

SAE The Engineering Society
For Advancing Mobility
Land Sea Air and Space®
INTERNATIONAL

400 Commonwealth Drive, Warrendale, PA 15096-0001

AEROSPACE STANDARD

SAE AS21985

Issued 1998-02

Submitted for recognition as an American National Standard

WHEELS - CUSHION TREAD (SEMI-PNEUMATIC) FOR MOBILE GROUND SUPPORT EQUIPMENT

NOTICE

This document has been taken directly from U.S. Military Specification MIL-W-21985, Amendment 2, and contains only minor editorial and format changes required to bring it into conformance with the publishing requirements of SAE technical standards. The initial release of this document is intended to replace MIL-W-21985, Amendment 2. Any part numbers established by the original specification remain unchanged.

The original Military Specification was adopted as an SAE standard under the provisions of the SAE Technical Standards Board (TSB) Rules and Regulations (TSB 001) pertaining to accelerated adoption of government specifications and standards. TSB rules provide for (a) the publication of portions of unrevised government specifications and standards without consensus voting at the SAE Committee level, and (b) the use of the existing government specification or standard format.

Any material relating to qualified product lists has not been adopted by SAE. This material was part of the original military specification and is reprinted here for historic reference only.

SAE Technical Standards Board Rules provide that: "This report is published by SAE to advance the state of technical and engineering sciences. The use of this report is entirely voluntary, and its applicability and suitability for any particular use, including any patent infringement arising therefrom, is the sole responsibility of the user."

SAE reviews each technical report at least every five years at which time it may be reaffirmed, revised, or cancelled. SAE invites your written comments and suggestions.

Copyright 1998 Society of Automotive Engineers, Inc.
All rights reserved.

Printed in U.S.A.

QUESTIONS REGARDING THIS DOCUMENT:
TO PLACE A DOCUMENT ORDER:
SAE WEB ADDRESS

(724) 772-8510
(724) 776-4970
<http://www.sae.org>

FAX: (724) 776-0243
FAX: (724) 776-0790

SAE AS21985**1. SCOPE:****1.1 Scope:**

This specification covers one type of cushion tread (semi-pneumatic) wheels for use on mobile ground support equipment.

2. APPLICABLE DOCUMENTS:**2.1 General:**

The following specifications, standards, drawings and publications, of the issue in effect on date of invitation for bids, form a part of this specification to the extent specified herein:

SPECIFICATIONS:**Federal**

TT-E-529	Enamel, Synthetic Semi-gloss
PPP-B-601	Boxes, Wood, Cleated-Plywood
PPP-B-621	Boxes, Wood, Nailed and lock-corner

Military

MIL-B-121	Barrier Material, Greaseproofed flexible (Waterproofed)
MIL-D-5028	Drawings and Data Lists; Preparation of Manufacturers (For Production Aircraft, Guided Missiles, Engines, Accessories and other Equipment)
MIL-E-5272	Environmental Testing, Aeronautical and Associated Equipment, General Specification for
MIL-C-5541	Chemical Films for Aluminum and Aluminum Alloys
MIL-W-8005	Wheels and Hubs, for Industrial Pneumatic Tires
MIL-P-8585	Primer Coating, Zinc Chromate, Low-Moisture-Sensitivity
MIL-A-8625	Anodic Coatings, For Aluminum and Aluminum Alloys
MIL-G-10924	Grease, Automotive and Artillery

STANDARDS:**Federal**

FED-STD-595	Colors; (For), Ready Mixed Paints
FED-STD-601	Rubber, Sample Testing

SAE AS21985

2.1 (Continued):

Military

MIL-STD-129	Marking for Shipment and Storage
MIL-STD-130	Identification Marking of U. S. Military Property
MS-24328	Hub-Cantilever Mounting for 6.00-9, 7.50-10, and 9.00-10 Wheels
MS-33586	Metals-Definition of Dissimilar

PUBLICATIONS:

Air Force - Navy Aeronautical Bulletin

143 Specifications and Standards; Use of

(When requesting specifications, standards, drawings and publications refer to both title and number. Copies of this specification and applicable specifications may be obtained upon application to the Commanding Officer, U. S. Naval Aviation Supply Depot, Philadelphia, Pennsylvania, Attention: Code CDD).

3. REQUIREMENTS:

3.1 Qualifications:

The wheels furnished under this specification shall be a product which has been tested and has passed the preproduction tests specified herein.

3.2 Preproduction Testing:

If the wheels to be furnished hereunder have not previously qualified as specified above, a preproduction sample shall be furnished by the contractor for inspection and testing as hereinafter specified to determine conformance with this specification. Production of wheels under the contract shall not be started until the preproduction sample has been approved. All testing shall be at the contractor's expense.

3.2.1 Approval: Approval of the preproduction sample by the activity concerned shall not relieve the contractor of his obligation to supply equipment conforming to this specification. No changes or deviations from the approved preproduction sample will be acceptable without prior written approval from the technical bureau.

3.2.2 Components: The wheel assembly shall consist of a one piece wheel with a cushion tread rubber tire attached, two (2) taper roller bearings, grease seal and hub cap.

SAE AS21985**3.3 Selection of Specifications and Standards:**

Specifications and Standards for necessary commodities and services not specified herein shall be selected in accordance with ANA Bulletin 143.

3.3.1 Standard Parts: MS and AN Standard parts shall be used where they suit the purpose. They shall be identified on the drawings by their part numbers.**3.4 Materials:****3.4.1 Protective Treatment:** The use of any protective coating that will crack, chip or scale with age or extremes of climatic and environmental conditions shall be avoided.**3.4.2 Metals:** Metals shall be of the corrosion-resistant type and/or shall be suitably protected to resist corrosion during normal service life.**3.4.3 Dissimilar Metals:** Unless suitably protected against electrolytic corrosion, dissimilar metals shall not be used in intimate contact with each other. However, metal plating or metal spraying of dissimilar base metals to provide similar or suitable abutting surfaces shall be permitted. Dissimilar metals are defined in MS-33586.**3.5 Design:**

The wheel shall be used on ground portable equipment which must be towed or moved by hand on paved areas, pierced plank areas, unpaved roads and unimproved level terrain whether such areas are dry, wet, or covered with up to 6 inches of snow or 4 inches of mud.

3.5.1 Construction: The wheel shall be one piece aluminum casting with an integral brake drum. The tire shall be bonded to the wheel.**3.4.1.1 Wheel:** The wheel shall be one of two sizes, Model I on which the tread bonding surface is to be 11 inches diameter by 4 inches wide and Model II on which the tread bonding surface is to be 15 inches diameter by 6 inches wide. The integral brake drum shall be of dimensions and located as shown in Figure I. The braking surface shall have a finish of a minimum 250 micro inches RMS.**3.5.1.2 Hub Portion:** The hub portion of the wheel casting shall conform with MS-24328 (Specification MIL-W-8005) for interchangeability with cantilever mounting for sizes 6.00-9, 7.50-10 and 9.00-10 pneumatic wheels.

SAE AS21985

- 3.5.1.3 **Tire Portion:** The tire portion shall have an outer case approximately, one half (½) inch thick, having hardness of 70 ± 3 durometers, and an inner core having a hardness of 55 ± 3 durometers. The tire depth shall be 2½ inches for Model I wheels and three (3) inches for Model II wheels. The overall dimensions for the tires shall be 16 inches in diameter by four (4) inches wide for Model I and 21 inches in diameter by six (6) inches wide for Model II. The tire shall have a tread design as approved by the procuring agency.
- 3.5.1.4 **Weight:** The weight of the complete wheel assembly shall not exceed twenty-eight (28) pounds for Model I and sixty-five (65) pounds for Model II.
- 3.5.1.5 **Seals:** Seals for the hub as shown on the Standard MS-24328 shall be standard grease seals of the molded synthetic-rubber type. The seals shall provide adequate protection for the wheel bearings under the conditions specified herein.
- 3.5.1.6 **Bearings:** Roller bearings for the hub portion shall be provided as shown on Standard MS-24328 and must meet the performance requirements specified herein. The bearings shall be packed with grease conforming to Specification MIL-G-10924 during assembly for shipment. Provisions shall be provided inside the hub portion to facilitate the removal of the bearing cones.
- 3.5.1.7 **Wheel Assembly:** The wheel assembly shall, in addition to that specified above, consist of necessary nuts, lock washers, cotter pins, hub cap, etc., necessary for attaching the wheel to an axle as specified in Standard MS-24328.
- 3.6 **Performance:**
- The wheels shall be capable of operation as specified in the towing requirements of SECTION 4 herein and under the rated loads of Table I when subjected to the following environmental conditions:
- a. A temperature of from -65° to $+125^{\circ}$ F.
 - b. A relative humidity of 95 ± 5 percent at a temperature of $125^{\circ} \pm 5^{\circ}$ F.
 - c. Exposure to airborne sand and dust particles encountered in normal and desert operation.
 - d. Exposure to atmosphere containing salt laden moisture.
- 3.7 **Finishes and Protective Coatings:**
- 3.7.1 **Exposed Parts and Surfaces:** Exterior surfaces shall be treated in accordance with Specification MIL-A-8625 or MIL-C-5541. A primer coat conforming to MIL-P-8585 shall be applied.
- 3.7.2 **Rubber Products:** The rubber portion of the wheel shall not be painted.
- 3.7.3 **Finish Coat:** The exterior portion of the wheels shall be finished with two coats of enamel, color, yellow in accordance with color 23538 of Specification Federal Standard 595, conforming to Specification TT-E-529.

SAE AS21985

3.7.4 Interior Surfaces: Sealed or bearing surfaces designed to permit lubrication, brake drum surface, etc., shall not be painted.

3.8 Identification of Product:

Wheels shall be marked for identification in accordance with Standard MIL-STD-130. The identification shall be placed so as to be visible when the wheels are installed. The marking shall be plainly visible after protective finishes have been applied and shall consist of the following:

Specification _____
 Model _____ Size _____
 Manufacturer's Name or Trade Mark _____

3.9 Interchangeability:

All parts having the same manufacturer's part number shall be functionally and dimensionally interchangeable. The drawing number requirements of MIL-D-5028 shall govern changes in the manufacturer's part number.

3.10 Workmanship:

The wheel assemblies shall be fabricated and finished in accordance with sound commercial practices. Particular attention shall be given to the smoothness of finish and thoroughness of painting.

4. QUALITY ASSURANCE PROVISIONS:

4.1 Classification of Tests:

The tests shall be classified as follows:

- a. Acceptance Tests
- b. Preproduction Sample Testing

4.1.1 Acceptance Tests: The acceptance tests shall consist of the following:

- a. Individual Tests
- b. Sampling Plan and Tests

4.1.2 Individual Tests: Each wheel shall be subjected to the following tests:

- a. Examination of Product (Visual inspection to determine compliance).
- b. Compression Set
- c. Overload Test
- d. Tensile Strength

SAE AS21985

4.1.3 Sampling Plan and Test: Two (2) wheels shall be selected at random from every 400 hundred or fraction thereof produced in a production run and subjected to the following tests:

- a. All the individual tests
- b. Roll Tests
- c. Towing Tests

4.1.4 Rejection and Retest: When one wheel assembly from a production lot fails to meet the specification, acceptance of all wheels in the production run shall be withheld until the extent and cause of failure are determined. After corrections have been made, all necessary tests shall be repeated.

4.1.4.1 Defects in Wheels Already Accepted: The investigation of a test failure could indicate that defects may exist in wheels already accepted. If so, the contractor shall fully advise the procuring activity of all defects likely to be found and method of correcting or returning of the items.

4.2 Test Conditions:

4.2.1 Tolerances: The capacities, pressures, temperatures and other data required for testing specified herein shall be accurate to within a tolerance of ± 2 percent. Data during endurance, environmental and individual inspection tests shall be accurate to within a tolerance of ± 4 percent.

4.2.2 Marking of Test Sample: All wheels submitted for preproduction testing shall be plainly identified by securely attached double tags marked with the following information:

Sample Wheel: Model _____ Size _____
 Contract No. _____
 Manufacturer's Name _____
 Manufacturer's Part No. _____

If wheels are submitted for qualification and no contract exists between the manufacturer and the Government the following shall be added to the above:

Specification No. _____
 Authority to Submit _____

SAE AS21985**4.3 Preproduction Tests:**

- 4.3.1 **Radial Load Test:** A radial load equal to five (5) times the MAXIMUM load specified in Table I for the applicable wheel size shall be applied through a flat steel plate to a wheel resting on a flat steel plate in such a manner that the direction of loading is parallel to the plane of the wheel and through the centerline of the hub. The load shall be made to act upon the wheel for a period of one (1) minute. After the load is removed, the wheel shall be inspected for failure or deformation. Deformation shall be grounds for rejection.
- 4.3.2 **Side Load Test:** The side load shall be applied to either side of the wheel and in a direction parallel to the axis of the hub by means of a block to the side of the tire. The load shall be applied uniformly to the block which shall conform to the contour of the side of the tire, covering an arc of not more than 60 degrees and whose centroid falls on a point midway between the rim flange outside diameter and the tire outside diameter. The wheel shall withstand without failure for one (1) minute, the limit side load specified in Table I.
- 4.3.3 **Rubber Physical Properties Test:** Unless otherwise specified below, rubber specimens taken from the tire shall be tested for Physical Properties in accordance with Specification FED-STD-601.
- 4.3.4 **Rubber Hardness:** The rubber hardness shall be determined by means of the Shore Durometer, Type A, or any Durometer similar and equal. The outer shell rubber shall register 70 ± 3 durometer. After all other testing specified herein is completed, a section shall be cut from the inner core of one (1) tire. This sample shall register 55 ± 3 durometer. After accelerated aging for seven (7) days in air at $158 \pm 2^\circ\text{F}$, the hardness shall not differ from the original value noted by more than 5 points.
- 4.3.5 **Adhesion:** To determine the adhesion of the rubber to the wheel, the tire shall be cut transversely in the plane of the wheel axis down to the wheel rim. The end of the tire shall be gripped in the jaws of the testing machine and pulled from the wheel circumferentially in a direction normal to the adhered surface and at a rate of 2 inches per minute. The force necessary to perform this test shall be a minimum of 80 pounds per inch of tire width at 21°C (70°F). The bond strength shall exceed the tear strength of the rubber.

SAE AS21985

4.4.6 Compression Set: The compression set of the tread shall be measured as follows:

- a. The outside diameter of the wheel tread shall be measured within 0.010 inch and the point of measurement shall be marked with a line not wider than 1/8 inch.
- b. The wheel shall then be loaded to its MAXIMUM load with the marked point of measurement at the point of ground contact and the tread deflection measured within 0.010 inch.
- c. The loaded wheel shall be placed in an air oven and subjected to a temperature 69° to 70°C (158°F) for a period of 24 hours.
- d. The loaded wheel shall be removed from the oven and allowed to cool at room temperature at approximately 21°C (70°F) for 30 minutes. The outside diameter of the wheel shall be measured at the marked point. The percentage of set shall not exceed 20 percent when calculated as follows:

$$C = \frac{(D - D1) \times 100}{R}$$

When: C = Percentage of set

D = Original diameter of wheel under (a) above

D1 = Final diameter of wheel under (d) above

R = Tread deflection under load (b) above

- 4.4.7 Elongation: Suitable tests shall be performed on rubber samples taken from the outer shell portion of the tire, to determine the elongation of the rubber. This value shall be not less than 300%.
- 4.4.8 Tensile Strength: The tensile strength as received shall be not less than 2000 psi on natural rubber and not less than 1500 psi on synthetic rubber.
- 4.4.9 Resistance to Abrasion: When tested as described in Specification FED-STD-601, the abrasion index shall be:
 - (1) Tire as received not less than 100%
 - (2) After accelerated aging as described in paragraph 4.4.4, not less than 80 percent of its original value
- 4.4.10 Roll Test: The sample wheel shall be pressed against a test wheel with an axial load equal to the MAXIMUM load (table 1). At a speed of 22 1/2 MPH ±2 MPH, the wheel shall be rolled for 5 miles, rested for 15 minutes, rolled again for 5 miles, then rested for 30 minutes. This cycle shall be repeated for a period of 8 hours daily for a total of 17 cycles, or approximately 170 miles. Upon completion of the last cycle; the sample wheel shall be loaded with an axial load equal to the RATED load (table 1). At a speed of 22 1/2 ±2 1/2 MPH, the wheel shall be rolled continuously for a minimum distance of 150 miles without failure.

SAE AS21985

4.4.11 **Overload Test:** The sample wheel shall be pressed against the test wheel with a force equal to 1.5 times the **MAXIMUM** load listed in Table I and rolled at a speed of $22 \frac{1}{2} \pm 2 \frac{1}{2}$ miles per hour. The wheel shall operate in a satisfactory manner for a minimum of 30 minutes.

4.4.12 **Towing Tests:** The following tests are required.

4.4.12.1 **Towing Test Equipment:** For the performance of this test, a suitable test trailer shall be provided by the contractor. The test trailer shall be of four wheel design, having front wheels steerable by means of tie-rods, suitably attached to a tow bar. The wheel base of the trailer shall be 7 ± 1 feet with a track tread of 5 ± 1 feet. The trailer shall include means of attachment of loads as required for the performance of the tests specified herein, and shall be capable of performing these tests without excessive deformation. The contractor shall provide as part of the test trailer, weights of the necessary number and sizes to load the test wheel as specified herein. The test trailer shall include means of mounting the test wheel in a front steerable position.

4.4.12.2 **Towing Test Procedure:** Under **RATED** load the wheel, mounted as indicated in 4.4.12.1, shall be towed over the following courses:

- (a) Smooth paved highways for a distance of 100 miles at an average speed of 20 MPH, maximum speed 25 MPH.
- (b) Graded gravel roads for a distance of 50 miles at an average speed of 10 MPH, maximum speed 15 MPH.

The course shall contain such obstacles as rail crossings and door sills. At speeds of 15 MPH, at least 50 right circle turns and 50 left circle turns, both at maximum cramping angle, shall be accomplished during the test. Also, under (a) above, 25 sudden stops shall be accomplished from speeds of 20 MPH.

At speeds of 15 MPH, with an overload of 10% per wheel, the trailer shall be towed over smooth paved surface in a circular path having a 35 foot radius as measured to the outside wheel of the trailer. The trailer shall make 5 complete circles clockwise and 5 complete circles counter-clockwise.

SAE AS21985

4.4.12.2 (Continued):

Under MAXIMUM load the wheel shall be towed over the following courses:

- (a) Smooth paved highways at an average speed of 20 MPH, maximum speed 25 MPH, for a distance of 5 miles, rest for 15 minutes, then towed again for 5 miles, rest for 30 minutes. This cycles shall be repeated four (4) times. (Total distance 40 miles - elapsed time 4 1/2 hours).
- (b) Graded level roads at an average speed of 10 MPH, maximum speed 15 MPH, for a distance of 5 miles, rest for 15 minutes, then towed again 5 miles, rest 30 minutes. (Total distance 20 miles - elapsed time 2 hours).

At the conclusion of these tests, the wheel shall be inspected for permanent deformation, excessive wear or damage. Permanent deformation, excessive wear or other damage shall be cause for rejection.

4.4.13 Environmental Tests: Environmental tests shall be conducted in accordance with the specified procedures of Specification MIL-E-5272. If the axle is removed, the grease seal bore shall be covered with a suitable closure. The sample wheel not destroyed by the previous test shall be used.

4.4.13.1 High Temperature Test: This test shall be conducted in accordance with procedure I, except the temperature shall be 125° F. At the conclusion of this test and with the temperature maintained, the wheel shall meet the test specified in 4.3.1 but with twice the load specified in Table I.

4.4.13.2 Low Temperature Test: This test shall be conducted in accordance with procedure I. At the conclusion of the test and with the temperature maintained, the wheel shall be subjected 20 times to an instantaneously applied load equal to the rated load specified in Table I, distributed along an axle 4 feet between wheel tread centers. The load shall be dropped a distance of 3 inches. No damage, distortion or tire separation shall result from this test.

4.4.13.3 Humidity Test: The test shall be conducted in accordance with procedure I, except the temperature shall not exceed 125 ±5°F. At the conclusion of the test there shall be no evidence of corrosion or failure of the coatings.

4.4.13.4 Sand and Dust Test: This test shall be conducted in accordance with procedure I. During the test the wheel shall be rotated at a simulated road speed of 10-15 miles per hour. There shall be no evidence of dust particles in the bearing area and no substantial failure of the protective coatings or finishes.

4.4.13.5 Salt Spray Test: This test shall be conducted in accordance with the procedure specified for a period of 50 hours. There shall be no evidence of corrosion or failure of finishes and protective coatings.