



Advisory Circular

Subject: Inspection, Retread,
Repair, and Alterations of
Aircraft Tires

Date: 7/10/06

AC No: 145-4A

Initiated by: AFS-309

1. PURPOSE. This advisory circular (AC) provides guidance for the development, qualification, and approval of bias and radial aircraft tire retreads, their repair and process specifications, and the use of special nondestructive inspection (NDI) techniques. This material is neither mandatory nor regulatory in nature and does not constitute a regulation. It describes acceptable means, but not the only means, for developing specifications to be submitted to the proper Federal Aviation Administration (FAA) office for approval. The FAA will consider other methods of demonstrating compliance that an applicant may elect to present. Terms such as “shall” and “must” are used only in the sense of ensuring applicability of this particular method of compliance when the methods of compliance described in this document are used.

2. CANCELLATION. AC 145-4, Inspection, Retread, Repair, and Alterations of Aircraft Tires, dated September 27, 1982, is canceled.

3. RELATED REGULATIONS AND REFERENCES (current editions).

a. Title 14 of the Code of Federal Regulations (14 CFR).

- (1) Part 21, Subpart O, Technical Standard Order Authorizations.
- (2) Part 23, Airworthiness Standards: Normal, utility, acrobatic, and commuter category airplanes.
- (3) Part 25, Airworthiness Standards: Transport category airplanes.
- (4) Part 27, Airworthiness Standards: Normal category rotorcraft.
- (5) Part 29, Airworthiness Standards: Transport category rotorcraft.
- (6) Part 43, Maintenance, preventive maintenance, rebuilding, and alteration.
- (7) Part 145, Repair stations.

b. AC. AC 20-97, Aircraft Tire Maintenance and Operational Practices.

c. **Technical Standard Order (TSO).** TSO-C62, Tires.

d. **Industry Documents.**

(1) ARP 4834, Aircraft Tire Retreading Practice—Bias and Radial.

(2) AS 4833, Aircraft New Tire Standard—Bias and Radial.

(3) TRA, Tire and Rim Association Aircraft Yearbook.

(4) ETRTO, European Tire and Rim Technical Organization Standards Manual.

4. DEFINITIONS.

a. **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.

b. **Specification.** Documents approved by the Administrator containing information for performing specialized maintenance, such as retreading of tires.

NOTE: Repair stations with limited ratings for specialized services are required under part 145, § 145.61(c) to include a specification on their operations specifications.

c. **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.

d. **Load Rating.** Load rating is the maximum permissible load at a specific inflation pressure. 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 document.

e. **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.

f. **Speed Rating.** The speed rating is the maximum takeoff speed to which the tire has been tested.

g. **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.

h. **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.

i. **Casing.** The casing is the structural part of the tire.

j. **Compatible Casing.** A compatible casing for retreading is one capable of passing all retreader acceptance criteria for that size, ply rating, and speed rating.

k. Skid Depth. The distance between the tread surface and the deepest groove as measured in the mold.

l. Maximum Outside Diameter (D_0). 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.

5. BACKGROUND. In parallel with the introduction and installation of new radial tire designs on the U.S. civil aircraft fleet, the FAA initiated a project to update appropriate safety standards and advisory support material. This includes revisions to TSO-C62, AC 145-4, and AC 20-97. The retreader's quality and escalation plans are based in part on the manner in which the airline operator maintains the retread tire in service. The long term integrity and reliability of the retread tire is significantly influenced by the inflation pressure schedule, the frequency of tire pressure checks, and the identification of tire removal conditions that may impact the continued airworthiness of the tire. This revision will ensure that repair stations which retread bias and/or radial tires, and aircraft operators who use these tires, have proper guidance which assures the continued performance of a tire through testing, as originally approved under the TSO (and requirements under part 43, § 43.13), and provides the basis for the development of a specification covering the inspection, retread, and repair of tires, as set forth under part 145.

6. SPECIFICATION REQUIREMENTS.

a. Title 14 CFR Requirements.

(1) Repair Station. A repair station that is certificated to retread aircraft tires is required by § 145.61(c). to perform that work in accordance with a specification approved by the FAA or in accordance with an operator's manual as outlined in § 43.13(c).

(2) Operator. A holder of an air carrier operating certificate or an operator with a 14 CFR part 125 operating certificate may adopt a retreading agency's approved specification and include it as a part of its manual as outlined in 14 CFR part 121, 125, or 135.

b. Specification Requirements. The retreader of bias or radial aircraft tires is required to establish maintenance and repair practices, including special nondestructive inspection techniques and retreading procedures. These practices could be techniques defined, developed, and validated by the retreader and approved by the FAA or from information provided by the tire manufacturer. The minimum requirements and issues to be addressed for a specification that would be developed and submitted for FAA approval by a repair station and retreader are identified within this document.

c. Applicability. For retreading bias and radial aircraft tires manufactured under TSO-C62, a specification and requirements defined here shall be developed and complied with by the repair station and retreader for all repaired and retreaded tires after the effective date of this AC. Bias tires that were manufactured to prior TSO standards may be repaired in accordance with maintenance instructions identified under AC 145-4, dated September 27, 1982. However, further escalation of these existing tires should comply with the escalation of these requirements.

7. MARKING.

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

- (1) The retreader's name or registered trademark.
- (2) The retread plant identification code.
- (3) The month and year the retread was performed.
- (4) The letter "R" followed by the number of times the casing has been retreaded.

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

- (1) Airworthiness compliance markings (only restore at the direction of the original casing manufacturer);
- (2) Size and load rating;
- (3) Casing manufacturer's name or trademark;
- (4) Ply rating;
- (5) Casing manufacturer's plant code;
- (6) Date of manufacture;
- (7) Serial number;
- (8) Speed rating;
- (9) Casing manufacturer's part number; and
- (10) Tire type. Tires requiring a tube in their operation shall be marked with the words "Tube Type."

c. Regrading Procedure.

(1) 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.

(2) 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 and the correct markings applied.

(3) The casing manufacturer's part number must not be altered without the original casing manufacturer's approval.

(4) 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.

d. 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.

8. CASING SELECTION. The new tire casing must be approved by the FAA. Unless otherwise restricted by the tire manufacturer or FAA, any eligible tire may be retreaded provided it meets the inspection and defect limitation criteria, and has met the R-level escalation inspection and test criteria established in the FAA-certificated repair station and the retreader's FAA-approved specification.

a. Inspection. The following are commonly available NDI techniques that should be used when necessary and as specified in this document.

(1) **Visual.** All tires should be visually inspected in the tread, sidewall, bead, and liner areas for conditions that need repair or which require that the tire be scrapped.

(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.

(3) **NDI.** Holography, shearography, ultrasonic, X-ray, and other NDI methods should be used as necessary and where applicable.

b. Disposition of Tire Casings.

(1) **Acceptable Casings.** Tires which meet the acceptable limits for repair listed in the FAA-approved retreader's specification may be repaired/retreaded and returned to service.

(2) **Unacceptable Casings.** Tires that fail the acceptable limits for repair listed in the retreader's specification should be rejected from further aircraft use. Casings not returned to the customer should have all airworthiness compliance markings removed. Removal of the serial number is at the discretion of the retreader. Further, the casing should be marked in a conspicuous manner indicating the casing is not suitable for aircraft use.

9. REPAIR PROCESS. Repairs are permitted if the anomaly (i.e., damage or fatigue) does not exceed limitations specified by the tire manufacturer or the rejection criteria identified in the repair station and retreader's specification, as approved by the FAA. Maximum permissible repairs identified in the process specification shall be validated by tests and/or analysis for FAA approval before returning to service. The specification shall include each of the repair types for bias and radial tires, as identified in the Appendix 1, and additional repairs identified by the retreader.

10. 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 retreading process identified by the repair station and retreader must be provided in the specification for approval by the FAA. Provisions should be included that assure that the retreaded tire weight will not exceed the maximum allowable weight (where it has been determined by the landing gear or airframe requirements established by the aircraft manufacturer).

11. QUALIFICATION TESTING.

a. General.

(1) 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 AC. The retread should not fail the applicable dynamometer tests specified herein nor have any signs of structural deterioration other than normal expected tread wear except when the overload takeoff cycle is run last (see paragraph 11b below). Casings selected for retread tests should have at least 80 percent of their new molded tire skid depth removed by wear (i.e., worn by aircraft usage).

(2) Design and construction differences between radial tires of different manufacturers 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 manufacturer's compatible casings of the same size, ply rating and speed rating.

b. Dynamometer Test Cycles. The retread test tire shall satisfactorily withstand 61-dynamometer cycles as specified in TSO-C62, 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. Good condition of the tire tread is not required after completion of the overload takeoff cycle if it is run last. The sequence of the cycles is optional. 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. A single tire specimen must be used to complete these cycles.

c. Requalification Tests. A retread tire that has been altered, and which has changes in materials, design and/or manufacturing processes that could adversely affect the performance and reliability of the tire, shall be requalified to the dynamometer tests described in paragraph 11b regardless of the escalation level. Examples of such changes include, but are not limited to, changes in tread construction, such as the number or composition of tread reinforcing and/or protector plies, tread compound formulation, number and location of tread grooves, and increases in skid depth and/or tread gauge. Requalification by similarity, as discussed in paragraphs (1) and (2) below, applies to all bias tires that are compatible with the new tread design and/or material change. However, requalification by similarity for radial tires only applies to tires of comparable design by a single manufacturer. Requalification by similarity is not allowed for radial tires from different manufacturers.

(1) Requalification by Similarity (Based on Load Rating). Requalification of a given load rated retreaded tire required as a result of a tread design or material change will automatically qualify the same changes in a lesser load rated retreaded tire of the same size, speed rating, and skid depth provided the lesser load rated retreaded tire has been qualified to the applicable requirements specified in this standard.

(2) Requalification by Similarity (Blanket Change). Requalification of any change that affects multiple sizes may be made by similarity providing that:

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

(b) The data in support of the change in the listed sizes should be submitted to and approved by the appropriate FAA office.

d. Overpressure. A retreaded tire, processed in a manner similar to the example tested on the dynamometer, shall successfully withstand a hydrostatic pressure of three times its rated pressure for 3 seconds without failure. The tire used to do the dynamometer qualification testing may be used if desired.

e. Tire/Rim Slippage. Slippage of the tire on the rim during dynamometer testing must not damage the tube valve of tube type tires, or the gas seal of the tire bead of tubeless tires.

12. RETREAD TIRE DIMENSIONS. The tire dimensional envelope for a given tire size should be within industry accepted practices (e.g., TRA or ETRTO guidelines). When inflated to its rated inflation pressure and allowed to stretch for 12 hours, the tire should not exceed a “grown” tire dimensional envelope.

13. RETREAD BALANCE. All tires must be tested for static unbalance.

a. Auxiliary Tires.

(1) The moment of static unbalance (M) for auxiliary tires shall not be greater than the value determined by Eq. 1.

$$\text{Equation 1.} \quad M = 0.025 D_0^2$$

(2) Computed Eq. 1 values must be rounded off to the next lower whole number where M is in inch/ounces and D_0 is the standardized maximum outside diameter in inches. Tires outside the limits must be corrected for balance before entering service.

b. Main Tires.

(1) The moment of M for main tires shall not be greater than the value determined by Eq. 2.

$$\text{Equation 2.} \quad M = 0.035 D_0^2$$

(2) Computed Eq. 2 values must be rounded off to the next lower whole number where M is in inch/ounces and D_0 is the standardized maximum outside diameter in inches. Tires outside the limits must be corrected for balance before entering service.

14. INFLATION RETENTION. The pressure retention of the tire must be confirmed in accordance with TSO-C62.

15. RETREAD ESCALATION.

a. The wide variation in tire operating environments, which affects the individual casing life, makes it inadvisable to arbitrarily specify the maximum number of times a tire should be retreaded. The number of times a tire can be retreaded should be controlled by an inspection and test system based on the retreader's reliability program and the use of nondestructive interferometric (shearography) tire inspection. This procedure is applicable to both bias and radial ply tires.

b. Following successful qualification of retreaded tires at the first retread level by size/ply rating/speed rating, and before entering into service tires of the first or subsequent R-levels, each part number should be escalated in accordance with the retread manufacturer's escalation plan. Each plan should be submitted to and approved by the FAA.

16. RETREAD RELIABILITY SYSTEM.

a. The Retread Reliability Program should monitor the in-service reliability of the retreaded aircraft tires. The reliability control system, to be consistent with the requirements of the aircraft it supports, should consist of a means to recognize a repetitive in-service issue, determine what plan of action would be needed to address this issue, and follow up on the action taken to remedy the issue.

b. The corrective action taken depends on the results of the data collection and analysis. The corrective action should result in the identified tire issue being reduced within a reasonable timeframe.

Original signed by Carol Giles for
James J. Ballough
Director, Flight Standards Service

**APPENDIX 1. PROCESS SPECIFICATION—
REPAIR GUIDELINES AND FATIGUE ASSESSMENT REQUIREMENTS**

As qualification for returning a repaired tire into service, each retreader must define and validate the maximum repair limits for the retreaded tire. These repair limits must be included in the specification developed by the repair station and retreader for FAA approval. As a minimum, the allowable damage criteria should be identified for following tire areas (if applicable) and any other tire region where damage can affect the continued tire airworthiness:

- Tread area
- Sidewall
- Bead area
- Bead seal
- Bead face and bead heel
- Bead toe
- Chafer strip
- Innerliner
- Areas with exposed cord

To ensure the continued airworthiness of aging casings, each retreader must define and validate a process to assess casing fatigue as part of the retread escalation process. The process to assess fatigue may include static and dynamic tire testing, material testing, and special NDI as described in paragraph 7a(3), and analysis. The process specification should identify the tire's most critical fatigue zone(s), the test method(s) to be applied, and the fatigue limits requiring the actions defined in paragraph 15.