U.S. Department of Transportation
Federal Aviation Administration

Advisory Circular

Subject: INSPECTION, RETREAD, REPAIR, AND ALTERATIONS OF AIRCRAFT TIRES

Date: 9/27/82 **AC No:** 145-4
Initiated by: AWS-340 **Change:**

1. PURPOSE. This advisory circular (AC) provides guidance for the development, qualification, and approval of aircraft tire repair and retread process specifications, and the use of special nondestructive inspection (NDI) techniques. This information sets forth an acceptable means, but not the only means of developing a process specification for approval.

2. RELATED REFERENCES. FAR Part 21, Certification Procedures for Products and Parts, Subpart O; FAR Part 43, Maintenance, Preventive Maintenance, Rebuilding and Alteration; FAR Part 145, Repair Stations; and Technical Standard Orders (TSO) C62b/C62c - Aircraft Tires.

3. BACKGROUND. As a result of Federal Aviation Administration's (FAA) evaluation of tire, wheel, and brake failures, the FAA Technical Standard Order TSO-C62c, Aircraft Tires, was adopted. TSO-C62c sets forth new minimum performance standards applicable to new aircraft main landing gear and nose wheel tires. To ensure that repair stations who retread aircraft tires and aircraft operators who use retreaded tires have adequate guidance to develop an appropriate process specification for retreading tires which assures the continuation of performance associated with a new TSO-C62c tire, acceptable procedures, applicable to FAR Section 43.13 have been developed. These requirements may form the basis for FAA approval of a process specification as set forth under FAR 145.

4. DEFINITIONS.

a. High speed tires are those operated in speed ranges of above 120 mph under TSO-C62c and above 160 mph under TSO-C62b.

b. The terms recap and recapping as used in the TSO-C62c are synonymous with the terms retread and retreading used in this AC.

c. Process Specifications are documents approved by the Administrator containing information for performing specialized maintenance, such as retreading of tires. Repair stations with limited ratings are required under FAR Section 145.33(c) to include a process specification on their operations specifications. Air carriers or commercial operators having a continuous airworthiness maintenance program under FAR Parts 121, 127, or 135, are required to include a process specification for retreading their tires in their program. Part 125 operators have inspection programs that require each operator to include a process specification in its manual for retreading its tires.

5. MAINTENANCE AND REPAIR INSTRUCTIONS. Tire manufacturers are required under TSO-C62c to furnish the FAA with maintenance data that includes the inspection criteria for tires to determine the eligibility of used tires to be continued in service. Retreading procedures are required to be included in the maintenance information along with any special repair methods applicable to the tire and special NDI techniques (Ref: TSO-C62c, paragraph (c)(2)). These or other methods, techniques, and practices acceptable to the Administrator may be used.

6. RETREAD, REPAIR, AND ALTERATION OF AIRCRAFT TIRES.

a. Retread. The term "retread" in this AC, refers to the methods of restoring a used tire by renewing the tread alone, or by renewing the tread plus one or both sidewalls. It refers as well to the process of extending new sidewall material to cover the bead area of the tire. Repairs are included in the retreading of tires.

b. Requirements.

(1) A repair station that is certificated to retread aircraft tires is required by FAR Section 145.33 to perform that work in accordance with a process specification approved by the FAA or in accordance with an operator's manual as outlined in FAR Sections 43.13(c) and 145.2.

(2) A holder of an air carrier operating certificate or commercial operating certificate or an operator with an FAR Part 125 operating certificate may adopt an approved process specification of a retreading agency and include it as a part of its manual as outlined in FAR Parts 121, 125, 127, or 135.

(3) A process specification is required to be qualified under FAR Section 43.13 in order to be approved by the FAA. The manufacturer of an aircraft tire is required by TSO-C62c to furnish maintenance data that includes maintenance and repair, retreading information, and special NDI techniques. Such data may be a sufficient basis for development of a process specification, or the retreading agency may develop a process specification which may be qualified under FAR Section 43.13 by using the inspection and testing techniques contained in this AC. Acceptable methods for developing tire retread procedures are outlined as follows:

(i) For retreading tires manufactured under TSO - C62b, the process specification is required to meet the requirements of FAR Section 43.13 and may be qualified by inspection and testing as outlined in AC 43.13-1A, Acceptable Methods, Techniques, and Practices, Aircraft Inspection and Repair, chapter 8, paragraph 332. Aircraft tires manufactured under TSO-C62b may continue to be retreaded using existing FAA approved process specifications for the TSO-C62b tires.

(ii) For retreading tires manufactured under TSO-C62c (or TSO-C62b tires requalified to TSO-C62c), the process specification should require all retreaded tires developed by each retreader subsequent to the effective date of this AC to meet the following test requirements;

(A) For tires operated above 160 mph, the process specification should provide inspection and dynamometer testing as outlined in paragraph 7 of this AC.

(B) For tires operated at 160 mph and less, the process specification should provide inspection and testing as outlined in paragraph 7 of this AC, or paragraphs 6. 2. through 6. 2. 4. 2 of TSO-C62c, or testing performed under paragraph 7c (8)(iii), R-Level Proof Test, for R-1 as outlined in this AC. For subsequent R-level escalation of these low speed retreads, only the R-level proof test would be required.

7. PERFORMANCE.

a. Tread design, skid depth, and materials used in retread tires may be proven per qualification testing as described in paragraphs 6 and 7 of this AC. Tire casings may be downgraded in both speed rating and load rating. Any upgrading, however, in speed rating or load rating or change in size designation or minimum undertread thickness from how the new tire was built and qualified by testing would be an alteration to the tire and would be considered a new product. As a new product, it would be necessary for the altered tire to be tested for approval under the TSO and be approved for use on each aircraft of which it would be a part.

b. For retreading tires manufactured under TSO-C62c (or TSO-C62b tires requalified to TSO-C62c), the process specification should require all retreaded tires developed by each retreader subsequent to the effective date of this AC to pass the inspection and tests of airworthiness outlined in paragraph 7c of this AC.

c. The following information, inspection and test requirements apply to both low-speed and high-speed tires when these tires are subjected to the applicable dynamometer test:

(1) Slippage. Tires should not slip on the wheel rim during the first five dynamometer cycles. Slippage that subsequently occurs should not damage the tube valve, or air seal of the tire bead of the tubeless tire.

(2) Loaded radius. The loaded radius is defined as the distance from the axle centerline to a flat surface for a tire initially inflated to the rated inflation pressure and then loaded to its rated load against the flat surface. The nominal loaded radius, the allowable tolerance on the loaded radius, and the actual load radius for the test tires should be identified.

(3) Dynamometer test. The tire may not fail the applicable dynamometer tests specified herein or have visible signs of deterioration other than normal expected tread wear.

(4) Tire test load. Unless otherwise specified herein for a particular test, the tire is required to be forced against the dynamometer flywheel at not less than the rated load of the tire during the entire roll distance of the test.

(5) Test inflation pressure. The test inflation pressure should be the pressure required at an identified ambient temperature to obtain the same loaded radius against the flywheel of the dynamometer as the radius for a flat surface as defined in paragraph 7c (2) of this AC. Adjustment to the test inflation pressure may not be made to compensate for increases due to temperature rise occurring during the tests.

(6) Test specimen. A single newly retreaded used tire specimen is required to be used in the applicable dynamometer tests specified herein.

(7) Testing. Tires operating at ground speeds greater than 160 mph are required to be tested on a dynamometer in accordance with paragraph 7c (7)(iii). Tires operating at ground speeds of 160 mph or less may, as an option, be tested on the dynamometer in accordance with paragraph 7c (7)(iii). The curves to be used as a basis for tests under paragraph 7c (7)(iii) are required to be established in accordance with the provisions of TSO-C62c, as appropriate. The load at the start of the test is required to be equal to the rated load of the tire.

(i) Test temperature. The temperature of the air contained in the tire or of the carcass measured at the hottest point of the tire is required to be not lower than 120°F at the start of at least 90 percent of the test cycles specified in paragraph 7c (7)(vi) and at least 105°F at the start of at least 90 percent of the test cycles specified in paragraphs 7c (7)(v). For the remaining 10 percent of each group of cycles, the contained air or carcass temperature is required to be not lower than 80°F at the start of each cycle. Rolling the tire on the dynamometer is acceptable for obtaining the minimum starting temperature.

(ii) Dynamometer test speeds. Applicable dynamometer test speeds for corresponding maximum ground speeds are as follows:

Maximum ground speed of aircraft, mph		Speed rating of tire mph	Minimum dynamometer speed at S2 mph
Over	Not over		
120	160	160	160
160	190	190	190
190	210	210	210
210	225	225	225
225	235	235	235
235	245	245	245

For ground 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.

(iii) Dynamometer cycles. The test tire is required to withstand 50 takeoff cycles, and 8 taxi cycles as described below. The sequence of the cycles is optional.

(iv) Symbol definitions. The numerical values which are used for the following symbols are required to be determined from the applicable airplane load-speed-time-data:

L_o = Tire load at start of takeoff, pounds, (not less than rated load).
L_1 = Tire load at rotation, pounds.
L_2 = Zero tire load (liftoff).
RD = Roll distance, feet.
S_o = Zero tire speed.
S_1 = Tire speed at rotation, mph.
S_2 = Tire speed at liftoff, mph (not less than speed rating).
T_o = Start of takeoff.
T_1 = Time to rotation, seconds.
T_2 = Time to liftoff, seconds.

(v) Takeoff cycles. For these cycles the loads, speeds, and distance are required to conform to either Figure 1 or Figure 2. Figure 1 defines a test cycle that is generally applicable to any aircraft. If Figure 2 is used to define the test cycle, the loads, speeds, and distance are required to be selected based on the most critical takeoff conditions established by the aircraft manufacturer.

(vi) Taxi cycles. The tire at rated load is required to withstand at least 8 taxi cycles on a dynamometer for a minimum speed of 40 mph and a minimum roll distance of 35,000 feet.

(8) Test requirements for both high speed and low speed tires.

(i) Overpressure. The tire is required to withstand, for at least 3 seconds without rupture, a minimum test inflation pressure of at least 3.0 times the rated inflation pressure at ambient temperature. A different aircraft tire from that used in the dynamometer test may be used.

(ii) Number of Retreads. The wide variation in tire operating environments which may affect total carcass life and serviceability make it inadvisable to arbitrarily prescribe the maximum number of times a tire should be retreaded. Tire studies have disclosed that due to the complexity of aircraft tires, the separation propagation mechanism is critically influenced by the overall structural strength and structural uniformity of the carcass. Small separations in a weak carcass may propagate very fast while the same separation in a very strong carcass will propagate very slowly and go through many R levels before it will lead to a terminal failure. Accordingly, the number of times a tire can be retreaded can only be controlled by a thorough inspection of the carcass, using the appropriate NDI methods for each area of the carcass being inspected.

(iii) R-Level Proof Test. The R-level adhesion test procedure should be made a part of the retreader's process specification. In order to establish the airworthiness of retreads, the following tests should be carried out on 20 inservice tires at the highest retread level in use for a sampling distributed among tire brands, sizes, and operators. If the distribution of tires is biased, it should be biased, in favor of higher load high speed tires.

(A) Visual Inspection

(B) Air Needle Inspection

FIGURE 1. FLYWHEEL SPEED IN MPH

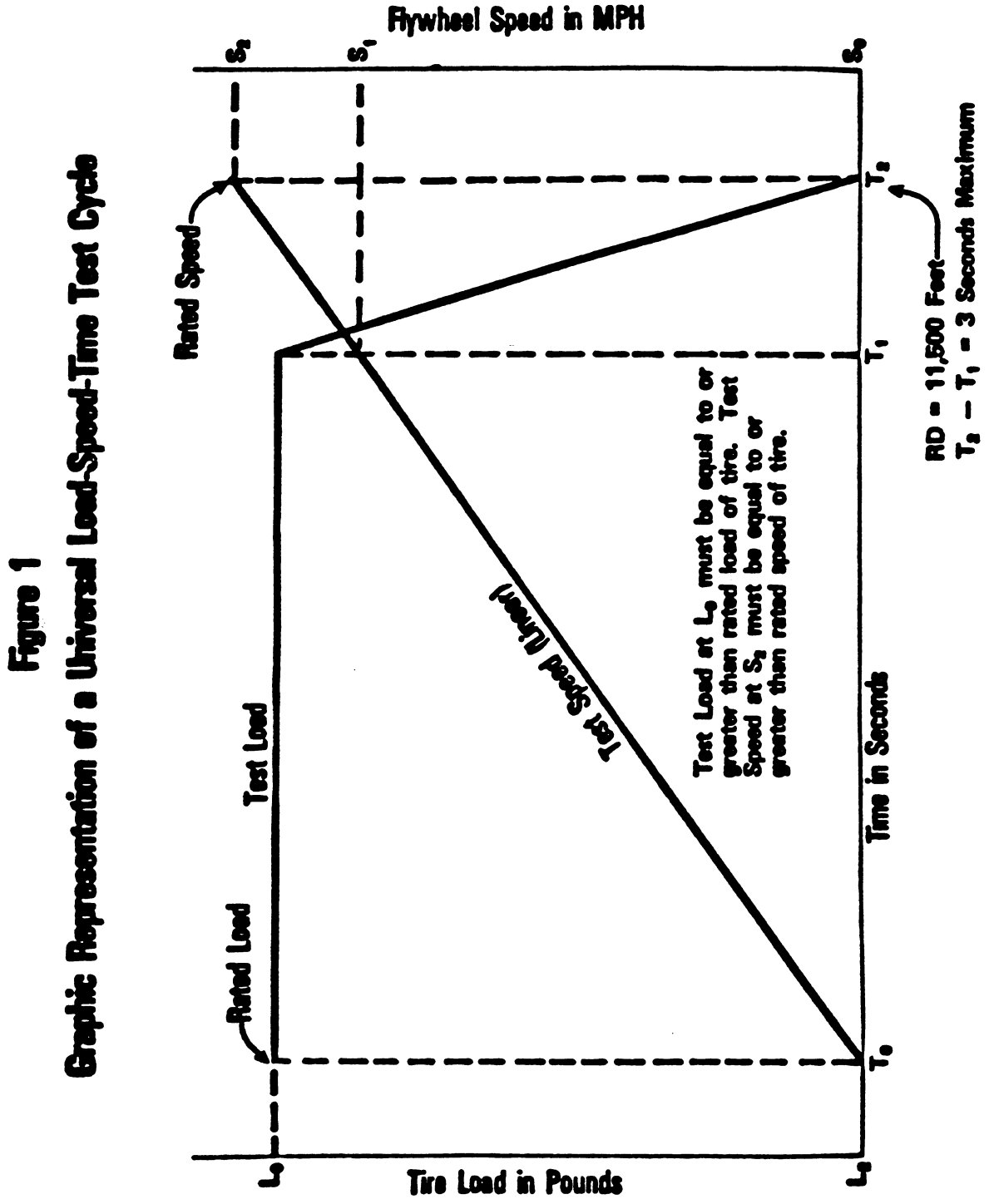

Figure 1
Graphic Representation of a Universal Load-Speed-Time Test Cycle

FIGURE 2. FLYWHEEL SPEED IN MPH

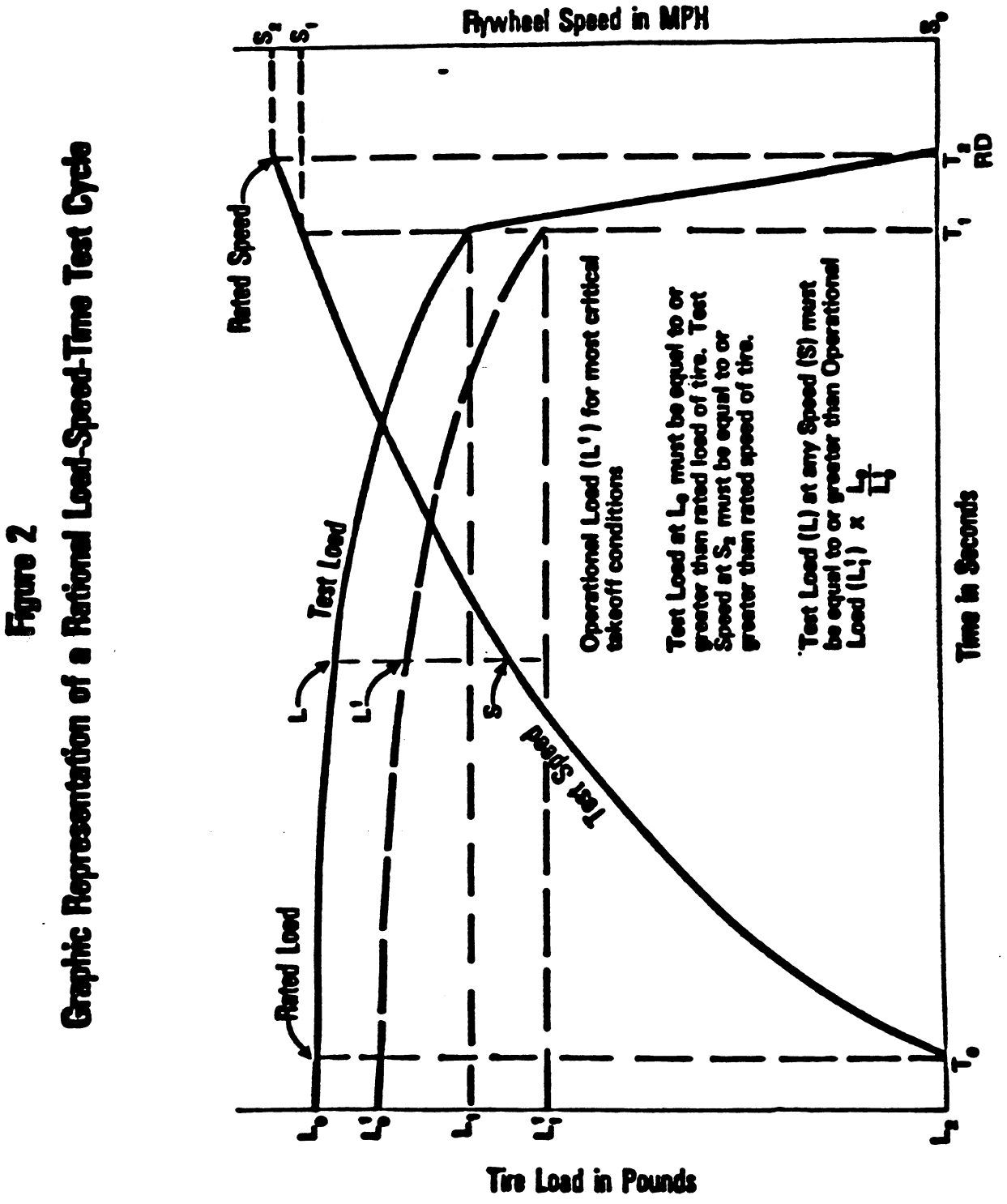

Figure 2

Graphic Representation of a Rational Load-Speed-Time Test Cycle

(C) Other approved nondestructive inspection(s) or cross-section sliver examinations for degradation and separations of all tires to ascertain that they conform with FAA approved pass/fail criteria (see paragraph 13d).

(D) Conduct unified tread and ply adhesion tests on all tires as follows:

(1) Tread Adhesion. Cut or stamp 3 samples from the center of the tread at equidistant (about 120° apart) places around the tire. Samples are to be 1"x6". The adhesion test will be conducted at the retread buff line in accordance with Federal Test Method #601 or American Standard Testing Materials (ASTM) Test D-413-76 for Strip Specimens Type A adapted for aircraft tire retreads (see Appendix 1). The results of the three samples will be averaged. The adhesion should not be less than 30 pounds per inch for the tire having the lowest adhesion value of the 20 tires. Adhesion should not be less than 33 pounds for the tire having the next lowest adhesion value. Adhesion should not be less than 36 pounds for the tire with the third lowest value and adhesion should not be less than 39 pounds for the tire having the fourth lowest adhesion value.

(2) Ply Adhesion. Samples as referred to in paragraph (D)(1), will be tested for ply adhesion as described in paragraph (D)(1). The test will be conducted on samples taken between the top 3rd and 4th body plies. The adhesion should not be less than 20 pounds per inch for the tire having the lowest adhesion value of the 20 tires. Adhesion should not be less than 23 pounds for the tire having the next lowest adhesion value. Adhesion should not be less than 26 pounds for the tire having the third lowest value and 29 pounds for the tire with the fourth lowest adhesion value.

(3) R-Level Proof. The R level represented by the 20 tire sample is dependent on the number of tires at each R level in the sample in accordance with the following table. The tires to be tested are to be newly retreaded; i.e., R4 = a newly retreaded worn R3.

TO QUALIFY FOR

Population must contain a minimum of tires at these R levels	R1	R2	R3	R4	R5	R6	R7	R8	R9	R10	R11	R12
R1	20	15										
R2		5	15									
R3			5	15	5	5						
R4				5	10		5					
R5					5	10		5				
R6						5	10	10	5			
R7							5		10	5	5	5
R8								5		10		
R9									5		10	10
R10										5		
R11											5	
R12												5
TOTAL	20	20	20	20	20	20	20	20	20	20	20	20

Read down in any column to find the number of tires at each R level for approval. The proportion of the sample below each R level should not exceed the proportion of retreaders production at that R level.

Example: A retreader who has met all of the requirements for retreading to R3 has tested a minimum of 20-R1 tires, 15-R2 tires and 5-R3 tires. In order to qualify for retreading at the R4 level, the retreader must test 10 additional R3 tires and 5-R4 tires. To go to R5, the retreader must test 5 additional R4 and 5-R5 tires.

(4) Retesting. If after selecting 20 tires and testing them, a retreader finds that they have failed to meet the acceptance criteria, an additional 20 tires can be retested. If the second set of 20 tires fails this test, the retreader can be certain, at the 98 percent confidence level, that the tires are below the minimum standards of airworthiness as measured either by the retreader's ability to screen tire casings or the ability to adhere tread to a casing, or the retreader must change its process specification and retest.

(5) A retreader who prior to the effective date of this AC was currently retreading aircraft tires manufactured under TSO-C62c (or TSO-C62b tires requalified to TSO-C62c) of many sizes (as an example) to R7 level or higher could meet the requirements for retreading all tires up to R7 by testing five (5) R4 tires, ten (10) R6 tires, and five (5) R7 tires. This 20-tire sample would be distributed among tire brands, sizes, and operators. If later the retreader wanted to qualify for retreading at R9, the retreader would need to test five (5) additional R7 tires and five (5) R9 tires.

(6) Subsequent to the effective date of this AC the retreaders referenced in paragraph 7c (8) (iii)(D)(5) may qualify tires of new design or new size by conducting the inspection and test of airworthiness as outlined in paragraph 7c (1) through 7c (8)(i) and the R level adhesion proof test outlined in paragraph 7c(8)(iii) of one tire for level R1. For subsequent increase in R levels it would be necessary to conduct adhesion tests, as tires of increasing R level become available, on the following basis.

(i) For R2, two tires.

(ii) For R3, three tires.

(iii) For R4 and above, one tire at each R Level.

(iv) Tires retreaded at each R level may be put into service without test, but tire may not be escalated to the next retread level until the adhesion test(s) on the number of tires of the previous R level have been accomplished.

(v) Any tire whose defects will not affect adhesion may be used for the adhesion proof test.

8. TIRE REPAIRS. The following guidelines represent present acceptable industry practices regarding aircraft tire repairs. However, other practices may be used if acceptable to the Administrator.

a. For tires operated above 120 mph:

(1) Tread Area. Cuts, cracks, or other tread injuries 1-1/2 inches in length and 1/4 inch in width or less on the first cord body ply, and which do not extend through more than 40 percent of the actual tire cord body plies are repairable. However, any tread injury repaired by skiving or rasping methods should not have the final repair greater than 2 inches in length.

(2) Tread Injuries. Tread injuries that penetrate a distance equal to 40 percent of actual tire cord body plies and are 1-1/2 inches in length or less on the first cord body should be limited to six per tire, and should not be less than 60 degrees apart along the tire circumference.

(3) Sidewall rubber. Surface defects of any degree (checking radial and circumferential cracks, cuts, and snags) may be repaired provided the injuries do not penetrate into the cord body fabric plies.

(4) Bead area. Minor injuries to the bead area may be repaired provided the plies are not damaged.

(5) Bead seal. The bead seal should not be affected or intersected by impressions or depressions.

(6) Bead face and bead heel. Those areas should be smooth.

(7) Bead toe. The bead toe should be trimmed so that no edges are exposed above the bead face and so that any bead toe flash remaining does not protrude more than 1/8 inch from the face contour of the bead. If trimming of the bead toe is necessary, the trimming shall not cut or expose the tire cord material or more than one layer of chafer fabric.

(8) Chafer strip. Minor injuries in the chafer strip or slight tire tool injuries in the general bead area are repairable, if they do not extend into the plies of the tire and there is no sign of separation in the bead area. Loose or blistered chafer strips can be repaired or replaced.

(9) Inner liner. Inner liner surface damage and defects other than liner splices that are less than two inches in length, may be repaired. A maximum of ten of these repairs are acceptable with no more than three repairs in any one quadrant. Liner splice damage defects may be repaired if less than ten inches in length.

(10) Exposed cord. Exposed cord, either in the breaker or carcass ply, should not exceed one percent of the buffed total tread area on one spot or more than two percent for the entire tire. Exposed fabric should not exceed one carcass ply in depth.

b. For tires operated below 120 mph:

(1) Bead injuries. Repairs may be made where only the chafe resistant material is damaged or loose, or where minor injuries do not penetrate into more than 25 percent of the tire plies up to three damaged plies.

(2) Tread or sidewalls. Injuries may be repaired by the spot method. This includes cuts in the tread area that are smaller than 1/2 inch in length and do not penetrate more than the following number of plies into the cord body.

Number of Plies	Maximum cut depth
Less than 8	None
8 through 16	2 plies
More than 16	4 plies

9. RETREADABLE TIRES. Tires with sound cord bodies and beads and those with flat spots which do not extend into more than one carcass ply are retreadable. This should be established by appropriate NDI using the equipment, techniques, and procedures which are recommended by the tire manufacturer or those outlined in the repair station's process specification approved by the FAA.

a. Marking of retreaded tires. Whenever it is necessary to replace the area containing the required original markings (Ref: TSO-C62c as applicable), or if those markings are damaged, such markings can be replaced by the retreader, except for the TSO identification, which can only be replaced at the direction of the manufacturer. When retreading tires for certain air carriers, they may require additional tire markings. In addition, each retreaded tire shoulder should be permanently embossed with at least the retread information as follows:

(1) The letter "R" followed by a number 1, 2, etc., to signify the sequential number of retreads applied thereon.

(2) The month and year of the retread application.

(3) The name or identifying letters of the retreader who retreaded the tire.

(4) The plant location of the retreader.

b. Balance marker. A balance marker, consisting of a red dot, is required to be affixed on the sidewall of the tire immediately above the bead to indicate the lightweight point of the tire. The dot is required to remain for any period of storage plus the retread life of the tire.

c. Tread design. All tires should have a full circumferential groove or other tread design which will provide adequate traction for all operational maneuvers as specified by the manufacturer.

d. Tread reinforcement fabric. The tread reinforcing fabric should not end directly under an outer tread groove.

e. Balance tolerance. All tires should be balanced in accordance with the schedule set forth in TSO-C62c.

f. Tire weight. The weight of a tire should not be greater than the applicable aircraft type certificate limitations unless specifically approved.

10. NONREPAIRABLE AIRCRAFT TIRES. If any of the following conditions exists, repair of the tire is not recommended, unless the repair is found acceptable to the Administrator:

a. Injuries to the bead or bead area (except that repairs may be made where only the chafe resistant material is damaged or loose or if damage does not extend into the plies of the tire and if there is no sign of separation in the bead area).

b. Bead injuries that affect the seal of the bead on tubeless tires.

c. Evidence of separation exceeding process specification limits between plies or around bead wire.

d. Injuries requiring reinforcement and all injuries requiring sectional repair.

e. Kinked or broken bead.

f. Weather checking or radial cracks that penetrate into body cords.

g. Evidence of flex breaks.

h. Loose, internally damaged or broken cords.

i. Broken or cut cords in the outside sidewall, or shoulder area.

j. Evidence of blisters or heat damage to the bead seat where reversion scorching, or rubber flaking has occurred.

k. Cracked, deteriorated or damaged inner liners which exceed the limits in paragraph 8a(9).

l. Flat spots and skid burns that have penetrated more than one carcass ply.

m. Tires that have been saturated with fuel, grease, or oil, to the point where tread adhesion or tire integrity could be adversely affected.

n. Tires when sidewall have been buffed and veneered three times.

o. Punctures that penetrate through the cord body are not repairable.

11. CERTIFICATION OF A REPAIR STATION FOR AIRCRAFT TIRE RETREADING. A limited rating-specialized service for aircraft tire retreading is issued to an operator who desires to operate a repair station to retread aircraft tires. The wide differences in the technique, materials, and processes used by the aircraft tire manufacturers make it necessary for a tire retreader to provide specific detailed process data for the repair and retreading of aircraft tires.

a. Repair stations may obtain such data from the respective tire manufacturer or may develop its own for inclusion in its process specification required by FAR Section 145.33(c). The process specification requirements are outlined in paragraph 6b of this AC.

b. Since a process specification for the retreading of aircraft tires contains in-depth details and instructions for the inspection, repair and retreading process, and the R-level proof test, the document should be given a title and number by the applicant. The process specification should identify all the types of tires to which the process specification applies, including qualification test reports and outlines of the procedure for the use of the specification by repair station personnel. A statement should be included stating that any change to the process specification is required to be submitted to the FAA for approval before being implemented. The specification should also state that if there are any conflicting details between it and any current or future requirements of the FAR, the FAR requirements will take precedence. After the process specification is approved by the FAA, it is required to be referenced on Repair Station Operations Specifications, FAA Form 8000-4-1 by title, number and date approved.

c. Repair stations retreading tires for an operator holding an air carrier certificate or an operating certificate having a continuous airworthiness maintenance and inspection program under FAR Parts 121, 125, 127, or 135 are required to perform that work in accordance with the procedures as outlined in the operator's maintenance manual.

(1) Operators should assure that the process specification for retreading their tires, required to be part of their maintenance manual, requires those tires to meet the performance rule of FAR Section 43.13 in accordance with the recommendations of this AC, or other methods acceptable to the Administrator.

(2) When available, the reasons for tire removal, if other than normal wear, should be supplied to the retread agency when the tire is returned for retreading.

d. The retreader's record of work performed for each tire processed should, at least, contain information as follows:

(1) Brand name.

(2) Tire size.

(3) Load rating or ply rating.

(4) Speed rating.

(5) Serial number.

(6) Retread number.

(7) Skid Depth.

(8) Repairs made to carcass during retreading and previous repairs noted that were not recorded.

(9) Type of tread applied.

(10) Plant code.

(11) Month and year applied.

(12) Applicable TSO number.

e. The retreader's quality control system is expected to maintain a satisfactory level of workmanship throughout the retread process, including assurance that each retreaded tire type meets the qualification tests and specifications as outlined in this AC, or others acceptable to the Administrator. It should contain an acceptable means for determining that the methods, techniques, and practices utilized in the retread procedure will continue to produce a tire that meets the requirements of FAR Section 43.13, and that the work is done in accordance with the retreader's FAA approved process specification, or the process specification of the air carrier for whom work is being done. Acceptable means includes subjecting representative tires to the qualification tests as outlined in this AC, or other tests acceptable to the Administrator, including the procedure for R-level proof test.

12. TIRE INSPECTION. The life span of an aircraft tire is expected to include several retreads. In order to provide an increase in tire life span, it is necessary to subject the worn or defective tire to inspection procedures and limiting defect criteria to qualify the tire for repair, retread, and return to service.

a. An aircraft tire is passed through a repair agency's inspection system to determine if the tire has defects that would make it unsuitable for retreading. The first unrepairable defect that is noted is cause for the tire to be marked for scrap and no further work is done on the tire.

b. All repairable damage and/or defects found are marked and identified on the work sheet for attention during the retread process.

13. INSPECTION METHODS.

a. Only three NDI procedures are now in widespread use by tire retread agencies: (1) visual; (2) air needle; and (3) holographic.

b. Other candidate procedures require further testing and validation before they can be considered effective for ensuring the airworthiness of tire casings. Each procedure has limitations and should be used with full knowledge of the risks of overlooking potentially damaging defects. As inspection technology evolves, other candidate procedures may be considered for inclusion in these recommendations.

c. A repair station in the development of its process specification should give consideration to including all necessary NDI procedures to assure a sound carcass for retreading.

d. Pass fail criteria should be established by each retreader for its process specification and by each air carrier or commercial operator for the process specification required to be part of its manual (ref. paragraph 4c). Such criteria including maximum flaw size will be determined based on the operation constraints for a given tire.

14. HIGH-SPEED TIRE MAINTENANCE AND OPERATIONAL PRACTICES. Studies show that tire failure and carcass deterioration of inservice tires can be alleviated by proper maintenance and operational practices. Advisory Circular 20-97, High-Speed Tire Maintenance and Operational Practices, provides information on the causes of aircraft tire failures and methods of increasing tire reliability. AC 20-97 is available from the U.S. Department of Transportation, Publications Section, M-443.1, Washington, D.C. 20590.

M. C. Beard
Director of Airworthiness

APPENDIX 1. ADHESION TEST METHOD FOR COMMERCIAL AIRCRAFT TIRES

1. SCOPE. To set forth specific methods of determining the strength of the adhesion between plies of fabric bonded with rubber as well as tread adhesion at the buff line where the new retread is bonded to the undertread rubber of the carcass. All adhesion tests required to be performed in this AC will be performed in accordance with the method described herein.

2. RELATED DOCUMENTS.

a. ASTM D 413-76. Published March 26, 1976.
RUBBER PROPERTY-ADHESION TO FLEXIBLE SUBSTRATE.

b. Canadian method known as Harcsar-Reiger Method.
DETERMINATION OF TIRE COMPONENTS ADHESION.

3. APPARATUS.

a. Testing machine. A tension testing machine, power driven, accurate to within ± 2%, is used for measuring the force required to separate the layers of the test specimens. The machine must be equipped with a chart recording device for measuring the applied force.

b. Grips. Strip specimens shall be held in the testing machine by grips that clamp firmly and prevent slipping at all times.

c. Chart. The machine shall be equipped with a chart and recording device to record the force applied. One chart axis is the distance separated and the applied tension is the other axis.

d. Rate of travel. The rate of travel of the power actuated grip is 2 in./min. for a distance of at least 20". The speed of the recorder chart is also 2 in./min.

e. Chart span. To achieve the greatest possible accuracy, the proper scale must be selected so that the tension applied shall be greater than 15% and less than 85% of the capacity of the machine.

4. STRIP SPECIMEN PREPARATION PROCEDURE.

a. Size and quantity. A minimum of three specimens will be removed from the tire at each 120° around the circumference. All samples will be cut in a direction parallel to the center line of the tread. The minimum length of the sample is 6". The desired width of the sample, prior to slitting (see paragraph 4b) is 1-1/8". The 6" sample must be parted or separated with a knife for a distance of 1-1/2" along the line of separation to give a place to grip the ends of the test specimen in the machine grips. The minimum distance of separation that the machine must pull is 3". Tread adhesion samples are to be removed from the center line rib of center rib tread designs and from either one of the two center ribs adjacent to the center line in center groove tread designs.

b. Slitting. With the sample that has a uniform width of 1-1/8", make a 1/16" deep slit with a pointed, razor sharp knife along each side where the specimen is to be separated during testing. Use a knife with an adjustable blade where only the desired depth of cut (1/16") of blade is exposed.

c. Temperature. The temperature during the tests shall be 73° ± 4°F.

5. PRECAUTIONS.

a. Tearing, it is quite important for the line of separation to follow the desired level and not be allowed to tear into other levels, upward or downward, from the desired level.

b. If during a test, one of the parts begins to tear instead of separating from the other part of the specimen, guide the parting line back to the desired line by cutting the material being torn with a sharp knife back to the surface of contact between the two parts.

c. Any lines on the chart, resulting from the tear into levels of lower or higher adhesions not on the path of desired separation are to be marked immediately and not considered in the final calculation of average adhesions.

6. DETERMINATION OF ADHESION VALUES.

a. Carcass adhesion. The carcass ply adhesion test is to be made between the third and fourth body plies, when counted from the outside of the tire and counting in the direction towards the liner. In so doing, only carcass or body plies are to be counted and not any breaker plies or tread reinforcing plies that might exist.

b. Tread adhesion. The desired line of separation is to be along the buffed line where the tread is bonded. In case there is a previous buff line showing on the specimens, the slitting or desired line of separation will be along the last (or highest) buff line.

7. CALCULATIONS.

a. Peaks. From the plot on the autographic chart, the proper value of each major peak is written beside each major peak. A major peak is one where there is more than five points (pounds) separating it from the next following valley or the immediately preceding valley.

b. Averaging value of each specimen. Of the total major peak values, the first 5% and the last 5% will be eliminated and not considered. Any values previously marked, per paragraph 7a, will be eliminated from consideration. All remaining values are mathematically averaged. The average adhesion value, in pounds per inch, is written on the autographic chart.

c. Correction for inch width. Each specimen is to be accurately measured (to the nearest .010") between the slit lines (paragraph 4b). This gives the actual width of the adhered surface to which the separating force was applied. If the width just measured is not 1 inch, the actual width is to be divided into the average adhesion value just calculated in paragraph 7b to get the actual pounds force per inch of width.

8. REPORT. The autographic chart constitutes the report. It must contain:

a. Results of adhesion test in accordance with Paragraph 7c.

b. Tire size, Ply rating or load rating Retread No., Serial Number and Manufacturer.

c. Date of test.

d. Initials of operator conducting the test.

e. Code for sample number (T_1, T_2 or T_3 for tread adhesion Samples; P_1, P_2 or P_3 for third to fourth ply adhesion samples).

f. The median of the three values, when considered in ascending order, will be recorded as the average adhesion value of the tead adhesion or ply adhesion.