



AEROSPACE INFORMATION REPORT

AIR5651™

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History of Commercial Aircraft New Tire Qualification Training

RATIONALE

AIR5651 has been reaffirmed to comply with the SAE five-year review policy.

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Documents
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1. SCOPE

This SAE Aerospace Information Report (AIR) is intended to provide a historical account of testing methods used during the years for Commercial Aircraft New Tire certification.

2. REFERENCES

2.1 Applicable Documents

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

2.1.1 The Tire and Rim Association (TRA) Publications

Available from The Tire & Rim Association, Inc., 175 Montrose West Avenue, Suite 150, Copley, OH 44321, www.us-tra.org.

Also available from The European Tyre and Rim Technical Organization, 32/2, avenue Brugmann, B-1060 Brussels, Belgium, <http://www.etrto.org>.

The European Tyre and Rim Technical Organisation (ETRTO) Yearbook

2.1.2 FAA TSO Publications

Available from http://www.faa.gov/regulations_policies/; then: [Regulatory and Guidance Library](#); then: [Technical Standard Orders](#).

TSO-C62, TSO-C62a, TSO-C62b, TSO-C62c, TSO-C62d, TSO-C62e

2.1.3 ISO Publications

Available from <http://www.webstore.ansi.org>.

ISO 3324-2 Aircraft Tyres and Rims – Part 2: Test Methods for Tyres

2.1.4 EASA Publications

Available from http://www.easa.europa.eu/ws_prod/g/rq_certspecs.php#CS-ETSO.

ETSO-C62d European Technical Standard Order 24 October 2003

3. INTRODUCTION

Tires have been receiving more scrutiny during recent years. There have been additions and changes to the aircraft tire qualification regiment in efforts to improve tire reliability and safety. Continuing discussions occur over exactly what is the best way to qualify aircraft tires. It is hoped that by presenting the history of aircraft tire test methods in the format of an AIR, it will provide a better understanding of how the current qualification test methods were developed.

3.1 Background

This panel was formed within A-5C to utilize the archives of the SAE membership to provide as much historical documentation as possible, while such documentation still exists.

4. HISTORICAL PERSPECTIVE

Aircraft tires were originally selected by fit and availability. The aircraft landing was determined at that time to be the event the tire must be designed to withstand. It's not clear why or how this was determined, but aircraft tires were eventually required to withstand at least 4 times the tire rated inflation pressure for burst strength. It soon became obvious that there needed to be some standards relating to tire dimensions, their interface with their respective rims (wheels) and tire load capability with its complementary required inflation pressure, so organizations like TRA and ETRTO developed standards and included aircraft tires in their yearbooks.

Dynamometer testing requirements for high speed tires remained the same from the initial TSO-C62 document through the (b) revision. In 1978, an incident occurred in which the failure of one tire on a multi-tired bogey led to the cascading failure of other tires on the same bogey. The ability of a tire to carry more than its rated load at rated inflation pressure for a brief period of time was seen as essential to aircraft safety. Therefore, TSO-C62c was issued to encompass this need for all high speed (>160 mph (71.5 m/s)) aircraft tires.

TSO-C62e was issued in 2006 and incorporated a 61-cycle (50 takeoffs, 10-35 000 ft (10 668 m) taxis (2 at 20% overload) and 1 takeoff at 50% overload) spectrum of testing for 120 mph (53.6 m/s) and 160 mph (71.5 m/s) tires as an alternate to the energy landing testing. The 61-cycle spectrum of testing had proved to be a successful testing regime for all high speed tires (>160 mph (71.5 m/s)) since the (c) revision had been issued 17 years earlier. Further, the equipment to conduct energy testing was not being updated and the correlation from energy test conditions to actual aircraft performance was not obvious. Therefore, a better alternative was to provide the 61-cycle spectrum for these tires also.

5. AIRCRAFT TIRE REGULATION CHRONOLOGY

<u>Date</u> M/D/Y	<u>Aircraft Tire Regulations</u>	<u>All Cat.</u> <u>A/C TIRES</u>	<u>Transport</u> <u>A/C TIRES</u>	<u>Small</u> <u>A/C TIRES</u>
3/1/1933	Aeronautical Bulletin 7-F	7(A)		
10/1/1934	Aeronautical Bulletin 7-A	40(B)		
11/1/1937	Old Part 04; Airplane A/W	04.443		
5/31/1938	Part 04 Reprinted	04.443		
4/1/1941	Part 04 Reprinted	04.443		
8/15/1942	Part 04 Reprinted	04.443		
11/1/1943	Part 04 Reprinted	04.443		
7/1/1944	CAM 04	04.443		
11/9/1945	Adopted <u>New Part 04</u> [T]		04.364	
11/13/1945	Adopted New Part 03			03.364
11/22/1946	Amendment 04-5, <u>New Part 04</u> became Part 04b			
12/15/1946	Part 03 Reprinted			03.364
11/1/1947	Part 04a Reprinted	04a.443		
5/1/1949	Part 04b designated as Part 4b			
5/1/1949	Part 03 designated as Part 3			
10/1/1949	Part 4b Reprinted		4b.392	
11/1/1949	Part 3 Reprinted			3.362
4/7/1950	Part 4a Reprinted	04a.480-481		
7/20/1950	Part 4b Reprinted		4b.336	
10/12/1951	Part 514; TSO System made available			
12/31/1953	Part 4b Reprinted		4b.336	
9/1/1954	CAM 3			3.362
3/13/1956	Amendment 4b-3		4b.336	
5/15/1956	Part 3 Reprinted			3.362
10/1/1956	CAM 3			3.362
1/1/1958	CAM 04b		4b.336	
3/1/1959	CAM 3			3.362
11/1/1959	CAM 3			3.362
4/15/1961	1st TSO for tires issued; TSO-C62	X	X	X
3/20/1962	TSO-C62a Issued; Aircraft Tires/Part 514§514.67	X	X	X
5/1/1962	CAM 3			3.362
6/3/1962	Protection of Equipment in Wheel Wells		4b.334	
9/1/1962	TSO-C62b Issued; Aircraft Tires/Part 514§514.67	X	X	X
11/17/1964	TSO-C62b issued as FAR§37.167 , Part 514	X	X	X
2/1/1965	Recodified 4b into FAR§§25.731		25.733	
2/1/1965	Recodified Part 3 into FAR§§23.731			23.733
4/11/1967	TSO-C62b/§37.167 amended/ Doc. # 8084	X	X	X
9/14/1969	Amendment 23-7			23.733
4/8/1970	Amendment 25-23		25.733	
12/20/1976	Amendment 25-23		25.733	
2/1/1977	Amendment 23-17			23.733
12/31/1979	Amendment 25-49, TSO-C62c Issued; FAR§37.167	X	X	X
9/12/1984	TSO-C62c with Addendum 1 Issued; FAR§37.167	X	X	X
7/20/1990	Amendment 25-72		25.733	
9/7/1990	TSO-C62d Issued	X	X	X
3/29/1993	Amendment 25-78, Added Nitrogen Inflation			
9/7/1993	Amendment 23-45			23.733
9/29/2006	TSO-C62e Issued	X	X	X

6. AIRCRAFT TIRE TESTING AND CERTIFICATION

6.1 Prior to April 15, 1961 TSO-C62 Requirements

- a. Tire meets burst pressure of 4 times rated inflation pressure
- b. Tire physically fits on wheel and landing gear

6.2 **TSO-C62** (April 15, 1961)

6.2.1 Marking Requirement

- a. Brand name or responsible manufacturer name
- b. Country of manufacture if outside the United States
- c. Type
- d. Size
- e. Ply Rating
- f. Serial Number
- g. Qualification Test Speed
- h. Skid Depth when speed is greater than 160 mph (71.5 m/s)
- i. The word “Reinforced”, if applicable
- j. Applicable Technical Standard Order (TSO) number

6.2.2 Data Requirements

- a. Statement of Conformance
- b. Tire Type and Size
- c. Static and Dynamic Load Rating
- d. Ply Rating
- e. Rated Inflation Pressure
- f. Outside Diameter
- g. Skid Depth
- h. Static Unbalance
- i. Tire Weight
- j. Summary of Load-Speed-Time parameters used in high speed dynamometer tests

6.2.3 New design tires manufactured on or after April 15, 1961 for Civil Aircraft of the United States shall meet the standards specified in Federal Aviation Agency Standard, "Aircraft Tires" dated February 15, 1961.

6.2.4 Previously Approved Equipment Tires of a specified design produced prior to April 15, 1961 were allowed to continue to be manufactured under the provision of their original design and test standards.

6.3 **TSO-C62a** (March 20, 1962)

6.3.1 Marking requirements are per TSO-C62

6.3.2 Data requirements are per TSO-C62

6.3.3 New design tires manufactured on or after September 1, 1962, for Civil Aircraft of the United States shall meet the standards specified in Federal Aviation Agency Standard, "Aircraft Tires" dated February 15, 1961.

6.3.4 Previously Approved Equipment

There are no technical or verbiage differences between TSO-C62 and TSO-C62a. Tires of a specified design produced prior to March 20, 1962 were allowed to continue to be manufactured under the provision of their original design and test standards.

6.4 **TSO-C62b** (September 1, 1962)

6.4.1 Marking requirement per TSO-C62a

6.4.2 Data requirements per TSO-C62a

6.4.3 New design tires manufactured on or after September 1, 1962, for Civil Aircraft of the United States shall meet the standards specified in Federal Aviation Agency Standard, "Aircraft Tires" dated August 1, 1962.

6.4.4 Aircraft Tires (August 1, 1962)

6.4.4.1

a. Low Speed Tires:

Type III, VII, and VIII for ground speeds of 160 mph (71.5 m/s) or less

b. High Speed Tires:

Type VII and VIII for ground speeds above 160 mph (71.5 m/s)

6.4.4.2 Unbalance:

a. Type III with $OD \leq 28$ inches

$$\text{Moment} = 1.5D - 0.023D^2$$

b. Type III with $OD > 28$ inches

$$\text{Moment} = 0.031D^2 - 0.253D$$

c. Type VII and VIII with $OD \leq 28$ inches

$$\text{Moment} = .01D^2 + 0.38D$$

d. Type VII and VIII with $OD > 28$ inches

$$\text{Moment} = 0.034D^2 - 0.304D$$

Where: Moment is expressed in in-oz, and, D is expressed in inches.

Conversion: 100 inches = 2.54 m; 100 in-oz = 0.7062 Nm

6.4.4.3 Balance Marker

A Red Dot shall be permanently placed on the tire sidewall immediately above the bead to indicate the lightweight point of the tire relative to the axis of rotation.

6.4.4.4 Burst Pressure

Minimum of 4 times rated inflation pressure

6.4.4.5 Temperature

Airworthiness of tires shall not be adversely affected by extreme ambient temperatures expected to be encountered during normal airplane operation.

6.4.4.6 Tread Design

Decreases in number of tread ribs and grooves and increases in skid depth require re-qualification.

6.4.4.6.1 Underskid Thickness

- a. For ribbed type or nonskid tread patterns, thickness of rubber between carcass and bottom of tread pattern shall not be less than 30% of mold skid depth.
- b. For Helicopter tires, minimum thickness shall not be less than 1/32 inch (0.79 mm).

6.4.4.7 Slippage

- a. No evidence of slippage on the wheel rim during first 5 dynamometer landings.
- b. Any subsequent slippage shall not damage the tube, valve, or air seal.

6.4.4.8 Tire Airworthiness

Tire shall withstand dynamometer landings specified without failure or visible signs of deterioration other than normal expected tread wear.

6.4.4.9 Tire Ratings

6.4.4.9.1 Static Load Rating

- a. For aircraft tires, the static load rating is based on 35% deflection for Type III tires and 32% deflection for Type VII and VIII tires.
- b. For Helicopter tires, the static load rating of aircraft tires may be increased by 1.5 with a comparable increase in inflation pressure without any additional qualification required.

6.4.4.9.2 Deflection

Vertical distance from top of rim flange to outermost surface of tire (0% deflection is tire outer surface at no load).

6.4.4.9.3 Deflection Tolerances

+1%, -4% for Type III tires

+3%, -4% for Type VII and VIII tires