AEROSPACE RECOMMENDED PRACTICE

ARP6225™ REV. B

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Superseding ARP6225A

(R) Aircraft Tire Inspection - In-Service Removal Criteria

RATIONALE

This revision clarifies the normal wear removal criteria, adds gear alignment as another possible cause of uneven wear, removes vibration criteria for tire removal, adds tire cold set as a condition, and adds “sidewall” and “inner liner” text boxes and arrows to Figure 1.

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1. SCOPE

This SAE Aerospace Recommended Practice (ARP) is written to establish tire removal criteria of on-wing civil aircraft tires only. This document is primarily intended for use with commercial aircraft, but may be used on other categories of civil aircraft, as applicable. The criteria are harmonized with the care and service manuals (CSMs) of the tire manufacturers for both radial and bias tires.

2. 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 the 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 SAE Publications

Available from SAE International, 400 Commonwealth Drive, Warrendale, PA 15096-0001, Tel: 877-606-7323 (inside USA and Canada) or +1 724-776-4970 (outside USA), www.sae.org.

AIR5541 Recommended Actions When Disinfectants, De-Icers, and Cleaners Come in Contact with Landing Gear Structure

ARP5507 Aircraft Tire-to-Wheel Performance Characteristics

ARP5265 Minimum Operational and Maintenance Resposibilities for Aircraft Tire Usage

2.2 Other Publications

Bridgestone Tire Care and Maintenance

Dunlop DM1172 Care Manual

Goodyear Aircraft Tire Care and Maintenance

Michelin Aircraft Tire Care and Service Manual

3. BACKGROUND

Airframe manufacturers often include on-aircraft criteria for tire inspection and removal in their aircraft maintenance manuals (AMMs) that may not align with the various tire manufacturers' CSMs. It is possible to find mixed configurations (i.e., tires of same size but from different manufacturers) on the same aircraft.

To better address airline requests, the airframe manufacturers have expressed an interest in having a common set of criteria harmonized across the tire manufacturers CSMs that could be incorporated into their AMMs as they relate to tire removal criteria. The tire industry agreed to issue a common document for on-aircraft tire removal criteria.

4. PROCEDURE

A summary of the tire removal conditions and actions listed below is shown in Table 1 as a quick reference guide. The detailed descriptions for the on-wing tire removal categories listed below are given in the following sections.

- Tread wear criteria:
  - Normal wear
  - Uneven wear (shoulder, center)
- Tread damage criteria:
  - Flat spots
  - Tread rubber reversion
  - Skid-through damage
  - Peeled rib
  - Thrown tread
  - Tread cuts
  - Chevron cutting
  - Groove cracking
  - Rib undercutting
  - Open tread splice
  - Rib tearing
  - Tread chipping and chunking
- Sidewall damage criteria:
  - Cuts
  - Circumferential cracks
  - Weathering and cracking
  - Rim flange area chafing and cracking
- Blister and bulge criteria
- Miscellaneous criteria:
  - Foreign object damage (FOD)
  - Tire contamination
  - Tire slippage on the rim
  - Tire cold set

The radial and bias tire components are shown in Figures 1 and 2. Due to design parameters, the actual tire may or may not contain all pictured components.

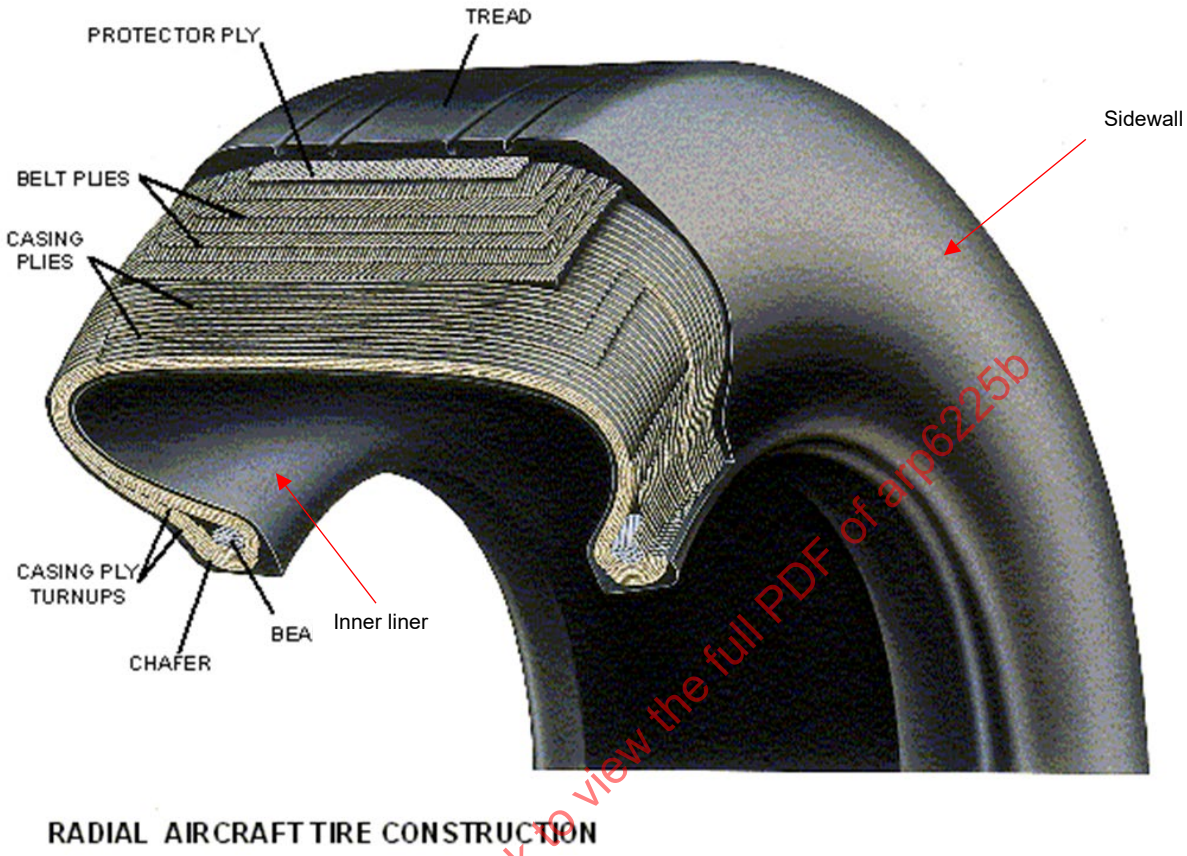

Figure 1 - Radial tire components nomenclature

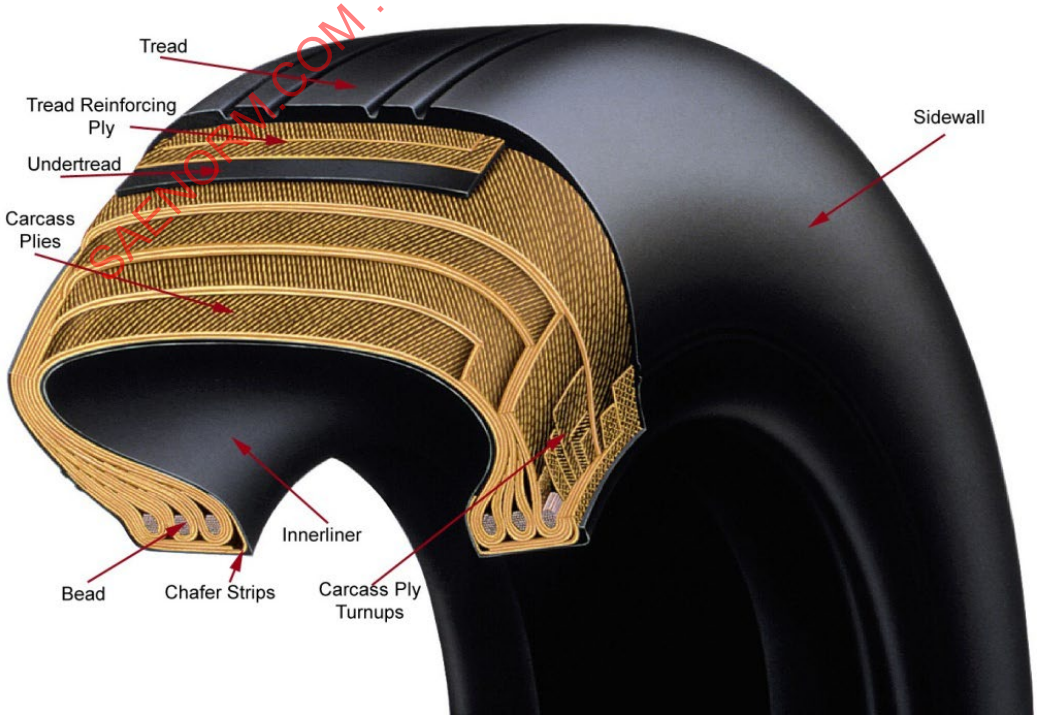

Figure 2 - Bias tire components nomenclature

Table 1 - Summary of removal conditions and actions

NOTE: This table is to be used as a quick reference for the removal conditions described in greater detail in the body of the document.

TREAD WEAR CRITERIA		
CONDITION	**OBSERVATION/DAMAGE**	**ACTION**
Normal Wear	An even tread wear indicates that the tire has been properly maintained during its service life.	Remove tire when the wear level criteria is reached (Figure 3), or when any fabric is exposed at any location over the tread surface, WHICHEVER COMES FIRST (Figures 4 and 5). NOTE: If the wear removal criteria is met at an outstation where maintenance is not available, the aircraft manufacturer should be contacted to assure the tire may remain in service and if any additional tire inspections are required prior to each aircraft departure before arriving at a suitable maintenance base for a wheel and tire assembly replacement. This should be accomplished as soon as possible. However, if any fabric or metallic material is exposed, the tire should be removed immediately
Uneven Wear (shoulder, center, asymmetric)	Under-inflation can lead to excessive tread shoulder wear. It will lead to high tire deflection and subsequent heat build-up which may result in severe tire damage. The cause for operating underinflated should be investigated by the operator and corrective actions taken (Figure 4). Underinflated tires should be corrected per the tire pressure maintenance schedule of ARP5265 and the AMM. Over-inflation can accelerate the center tread wear, reduce tire traction, reduce the number of landings per tread, and make the tire more susceptible to cutting and foreign object damage (FOD) (Figure 5). Overinflated tires should be corrected per the tire pressure maintenance schedule of ARP5265 and the AMM. On some aircraft, gear alignment factors such as camber and toe can lead to asymmetric wear, where one side of the tire wears more rapidly than the other. In addition, asymmetric wear may occur on gear with multiple axles (Figure 6). This could be indicative of deformation or damage elsewhere on the landing gear. The airframe manufacturer and Landing Gear OEM should be informed of such wear for possible root cause investigation.	Tires with uneven wear should be removed from the aircraft if the wear limits (defined under normal wear) are reached.

Table 1 - Summary of removal conditions and actions (continued)

TREAD DAMAGE CRITERIA		
CONDITION	**OBSERVATION/DAMAGE**	**ACTION**
Flat Spots	Tread flat spot or severe tread rubber abrasion results from steering maneuvers prior to aircraft rolling, or the locking of the wheel during braking or touchdown (Figure 7). Flat spotting due to cold temperature or prolonged parking is not a condition for tire removal.	The tire should be removed from the aircraft when the flat spot damage exceeds the wear removal criteria of 5.1.
Tread Rubber Reversion	Tread rubber reversion is generally caused by wheel locking on wet or ice-covered runways. The affected area is similar in shape to a flat spot (oval), but the rubber appears to be melted (Figure 8).	The tire should be removed from the aircraft when the reversion flat spot damage exceeds the wear removal criteria of 5.1.
Skid-Through Burst	Skid-through burst results from the locking of the wheel. In this case, the tire experiences either a loss of inflation pressure or an explosive blowout (Figure 9).	Both the failed tire and axle mate tire should be removed from the aircraft, the burst tire marked as "scrap," and the axle mate tire marked with the removal reason ("mate to flat"). The skid-through tire can be scrapped locally, but the mate to flat tire should be returned to the tire manufacturer or retreader.
Peeled Rib	A peeled rib usually starts with a cut or damage in the tread and results in a circumferential delamination of the tread rib away from the tire casing, typically with no loss of reinforcing plies (Figure 10) or tire pressure.	The tire should be removed immediately from service when the peeled section, regardless of length, is exposing fabric or has fully detached. Pieces from the tread should be requested from airport authorities and returned to the home base for potential analysis by the tire supplier.
Thrown Tread	A thrown tread on an inflated tire is a partial or complete loss of the tread down to the casing plies or tread reinforcing plies/protector ply (Figure 11).	The tire should be removed immediately from service. Pieces from the tread should be requested from airport authorities and returned to the home base for potential analysis by the tire supplier. If the damaged tire is deflated due to a loss of inflation pressure, then the axle mate should be removed also. If the tire is still inflated after the aircraft is parked, if time permits, record the tire pressure after it has cooled down (allow 3 hours).
Tread Cuts	Foreign objects that are present on runways, taxiways, and parking areas can cause cuts to the tires (Figure 12).	Tire should be removed immediately from the aircraft if: ▪ The cut exposes or penetrates any fabric over the tread surface, or ▪ The cut or damage severs or extends across a tread rib, or ▪ Undercutting occurs at the base of any tread rib cut.
Chevron Cutting	Chevron cutting is tread damage (small z-, s-, or v-shaped tears) caused by touchdown, running, and/or braking on cross-grooved runways (Figure 13). Chevron cutting is a condition of the tread rubber only.	Tire should be removed from aircraft if: ▪ The tread cut criteria are reached, or ▪ Fabric beneath the tread is exposed for more than 1.0 inch^2 (6.45 cm^2), or ▪ The cutting involves the full width of any one of the tread ribs.
Groove Cracking	Groove cracking may result from ozone attack of the rubber or excessive flexing of the groove bottoms as a result of insufficient inflation of the tire. These cracks occur along the bottom of tread grooves (Figure 14).	The tire should be removed immediately from the aircraft if: ▪ Groove cracking exposes the fabric beneath the tread for more than 0.25 inch (6.35 mm) circumferentially in length. ▪ Groove cracking has led to undercutting of the adjacent rib by more than 0.25 inch (6.35 mm).

Table 1 - Summary of removal conditions and actions (continued)

Rib Undercutting	Rib undercutting can be an extension of groove cracking progressing under a tread rib or develop as a break in the groove wall extending under the rib. This can lead to tread chunking, peeled rib, or thrown tread (Figure 15).	The tire should be removed immediately from the aircraft if undercutting extends more than 0.25 inch (6.35 mm) under the tread rib.
Open Tread Splice	An open tread splice is a crack in the tread rubber where the manufacturing joint or splice separates in a radial direction across the tread ribs (Figure 16).	The tire having this defect should be removed immediately from the aircraft.
Rib Tearing	Rib tearing occurs when the tire is subjected to excessive side force during landing or taxiing (Figure 17).	The tire should be removed immediately from the aircraft if fabric beneath the tread is exposed for more than 1.0 inch^2 (6.45 cm^2) or the damage extends the full width of the tread rib.
Tread Chipping and Chunking	This is a condition visible at the edge of the tread rib in which small amounts of rubber begin to separate from the tread surface. Tread chunking can be caused by rib undercutting, tight turning, or a high lateral force applied to the tire tread (Figure 18). This can lead to rib undercutting under severe conditions.	The tire should be removed immediately from the aircraft if any fabric is exposed.
SIDEWALL DAMAGE CRITERIA		
CONDITION	**OBSERVATION/DAMAGE**	**ACTION**
Cuts on the Sidewall	Cuts on the sidewall are caused by damage from FOD (Figure 19).	The tire should be removed immediately from the aircraft if any sidewall cord is visible. Cuts in the rubber which do not reach the cord plies are not detrimental to tire performance, but should be monitored at subsequent inspections. The tire can be left in service if the cuts do not reach the ply cords.
Circumferential Cracks	Circumferential cracks can be caused by a molding condition of the rubber or load shear and stress combined with low tire inflation pressure (Figure 20).	The tire should be removed immediately from the aircraft if sidewall cord is visible. If operating underinflated is suspected, the operator should investigate and take corrective actions.
Weathering and Cracking	Weathering and cracking occur when tires are exposed to ozone or to direct sunlight for an extended period of time (Figure 21). An insufficient tire inflation pressure accelerates the phenomenon.	The tire should be removed immediately from the aircraft if the sidewall plies are visible. If operating underinflated is suspected, the operator should investigate and take corrective actions.
Rim Flange Area Chafing and Cracking	Chafing and cracking can occur when the lower sidewall of the tire deflects over the wheel flange (Figure 22). An insufficient tire inflation pressure accelerates the phenomenon.	The tire should be removed immediately from the aircraft if sidewall cord is visible. The tire can be left in service if the chafing/cracking does not reach the ply cords.
Blister or Bulge	Operating conditions outside the tire specification can cause bulges or blisters on the tread or on the sidewalls (Figure 23). They normally indicate a separation of components. When present, these defects can be observed mainly in the shoulder area of the tire while it is still warm.	Any tire showing a bulge or blister should be removed immediately from the aircraft. Clearly mark the affected area before deflating the tire.

Table 1 - Summary of removal conditions and actions (continued)

MISCELLANEOUS CRITERIA		
CONDITION	**OBSERVATION/DAMAGE**	**ACTION**
Foreign Object Damage (FOD)	Foreign object damage (FOD) (Figure 24) occurs when material left on the runway, taxiway, or ramp causes damage to tires, engines, or other aircraft structure. It is the most common cause for tires being removed before full wear out. Airport authorities should be notified when it can be confirmed that tire removals for FOD are prevalent.	Warning: Do not attempt to remove embedded FOD from an inflated tire. Remove tires from the aircraft if: ▪ Cuts, embedded objects, or other injuries expose or penetrate the fabric beneath the tread. ▪ Cuts, embedded objects, or other injuries that do not expose or penetrate the fabric beneath the tread but extends entirely across a tread rib (any depth).
Tire Contamination (Hydraulic Fluid, Fuel, Disinfectants, Hydrocarbons, etc.)	In case of contamination, check for rubber condition (Figure 25). The tire has to be cleaned quickly with commercially available denatured alcohol to remove the contaminant, and then washed with a soap and water solution.	Ensure that the contaminated rubber surface is not swelled. An easy check is to push your fingernail into the contaminated surface, and in case of swelling, the nail will leave a permanent imprint. In this case, the tire should be returned to the retreader for inspection/possible repair. If the subject tire needs to be removed and sent to the retreader for inspection, clearly identify the tire by marking "contaminated tire."
Tire Slippage on the Rim	After installation of a new tire on the rim, some cycles on the aircraft may be necessary before the tire reaches its final position. During this period of time, a slippage of the tire on the rim may be observed (e.g., the red mark on the tire is no longer aligned with the inflation valve or the wheel heavy point if marked).	ARP5507 recommends a maximum slippage of 20 degrees following installation. ARP5507 further recommends that tires which move in excess of 20 degrees should be disassembled and evaluated for appropriate action.
Tire Cold Set	Loaded tires that are left stationary for any length of time can develop temporary flat spots. The degree of this flat spotting depends on the load, tire deflection and temperature. Flat spotting is more severe and more difficult to work out during cold weather.	Under normal conditions, this condition will disappear by the end of the taxi run. It should not be considered as a reason for tire removal from service.

5. TIRE REMOVAL CRITERIA

WARNING: Aircraft tires should be mounted only with the proper equipment, instructions, and operator training. Serious injury may occur as a result of improper equipment or procedures.

WARNING: Always approach a tire/wheel assembly mounted on an aircraft from an oblique angle (direction of the tire's shoulder).

WARNING: Aircraft tire and wheel assemblies should be treated with the same care as any other high-pressure vessel. Improper handling may lead to serious injury.

WARNING: Aircraft tires should always be inflated with a properly regulated dry nitrogen inflation source. Regulate the supply line to a pressure no greater than 1.5 times the operating inflation pressure. Inflating a tire without a pressure regulator presents a risk of personal injury and/or damage to equipment.

CAUTION: Be careful when handling, assembling, and disassembling wheel components, to avoid damage.

WARNING: Do not probe cuts, embedded objects or remove embedded objects from an inflated tire. Such action could further damage a tire, causing it to rupture, resulting in personal injury or equipment damage.

WARNING: A tire/wheel assembly that has known damage should be allowed to cool to ambient temperature (a minimum of 3 hours) before the tire is deflated.

WARNING: Use care when removing the valve core from an inflated tire. Use of a valve core removal tool is recommended. The valve core of an inflated tire can be projected at a high speed and possibly cause injury.

NOTE: Tires removed for other than normal wear should be investigated for cause with corrective actions taken, if appropriate.

NOTE: The regular care and maintenance of aircraft tires while in service is essential to maximizing the number of duty cycles that can be achieved by each tire, and to minimizing the risk of aircraft damage from tire failures. It is important that tire condition and pressure are checked daily and underinflated tires should be addressed per the tire pressure maintenance schedule of ARP5265 and the AMM.

NOTE: This document is primarily intended for use with commercial aircraft, but may be used on other categories of civil aircraft, as applicable. Much of this information can be used on military tires also. However, some military tires have reinforcing fabric within the wearable portion of the tread so wear criteria shown in the tables above cannot be used when evaluating these military tires.

5.1 Tread Wear Criteria

5.1.1 Normal Wear

An even tread wear indicates that the tire has been properly maintained during its service life.

REMOVAL LIMIT: Remove tire when the bottom of any groove at one point up to 1/8 of the tire circumference is reached (Figure 3), or when any fabric or metallic material is exposed at any location over the tread surface, WHICHEVER COMES FIRST (Figures 4 and 5).

Figure 3 - Normal wear

NOTE: If the wear removal criteria is met at an outstation where maintenance is not available, the aircraft manufacturer should be contacted to assure the tire may remain in service and if any additional tire inspections are required prior to each aircraft departure before arriving at a suitable maintenance base for a wheel and tire assembly replacement. This should be accomplished as soon as possible. However, if any fabric or metallic material is exposed, the tire should be removed immediately.

5.1.2 Uneven Wear (Shoulder, Center, Asymmetric)

Under-inflation can lead to excessive tread shoulder wear. It will lead to high tire deflection and subsequent heat build-up, which may result in severe tire damage. The cause for operating underinflated should be investigated by the operator and corrective actions taken (Figure 4). Underinflated tires should be corrected per the tire maintenance schedule of ARP5265 and the AMM.

Over-inflation can accelerate the center tread wear, reduce tire traction, reduce the number of landings per tread, and make the tire more susceptible to cutting and foreign object damage (FOD) (Figure 5). Overinflated tires should be corrected per the tire pressure maintenance schedule of ARP5265 and the AMM.

On some gear alignment, factors such as camber and toe can lead to asymmetric wear, where one side of the tire wears more rapidly than the other. In addition, asymmetric wear may occur on gear with multiple axles (Figure 6). This could be indicative of deformation or damage elsewhere on the landing gear. The airframe manufacturer and landing gear OEM should be informed of such wear for possible root cause investigation.

REMOVAL LIMIT: Tires with uneven wear should be removed from the aircraft if the wear limits (defined under normal wear) are reached.

Figure 4 - Shoulder wear

Figure 5 - Center wear

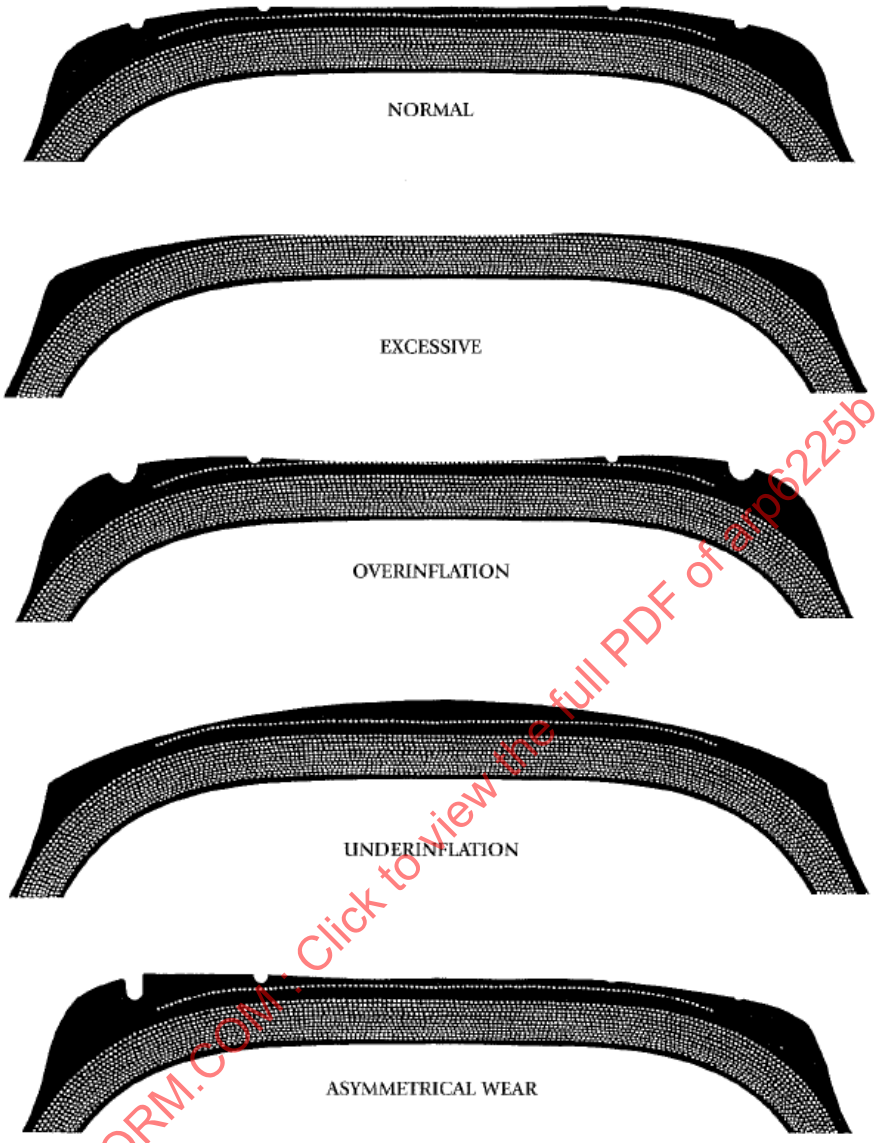

Figure 6 - Typical tire wear characteristics

NOTE: If the wear removal limit is met at an outstation where maintenance is not available, the aircraft manufacturer should be contacted to assure the tire may remain in service and if any additional tire inspections are required prior to each aircraft departure before arriving at a suitable maintenance base for a wheel and tire assembly replacement. However, if any fabric or metallic material is exposed, the tire should be removed immediately.

5.2 Tread Damage Criteria

5.2.1 Flat Spots

Tread flat spot or severe tread rubber abrasion results from steering maneuvers prior to aircraft rolling, or the locking of the wheel during braking or touchdown (Figure 7).

REMOVAL LIMIT: The tire should be removed from the aircraft when the flat spot damage exceeds the wear removal criteria of 5.1.

Locked wheel tire flat spot

Typical tire flat spot

Figure 7 - Flat spot

NOTE: The tire can remain in service if the flat spot does not reach the above-mentioned limit and if there is (1) sufficient groove depth in the whole flat spot area, or (2) no incipient (visible) separation.

5.2.2 Tread Rubber Reversion

Tread rubber reversion is generally caused by wheel locking on wet or ice-covered runways. The affected area is similar in shape to a flat spot (oval), but the rubber appears to be melted (Figure 8).

REMOVAL LIMIT: The tire should be removed from the aircraft when the reversion flat spot damage exceeds the wear removal criteria of 5.1.

Figure 8 - Tread rubber reversion

5.2.3 Skid-Through Burst

Skid-through burst results from the locking of the wheel. In this case, the tire experiences either a loss of inflation pressure or an explosive blowout (Figure 9).

REMOVAL LIMIT: Both the failed tire and axle mate tire should be removed from the aircraft, the burst tire marked as “scrap” and the axle mate tire marked with the removal reason (“mate to flat”). The skid-through tire can be scrapped locally, but the mate to flat tire should be returned to the tire manufacturer or retreader.

Figure 9 - Skid through

5.2.4 Peeled Rib

A peeled rib usually starts with a cut or damage in the tread and results in a circumferential delamination of the tread rib away from the tire casing, typically with no loss of reinforcing plies (Figure 10) or tire pressure.

REMOVAL LIMIT: The tire should be removed immediately from service when the peeled section, regardless of length, is exposing fabric or has fully detached. Pieces from the tread should be requested from airport authorities and returned to the home base for potential analysis by the tire supplier.

Figure 10 - Peeled rib

5.2.5 Thrown Tread

A thrown tread on an inflated tire is a partial or complete loss of the tread down to the casing plies or tread reinforcing plies/protector ply (Figure 11).

NOTE: A thrown tread tire should not be reported as a burst tire unless the tire experienced a rapid pressure loss concurrent with the thrown tread.

NOTE: Inspection of the aircraft after a tire burst, thrown tread, or wheel failure should be completed prior to release of the aircraft.

REMOVAL LIMIT: The tire should be removed immediately from service. Pieces from the tread should be requested from airport authorities and returned to the home base for potential analysis by the tire supplier. If the damaged tire is deflated due to a loss of inflation pressure, then the axle mate should be removed also.

Figure 11 - Thrown tread

If the tire is still inflated after the aircraft is parked, if time permits, record the tire pressure after it has cooled down (allow 3 hours for safety).

NOTE: Early signs of tread separation can manifest themselves in the form of tread bulges, local uneven wear (depression), or local tread/sidewall rubber split.

5.2.6 Tread Cuts

Foreign objects that are present on runways, taxiways, and parking areas can cause cuts to the tires (Figure 12).

REMOVAL LIMIT: Tire should be removed immediately from the aircraft if the cut exposes or penetrates fabric beneath the tread, the cut or damage severs or extends across a tread rib, or undercutting occurs at the base of any tread rib cut.

Figure 12 - Tread cut

NOTE: Mark all cuts, FOD, or leak sites while the tire is still inflated. Damage can be difficult to locate when the tire is deflated.

5.2.7 Chevron Cutting

Chevron cutting is tread damage (small z-, s-, or v-shaped tears) caused by touchdown, running, and/or braking on cross-grooved runways (Figure 13). Chevron cutting is a condition of the tread rubber only.

REMOVAL LIMIT: Tire should be removed from aircraft if the tread cut criteria are reached, the fabric beneath the tread is exposed for more than 1.0 inch^2 (6.45 cm^2), or the cutting involves the full width of any one of the tread ribs.

Figure 13 - Chevron cutting

5.2.8 Groove Cracking

Groove cracking may result from ozone attack of the rubber or excessive flexing of the groove bottoms as a result of insufficient inflation of the tire. These cracks occur along the bottom of tread grooves (Figure 14).

REMOVAL LIMIT: The tire should be removed immediately from the aircraft if groove cracking exposes the fabric beneath the tread for more than 0.25 inch (6.35 mm) circumferentially in length or groove cracking has led to undercutting of the adjacent rib by more than 0.25 inch (6.35 mm).

Figure 14 - Groove cracking

5.2.9 Rib Undercutting

Rib undercutting can be an extension of groove cracking progressing under a tread rib or develop as a break in the groove wall extending under the rib. This can lead to tread chunking, peeled rib, or thrown tread (Figure 15).

REMOVAL LIMIT: The tire should be removed immediately from the aircraft if undercutting extends more than 0.25 inch (6.35 mm) under the tread rib.

Figure 15 - Rib undercutting

5.2.10 Open Tread Splice

An open tread splice is a crack in the tread rubber where the manufacturing joint or splice separates in a radial direction across the tread ribs (Figure 16).

REMOVAL LIMIT: The tire having this defect should be removed immediately from the aircraft.

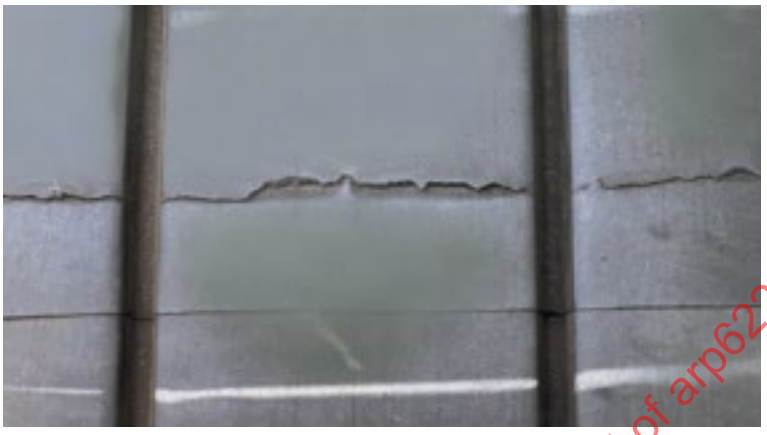

Figure 16 - Open tread splice

5.2.11 Rib Tearing

Rib tearing occurs when the tire is subjected to excessive side force during landing or taxiing (Figure 17).

REMOVAL LIMIT: The tire should be removed immediately from the aircraft if cords are exposed for more than 1.0 in^2 (6.45 cm^2), or if the damage extends the full width of the tread rib.

Figure 17 - Rib tearing