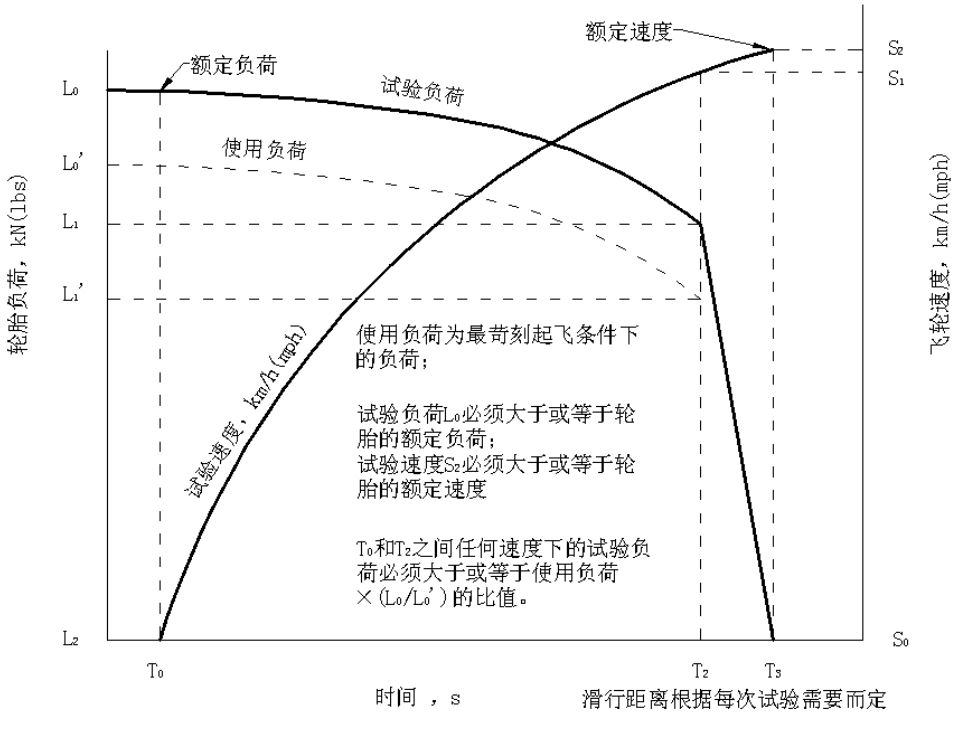


图 A3 合理的负荷-速度-时间试验曲线图

（适用于由飞机给定最苛刻起飞负荷、速度和距离的任意轮胎）

图 A1、A2、A3 符号定义：

L_0—— 起飞试验的起始轮胎负荷（不低于轮胎额定负荷，）,kN(lbs)，见图 A1、A2 和 A3；

L_0' ——按使用负荷曲线起飞试验的起始轮胎负荷,kN(lbs)，见图 A3；

L_1——轮胎在拐点处的负荷, kN(lbs)，见图 A1 和 A3；

L_1' ——轮胎负荷, kN(lbs)，见图 A3；

L_2——轮胎的离陆负荷，0 kN(lbs)，见图 A1、A2 和 A3；

S_0——轮胎零速度,km/h(mph)，见图 A1、A2 和 A3；

S_1——轮胎在拐点处的速度,km/h(mph)，见图 A3；

S_2——轮胎的离陆速度（不低于额定速度）,km/h(mph)，见图 A1、A2 和 A3；

T_0——起飞起始时间,s，见图 A1、A2 和 A3；

T_1——20s，见图 A1；

T_2——拐点时间,s，见图 A1、A2 和 A3；

T_3——离陆时间,s，见图 A1、A2 和 A3。

(3) 试验负荷

试验开始时的最小允许负荷为轮胎的额定负荷。试验负荷必须符合图 A1、图 A2 或图 A3，图 A1 和 A2 所代表的试验普遍适合于任何航空器。如果选用图 A3 所代表的试验，则必须根据申请人确定的最苛刻起飞条件选择负荷。在试验过程中的任何速度位置上，试验负荷与使用负荷之比应当大于或等于试验开始时的比率。

（4）试验充气内压

试验充气内压必须是使轮胎在试验飞轮上的负荷半径与轮胎在额定负荷和额定充气内压条件下在平板上的负荷半径相等的充气内压。上述两者的测量必须在相同的环境温度下进行。不得调整试验充气内压来补偿试验期间由于温度变化而引起的充气内压变化。

（5）试验温度和间隔时间

轮胎胎腔内的气体温度或胎体最热点的温度：

（a）超载起飞试验和 50 次起飞试验中至少 45 次在试验开始时不得低于 41℃（105℉）；

（b）10 次滑行试验中至少 9 次在试验开始时不得低于 49℃（120℉）。

其余试验次数，在试验开始时，轮胎胎腔内的气体温度或胎体温度不得低于 27℃（80℉）。允许用在试验飞轮上滚动轮胎的方法达到最低起始温度。

（6）动力试验起飞速度

与飞机最大起飞速度相对应的动力模拟试验速度见表 A1。

（7）滑行试验

轮胎必须按表 A2 列出的试验条件在动力试验台上通过 10 次滑行试验。

表 A2　试验条件

滑行次数	最小轮胎试验负荷 kN(lb)	最小试验速度，km/h(mph)	额定速度等于 193、257km/h (120、160mph) 的轮胎，最小滚动距离， m(ft)	额定速度大于 257km/h (160mph) 的轮胎，最小滚动距离，m(ft)
8	额定负荷	64.4(40)	7620(25000)	10668(35000)
2	1.2 倍额定负荷	64.4(40)	7620(25000)	10668(35000)

（8）超载起飞试验

除试验负荷增加到 1.5 倍额定负荷以外，超载起飞试验与 A5.a.(2)条规定的起飞试验完全一样。如果超载起飞安排在整套动力试验程序的最后，该试验完成后不要求胎面完好。如果超载起飞试验

不安排在整套动力试验程序的最后，该试验完成后轮胎不应出现除胎面正常磨耗以外的损坏现象。

（9）内压损失试验

在完成 61 次动力试验后，在 24h 内损失的轮胎内压必须在起始试验充气内压的 10％以内。应测定试验开始及结束时的环境温度，确保轮胎充气内压变化不是由环境温度变化引起的。

（10）轮胎／轮辋转位

在最初 5 次动力试验期间，轮胎不得在轮辋上滑动。在这之后的试验中出现的滑动现象不能损坏有内胎轮胎的内胎气门嘴，或无内胎轮胎胎圈的气密层。

b．额定速度为 193km/h(120mph)轮胎的替代鉴定试验程序

对于额定速度为 193km/h(120mph)的轮胎，可以使用以下可变质量飞轮程序进行试验：

（1）试验负荷

在动力试验的整个滚动距离内，负荷必须大于或等于轮胎额定负荷。

（2）试验充气内压

试验充气内压必须是使轮胎在试验飞轮上的负荷半径与轮胎在额定负荷和额定充气内压条件下在平板上的负荷半径相等时的充气内压。上述两者的测量必须在相同的环境温度下进行。不得调整试验充气内压来补偿试验期间由于温度变化而引起的充气内压变化。

（3）试验温度和间隔时间

在 200 次着陆试验中，至少有 180 次在试验开始时轮胎胎腔内的气体温度或胎体最热点的温度不得低于 41℃(105℉)；其余 20 次在试验开始时，该温度不得低于 27℃(80℉)。允许用在试验飞轮上滚动轮胎的方法达到最低起始温度。

（4）动能

轮胎吸收的飞轮动能按公式（3）计算：

$$KE=CWV^2 \quad \cdots\cdots\cdots\cdots\cdots\cdots\cdots\cdots \text{（3）}$$

国际单位制时，式中：

KE——动能，J；

C——0.00513；

W——轮胎额定负荷，kg；

V——193km/h

英制时，式中：

KE——动能，ft·lb；

C——0.0113；

W——轮胎额定负荷，lbs；

V——120mph

（5）动力试验次数

轮胎必须在可变质量的飞轮上通过200次着陆试验。不能用实际的飞轮片数获得计算动能时，可选用更多的飞轮片数，并调整动力试验速度来获得要求的动能。整个着陆试验次数可以分成A5.b.(5)(a)和A5.b.(5).(b)两组。

（a）低速着陆

第一组100次着陆，最大着陆速度为145km/h(90mph)，最小完成着陆速度为0km/h(mph)。调整着陆速度，以使轮胎吸收按以上A5.b.(4)公式计算动能的56％。如经计算调整后的着陆速度小于129km/h(80mph)，则必须作如下处理：用103km/h(64mph)时的飞轮动能加上按A5.b.(4)公式计算所得的动能的28％来确定着陆速度；用103km/h(64mph)时的飞轮动能减去按A5.b.(4)公式计算所得的动能的28％来确定完成着陆速度。

（b）高速着陆

第二组100次着陆，最小着陆速度为193km/h(120mph)，名义完

成着陆速度为 145km/h(90mph)。调整完成着陆速度，以便使按 A5.b.(4)公式计算所得的动能的 44%被轮胎吸收。

A6. 重新鉴定试验

a．材料、设计和／或制造工艺发生有可能对其性能和可靠性产生不利影响的变化,更改后的轮胎必须按 A5 规定的动力试验要求进行重新鉴定试验。包括下述示例中的（1）、（2），或两者都包括：

（1）胎体结构改变，例如帘线根数和/或胎圈钢丝根数、胎体帘布构造（例如材料、旦数、股数等)、轮胎结构形式（例如子午线、斜交等);

（2)胎面结构改变,例如胎面补强层和／或保护层的构造或数目、胎面胶料配方、胎面花纹沟的位置和数目、增加花纹沟深度。

b．相似性重新鉴定（以额定负荷为基准）

一个给定额定负荷的轮胎因材料或胎面设计更改重新鉴定合格后，与该轮胎规格、额定速度和花纹沟相同但负荷较低的轮胎进行相同的更改，无需重新鉴定而自动取得合格资格的条件是：

（1）该较低额定负荷的轮胎已按本 CTSO 标准规定的相应要求鉴定合格，并且，

（2）在任何给定试验条件下，该较低额定负荷轮胎的合格鉴定试验负荷与其额定负荷的比值不大于较高额定负荷轮胎的该比值。

c．相似性重新鉴定（覆盖式更改）

影响到所有规格轮胎的任何更改，其相似性重新鉴定合格的条件是：

（1）包含最高额定负荷、额定速度和角速度的 5 个有代表性的规格更改后，按本标准的最低性能标准鉴定合格，并且，

（2）将轮胎规格清单中轮胎更改的支持数据提交至局方。

Department of Transportation
Federal Aviation Administration
Aircraft Certification Service
Washington, D.C.

TSO-C62e

Effective
Date: 09/29/06

Technical Standard Order

Subject: AIRCRAFT TIRES

1. PURPOSE. This technical standard order (TSO) is for manufacturers applying for a TSO authorization (TSOA) or letter of design approval (LODA). In it, we (the Federal Aviation Administration, or FAA) tell you what minimum performance standards (MPS) your aircraft tires, excluding tailwheel tires, must meet before their approval and identification with the applicable TSO marking.

2. APPLICABILITY. This TSO affects new applications submitted after its effective date.

a. All prior revisions to this TSO are no longer effective. Generally we will not accept applications after the effective date of this TSO. However, we may do so up to six months after this approval date, if we know that you were working against the earlier MPS before the new change became effective.

b. Aircraft tires approved under a previous TSO/LODA may still be manufactured under the provisions of their original approval.

c. Major design changes to aircraft tires approved under this TSO will require a new authorization. See Title 14 of the Code of Federal Regulations (14 CFR) § 21.611(b).

d. Previously Approved Articles.

(1) Notwithstanding 14 CFR § 21.603(a) and the terms of any specific previous TSO approval, after December 31, 1982, you may not identify or mark a tire having a speed rating above 160 mph with TSO numbers TSO-C62, TSO-C62a, or TSO-C62b. Further, you may not manufacture a tire having a special rating above 160 mph approved before December 31, 1979, under its original approval.

(2) You can continue to manufacture tires, except for those specified in paragraph **2.d.(1)** above, under their original approval.

3. REQUIREMENTS.

a. New models of aircraft tires identified and manufactured on or after the effective date of this TSO must meet the MPS qualification and documentation requirements in appendix 1 of this TSO.

b. Deviations. We have provisions for using alternate or equivalent means of compliance to the criteria in the MPS of this TSO. If you invoke these provisions, you must show that your equipment maintains an equivalent level of safety. Apply for a deviation under 14 CFR § 21.609 before submitting your data package.

4. MARKING. Instead of the marking requirements of 14 CFR § 21.607(d), mark tires manufactured under this TSO legibly and permanently with the following:

a. Applicable TSO number.

b. Balance marker, consisting of a red dot, on the sidewall of the tire immediately above the bead to indicate the lightweight point of the tire.

c. Brand name and the name, or registered trademark, of the manufacturer responsible for compliance.

d. Production date code (may be included in the established serial number).

e. Part number.

f. Plant code: the tire may have the manufacturer's country code instead of the plant code on the sidewall if only one manufacturing plant exists within the country. Codes may also be encoded in the serial number.

g. Ply rating must be established. Submit these ratings to the Tire and Rim Association, Inc. (TRA) or European Tyre and Rim Technical Organization (ETRTO). If the ply rating is marked on the tire, the load rating marked on the tire must be consistent with the ply rating established.

> **NOTE:** for a new program aircraft, define new tire dimensions and submit them to TRA for publication in the TRA Data Book. You do not have to wait until your submitted dimensions are incorporated into the Data Book before applying for the TSO.

h. Serial number: the plant code and production date code may be included.

i. Size and load ratings, established and identified in a timely manner in the TRA *Aircraft Year Book*, latest edition or in the ETRTO *Aircraft Tyre and Rim Data Book*, latest revision. See the NOTE at paragraph **4.g.**

j. Skid depth, marked in inches to the nearest one-hundredth as defined in appendix 1.

k. Speed rating, in MPH and as identified in appendix 1, paragraph 4.b that is equal to or less than the speed at which the tire has been qualified.

l. Tire type. Mark tires requiring a tube with the words "Tube type."

m. Non-re-treadable tires must be marked accordingly.

5. <u>APPLICATION DATA REQUIREMENTS</u>. As a TSO manufacturer-applicant, you must give the FAA aircraft certification office (ACO) manager responsible for your facilities, a statement of conformance, as specified 14 CFR § 21.605(a)(1) and one copy each of the following technical data to support our design and production approval. (Under 14 CFR § 21.617(a)(2), LODA applicants submit the same data through their civil aviation authority:)

a. Size.

b. Ply rating, if specified.

c. Tire speed rating.

d. Load rating.

e. Rated inflation pressure.

f. Tire outside diameter measurement.

g. Tire section width measurement.

h. Skid depth.

i. Tire shoulder diameter and shoulder width measurement or envelope drawing. See the NOTE at paragraph **4.g**.

j. Nominal loaded radius at rated load and inflation pressure and permissible tolerance on the nominal loaded radius.

k. Actual loaded radius of the test tire at rated load and inflation pressure.

l. Weight of tire.

m. Casing burst pressure per appendix 1, paragraph 4.c.

n. Test tire static unbalance.

o. Wheel rim size designation.

p. Tire manufacturer part number.

q. Load deflection curve at loads up to 1.5 times the load rating at rated pressure.

r. Summary of the load-speed-time parameters used in the dynamometer tests.

s. Material and process specifications list.

t. Care and maintenance instructions. The maintenance data must include inspection criteria for the new tire to determine eligibility for in-service tires to remain in operation. Include special nondestructive inspection techniques and re-treading procedures, if applicable, in the maintenance information with any special repair methods applicable to the tire. Further, following 14 CFR § 21.3, notify us of known or potential problems with in-service tires that affect aviation safety. Tire size (outside diameter, shoulder diameter, etc.) must be maintained within tolerances set by TRA or ETRTO.

u. Limitations. TSO approval does not automatically constitute authority to install and use the tire on an aircraft. We may require further aircraft testing or analysis to approve installing a re-qualified tire (with a new part number) on an aircraft. Such aircraft tests would be appropriate to substantiate changes in tire materials, design and/or manufacturing processes that could:

(1) Alter the basic mechanics of the tire (such as the way the tire supports the load, distributes the load in the footprint, and transmits torsional and lateral forces to the landing gear structure), and

(2) Affect previously established performance levels (such as handling and stopping distance). For example, we require additional aircraft tests to substantiate changes that affect the casing construction, identified in appendix 1, paragraph 6.

v. Include a note with the following statement:

> The conditions and tests for TSO approval of this article are minimum performance standards. Those installing this article, on or within a specific type or class of aircraft, must determine that the aircraft operates under conditions within the TSO standards. TSO articles must have separate approval for installation in an aircraft. The article may be installed only according to 14 CFR part 43 or the applicable airworthiness requirements.

6. MANUFACTURER DATA REQUIREMENTS. Besides the data given directly to us, have the following technical data available for review by the responsible ACO or civil aviation authority:

a. Functional qualification specifications for qualifying each production article to ensure compliance with this TSO.

b. Equipment calibration procedures.

c. Corrective maintenance procedures.

d. Schematic drawings or a photograph with a resolution suitable for identifying key characteristics of the tire cross-section.

e. Material and process specifications.

7. FURNISHED DATA REQUIREMENTS. If furnishing one or more tires manufactured under this TSO to one entity (such as an operator or repair station), provide one copy of the data in paragraphs **5.a, b, c, d, e, h, j, l, o, p and t** and **6.c and d** of this TSO for each tire. Add any other data needed for the proper installation, certification, use, or for continued airworthiness, of the aircraft tires.

8. HOW TO GET REFERENCED DOCUMENTS.

a. Order copies of 14 CFR Part 21, Subpart O, from the Superintendent of Documents, Government Printing Office, P.O. Box 37154, Pittsburgh PA 15250-7954. Telephone (202) 512-1800, fax (202) 512-2250. You can also order copies online at www.access.gpo.gov. Select "Access," then "Online Bookstore."

b. You can find a current list of technical standard orders on the FAA Internet website Regulatory and Guidance Library at www.airweb.faa.gov/rgl. You will also find the TSO Index of Articles at the same site.

c. Order TRA yearbooks and other publications from the Tire and Rim Association Inc., 175 Montrose West Avenue, Suite 150, Copely, Ohio 44321. Telephone (330) 666-8121. You can also order online at:http://www.us-tra.org.

d. Order the ETRTO standards manual and other documents from the European Tyre and Rim Technical Organisation, 32/2 Avenue Brugmann B-1060, Brussels, Belgium. Telephone 011-32-2-344-40-59. You can also contact the organization at www.etrto.org for instructions on how to order publications.

/s/ Susan J. M. Cabler

Susan J. M. Cabler
Acting Manager, Aircraft Engineering Division
Aircraft Certification Service

APPENDIX 1. FAA STANDARD FOR AIRCRAFT TIRES

1. PURPOSE. Minimum performance standards for new and re-qualified radial and bias tires, excluding tailwheel tires, to be identified as meeting the standards of TSO-C62e.

2. SCOPE. Minimum performance standards apply to aircraft tires having speed and load ratings based on the speeds and loads to which the tires have been tested.

3. DEFINITIONS.

Bias tire: a pneumatic tire whose ply cords extend to the beads and are laid at alternate angles substantially less than 90º to the centerline of the tread. May also have a bias belted tire with a circumferential belt.

Radial tire: a pneumatic tire whose ply cords extend to the beads and are laid substantially at 90º to the centerline of the tread, the carcass being stabilized by an essentially inextensible circumferential belt.

Load rating: maximum permissible static load at a specific inflation pressure. Use the rated load combined with the rated inflation pressure when selecting tires for application to an aircraft, and for testing to the performance requirements of this TSO.

Rated inflation pressure: Specified unloaded inflation pressure which will result in the tire deflecting to the specified static loaded radius when loaded to its rated load against a flat surface.

Static loaded radius (SLR): perpendicular distance between the axle centerline and a flat surface for a tire initially inflated to the unloaded rated inflation pressure and then loaded to its rated load.

Ply rating: an index of tire strength from which a rated inflation pressure and its corresponding maximum load rating are determined for a specific tire size.

Speed rating: maximum ground speed at which the tire has been tested in accordance with this TSO.

Skid depth: distance between the tread surface and the bottom of the deepest groove as measured in the mold.

APPENDIX 1. FAA STANDARD FOR AIRCRAFT TIRES, continued

4. DESIGN AND CONSTRUCTION.

a. General Standards. Tires selected for use on a specific aircraft must demonstrate suitability through appropriate laboratory simulations described in paragraphs **5.a** or **5.b**, this appendix, as appropriate. Determine material suitability by:

(1) Temperature: show by tests or analysis that the physical properties of the tire materials are not degraded by exposure to temperature extremes of -40ºF and +160ºF for a period of not less than 24 hours at each extreme.

(2) Wheel rim heat: substantiate by the applicable tests or show by analysis that the physical properties of the tire materials have not been degraded by exposure of the tire to a wheel-bead seat temperature of not lower that 300°F for at least 1 hour, except that low-speed tires or nose-wheel tires may be tested or analyzed at the highest wheel-bead seat temperatures expected to be encountered during normal operations.

b. Speed Rating. See Table 1 below for applicable dynamometer test speeds for corresponding maximum takeoff ground speeds. For takeoff speeds over 245 mph, the tire must be tested to the maximum applicable load-speed-time requirements and identified with the proper speed rating.

TABLE 1. Applicable Dynamometer Test Speeds

Max Takeoff Speed *Mph at liftoff over:*	*But not over:*	Max takeoff Speed Of Aircraft *Max Tire mph:*	Min Dynamometer Speed (Figures 1, 2 or 3) *Min Tire mph*:
0	120	120	120
120	160	160	160
160	190	190	190
190	210	210	210
210	225	225	225
225	235	235	235
235	245	245	245

c. Overpressure. The tire must successfully withstand a hydrostatic pressure of at least four times its rated inflation pressure for 3 seconds without bursting.

d. Helicopter tires. You may use aircraft tires qualified according to this TSO on helicopters. In such cases for standard tires, you may increase the maximum static load rating

APPENDIX 1. FAA STANDARD FOR AIRCRAFT TIRES, continued

4.d. <u>DESIGN AND CONSTRUCTION,</u> continued

by a factor of 1.5 with a corresponding increase in rated inflation pressure without additional qualification testing (round loads to the nearest 10 lbs and inflation pressures to the nearest whole psi.). If significant taxi distance is expected, these guidelines may not apply. Consult tire and rim manufacturers for appropriate tire size selection. Maximum permissible inflation for aircraft tires used on helicopters is 1.8 times the rated inflation pressure.

e. Dimensions. Maintain the tire size (outside diameter, shoulder diameter, section and shoulder width), within specified tolerances.

> **NOTE:** for a new program aircraft, define new tire dimensions and submit them to TRA for publication in the TRA Data Book. You do not have to wait until your submitted dimensions are incorporated into the Data Book before applying for the TSO.

(1) Outside diameter, shoulder diameter, section width and shoulder width: For the bias ply tire, outside diameter and section width are specified to a maximum and minimum value after a 12 hour growth period at rated inflation pressure. Shoulder diameter and width dimensions are specified to a maximum value after a 12-hour growth period at rated inflation pressure. Radial tire dimensions are limited by the grown tire envelope according to the static loaded radius (SLR) requirements in paragraph **4.e.(3)** below.

(2) Due to the increased inflation pressures permitted when using an aircraft tire in a helicopter application, we permit tire dimensions to be 4% larger.

(3) Static loaded radius (SLR):

(a) Bias tires: provide the nominal SLR. The actual SLR is determined on a new tire stretched for a minimum of 12 hours at rated inflation pressure.

(b) Radial tires: provide the nominal SLR. The actual SLR of a radial tire is determined at rated inflation pressure after running 50 takeoffs, following paragraph **5.a.(2)** requirements.

(4) Helicopter tires: maximum dimensions for new tires used on helicopters are 4% larger than maximum aircraft tire dimensions. (In calculating maximum overall and shoulder diameters, rim diameter should be deducted before applying 4%.)

f. Inflation retention. After an initial 12-hour minimum stabilization period at rated inflation pressure, the tire must retain the inflation pressure with a loss of pressure not exceeding 5% of

APPENDIX 1. FAA STANDARD FOR AIRCRAFT TIRES, continued

4.f. <u>DESIGN AND CONSTRUCTION,</u> continued

the initial pressure for 24 hours. Measure the ambient temperature at the start and finish of the test to ensure that any pressure change was not caused by an ambient temperature change.

g. Balance. Test all tires for static unbalance. A balance marker, consisting of a red dot, must be affixed on the sidewall of the tire immediately above the bead to indicate the lightweight point of the tire. The dot must remain for any period of storage plus the original tread life of the tire.

(1) Auxiliary tires (not main or tailwheel tires): the moment of static unbalance (M) for auxiliary tires shall not be greater than the value determined using this equation:

$$M = 0.025D^2$$

Round the computed equation values to the next lower whole number where M is in inch-ounces and D is the standardized maximum new tire inflated outside diameter in inches. Your design must include requirements to measure the level of unbalance on each tire, and approved procedures to correct the unbalance within the above limits if necessary.

(2) All main tires and all tires with 46-inch and larger outside diameter: the moment of static unbalance (M) for main tires shall not be greater than the value determined using this equation:

$$M = 0.035D^2$$

Round the computed equation values to the next lower whole number where M is in inch-ounces and D is the standardized maximum new tire inflated outside diameter in inches. Your design must include requirements to measure the level of unbalance on each tire, and approved procedures to correct the unbalance within the above limits if necessary.

5. <u>TIRE TEST REQUIREMENTS</u>.

a. Use a single test specimen for a qualification test. The tire must withstand the following dynamometer cycles without detectable signs of deterioration, other than normal expected tread surface abrasion, except when the overload takeoff condition is run last (see paragraph **5.a.(8)** below).

(1) Dynamometer cycle requirements: all aircraft tires must satisfactorily withstand 58 dynamometer cycles as a demonstration of overall performance, plus 3 overload dynamometer cycles as a demonstration of the casing's capability under overload. The 58 dynamometer cycles consists of 50 takeoff cycles, per **5.a.(2)**, and 8 taxi cycles, per **5.a.(7)**. The overload cycles consist of 2 taxi cycles, per **5.a.(7)** at 1.2 times rated load and 1 overload takeoff cycle per **5.a.(8)** starting at 1.5 times rated load. Run the dynamometer cycles in any order. However, if the overload takeoff cycle is not run last, the tire must not show detectable signs of deterioration after the cycle completion, other than normal expected tread surface abrasion.

APPENDIX 1. FAA STANDARD FOR AIRCRAFT TIRES, continued

5.a. <u>TIRE TEST REQUIREMENTS,</u> continued

(2) Takeoff cycles: the 50 takeoff cycles shall realistically simulate tire performance during runway operations for the most critical combination of takeoff weight and speed, and aircraft center-of-gravity position. When determining the most critical combination of the above, be sure to account for increased speeds resulting from high field elevation operations and high ambient temperatures, if applicable. Specify the appropriate load-speed-time data or parameters that correspond to the test envelope in which the tire is to be tested. Figures 1, 2, and 3 are graphic representations of the test. Starting at zero speed, load the tire against the dynamometer flywheel. The test cycles must simulate one of the curves illustrated in Figure 1 or 2 (as applicable to speed rating), or Figure 3.

- Figure 1 defines a test cycle that applies to any aircraft tire with a speed rating of 120 mph or 160 mph.

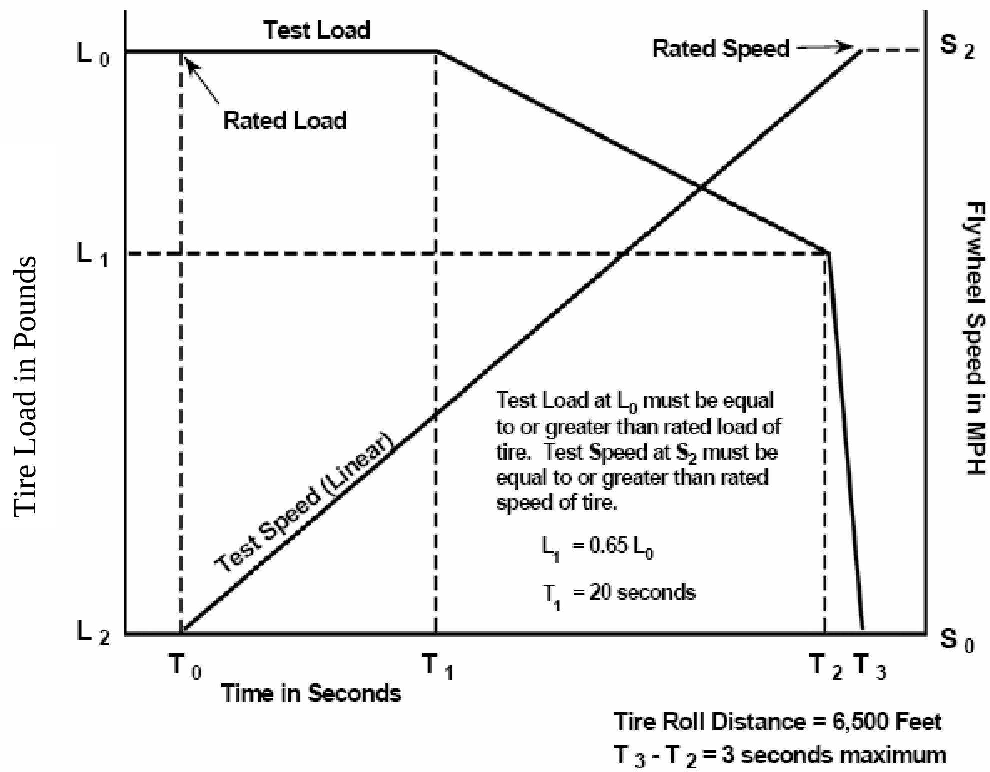
- Figure 2 defines a test cycle that applies to any aircraft tire with a speed rating greater than 160 mph.

- Figure 3 defines a test cycle that applies for any speed rating, is based on the most critical takeoff loads, speeds, and distances, and is aircraft specific.

APPENDIX 1. FAA STANDARD FOR AIRCRAFT TIRES, continued

5.a.(2) <u>TIRE TEST REQUIREMENTS,</u> continued

Figure 1
Graphic Representation of a Typical Universal Load-Speed-Time Test Cycle
(For 120 MPH and 160 MPH Tires)



APPENDIX 1. FAA STANDARD FOR AIRCRAFT TIRES, continued

5.a.(2) TIRE TEST REQUIREMENTS, continued

Symbol Definitions (Figures 1, 2, and 3):

L_0 Tire load (lbs) at start of takeoff (not less than the load rating), Figures 1, 2, and 3.

L_0^1 Tire load (lbs) at start of takeoff for the operational load curve, Figure 3.

L_1 Tire load (lbs) at rotation, Figures 1 and 3.

L_1^1 Tire load (lbs), Figure 3.

L_2 Tire load at liftoff, 0 lbs, Figures 1, 2, and 3.

S_0 Zero (0) mph, Figures 1, 2, and 3.

S_1 Speed at rotation in mph, Figure 3.

S_2 Tire speed at liftoff in mph (not less than the speed rating), Figures 1, 2, and 3.

T_0 Time at start of takeoff, 0 s, Figures 1, 2, and 3.

T_1 20 seconds, Figure 1.

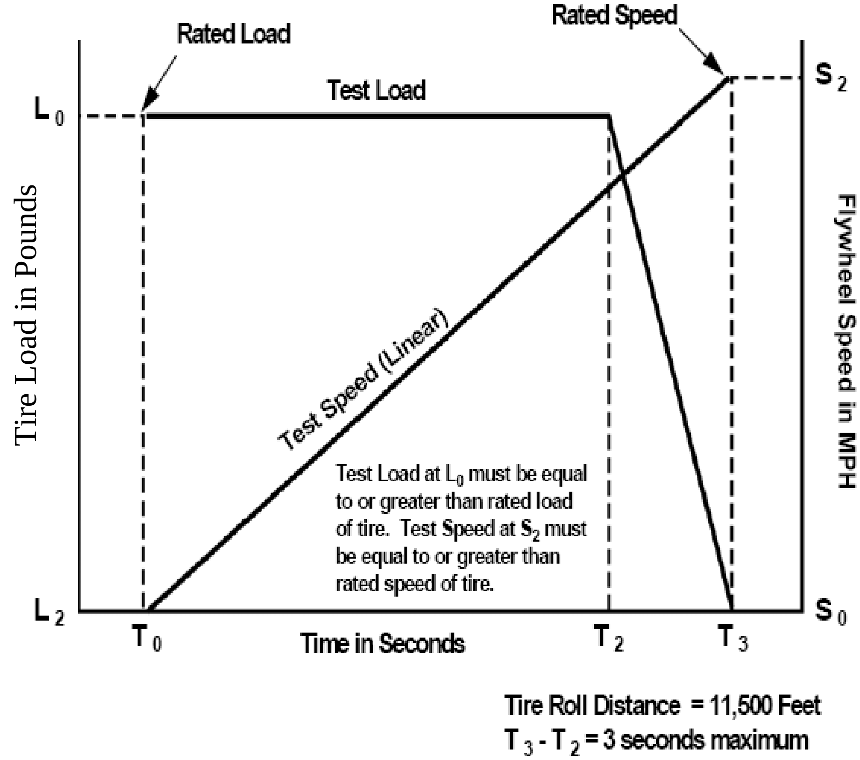
T_2 Time to rotation in seconds, Figures 1, 2, and 3.

T_3 Time to liftoff in seconds, Figures 1, 2, and 3.

APPENDIX 1. FAA STANDARD FOR AIRCRAFT TIRES, continued

5.a.(2) <u>TIRE TEST REQUIREMENTS,</u> continued

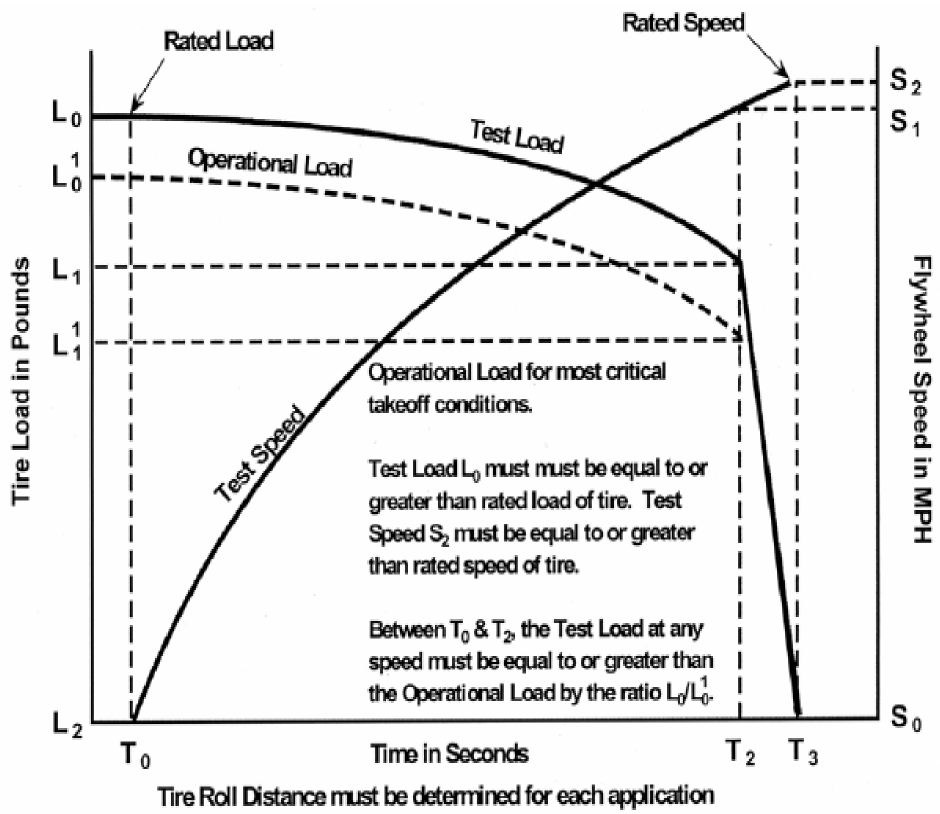
Figure 2
Graphic Representation of a Typical Universal Load-Speed-Time Test Cycle
(For Tires Rated above 160 MPH)



APPENDIX 1. FAA STANDARD FOR AIRCRAFT TIRES, continued

5.a.(2) TIRE TEST REQUIREMENTS, continued

Figure 3
Graphic Representation of a Typical Rational Load-Speed-Time Test Cycle



APPENDIX 1. FAA STANDARD FOR AIRCRAFT TIRES, continued

5.a. <u>TIRE TEST REQUIREMENTS,</u> continued

(3) Test load: the minimum allowable load at the start of the test is the rated load of the tire. The test loads must conform to Figures 1 or 2 (as applicable), or Figure 3. Figures 1 and 2 define a test cycle generally applicable to any aircraft. If you use Figure 3 to define the test cycle, select the loads based on the most critical takeoff conditions you established. At any speed throughout the test cycle, the ratio of the test load to the operational load must be the same as, or greater than, the ratio at the start of the test.

(4) Test inflation pressure: the pressure needed to provide the same loaded radius on the flywheel as was obtained on a flat surface at the rated tire load and inflation pressure. Make both determinations at the same ambient temperature. Do not adjust the test inflation pressure to compensate for changes created by temperature variations during the test.

(5) Test temperatures and cycle interval: the temperature of the gas in the tire or the casing temperature measured at the hottest point of the tire may not be:

(a) Lower than 105ºF at the start of the overload takeoff cycle and at the start of at least 45 of the 50 takeoff cycles, and

(b) Lower than 120ºF at the start of at least 9 of the 10 taxi cycles.

For the remaining cycles, the contained gas or casing temperature may not be lower than 80ºF at the start of each cycle. Rolling the tire on the dynamometer flywheel is an acceptable method for obtaining the minimum starting temperature.

(6) Dynamometer takeoff cycle speeds: see Table 1 for the dynamometer test speeds for the corresponding maximum aircraft takeoff speeds.

(7) Taxi cycles: tire must withstand 10 taxi cycles on a dynamometer under the test conditions in Table 2 below.

TABLE 2. Test Conditions

Number of Taxi Runs	Min Tire Load (lbs)	Min Speed (mph)	Tire speed rating 120/160 mph Min Rolling Distance (ft)	Tire speed rating Over 160 mph Min Rolling Distance (ft)
8	Rated	40	25,000	35,000
2	1.2 x Rated	40	25,000	35,000

APPENDIX 1. FAA STANDARD FOR AIRCRAFT TIRES, continued

5.a. <u>TIRE TEST REQUIREMENTS,</u> continued

(8) Overload takeoff cycle: the overload takeoff cycle shall duplicate the test described in paragraph **5.a.(2)** with the test load increased by a factor of 1.5 throughout. Good condition of the tire tread is not required after completion of this test cycle, if you run this test last. If the overload takeoff cycle is not run last, the tire must withstand the cycle without detectable signs of deterioration, other than normal expected tread surface abrasion.

(9) Diffusion test: after completing the 61 test cycles, the tire must retain the inflation pressure to within 10% of the initial test pressure for a period of 24 hours. Measure the ambient temperature at the start and finish of this test to ensure that any pressure change was not caused by an ambient temperature change.

(10) Tire/wheel slippage: tires should not slip on the wheel rim during the first five dynamometer cycles. Any slippage that subsequently occurs must not damage the tube valve of tube type tires, or the gas seal of the tire bead of tubeless tires.

b. Alternate qualification procedures: 120 mph rated tires. For 120 mph speed rating tires, you may use the following variable mass flywheel procedure:

(1) Test load: load must meet or exceed the tire rated load throughout the entire test roll distance.

(2) Test inflation pressure: pressure needed to provide the same loaded radius on the flywheel as was obtained on a flat surface at the rated tire load and inflation pressure. Make both determinations at the same ambient temperature. Do not adjust the test inflation pressure to compensate for changes created by temperature variations during the test.

(3) Temperature and cycle interval: the temperature of the gas in the tire, or the casing temperature measured at the hottest point of the tire, may not be lower than 105ºF at the start of at least 180 of the 200 landing cycles. For the remaining cycles, the contained gas or casing temperature may not be lower than 80ºF at the start of each cycle. Rolling the tire on the dynamometer is an acceptable method for obtaining the minimum starting temperature.

(4) Kinetic energy: calculate the kinetic energy of the flywheel to be absorbed by the tire using this equation:

$$KE = CW(V^2) = \text{Kinetic energy (ft-lbs)}$$

where
C = 0.0113
W = Load rating of the tire (lbs)
V = 120 mph

APPENDIX 1. FAA STANDARD FOR AIRCRAFT TIRES, continued

5.b. TIRE TEST REQUIREMENTS, continued

(5) Dynamometer cycle requirements: tire must satisfactorily withstand 200 landing cycles on a variable mass dynamometer flywheel. If you cannot use the exact number of flywheel plates to obtain the calculated kinetic energy value, select a greater number of plates and adjust the dynamometer speed to obtain the required kinetic energy. Divide the total number of dynamometer landings into two equal parts having the speed ranges provided in paragraphs **5.b.(5)(a)** and **5.b.(5)(b)**.

(a) Low speed landings: in the first series of 100 landings, the maximum landing speed is 90 mph and the minimum unlanding speed is 0 mph. Adjust the landing speed so the tire will absorb 56% of the kinetic energy calculated using the equation in paragraph **5.b.(4)** above. If the adjusted landing speed is calculated to be less than 80 mph, then determine the landing speed by adding 28% of the calculated kinetic energy (see paragraph **5.b.(4)** above) to the flywheel kinetic energy at 64 mph, and determine the unlanding speed by subtracting 28% of the calculated kinetic energy from the flywheel kinetic energy at 64 mph.

(b) High speed landings: in the second series of 100 landings, the minimum landing speed is 120 mph and the nominal unlanding speed is 90 mph. Adjust the unlanding speed as needed to ensure that the tire will absorb 44% of the calculated kinetic energy (see paragraph **5.b.(4)** above).

6. REQUALIFICATION TESTS.

a. Re-qualify altered tires, with changes in materials, design and/or manufacturing processes that could adversely affect the performance and reliability, to the dynamometer tests described under paragraph **5**. Some examples include **(1)** or **(2)** below, or both:

(1) Changes in casing construction, such as the number of plies and/or bead bundles, ply cord makeup (material, denier, number of strands) and configuration (radial and bias).

(2) Changes in tread construction, such as number or composition of tread reinforcing and/or protector plies, tread compound formulations, number and location of tread grooves, and an increase in skid depth.

b. Re-qualification by similarity (based on load rating). Re-qualifying a given load rated tire due to a change in material or tread design, automatically qualifies the same changes in a lesser load tire of the same size, speed rating, and skid depth, if:

(1) The lesser load rated tire was qualified to the applicable requirements specified in this TSO, and

APPENDIX 1. FAA STANDARD FOR AIRCRAFT TIRES, continued

6.b. <u>REQUALIFICATION TESTS,</u> continued

(2) The ratio of qualification test load to rated load for the lesser load rated tire does not exceed the same ratio to the higher load rated tire at any given test condition.

c. Re-qualification by similarity (blanket change). You can gain re-qualification of any change that affects all sizes by similarity, if:

(1) Five representative sizes, including tires of the highest load rating, speed rating and angular velocity, were qualified to the minimum performance standard with the change, and

(2) You submit data supporting the change in the listed sizes to the appropriate FAA approving office.