AEROSPACE RECOMMENDED PRACTICE

ARP4834	REV. A

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Superseding ARP4834

(R) Aircraft Tire Retreading Practice - Bias and Radial

RATIONALE

ARP4834A has been reaffirmed to comply with the SAE five-year review policy.

1. SCOPE

This SAE Aerospace Recommended Practice (ARP) sets forth criteria for the selection, inspection, retread and repair of worn civil aircraft tires, and the means to verify that the retreaded tire is suitable for continued service. This document is applicable to both bias ply and radial aircraft tires qualified subsequent to the adoption of this document.

1.1 Purpose

This document sets forth the minimum recommended requirements for retreaded tires used on civil aircraft. It also provides criteria for the escalation of retread level of tires used on civil aircraft. The combined recommendations contained in this document form an acceptable practice, but not the only practice, for retreaded aircraft tires.

2. REFERENCES

2.1 Applicable Documents

The following publications form a part of this document to the extent specified herein. The latest issue of SAE publications shall apply. The applicable issue of other publications shall be the issue in effect on the date of the purchase order. In the event of conflict between the text of this document and references cited herein, the text of this document takes precedence. Nothing in this document, however, supersedes applicable laws and regulations unless a specific exemption has been obtained.

2.1.1 SAE Publications

Available from SAE International, 400 Commonwealth Drive, Warrendale, PA 15096-0001, Tel: 877-606-7323 (inside USA and Canada) or 724-776-4970 (outside USA), www.sae.org.

AS4833 Aircraft New Tire Standard - Bias and Radial

TO PLACE A DOCUMENT ORDER: **Tel: 877-606-7323 (inside USA and Canada)**
Tel: +1 724-776-4970 (outside USA)
Fax: 724-776-0790
Email: CustomerService@sae.org
SAE WEB ADDRESS: **http://www.sae.org**

SAE values your input. To provide feedback on this Technical Report, please visit
http://www.sae.org/technical/standards/ARP4834A

2.1.2 ASTM Publications:

Available from ASTM International, 100 Barr Harbor Drive, P.O. Box C700, West Conshohocken, PA 19428-2959, Tel: 610-832-9585, www.astm.org.

ASTM D 413 American Society for Testing and Materials - Rubber Property: Adhesion to Flexible Substrate

2.1.3 FAA Publications

Available from Federal Aviation Administration, 800 Independence Avenue, SW, Washington, DC 20591, Tel: 866-835-5322, www.rgl.faa.gov.

FAA AC145-4A Advisory Circular - Inspection, Retread, Repair and Alteration of Aircraft Tires

FAA TSO-C62e Technical Standard Order - Tires

14 CFR Part 21 Certification Procedures for Products and Parts.

2.2 Applicable References

T&RA Tire and Rim Association - Standards

ETRTO European Tire and Rim Technical Organization - Standards

3. DEFINITIONS

RETREADING: The term retreading refers to the methods of restoring a worn tire by renewing the tread area, or by renewing the tread area plus one or both sidewalls. Repairs are included in the tire retreading process.

PROCESS SPECIFICATION: Documents approved by the cognizant airworthiness authorities containing information for performing specialized maintenance, such as retreading tires.

RETREAD LEVEL (R-LEVEL) ESCALATION: R-level escalation is the process used to verify that a population of retreaded tires is suitable for an additional service life.

LOAD RATING: Load rating is the maximum permissible load at a specific inflation pressure. Load ratings are established and standardized by the Tire & Rim Association (TRA) or the European Tire & Rim Technical Organization (ETRTO). The rated load combined with the rated inflation pressure will be used when selecting tires for application to an aircraft and for testing to the performance requirements of this standard.

PLY RATING: This term is used to identify the maximum recommended load rating and inflation pressure for a specified tire. It is an index of tire strength.

SPEED RATING: The speed rating is the maximum takeoff speed to which the tire has been tested.

BIAS TIRE: A pneumatic tire in which the ply cords extend to the beads and are laid at alternate angles substantially less than 90 degrees to the centerline of the tread.

RADIAL TIRE: A pneumatic tire in which the ply cords extend to the beads and are laid substantially at 90 degrees to the centerline of the tread, the casing being stabilized by an essentially inextensible circumferential belt.

MAIN TIRES: Main tires support the principal weight of the aircraft.

AUXILIARY TIRES: Auxiliary tires support the remaining weight of the aircraft not supported by the main tires.

NOSE TIRE: A nose tire is an auxiliary tire which is mounted forward of the center of gravity of an aircraft.

TAIL TIRE: A tail tire is an auxiliary tire which is mounted aft of the center of gravity of an aircraft.

CASING: The casing is the structural part of the tire.

COMPATIBLE CASING: A compatible casing for retreading is one capable of passing all retreader acceptance criteria for that size, ply rating, and speed rating.

SKID DEPTH: The distance between the tread surface and the deepest groove as measured in the mold.

MAXIMUM OUTSIDE DIAMETER (D_o): For the bias tire, it is the maximum new (ungrown) diameter along the centerline of the tire as denoted in TRA and ETRTO. For the radial tire, it is the maximum new (ungrown) diameter of its bias tire equivalent.

4. MARKINGS

4.1 Retread Identification

The following minimum information must appear in permanent markings between the wearing surface and the edge of the newly applied rubber.

a. The retreader's name or trademark

b. The retread plant identification code

c. The month and year the retread was performed

d. The letter "R" followed by the number of times the casing has been retreaded.

e. Skid Depth - If retread mold skid depth is different than original casing then original skid should be removed from casing and retread skid depth added.

4.2 Casing Identification

Retread processing may destroy some or all of the casing identification. The following information must be restored if removed during retreading:

a. Airworthiness compliance markings

b. Load rating

c. Casing manufacturer's name or trademark

d. Ply rating or inflation pressure

e. Size

f. Casing manufacturer's plant code

g. Date of manufacture

h. Serial number

i. Speed rating

j. Casing manufacturer's part number

k. Tube type, if applicable

4.3 Regrading Procedure

a. The ply rating/load rating and/or speed rating on either the casing or the retread may be decreased without approval. All performance and qualification parameters under the new rating must be met.

b. If the ply rating, load rating and speed rating markings of the casing do not agree with the retread qualification status, they must be buffed off the casing, and the correct markings applied to the casing.

c. The casing manufacturer's part number must not be altered without original casing manufacturer's approval.

d. Any upgrading in the speed rating or load rating, or any change in the tire size from the qualified new tire size will be considered a new product.

4.4 Marking Maximum Cut Limit Repairs

Casings containing maximum allowable cut limit repairs in the tread area should be identified with a sidewall brand in line with the repair. The guidelines and conditions under which this brand is applied should be specified in the retreader's specification.

5. CASING SELECTION

The new tire casing must be approved by the cognizant airworthiness authority. Unless otherwise restricted by the tire manufacturer or airworthiness authority, any aircraft tire may be retreaded provided that it meets the inspection and defect limitation criteria, and has met the R-level escalation inspection and test criteria established in the airworthiness authority certified repair station manuals and the retreader's airworthiness authority-approved process specification.

5.1 Inspection

The following non destructive inspection (NDI) techniques are available in the industry.

5.1.1 Visual

All tires shall be visually inspected in the tread, sidewall, bead and liner areas for conditions that need repair or which require the tire to be scrapped.

5.1.2 Air Injection

Tubeless tires may be air injected with a dry filtered gas (e.g., air or nitrogen) to inspect the casing for proper venting, separations, bead and liner condition, etc. Typical air injection pressure range is 100 to 125 psi.

5.1.3 Other NDI

Holography, shearography, ultrasonics, X-ray, etc. should be used as necessary.

5.2 Disposition of Tire Casings

5.2.1 Acceptable Casings

Tires which meet the acceptable limits for repair listed in the airworthiness authority's approved retreader's process specification may be repaired/retreaded and returned to service.

5.2.2 Non-acceptable Casings

Tires which fail the acceptable limits for repair listed in the retreader's process specification shall be rejected from further aircraft use. Casings not returned to the customer should have the TSO-C62 compliance marking(s) removed.

6. REPAIRING

Repairs are permitted if the anomaly does not exceed the limitations or the rejection criteria identified in the retreader's process specification, as approved by the cognizant airworthiness authority. Maximum permissible repairs identified in the process specification shall be validated by tests and/or analysis for the cognizant airworthiness authority approval before returning to service. The specification shall include each of the repair types for bias and radial tires, as identified in the Appendix A, and additional repairs identified by the retreader

7. RETREADING PROCESS

The retreading process includes removal of old material, renewing the tread area and curing and bonding of the new material to the casing. A process specification describing each retreader's process must be approved by the cognizant airworthiness authority.

8. QUALIFICATION TESTING

General: The test procedures described herein are intended to ensure compatibility between the original tire casing and newly applied retread. This qualification test is required with the first (R-1) application of a new tread and as otherwise specified in this document. The retread should not fail the applicable dynamometer tests specified herein nor have any signs of structural deterioration other than normal expected treadwear, except when the overload takeoff cycle is run last (see 8.1). Casings selected for retread qualification tests should have at least 80% of their new molded tire skid depth removed by wear (i.e., worn by aircraft usage). Design and construction differences between radial tires of different manufacture dictate that retread dynamometer testing be conducted on one sample of each manufacturer's radial tire casing at the first (R-1) application of a new tread. Qualification of bias tire retreads on a single manufacturer's casing qualifies the retread on other manufacturers' compatible casings of the same size, ply rating and speed rating.

8.1 Dynamometer Cycles

The retread test tire shall satisfactorily withstand 61 dynamometer cycles as a demonstration of overall performance. The 61 dynamometer cycles shall consist of 50 takeoff cycles, 8 taxi cycles at rated load, 2 taxi cycles at 1.2 times rated load, and 1 overload takeoff cycle starting at 1.5 times rated load. The sequence of the cycles is optional. A single tire specimen must be used to complete these cycles.

8.1.1 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. Consideration should be given to increased speeds resulting from elevated airport operations and high ambient temperatures.

Starting at zero speed, the tire shall be loaded against the dynamometer wheel. The test cycles shall simulate one of the curves in Figures 1, 2, or 3.

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

b. Figure 2 defines a test cycle that is applicable to any aircraft tire with a speed rating above 160 mph.

c. Figure 3 defines a test cycle that is applicable for any speed rating and is based on the most critical loads, speeds and distances in accordance with the airframe manufacturer's specifications.

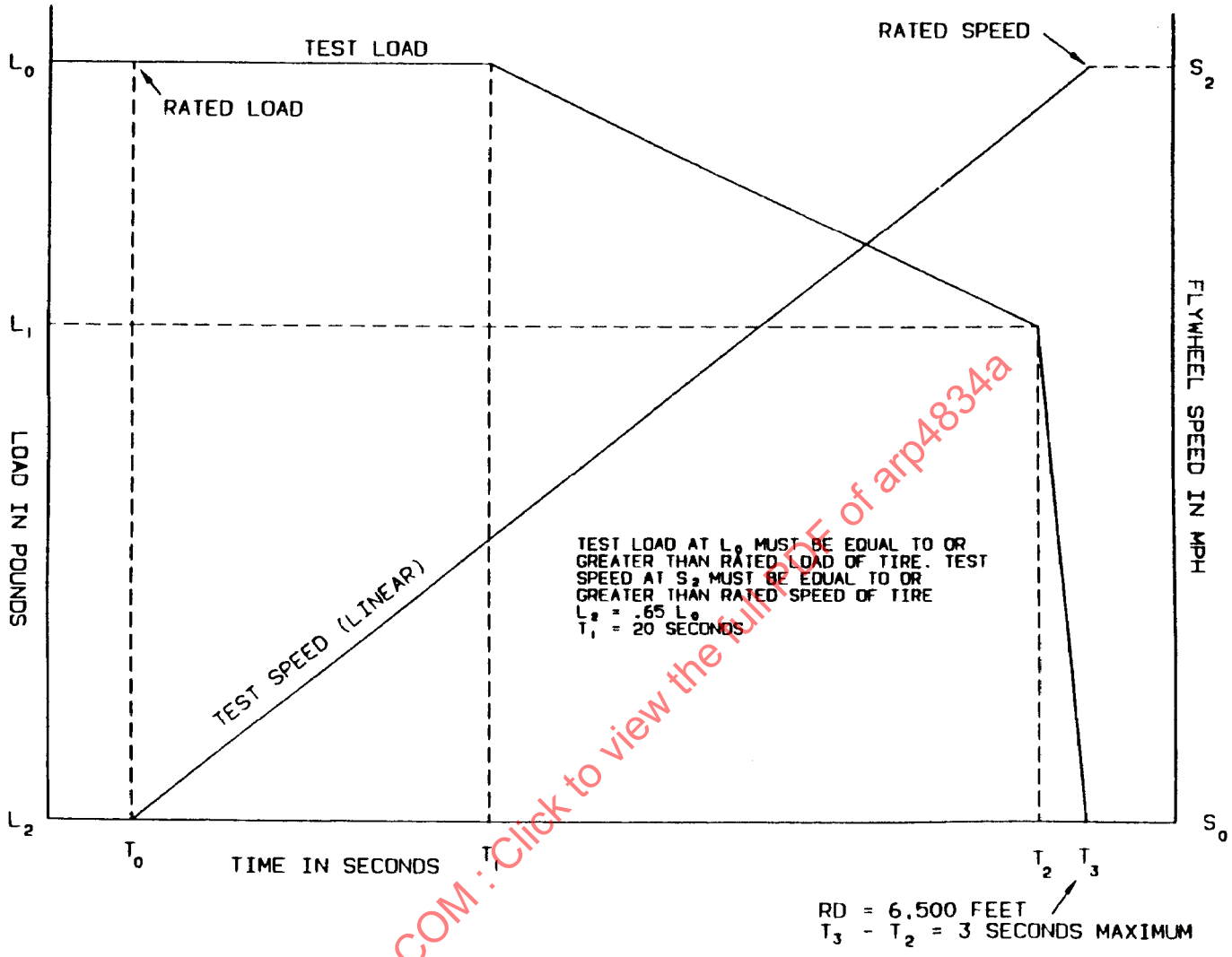

FIGURE 1 - GRAPHIC REPRESENTATION OF A UNIVERSAL LOAD-SPEED-TIME TEST CYCLE (FOR 120 MPH AND 160 MPH TIRES)

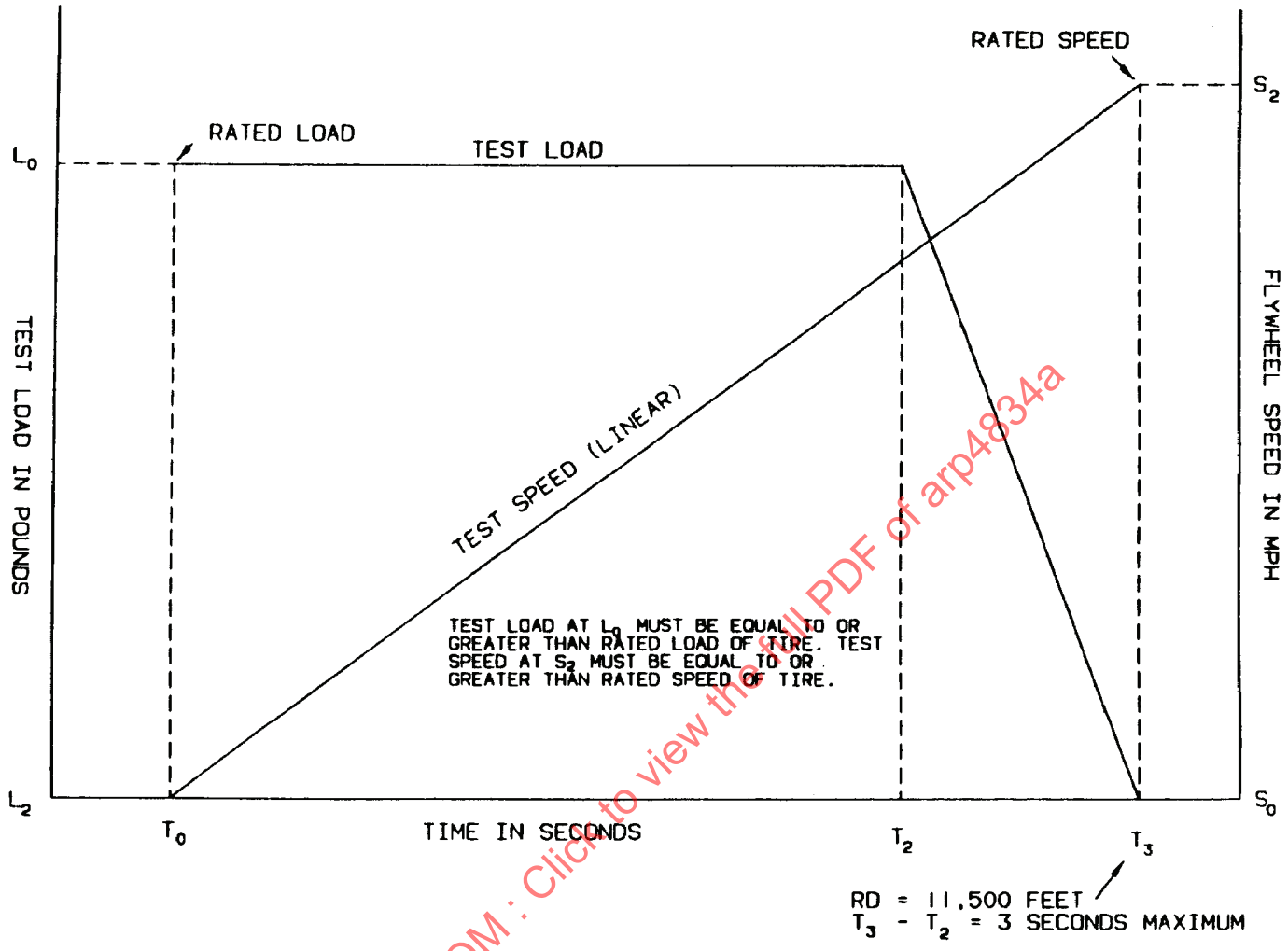

FIGURE 2 - GRAPHIC REPRESENTATION OF A UNIVERSAL LOAD-SPEED-TIME TEST CYCLE (FOR TIRES RATED ABOVE 160 MPH)

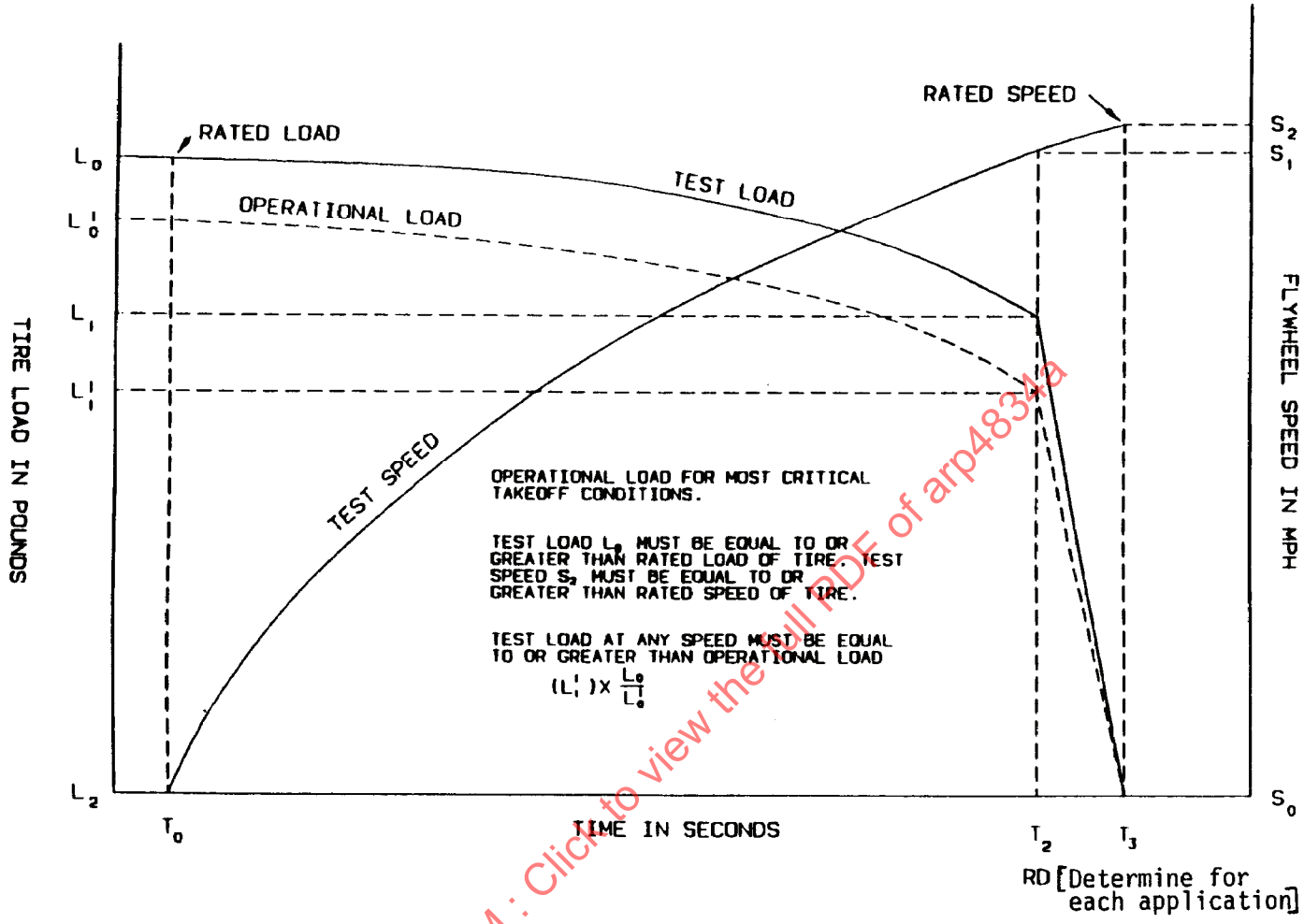

FIGURE 3 - GRAPHIC REPRESENTATION OF A RATIONAL LOAD-SPEED-TIME TEST CYCLE

8.1.2 Test Load

The load at the start of the test must be no less than the rated load of the tire. The test loads must conform to Figures 1, 2, or 3. Figures 1 and 2 define a test cycle that is generally applicable to any aircraft. If Figure 3 is used to define the test cycle, the loads must be selected based on the most critical takeoff conditions established by the applicant based on the data obtained from the airframe manufacturer. At any speed throughout the test cycle, the ratio of the test load to the operational load shall be the same as at the start of the test.

8.1.3 Test Inflation Pressure

The test inflation pressure shall be that which is necessary to provide the same static loaded radius on the curved surface as was obtained on a flat surface at the rated load and inflation pressure of the tire. Both determinations shall be made at the same ambient temperature. An adjustment in test inflation pressure may not be made to compensate for changes created by temperature variations during the test.

8.1.4 Test Temperatures and Cycle Interval

The temperature of the gas contained in the tire or of the casing measured at the hottest point of the tire may not be lower than 105 °F at the start of at least 45 of the 50 takeoff cycles and 120 °F 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 80 °F at the start of each cycle. Rolling the tire on the dynamometer is acceptable to obtain the minimum starting temperature.

8.1.5 Dynamometer Takeoff Test Speeds

Applicable dynamometer test speeds for corresponding maximum takeoff speeds are as follows in Table 1.

For takeoff speeds over 245 mph, the tire is required to be tested to the maximum applicable load- speed-time requirements and appropriately identified with the proper speed rating.

TABLE 1 - TAKEOFF SPEEDS

Maximum Takeoff Speed of Aircraft mph - Over	Maximum Takeoff Speed of Aircraft mph - Not Over	Speed Rating of Tire - mph	Minimum Dynamometer Speed at Takeoff Figures 1, 2, 3
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

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

L_{o^1} = Tire load at start of takeoff in pounds (not less than the load rating), Figures 1, 2 and 3

L_o = Tire load at the start of takeoff in pounds for the operational load curve, Figure 3

L_{1^1} = Tire load at rotation in pounds, Figures 1 and 3

L_1 = Tire load at rotation in pounds for the operational load curve, Figure 3

L_2 = Tire load at liftoff, zero (0) pounds, 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, zero (0) seconds, Figures 1, 2 and 3

T_1 = Twenty (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

RD = Tire Roll Distance in Feet

8.1.7 Taxi Cycles

The tire must withstand at least 10 taxi cycles on a dynamometer under the following test conditions in Table 2:

TABLE 2 - TAXI CYCLES

Number of Taxis	Minimum Tire Load - lb	Minimum Speed MPH	Minimum Roll Distance - ft Tire Speed Rating MPH - 120/160	Minimum Roll Distance - ft Tire Speed Rating MPH - Over 160
8	Rated	40	25 000	35 000
2	1.2xRated	40	25 000	35 000

8.1.8 Overload Takeoff Cycle

The overload takeoff cycle shall duplicate the test noted in 8.1.1 except that the test load shall be increased by a factor of 1.5 throughout. Good condition of the tire tread is not required after completion of this test cycle if it is run last. If the overload takeoff cycle is not run last, it must withstand the cycle without detectable signs of deterioration, other than normal expected tread surface abrasion.

8.1.9 Diffusion Test

Upon completion of the 61 test cycles, the tire must be capable of retaining inflation pressure with the loss of pressure not exceeding 10% in 24 h from the initial test pressure. Ambient temperature should be measured at the start and finish of this test to assure that the pressure change was not caused by an ambient temperature change.

8.2 Alternate Qualification Procedures - 120 mph Rated Tire

For 120 mph speed rated tires, the following variable mass flywheel procedure may be used:

8.2.1 Test Load

The load must not be less than the rated load of the tire during the entire roll distance of the test.

8.2.2 Test Inflation Pressure

The test inflation pressure shall be that which is necessary to provide the same loaded radius on the curved surface as was obtained on a flat surface at the rated load and inflation pressure of the tire. Both determinations shall be at the same ambient temperature. An adjustment in test inflation pressure may not be made to compensate for changes created by temperature variations during the test.

8.2.3 Test Temperature and Cycle Interval

The temperature of the gas contained in the tire or of the casing measured at the hottest point of the tire may not be lower than 105 °F 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 80 °F at the start of each cycle. Rolling on the dynamometer is acceptable for obtaining the minimum starting temperature.

8.2.4 Kinetic Energy

The kinetic energy of the dynamometer wheel to be absorbed by the tire must be calculated as follows in Equation 1:

$$KE = CW(V^2) = \text{Kinetic Energy in foot-pounds} \quad \text{(Eq. 1)}$$

where:

C = 0.0113

W = Load rating of the tire in pounds

V = 120 mph

8.2.5 Dynamometer Cycle Requirements

The tire shall satisfactorily withstand 200 landing cycles on a variable mass dynamometer wheel. If the exact number of wheel plates cannot be used to obtain the calculated kinetic energy value, a greater number of plates must be selected and the dynamometer speed adjusted to obtain the required kinetic energy. The total number of dynamometer landings must be divided into two equal parts having the speed ranges shown below.

8.2.5.1 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. The landing speed must be adjusted so that 56% of the kinetic energy calculated under 8.2.4 will be absorbed by the tire. If the adjusted landing speed is calculated to be less than 80 mph, the following must be done. The landing speed must be determined by adding 28% of the calculated kinetic energy under 8.2.4 to the flywheel kinetic energy at 64 mph, and the unlanding speed must be determined by subtracting 28% of the kinetic energy calculated under 8.2.4 from the flywheel kinetic energy at 64 mph.