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Standard Test Method for Tires, Pneumatic, Vehicular, Highway¹

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INTRODUCTION

In 1998, the standards used for the U.S. Army's Cooperative Tire Qualification Program (CTQP), which replaced the Federal Tire Program, were officially approved by ASTM. This ASTM Standard has been developed to serve federal, state and local agencies that want to purchase qualified tires using this test method.

This test method is designed to be used in conjunction with the Administrator's Approval and Requirements Manual (CTQP F1922) (1),² to qualify tires for purchase primarily by the U.S. federal government, military, and other state and local entities.

1. Scope

1.1 This test method covers comparative tire durability and treadwear. This test method covers commercially available, over the highway pneumatic tires, new and retreaded, both tube type and tubeless, for use on conventional passenger cars, station wagons, pursuit and emergency high speed and pursuit passenger vehicles, light trucks, medium to heavy truck, trailers, buses, and similar vehicles normally operated on public roads and highways. This test method also covers commercially available, special application light truck tires for operation on non-improved road surfaces.

1.2 The values stated in SI units are to be regarded as the standard. The values given in parentheses are for information only.

1.3 *This standard does not purport to address all of the safety concerns, if any, associated with its use. It is the responsibility of the user of this standard to establish appropriate safety, health, and environmental practices and determine the applicability of regulatory limitations prior to use.*

1.4 *This international standard was developed in accordance with internationally recognized principles on standardization established in the Decision on Principles for the Development of International Standards, Guides and Recommendations issued by the World Trade Organization Technical Barriers to Trade (TBT) Committee.*

¹ This test method is under the jurisdiction of ASTM Committee F09 on Tires and is the direct responsibility of Subcommittee F09.20 on Vehicular Testing.

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² The boldface numbers in parentheses refer to the list of references at the end of this standard.

2. Referenced Documents

2.1 *ASTM Standards*:³

F538 *Terminology Relating to Characteristics and Performance of Tires*

3. Terminology

3.1 *Definitions*:

3.1.1 *alignment, n*—the adjustment of various parts of the vehicle's suspension system to ensure proper handling stability and to minimize abnormal tire treadwear. **F538**

3.1.2 *balancing, n*—a process to correct for heavy or light areas of a tire and wheel assembly. **F538**

3.1.2.1 *Discussion*—There are some instances where balancing is done to the tire within the factory by the manufacturer.

3.1.3 *bead, n—of a tire*, the part of a tire that comes in contact with the rim and is shaped to secure the tire to the rim. **F538**

3.1.4 *bead separation, n*—a breakdown of bond between tire components in the bead area. **F538**

3.1.5 *belt separation, n*—a breakdown of bonding between the belts or plies or tread, or combination thereof. **F538**

3.1.6 *break, n*—a crack or tear extending into or through the reinforcing material. **F538**

3.1.7 *candidate tire (set), n*—test tire (or test tire set) that is part of an evaluation program; each candidate tire (set) usually has certain unique design or other features that distinguish it from other candidate tires (sets) in the program. **F538**

³ For referenced ASTM standards, visit the ASTM website, www.astm.org, or contact ASTM Customer Service at service@astm.org. For *Annual Book of ASTM Standards* volume information, refer to the standard's Document Summary page on the ASTM website.

3.1.8 *caravan*, *n*—for purposes of a tire test, two or more vehicles running in the same time frame, over the same test course(s), under similar but independent conditions. **F538**

3.1.8.1 *Discussion*—A caravan can have dissimilar control groups for each vehicle in the group with independent rotation schedules for each tire group and vehicle. A caravan is independent and a convoy is interdependent.

3.1.9 *casing*, *n*—of a tire, a used or treadless tire to which additional tread rubber may be attached for the purpose of retreading. **F538**

3.1.10 *control tire (set)*, *n*—a reference tire (or reference set) repeatedly tested in a specified sequence, typically in conjunction with a candidate tire (set), throughout an evaluation program. **F538**

3.1.10.1 *Discussion*—Control tires (sets) are used for adjustment of data sets generated from an evaluation program or the statistical procedures used on data sets, or both, in order to offset or reduce variation in test results. They can also be used to improve the accuracy of candidate tire (set) data and to detect variation in test equipment.

3.1.11 *convoy*, *n*—in tire testing, two or more vehicles running at the same time, over the same test course, under the same interdependent conditions. **F538**

3.1.12 *cord*, *n*—in a tire, filament(s) or plied yarns used in making a tire ply. **F538**

3.1.13 *cross-country track*, *n*—surface not subject to repeated traffic in addition, no roads, routes, well-worn trails or man-made improvements; can consist of tank trails with crushed rock or having large exposed obstacles (rocks, boulders, etc.). **F538**

3.1.14 *gravel road*, *n*—two lane, all-weather, occasionally maintained, hard or loose surface (for example, large rock, paved, crushed rock, gravel) intended for medium-weight, low-density traffic, in accordance with the U.S. Federal Highway Administration. **F538**

3.1.15 *groove*, *n*—a void that is relatively narrow compared to its length. **F538**

3.1.16 *groove (void) depth*, *n*—measurement of the perpendicular distance from a real or calculated reference defined by edges of two adjacent ribs (lugs) to the lowest point of contact in the groove (void). **F538**

3.1.17 *load range*, *n*—a letter designation (A, B, C, D) or, for P-metric tires, standard load (SL) or extra load (XL), used to identify a given size tire with its load and inflation limits when used in a specific type of service. **F538**

3.1.18 *load rating*, *n*—the maximum load a tire is rated to carry for a given usage at a specified cold inflation pressure. **F538**

3.1.19 *outside diameter*, *n*—the maximum diameter of a tire when it is mounted and inflated. **F538**

3.1.20 *overall width*, *n*—the maximum cross-sectional width of a tire, including protective or decorative ribs. **F538**

3.1.21 *paved road*, *n*—two or more lanes, all-weather, maintained, hard surface roads with good driving visibility

used for heavy and high-density traffic, in accordance with the U.S. Federal Highway Administration. **F538**

3.1.22 *secondary road*, *n*—two lane, occasionally maintained, hard or loose surface (for example, large rock, paved crush rock, gravel, soil aggregate) intended for medium-weight, low-density traffic, in accordance with the U.S. Federal Highway Administration. **F538**

3.1.23 *section width*, *n*—the width of a new tire, including 24-h inflation growth and including normal sidewalls, but not including protective side ribs, bars, or decorations. **F538**

3.1.24 *sidewall*, *n*—of a tire, that portion of a tire between the tread and the bead. **F538**

3.1.25 *tire*, *n*—a load-bearing ground-contacting circumferential attachment to a vehicle wheel. **F538**

3.1.26 *tire, bias*, *n*—a pneumatic tire in which the ply cords that extend to the beads are laid at angles substantially less than 90° to the center line of the tread. **F538**

3.1.26.1 *Discussion*—It should be noted that the International Organization for Standardization (ISO) defines the word as “*bias ply tire (diagonal)*, *n*—a pneumatic tire in which the ply cords extending to the beads are laid at alternate angles substantially less than 90 degrees to the center line of the tread.”

3.1.27 *tire, radial*, *n*—a pneumatic tire in which the ply cords that extend to the beads are laid substantially at 90° to the center line of the tread, the tire being stabilized by a belt. **F538**

3.1.27.1 *Discussion*—It should be noted that the International Organization for Standardization (ISO) defines the word as “*radial tire*, *n*—a pneumatic tire structure in which the ply cords extend to the beads and are laid substantially at 90 degrees to the center line of the tread, the carcass being stabilized by an essentially inextensible circumferential belt.”

3.1.28 *tread*, *n*—of a tire, the part of a tire that comes in contact with the ground. **F538**

3.1.29 *tread arc width*, *n*—the length of the arc measured from one extreme of tread design proper to the opposite extreme; that is, from shoulder to shoulder perpendicular to the circumferential center line. **F538**

3.1.30 *tread radius*, *n*—the radius of a circle whose arc best fits the tread surface when radius template used in head perpendicular to the circumferential center line of an inflated tire. **F538**

4. Significance and Use

4.1 This test method establishes a standard procedure of comparative testing, for tire durability and treadwear, for the use of approving tires under the Administrator’s Cooperative Approved Tire List (CATL) (2).

5. Procedure

5.1 Procedures for testing passenger car, light truck, and truck-bus tires are contained in Methods 1, 2, and 3, respectively. Procedures for testing Off Road Severe Application (ORSA) tires are contained in Method 4.

5.2 Method 1—Passenger Car Tires:

5.2.1 Selection and Preparation of the Test Tires:

5.2.1.1 All tires shall meet specified requirements of 49 CFR 571 Federal Motor Vehicle Safety Standard 109 (bias tires), 139 (radial tires), 110, 117 (3); part 574 (4); part 575.104 (5); as well as state and local regulations, as applicable. All tire sidewall markings shall be recorded.

5.2.1.2 Retreaded tires submitted for testing shall meet the requirements in the Administrator's Approval and Requirements Manual for Tire, Pneumatic: Retreaded and Repaired (CTQP-441) (6).

5.2.2 *Tire Durability and Treadwear Road Test*—The durability and treadwear road tests shall be performed at a commercial test facility acceptable to the Administrator or at a Government test facility as specified.

5.2.3 *Vehicle(s) Selection and Preparation*—The vehicle(s) used for testing passenger car tires shall be of the same manufacture, model and model year, have identical drive trains (engine CID and horsepower, transmissions, and rear axle ratio), brake shoes/disc pads and drums/rotors, suspension components, etc., and be of identical curb weight. All vehicle(s) used for testing shall be rear wheel drive. The load on each wheel shall not be less than 85 % nor more than 90 % of the maximum single load of the test tire for passenger car, as specified in The Tire and Rim Association, Inc., Year Book (7), The European Tyre and Rim Technical Organization, Standards Manual (8), or the Japan Automobile Tire Manufacturers' Association, Inc., Year Book (9). After the vehicle(s) is (are) correctly loaded, it (they) shall stand for 24 h. If the suspension bottoms out during this period, the vehicle(s) shall not be used to conduct the test. A constant weight shall be maintained in the driver's seat area that will equate the driver to that of the heaviest driver in the caravan. All axles of the vehicle(s) shall be aligned in accordance with the vehicle manufacturers' specifications prior to the beginning of the test. This alignment shall be checked at each tire rotation period. Any change in the vehicle's(s') or wheel's(s') alignment outside the manufacturer's specifications shall be recorded and corrected. Vehicle(s) shall be inspected before each test period for loose steering linkage, loose suspension components, loose wheel nuts, damaged rims, etc. If an anomaly is noted, it shall be recorded and corrected. Tires of different sizes or constructions shall not be mixed on any test vehicle(s). Tires of each group shall be mounted on the test vehicle(s) as singles—one tire on each wheel position. Tires of each group shall be tested on vehicle(s) in caravan or in a convoy at the Administrator's discretion. Any modification(s) to the vehicle(s) or to test procedures to carry the load must be approved by the Administrator.

5.2.4 *Mounting*—The tires shall be mounted with tubes (when required) and flaps (if required) on rims specified in and inflated to the air pressure for the specified load as in The Tire and Rim Association, Inc., Year Book (7), The European Tyre and Rim Technical Organization, Standards Manual (8), or the Japan Automobile Tire Manufacturers' Association, Inc., Year Book (9). The air used for inflating tires or tubes, or both, shall be filtered to remove oil, dirt and water. Any pieces of rubber (vents, flash, etc.) remaining on the tire tread after trimming, that may interfere with proper tire measurements, shall be removed. Tire and wheel shall be dynamically balanced. Tire measurements shall be recorded as detailed in the Administrator's

Approval and Requirements Manual for use with F1922 (1). Rims used for mounting passenger car tires are to be placed on the test vehicle(s) and shall not have more than 0.9 mm (0.034 in.) lateral and radial runout. If an anomaly is noted, the rim shall be discarded.

5.2.5 *Test Procedures:*

5.2.5.1 *Tread Measurements*—Measurements shall be taken every 5149 km (3200 miles) and shall begin following the 1287 km (800 mile) break-in period. Measurements shall not be made on the treadwear indicators.

5.2.5.2 *Control Tire Selection*—New and retreaded tires shall be tested separately. Testing for new tires shall incorporate a new passenger car tire as the control tire, and testing for retreaded tires shall incorporate a retread passenger car tire as the control tire.

5.2.5.3 *Tire Rotation Procedure*—The tire rotation period for each passenger car tire shall be at each 1287 km (800 mile) increment of the test (25 rotation periods). Each test tire shall be rotated to a different wheel position at each tire rotation period of the test. Each test tire shall be rotated to another vehicle after being mounted on two positions of a vehicle. Each test tire is to be rotated to a different wheel position at each prescribed rotation period (see Administrator's Approval and Requirements Manual for use with F1922 (1)). The rotation pattern is to be a rearward-cross pattern in which the tire on the forward axle of the test vehicle is moved to the rear axle of that vehicle on the opposite side. The tire on the rear axle is to be rotated to the forward axle of the next test vehicle in the convoy on the same side. The tire on the rear axle of the last test vehicle in the convoy is to be moved to the front most axle on the same side of the first test vehicle in the convoy. When only a single test vehicle is involved, the tire rotation shall continue on that vehicle for the duration of the test. The test vehicle shall remain in the same order in the convoy throughout the entire test for any particular type of tire. 21

5.2.5.4 *Test Course Procedure*—The test course for passenger car tires shall consist of 32 180 ± 32 km (20 000 ± 20 miles) of paved operation for each tire. The first 1287 km (800 miles) shall be a break-in period. At least 80 % of the paved surface test shall be conducted at no less than 88 km/h (55 mph) and no more than 105 km/h (65 mph). The remaining portion of the test shall be conducted between 0 and 105 km/h (0 and 65 mph). Vehicle(s) shall be operated over the same route at the same speed, to the maximum extent possible. Maximum speed is 105 km/h (65 mph).

5.3 *Method 2—Light Truck Tires:*

5.3.1 *Selection and Preparation of the Test Tires:*

5.3.1.1 All tires shall meet specified requirements 49 CFR 571 Federal Motor Vehicle Safety Standard 119 (bias tires and radial tires with a tread depth of $\frac{18}{32}$ nds or greater), 139 (radial tires), 120 (3); part 574 (4); as well as state and local regulations, as applicable. All tire sidewall markings shall be recorded.

5.3.1.2 Retreaded tires submitted for testing shall meet the requirements in the Administrator's Approval and Requirements Manual for Tire, Pneumatic: Retreaded and Repaired (CTQP-441) (6).

5.3.2 Tire Durability and Treadwear Road Test—The durability and treadwear road tests shall be performed at a commercial test facility acceptable to the Administrator or at a Government test facility as specified.

5.3.3 Vehicle(s) Selection and Preparation: The vehicle(s) used for testing light truck tires shall be of the same manufacture, model and model year, have identical drive trains (engine CID and horsepower, transmissions, and rear axle ratio), brake shoes/disc pads and drums/rotors, suspension components, etc., and be of identical curb weight. All vehicle(s) used for testing shall be rear wheel drive. The load on each wheel shall not be less than 85 % nor more than 90 % of the maximum single load of the test tire for light truck tires, as specified in The Tire and Rim Association, Inc., Year Book (7), The European Tyre and Rim Technical Organization, Standards Manual (8), or the Japan Automobile Tire Manufacturers' Association, Inc., Year Book (9). After the vehicle(s) is (are) correctly loaded, it (they) shall stand for 24 h. If the suspension bottoms out during this period, the vehicle(s) shall not be used to conduct the test. A constant weight shall be maintained in the driver's seat area that will equate the driver to that of the heaviest driver in the caravan. All axles of the vehicle(s) shall be aligned in accordance with the vehicle manufacturers' specifications prior to the beginning of the test. This alignment shall be checked at each tire rotation period. Any change in the vehicle's(s') or wheel's(s') alignment outside the manufacturer's specifications shall be recorded and corrected. Vehicle(s) shall be inspected before each test period for loose steering linkage, loose suspension components, loose wheel nuts, damaged rims, etc. If an anomaly is noted, it shall be recorded and corrected. Tires of different sizes or constructions shall not be mixed on any test vehicle(s). Tires of each group shall be mounted on the test vehicle(s) as singles—one tire on each wheel position. Tires of each group shall be tested on vehicle(s) in caravan or in a convoy at the Administrator's discretion. Any modification(s) to the vehicle(s) or to test procedures to carry the load must be approved by the Administrator.

5.3.4 Mounting—The tires shall be mounted with tubes (when required) and flaps (if required) on rims specified in and inflated to the air pressure for the specified load as in The Tire and Rim Association, Inc., Year Book (7), The European Tyre and Rim Technical Organization, Standards Manual (8), or the Japan Automobile Tire Manufacturers' Association, Inc., Year Book (9). The air used for inflating tires or tubes, or both, shall be filtered to remove oil, dirt, and water. Any pieces of rubber (vents, flash, etc.) remaining on the tire tread after trimming, that may interfere with proper tire measurements, shall be removed. Tire and wheel shall be dynamically balanced. Tire measurements shall be recorded as detailed in the Administrator's Approval and Requirements Manual for use with F1922 (1). Rims used for mounting light truck tires are to be placed on the test vehicle(s) and shall not have more than 1.4 mm (0.055 in.) lateral and radial runout. If an anomaly is noted, the rim shall be discarded.

5.3.5 Test Procedures:

5.3.5.1 Tread Measurements—Measurements shall be taken every 5149 km (3200 miles) and shall begin following the 1287 km (800 mile) break-in period. Measurements shall not be made on the treadwear indicators.

5.3.5.2 Control Tire Selection—New and retreaded tires shall be tested separately. Testing for new and retreaded tires shall incorporate a new tire as the control tire.

5.3.5.3 Tire Rotation Procedure—The tire rotation period for each light truck tire shall be at each 1287 km (800 mile) increment of the test (25 rotation periods). Each test tire shall be rotated to a different wheel position at each tire rotation period of the test. Each test tire shall be rotated to another vehicle after being mounted on two positions of a vehicle. Each test tire is to be rotated to a different wheel position at each prescribed rotation period (see Administrator's Approval and Requirements Manual for use with F1922 (1)). The rotation pattern is to be a rearward-cross pattern in which the tires on the forward axle of the test vehicle are moved to the rear axle of that vehicle on the opposite side. Tires on the rear axle are to be rotated to the forward axle of the next test vehicle in the convoy on the same side. Tires on the rear axle of the last test vehicle in the convoy are to be moved to the front most axle on the same side of the first test vehicle in the convoy. When only a single test vehicle is involved, the tire rotation shall continue on that vehicle for the duration of the test. The test vehicle shall remain in the same order in the convoy throughout the entire test for any particular type of tire.

5.3.5.4 Test Course Procedures—The test for light truck tires shall consist of $32\,180 \pm 32$ km ($20\,000 \pm 20$ miles) of paved operation for each tire. The first 1287 km (800 miles) shall be a break-in period. At least 80 % of the paved surface test shall be conducted at no less than 88 km/h (55 mph) and no more than 105 km/h (65 mph). The remaining portion of the test shall be conducted at between 0 and 105 km/h (0 and 65 mph). Maximum speed is 105 km/h (65 mph).

5.4 Method 3—Truck-Bus Tires:

5.4.1 Selection and Preparation of the Test Tires:

5.4.1.1 All tires shall meet specified requirements of 49 CFR 571 Federal Motor Vehicle Safety Standard 119, 120, (3); part 574 (4) ; as well as state and local regulations, as applicable. All tire sidewall markings shall be recorded.

5.4.1.2 Retreaded tires submitted for testing shall meet the requirements in the Administrator's Approval and Requirements Manual for Tire, Pneumatic: Retreaded and Repaired (CTQP-441) (6).

5.4.2 Tire Durability and Treadwear Road Test—The durability and treadwear road tests shall be performed at a commercial test facility acceptable to the Administrator or at a Government test facility as specified.

5.4.3 Vehicle(s) Selection and Preparation—The vehicle(s) used for testing truck-bus tires shall be of the same manufacture, model and model year, have identical drive trains (engine CID and horsepower, transmissions, and rear axle ratio), brake shoes/disc pads and drums/rotors, suspension