Aviation Mechanic Handbook

Sixth Edition
by Dale Crane

Aviation Supplies & Academics, Inc.
Newcastle, Washington

Aviation Mechanic Handbook, Sixth Edition
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Acknowledgments: Greg Mellema/Abaris, Section 17; Champion Aviation Products, Appendix 2; Concorde Battery, Appendix 3; Michelin Aircraft Tire, Appendix 4.

Printed in the United States of America

2014 2013 2012 2011 9 8 7 6 5 4 3 2 1

ISBN 1-56027-910-9
978-1-56027-910-5
ASA-MHB-MICHELIN

Library of Congress Cataloging-in-Publication Data:
Crane, Dale.
Aviation mechanic handbook / by Dale Crane
p. cm.
"ASA-M-HB1"—T.p. verso.
1. Airplanes — Maintenance and repair — Handbooks, manuals, etc. I. Aviation Supplies & Academics, Inc. II. Title.
TL671.9.C6648 1992
629.134'6 — dc20 92-34331 CIP

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Introduction

Your time as an aviation mechanic is too valuable to be spent looking through stacks of reference books to find a particular chart, formula or diagram you need on a particular job. The editorial staff at ASA has done this job for you and compiled this *Aviation Mechanic Handbook* to be a handy toolbox source of useful information.

For your convenience, this handbook is arranged in 17 sections with a table of contents at the beginning of each section, as well as a complete table of contents at the front of the book and index at the back.

This information has been compiled from a large number of industry and government publications, and every effort has been made to ensure its applicability and accuracy.

The *ASA Aviation Mechanic Handbook* is a companion volume to the *ASA Dictionary of Aeronautical Terms*. The two books are the core of ASA's training materials for aircraft mechanics.

ASA is dedicated to providing quality training materials for the aviation industry. Your feedback regarding our books will help us to continue to produce the materials you need. Visit the ASA website often (www.asa2fly.com) to find updates to operations and procedures due to FAA changes that may affect this publication, downloadable from ASA's Product Update pages.

ASA and the author wish to thank Greg Mellema of Abaris Training for his contribution of the material for Section 17, "Composites" for the Third Edition of the *Aviation Mechanic Handbook*.

Dale Crane, Editor

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Appendix 4: Michelin Aircraft Tires

Courtesy Michelin Aircraft Tire

Aircraft Tire Construction

Tread

The term “tread” refers to the area of the tire that is actually in contact with the ground. Also referred to as the “crown” area, the tread of most Michelin® aircraft tires contain circumferential grooves molded into the tire in the tread area. These grooves are designed to channel water from between the tire and the runway surface thereby improving ground traction on wet runways.

Undertread

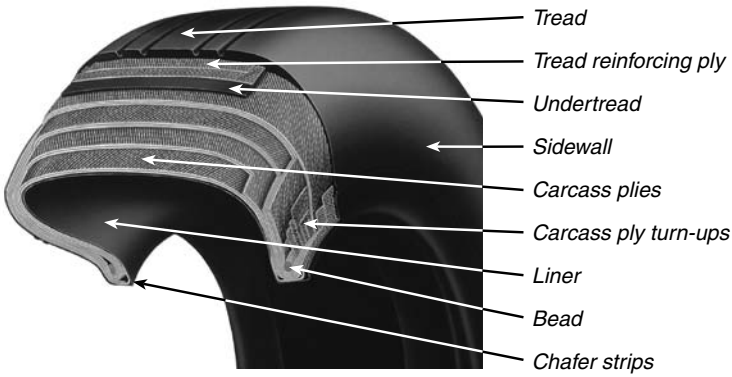
The term “undertread” refers to a layer of specially formulated rubber designed to enhance the bonding between the carcass body and the tread reinforcing plies in bias tires or the protector plies in radial tires.

Carcass Ply

A carcass ply consists of fabric cords (most often nylon), sandwiched between two layers of rubber. The carcass body itself is made from multiple layers of carcass plies, each adding to the strength and load bearing capacity of the tire. The carcass plies are anchored by wrapping them around bead wires, thus forming the ply turn-ups.

Bead

The bead, composed of a number of bead wires, anchor the tire to the wheel. They are made from steel wires that are layered together and embedded



Bias tire construction

Courtesy Michelin Aircraft Tire

in rubber to form a bundle. This bundle is then wrapped with rubber coated fabric for reinforcement. Generally, bias tires are made with 2–6 bead bundles (1–3 per side) whereas radial tires have 2 bead bundles (1 per side) regardless of the tire size.

Chafer Strips

Strips of protective fabric or rubber laid over the outer carcass plies in the bead area of the tire. The purpose of these strips is to protect the carcass plies from damage when mounting or demounting the tire and to reduce the effects of wear and chafing between the wheel and the tire bead.

Liner

In a tubeless tire, this is a layer of rubber specially compounded to resist the permeation of nitrogen and moisture through to the carcass. It is vulcanized to the inside of the tire and extends from bead to bead. On a tubeless tire, the liner replaces the inner tube. With a tube-type tire, a different, thinner liner material is used to protect the carcass plies from moisture and the tube from chafing. The liner of a tube-type tire is generally insufficient for air retention.

Sidewall

This is a layer of rubber covering the outside of the carcass plies. It protects the cord plies and contains anti-oxidants. These chemicals are slowly released over time to help protect the tire from UV and ozone damage.

The following terms are specific to bias-ply tires:

Definition of "Bias"

Bias ply tires are constructed with the carcass plies laid at angles between 30° and 60° to the centerline or rotation direction of the tire. The succeeding plies are laid with the cord at angles that are opposite to each other. This provides balanced carcass strength. Most aircraft tires in service today are bias ply tires.

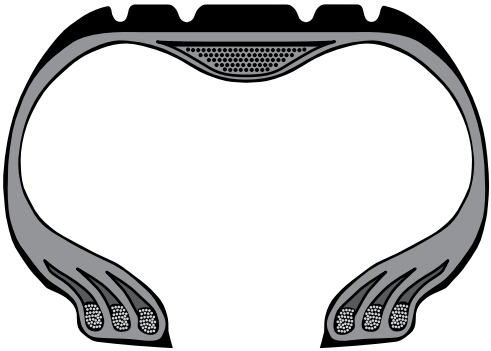
Tread Reinforcing Ply

This consists of single or multiple layers of a special nylon fabric and rubber laid midway beneath the tread grooves and top carcass ply. These plies help to strengthen and stabilize the crown area by reducing tread distortion under load. Additionally, the tread reinforcing ply increases high speed stability and offers added resistance to tread puncture and cutting.

Breaker Plies

These are sometimes used to reinforce the carcass in the tread area of the tire.

Courtesy Michelin Aircraft Tire



New Bias Technology (NBT™)

New Bias Technology (NBT™)

This is a technology developed by Michelin that is unique to the construction of some of the Michelin® bias tires. It consists of a crown reinforcement placed on the inside of the tire. This reinforcement strengthens and provides a more uniform pressure distribution in the footprint of the tire. This slows the rate of wear and improves the landing performance of a tire with a lighter weight design.

Radial-Specific

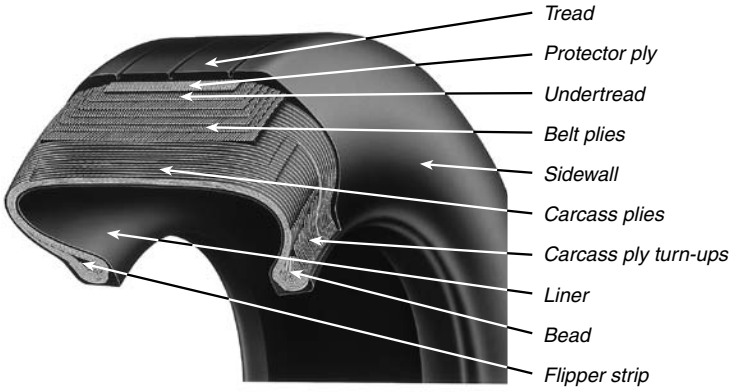
Definition of "Radial"

Radial tires are constructed with each carcass ply laid at an angle that is approximately 90° to the centerline of rotational direction of the tire. Each successive layer is laid at a similar angle. Radial tires have fewer plies than bias tires of the same size because the cord direction is aligned with the burst pressure radial force, allowing for optimized construction.

Protector Ply

This is typically found in retreadable tires in the crown area just under the tread rubber. It provides cut resistance to the underlying belts and carcass plies.

Courtesy Michelin Aircraft Tire



Radial tire construction

Belt Plies

These are laid between the tread area and the top carcass ply. The purpose is to restrain the outer diameter of the tire thereby providing a tread surface with greater resistance to squirm and wear. It also provides a more uniform pressure distribution in the footprint for improved landing performance.

Chine

The chine tire is a nose wheel specially designed to deflect water and slush to the side and away from aft-fuselage mounted engines.

Safety

Aircraft tire and wheel assemblies must operate under high pressures in order to support the loads placed on them. Consequently they should be treated with respect and regard for the high-pressure nature of the assembly. Follow the recommendations outlined in this Michelin Aircraft Tire care and service guide, as well as those guidelines, recommendations and regulations provided by industry authorities such as wheel manufacturers, airframe manufacturers and governmental agencies.

Courtesy Michelin Aircraft Tire

Later in this tire guide, you will learn about considerations when **mounting aircraft tires**. When you are doing this type of work there are two basic safety concerns to remember in addition to the mounting information found later in this guide:

- In order to avoid back pain and other lifting-related injuries, always roll tires on the floor rather than carrying the tire. And always use mechanical lifting tools rather than picking the tire up. Aircraft tires and wheel assemblies are often heavy and represent a potential for injury if not handled properly.
- Before mounting any tire, visually check the tire and the wheel for damage that may have occurred in shipping or even during the time that the tire was stored in your facility.

> **IMPORTANT:** In the event of a conflict between recommended procedures, be sure to contact your Michelin representative before undertaking the procedure in question.

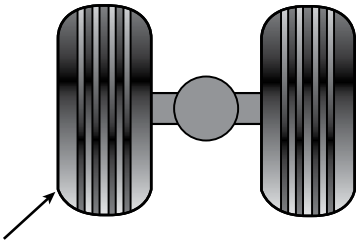
After a tire has been mounted it will need to be inflated. It is important to respect the recommended inflation pressures and all other safety recommendations during the process of inflation. Most aircraft tires rated for over 190 MPH are inflated with nitrogen.

- When inflating tires, be sure to use a suitable inflation cage.
- Keep pressure hose and fittings used for inflation in good condition.
- Allow the tire to remain in the inflation cage for several minutes after reaching its full inflation pressure.

In service, tires should also be treated with care so as to avoid conditions that would damage the tire and wheel assembly or create a dangerous situation for those around the assembly or aircraft.

- Careful attention should be shown to tire and wheel assemblies that are being handled or that are in storage. The Storage section on the next page will give you more details on proper storage.
- You should never approach, or allow anyone else to approach, a tire and wheel assembly mounted on an aircraft that has obvious damage until that assembly has been allowed to cool to ambient temperature. This cooling generally requires at least three hours.
- Always approach a tire and wheel assembly from an oblique angle, in the direction of the tire's shoulder.

Courtesy Michelin Aircraft Tire



Recommended approach angle

- Deflate tires before removing the assembly from the aircraft unless it will be immediately remounted (for example, in the case of a brake inspection).
- Always deflate the tires before attempting to dismount the tire from the wheel or disassembling any wheel component.
- Use extreme caution when removing valve cores as they can be propelled from the valve stem at a high rate of speed.
- When tire and wheel assemblies are found with one or more tie bolt nuts damaged or missing, remove the assembly from service.
- Transporting serviceable tire and wheel assemblies must be done in accordance with the applicable regulatory body for the airline. The transportation of a serviceable inflated aircraft tire is covered by the U.S. Department of Transportation Code of Federal Regulations, the International Air Transport Association (IATA) and other regulatory bodies.
- While serviceable tires may be shipped fully pressurized in the cargo area of an aircraft, it is Michelin's preference to reduce pressure to 25% of the operating pressure or 3 bars/40 psi, whichever is less.

Tire Care Basics

Storage

Aircraft tires and tubes should always be stored in a dry dark environment, free from sunlight and ozone producing appliances such as air compressors. Aircraft tires do

Tires should be stored vertically in racks

Courtesy Michelin Aircraft Tire

not have a specific shelf life and can successfully be stored for long periods of time, if proper techniques are used. Try to avoid florescent lighting and mercury vapor lights as they generate ozone. Tires should always be stored vertically, on their tread. Stacking tires on their sidewall can cause the beads to collapse, making the mounting process difficult.

Inflation Pressure

The most important service you can perform on your aircraft's tires is to make sure they are properly inflated at all times. If you make one or more flights a day, tire pressure should be checked daily. Tire pressure should be checked on the tires before the first flight of the day. If you fly less than one time per day, you should check tire pressure before each flight. Whether using tube-type or tubeless tires, the operating pressures should be set following the instructions given by the airframe manufacturer.

Properly Inflating Tube-Type Tires

Air is usually trapped between the tire and the tube during mounting. Although initial readings show proper pressure, the trapped air will seep out around the valve stem hole in the wheel, and under the tire beads. Within a few days, as the tube expands to fill the void left by the trapped air, the tire may become severely underinflated. To compensate for this effect, check tire pressure before each flight for several days after installation, adjusting as necessary, until the tire maintains proper pressure.

Tire Growth

During the first 12 hours after mounting and initial inflation, aircraft tires will generally grow between 6–10%. This is due to the stretching of the nylon plies that make up the internal structure of the tire. This growth will cause the inflation pressure of the tire to drop 6–10% as well. This is entirely normal, and is accounted for during mounting procedures.

Mounting

Wheels

Make sure you are familiar with and inspect all key wheel parts before beginning to mount a tire. To assist in this process, wheel manufacturers publish specific instructions in their maintenance manuals. Follow their recommendations and procedures for wheel assembly and disassembly to help obtain trouble-free mounting and dismounting.

Courtesy Michelin Aircraft Tire

Wheel half and O-ring

Special care should be given to the following:

- Ensure that the bead seating area of the wheel is clean.
- Mating surfaces of the wheel halves should be free of nicks, burrs, small dents, or other damage. Painted or coated surfaces should be in good condition.
- Be sure fuse plugs, inflation valves, and wheel plugs are in good condition and properly sealed against pressure loss.
- O-ring grooves in the wheel halves should be checked for damage or debris.
- O-rings must be of the proper material.

Tires

Before mounting any tire, check that the tire markings are correct for the required application (size, ply rating, speed rating, part number, and TSO marking).

Visually inspect the outside of the tire for:

- Damage caused by improper shipping or handling.
- Cuts, tears, or other foreign objects penetrating the rubber.
- Permanent deformations.

Courtesy Michelin Aircraft Tire

- Debris or cuts on the bead seating surfaces.
- Bead distortions.
- Cracking that reaches the cords.
- Contamination from foreign substances (oil, grease, brake fluid, etc.) which can cause surface damage.

Inspect the inside of the tire for:

- Foreign material.
- Wrinkles in the inner liner.
- Inner liner damage.

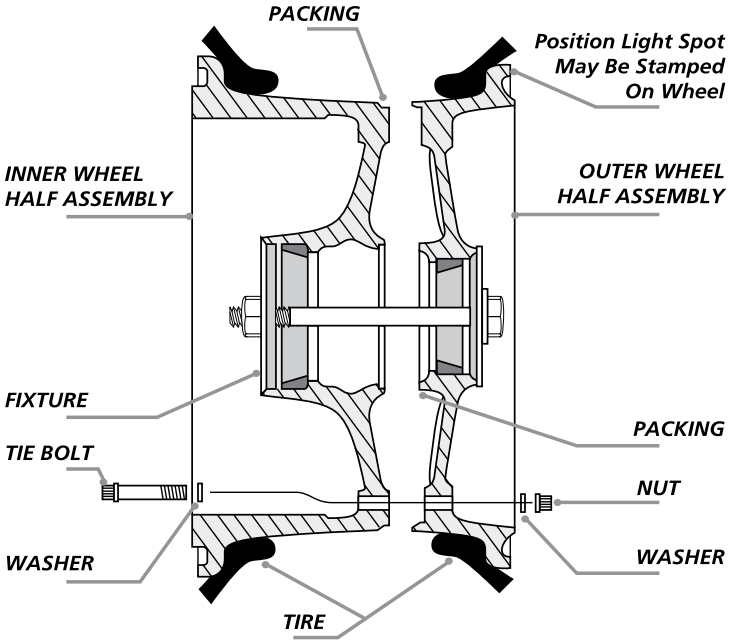
Initial Pressure Retention Check

The initial pressure retention check requires approximately 15 hours to determine if an assembly can be accepted for service. This important process helps assure reliable service and avoid costly returns for repairs. Additional checks are performed on tire/wheel assemblies not meeting the minimum acceptance criteria for pressure loss.

The procedure is as follows:

1. Inflate the newly mounted tire/wheel assembly to operating pressure as specified.
2. Store the inflated assembly for 3 hours.
3. Check the inflation pressure (be sure that the ambient temperature has not changed more than 5°F—a drop of 5°F will reduce inflation pressure by 1%).
   a. If the inflation pressure is ≥ 90% of the operating pressure, go to step 4. If the inflation pressure is ≤ 90% of the operating pressure, inspect the assembly for leakage. Use a soap solution on tire beads, valves, fuse plugs, etc.
   b. If soap bubbles or leaks are found, make appropriate repairs and return to step 1.
4. Re-inflate the tire to the specified operating pressure.
5. After a 12 hour storage period, check the inflation pressure (once again be sure the ambient temperature has not changed more than 5°F).
   a. If the inflation pressure is ≥ 97.5% of the operating pressure, re-inflate the tire to the specified operating pressure and accept the tire/wheel assembly. Stop initial pressure retention check.
   b. If the inflation pressure is ≤ 97.5% of the operating pressure, inspect the assembly for leakage as in step 3b and proceed to step 6.

Courtesy Michelin Aircraft Tire



Aircraft tire/wheel assembly

6. Re-inflate the tire to the specified operating pressure.
7. After a 24 hour storage period, check inflation pressure (be sure the ambient temperature has not changed more than 5°F).
   a. If inflation pressure is ≥ 95% of the operating pressure, re-inflate the tire to the specified operating pressure and accept the tire/wheel assembly. Stop initial pressure retention check.
   b. If inflation pressure is ≤ 95% of the operating pressure, reject the tire/wheel assembly.

Courtesy Michelin Aircraft Tire

On-Aircraft Tire Inspection

Inflation Pressure

To help avoid false readings, tire pressure should be checked on tires before the first flight of the day. If this is not possible, wait at least 3 hours after landing to allow the tire to cool to ambient temperature. Air in a hot tire will expand, causing a temporary higher pressure reading. Never bleed pressure from a hot tire.

Effects of Underinflation

Too little pressure can be harmful to your tires and dangerous to your aircraft and those in it. Underinflated tires can creep or slip on the wheel under stress or when brakes are applied. Valve stems can be damaged or sheared off and the tire, tube or complete wheel assembly can be damaged or destroyed. Excessive shoulder wear may also be seen. Underinflation can allow the sidewalls of the tire to be crushed, causing bead damage and making the tire unsafe to use. Severe underinflation may cause ply separation and carcass degradation. This same condition can cause inner tube chafing and a resultant blowout.

Effects of Overinflation

Tires operating under too much inflation pressure are more susceptible to bruising, cuts, and shock damage. Ride quality as well as traction will be reduced. Continuous high pressure operation will result in poor tire wear and reduced landings. Extremely high inflation pressures may cause the aircraft wheel or tire to explode or burst, which may result in serious or fatal injuries. Never operate aircraft tires above rated inflation pressure.

Checking tire pressure

Courtesy Michelin Aircraft Tire

Wear

Removal Criteria

In the absence of specific instructions from the airframe manufacturer, a tire should be removed from service for wear using the following criteria. Based on the fastest wearing location, remove tires:

- When the wear level reaches the bottom of any groove along more than 1/8 of the circumference on any part of the tread, or
- If either the protector ply (radial) or the reinforcing ply (bias) is exposed for more than 1/8 of the circumference at a given location.

> **NOTE:** If an aircraft has made an emergency or particularly rough landing, the tire, tube and wheel should always be checked.

Overinflation

Operating a tire at a higher pressure than required will cause increased wear at the center of the tread. This will reduce the life of the tire and make the tire more susceptible to bruises, cutting, and shock damage.

Underflation

When a tire is consistently operated underinflated, shoulder wear will result. Severe underinflation may cause ply separations and carcass heat build-up, which can lead to thrown treads, sidewall fatigue, and shortened tire life.

Worn Beyond Recommended Limits

If a tire is worn into the carcass/body plies, the strength of the tire will be reduced. This may cause the tire to burst or explode, which may result in serious or fatal injuries.

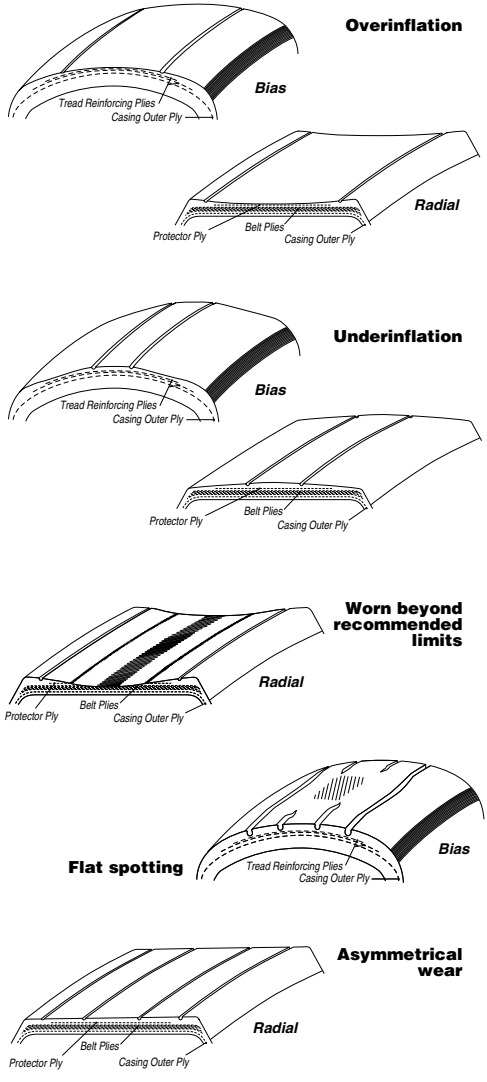
Flat Spotting

This wear condition is a result of the tire skidding without rotating, and is usually caused by brake lock-up or a large steer angle. The tire should be removed from service if the flat spotting exposes the protector or reinforcing ply, otherwise the tire may remain in service if it does not cause aircraft vibration.

Asymmetrical Wear

This is a result of the tire operating under prolonged yaw and/or camber. Tires that do not expose any fabric can be dismounted, turned around, and remounted to even up wear.

Courtesy Michelin Aircraft Tire



Common tire wear conditions

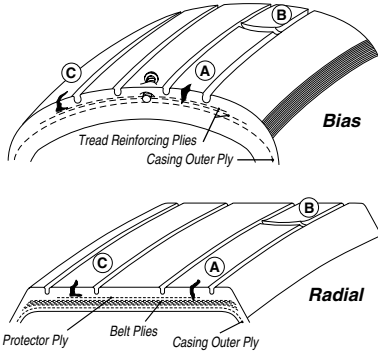
Courtesy Michelin Aircraft Tire

Limits for Tire Damages

Tread Cuts/Foreign Objects

In the absence of specific cut removal instructions from the airframer, tires should be removed when:

- Cuts, embedded objects, or other injuries expose or penetrate the carcass plies (bias) or tread belt layers (radial).
- A cut or injury severs or extends across a tread rib.
- Undercutting occurs at the base of any tread rib cut.
- Round foreign object openings are acceptable up to .375" in diameter.



Remove tire from service when:

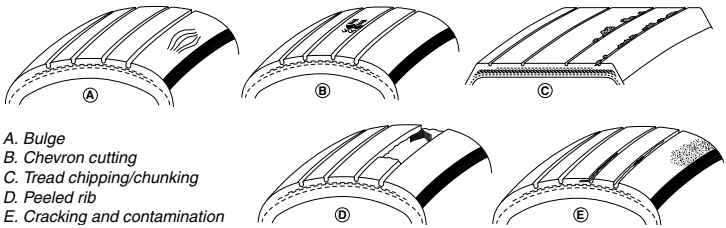
A. Depth of cut exposes the casing outer ply (bias) or outer belt layer (radial).
B. A tread rib has been severed.
C. Undercutting occurs at the base of any cut.

Bulges or Separations

Immediately remove the tire from service. Mark these areas with a color crayon before deflating.

Chevron Cutting

Remove from service if the chevron cutting results in chunking which extends to and exposes the reinforcing or protector ply more than one square inch.



A. Bulge
B. Chevron cutting
C. Tread chipping/chunking
D. Peeled rib
E. Cracking and contamination

Common damage conditions

Courtesy Michelin Aircraft Tire

Chevron cutting is caused by the sharp-edged ridges of concrete on runways which have been crosscut.

Tread Chipping/Chunking

Remove from service if the reinforcing ply or protector ply is exposed for more than one square inch.

Peeled Rib

Remove from service if the reinforcing ply or protector ply is exposed.

Groove Cracking

Remove from service if the groove cracking exposes the reinforcing ply of protector ply for more than 1/4" in length. An aircraft may return to a maintenance base to replace tires meeting this condition if there is no continuous cracking exposing fabric greater than one inch in length.

Rib Undercutting

Remove from service if undercutting extends more than 1/4" under the rib.

Contamination From Hydrocarbons

Oil, grease, brake fluids, solvents, etc., can soften or deteriorate rubber components. If a tire comes in contact with any of these, immediately

Protect tires from contaminants

Courtesy Michelin Aircraft Tire

wash the contaminated area with denatured alcohol, then with a soap and water solution. If the contaminated area is soft and spongy compared to an unaffected area of the tire, remove the tire from service.

Sidewall Cuts

If sidewall cords are exposed or damaged, remove the tire from service. Cuts in the rubber which do not reach the cord plies are not detrimental to tire performance—the tire may remain in service.

Weather/Ozone Cracking

Remove from service only if weather or ozone cracks extend to the cord plies.

Dismounting

Proper dismounting procedures simplify the job of servicing aircraft tires, while increasing safety and reducing the chances of damaging tires or wheels. The task of dismounting tires should not be undertaken without proper equipment, instructions, and trained personnel. The following is the basic sequence that should be followed:

- Before beginning any tire dismount, be sure to follow the instructions and precautions published in the wheel supplier's maintenance manual.
- Mark damaged or bulge areas, if any, before deflating, using a contrasting color chalk.
- Completely deflate the tire or tube before dismounting.
- Use a bead breaker to loosen tire beads from both wheel-half flanges.
- Apply bead breaker ram pressure or arm pressure slowly, or in a series of sequences or jogs, to allow time for the tire's beads to slide on the wheel.

What to do if the tire becomes fixed to the wheel:

- Release ram pressure. Apply a soap solution to the tire/wheel interface.
- Allow several minutes for the solution to penetrate between the tire and wheel.
- Reapply a reduced hydraulic pressure to the tire.
- Repeat several times if necessary.

Courtesy Michelin Aircraft Tire

If the tire still remains fast:

- Remove the tire/wheel assembly from the machine.
- Reinflate the tire in a cage until the bead moves back to its correct position.
- Deflate the tire.

Recommence the dismounting procedure:

- Remove tie bolts and slide out both parts of the wheel from the tire.
- For tube-type tires, remove the tube.
- Tire is now dismounted.

Off-Aircraft Inspection with Tire Dismounted

A systematic approach to tire inspection is recommended to ensure that all areas are properly inspected. The following system is recommended:

- Inspect the tread area—follow the procedures for on-aircraft inspections.
- Inspect both sidewall areas — follow the procedures for on-aircraft inspections.
- Inspect the bead areas—check the entire bead area for chafing or damage.
- Inspect the innerliner—any tire with loose, frayed or broken cords or wrinkles should be discarded. Liner blisters, especially in tubeless tires, should be left undisturbed.
- Inspect the inner tube, if applicable—tubes with leaks, severe wrinkles or creases, or chafing should be properly discarded.
- Inspect for wheel damage—wheels should be inspected according to the wheel manufacturer's recommendations.

Suggested approach:
1. Tread; 2. Sidewalls;
3. Bead areas; 4. Innerliner

Vibration and Balance

Vibration, shimmy, and other similar conditions are usually blamed on improper tire balance. Imbalance is a well known and easily understood

Courtesy Michelin Aircraft Tire

cause for vibration. In many cases, though, this may not be the cause. There are a number of specific aspects of the tire, wheel, and gear assembly which can be the cause or contribute to aircraft vibration. As with any concern, a systematic approach should be taken to isolate its cause. The following inspections will help identify and/or prevent this problem:

- Check that the tire has been inflated to the proper inflation pressure.
- Ensure that the tire reaches full growth before it is installed on the aircraft.
- Check that the beads of the tire have been properly seated.
- Check the tire for flat spotting or uneven wear.
- Verify that the tires have been properly mounted.
- Check for air trapped between the tire and tube.
- Check for wrinkles in the tube.
- Check the wheel for an imbalance due to improper assembly.
- Check the condition of the wheel to see if it has been bent.
- Check for a loose wheel bearing caused by an improperly torqued axle nut.
- Check for poor gear alignment as evidenced by uneven wear.
- Check for worn or loose landing gear components.

Understanding Regulatory Requirements

FAA Certification/New Tires

This certification requires qualification of the tire to FAA Technical Standard Order (TSO) C62d. Generic static and dynamic tests are determined based upon the speed and load rating of the tire, and may include numerous landing, taxi, and take-off cycle tests.

FAA Certification/Retreaded Tires

Tires are qualified to the requirements of FAA Advisory Circular 145-4. Tires are tested based upon the speed rating and current retread level.

OEM Certification

This certification is generally based on aircraft specific requirements, as required by the OEM, in addition to FAA certification per TSO-C62d.

Courtesy Michelin Aircraft Tire