Designation: F3015 – 13

Standard Test Method for Accelerated Laboratory Roadwheel Generation of Belt Separation in Radial Passenger Car and Light Truck Tires through Load Range E[1]

This standard is issued under the fixed designation F3015; the number immediately following the designation indicates the year of original adoption or, in the case of revision, the year of last revision. A number in parentheses indicates the year of last reapproval. A superscript epsilon (ε) indicates an editorial change since the last revision or reapproval.

INTRODUCTION

The United States Congress passed the Transportation Recall Enhancement, Accountability and Documentation (TREAD) Act in November 2000. Included in the Act were specific directions to the National Highway Traffic Safety Administration (NHTSA) to upgrade tire safety standards.

As tire wear life has increased over the years, interest in the in-service aging of a tire's internal components has increased. To quote NHTSA, "... some members of Congress expressed the view that there is a need for an aging test to be conducted on light vehicle tires. The agency tentatively concludes that we agree there is a need for an aging test in the proposed light vehicle tire standard because most tire failures occur at mileages well beyond 2,720 kilometers (1,700 miles) to which tires are exposed in the current FMVSS No. 109 Endurance Test."[2] Until the publication of this standard, there was neither an industry nor a government standard practice for the accelerated laboratory roadwheel generation of belt separation in tires.

This standard represents the body of work whose goal was to develop a scientifically valid, short duration aged tire test standard focused on the generation of belt edge separation. The scope of this work is limited to radial passenger car and light truck tires through Load Range E. The standards development task group conducted research in order to determine: *(1)* the appropriate accelerated laboratory aging conditions which correlate material property changes at the belt edge of the tire as produced in the laboratory with those observed in service (as described in Practice F2838), and *(2)* the appropriate laboratory roadwheel durability test parameters which are capable of producing belt edge separations while avoiding those conditions which are exclusively by-products of roadwheel testing (as described in this standard).

1. Scope

1.1 This standard describes a laboratory method to evaluate tires for their tendency to develop belt edge separation, via the use of a standard roadwheel (Practice F551/F551M). This evaluation is conducted on tires that have undergone accelerated laboratory aging as described in Practice F2838.

1.2 The End-of-Test (EOT) conditions that can be produced by this method include target (belt-edge separation), non-target (conditions other than belt-related separations that can be developed in passenger and light truck tires through on-road use), and non-representative (conditions that are typically developed only on laboratory roadwheels). There is also the possibility that no visible EOT conditions may be generated during the course of this test. In this instance the user may choose to select a designated completion time (DCT) as the EOT condition.

1.3 The values stated in SI units are to be regarded as the standard. The values given in the data log in Appendix X1 in parentheses are provided for information only.

[1] This test method is under the jurisdiction of ASTM Committee F09 on Tires and is the direct responsibility of Subcommittee F09.30 on Laboratory (Non-Vehicular) Testing.

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[2] Federal Register Vol. 67, No. 43, Tuesday, March 5, 2002, p. 10068, Paragraph 6, "Aging Effects."

1.4 *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 and health practices and determine the applicability of regulatory limitations prior to use. For specific precautionary statements, see Section 6.*

2. Referenced Documents

2.1 *ASTM Standards:*[3]

F538 Terminology Relating to the Characteristics and Performance of Tires

F551/F551M Practice for Using a 1.707-m [67.23-in.] Diameter Laboratory Test Roadwheel in Testing Tires

F2838 Practice for Accelerated Laboratory Aging of Radial Passenger Car and Light Truck Tires through Load Range E for the Laboratory Generation of Belt Separation

2.2 *Other Standards:*

ANSI/ISO/IEC 17025 General requirements for the competence of testing and calibration laboratories[4]

European Tyre and Rim Technical Organisation (ETRTO) Standards Manual[5]

ISO 4000 Passenger Car Tyres and Rims[6]

Japan Automobile Tyre Manufacturers Association Inc. (JATMA) Year Book[7]

Rubber Manufacturers Association (RMA): Volume 4: Tire Service Manual[8]

Tire and Rim Association (TRA) Year Book[9]

3. Terminology

3.1 *Definitions:*

3.1.1 *aging, accelerated laboratory (also: aging, laboratory), n*—increased rate of tire material property changes under specified conditions, including: temperature, inflation pressure, oxygen concentration in the filling gas, and time.

3.1.2 *aging, in-service, n*—material property changes within tires due to consumer usage.

3.1.3 *aging, oven, n*—accelerated laboratory aging in an elevated temperature environment.

3.1.4 *belt, n—in a tire*, a breaker that substantially restricts the carcass in a circumferential direction. **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 *breaker, n—in a tire*, one or more plies under the tread region of a tire that are additional to those which extend from bead to bead. **F538**

3.1.7 *cold inflation pressure, n*—the gauge pressure of a tire, measured after equilibration at ambient temperature.

3.1.8 *designated completion time (DCT), n*—a time period selected by the user of the test method as an alternative to the development of a tire test condition which triggers the end of the test.

3.1.9 *end-of-test (EOT) condition, n*—any tire finding observed and reported by the user at the completion of roadwheel testing.

3.1.9.1 *Discussion*—The test is completed when a target condition, a non-target condition, a non-representative condition, or a DCT has been achieved.

3.1.10 *inflation gas, n*—the specific filling medium used to pressurize the tire cavity and maintain a specified gauge pressure (for example, oxygen/nitrogen gas mixture, air).

3.1.11 *measured inflation pressure, n*—gauge pressure of a tire measured at a given time under ambient temperature and barometric pressure source. **F538**

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

4. Significance and Use

4.1 Belt edge separation is a tire condition that can be encountered in tire use, particularly in high tire temperature environments.

4.2 The goal of this standard is to define a scientifically valid protocol for the laboratory generation of belt edge separation in a tire that has previously completed accelerated laboratory aging as described in Practice F2838. This test method does not establish performance limits or tolerances for tire specifications.

4.3 However, as stated in the scope, some tires may not develop belt edge separations under the specified test conditions. They may develop other EOT conditions that are not due to belt edge separation. Also, some tires may not develop any EOT conditions during the course of the test prior to a DCT.

5. Apparatus

5.1 A roadwheel, as specified by Practice F551/F551M, shall be used for this testing.

5.2 Roadwheel control mechanisms shall be calibrated per the latest requirements of ANSI/ISO/IEC 17025.

6. Hazards

6.1 *Potential Hazards with Use of Tires from Practice F2838*—Tires with prior oven exposure may be more likely to experience a sudden loss of air upon pressurization, heating, or due to fatigue than new tires not previously oven exposed. Personal protection should be implemented during handling, inflation, and inspection of tires with prior oven exposure.

6.2 *Hazards During Roadwheel Tire Testing*—A tire is a pressure vessel that becomes progressively weaker during a

[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.

[4] Available from American National Standards Institute (ANSI), 25 W. 43rd St., 4th Floor, New York, NY 10036, http://www.ansi.org.

[5] Available from European Tyre and Rim Technical Organisation (ETRTO), Rue Defacqz 78-80, B - 1060 Brussels, Belgium, http://www.etrto.org.

[6] Available from International Organization for Standardization (ISO), 1, ch. de la Voie-Creuse, CP 56, CH-1211 Geneva 20, Switzerland, http://www.iso.org.

[7] Available from The Japan Automobile Tyre Manufacturers Association, Inc. (JATMA), 8 Floor, No. 33 Mori Bldg., 3-8-21 Toranomon, Minato-ku, Tokyo, 105-0001 Japan, http://www.jatma.or.jp.

[8] Available from Rubber Manufacturers Association, 1400 K. St. N.W., Washington, DC 20005.

[9] Available from Tire and Rim Association, Inc. (TRA), 175 Montrose West Ave., Suite 150, Copley, OH 44321, http://www.us-tra.org.

roadwheel test, both because of fatigue damage and by the lower tensile strength of the components at the high temperatures developed. Therefore, a catastrophic loss of air pressure shall be anticipated at every stage of the test. Such a failure may be accompanied by fragments having a high energy level being thrown from the degenerated tire. Adequate machine safeguards and fire and personal protection equipment shall be provided at all times.

7. Sampling and Tire Selection

7.1 All of the tires shall have the desired production plant and date codes and similar storage and temperature history exposure. Tires must be free of conditions that may affect the outcome of the test.

7.2 Test tires shall be mounted on wheels for testing, of the appropriate measuring rim width and diameter. The same wheel should be used for both oven aging as specified in Practice F2838 and roadwheel testing without dismounting, to prevent any damage incurred through removal of the tire from the wheel. If the measuring rim size is not available, the operator shall use an alternate size per current published standards. Refer to the current published standards of TRA, ETRTO, JATMA, ISO, or other tire standards organization for lists of standardized wheel widths for applicable tire dimensions.

7.3 Record the manufacturer's identification, brand name, tire identification number, size, load range, specified cold inflation pressure, and type of tire on the appropriate roadwheel data log.

8. Preparation of Test Tires

8.1 *Tire Mounting and Tire Inflation Preparation Prior to Roadwheel Testing:*

8.1.1 Tires shall not be stored for periods greater than 3 months between oven aging and this roadwheel test.

8.1.2 Test tires should remain mounted on the wheels used for accelerated oven aging. However, in the event that these wheels are not available for use on the roadwheel, see 8.2.1 – 8.2.7.

8.2 *Mounting of Oven Aged Test Tires:*

8.2.1 Test tires are to be mounted on wheels of the appropriate measuring rim bead seat diameter with clean, smooth surfaces in the bead seat areas, particularly in the vicinity of the weld. Wheel rim flanges shall be free of sharp edges or scuffs that could damage the tire during mounting. Bead seat diameters shall be verified using a certified disc tape (a.k.a. ball tape) and be acceptable according to an applicable published standard of TRA, ETRTO, JATMA, ISO, or other tire standards organization.

8.2.2 Tires shall be mounted on wheels that can support the load capacity of each tire. Any tires mounted on light alloy wheels shall be noted in the observation/comments fields of the appropriate data log.

8.2.3 Metal valves shall be used on any tires which are to be subjected to oven exposure. If only a rubber valve is available, it shall be new at the beginning of this test. All valves shall be rated for pressures exceeding those to be encountered during the test.

8.2.4 A commercial bead-rim lubricant shall be applied to the tire bead areas and rim before mounting. Vegetable oil or soap-based lubricants are recommended.

8.2.5 Mount the tire on the wheel using air according to Volume 4: Tire Service Manual of the Rubber Manufacturers Association (RMA).

8.2.6 Inflate the tire/wheel assembly to 100 % of the minimum pressure at which the tire achieves its maximum load capacity per the applicable standard.

8.2.7 Testing for leaks is suggested. Leak checks can be conducted by either submersion in a water tank for at least 30 min or by carefully checking both beads and fittings for leaks with leak detection fluid. If a light alloy wheel is used, the entire wheel assembly shall be checked for leaks.

8.3 *Conditioning*—The test tire, after being mounted on a test wheel and inflated to the applicable test pressure, shall remain at the ambient temperature of 38°C for at least 3 h prior to testing.

9. Procedure

9.1 *Roadwheel Tire Testing:*

9.1.1 Mount tire/wheel assembly on a laboratory roadwheel which conforms to Practice F551/F551M.

NOTE 1—Tolerances are to be found in Practice F551/F551M, and the test parameters are to be considered set points.

9.1.2 Adjust inflation pressure to 100 % of the minimum pressure at which the tire achieves its maximum load capacity per the applicable standard.

9.1.3 Set a tread separation trip mechanism to within 2 cm across the full tread face.

9.1.4 The load shall be 75 % of maximum rated tire load for single tire application, as specified by applicable TRA standard.

9.1.5 The roadwheel speed shall be 120 km/h.

9.1.6 The test ambient temperature shall be 38°C.

9.1.7 Run the test until a target EOT condition, a non-target EOT condition, a non-representative EOT condition, or a DCT has been achieved.

9.1.8 After 1 h of test time, stop the roadwheel, unload the tire, and allow the tire to cool for 15 min, then check the inflation pressure and record it on the applicable data log. This will be the set pressure for subsequent periodic inspections. Resume testing.

9.1.9 At the end of every 24 h period, stop the roadwheel, unload the tire, and allow the tire to cool for 15 min, then perform a visual inspection and pressure check.

9.1.10 Measure the inflation pressure, record it on the applicable data log, and readjust if the pressure is more than 7.0 kPa away from the set inflation pressure measured in 9.1.8.

9.1.11 Visually inspect the tire for evidence of an EOT condition, as observed and reported by the user.

9.1.12 Resume the test after completion of inspection, provided an EOT condition has not been achieved.

9.1.13 Test completion can be indicated by observation of a target EOT condition, a non-target EOT condition, a non-representative EOT condition during any routine 24 h visual

and pressure check or by automatic machine indication (carriage over-travel, trip wire, etc.), or the test reaches a designated completion time (DCT).

9.2 *Post Roadwheel Tire Testing Inspection and Storage:*

9.2.1 For operator safety, at the end of the roadwheel test, unload the tire and allow it to cool for a minimum of 15 min before approaching the tire.

9.2.2 Measure inflation pressure and record as final inflation pressure value in appropriate data log.

9.2.3 After recording of final inflation pressure, visually inspect the exterior of the tire for any findings. Remove the tire from the roadwheel, then remove the valve core and deflate the tire. Dismount the tire from the wheel and inspect the inside of the tire for any further evidence of findings (for example, cracks or delaminations).

9.2.4 All tires shall be cut to inspect for belt edge separation.

9.2.5 If tires or sections are to be stored, it is recommended to place tire or tire sections in a clean, dry, enclosed storage area away from ozone sources per the RMA Tire Care and Service Manual with a maximum temperature of 38°C. Record date, time, and technician identification.

9.2.6 If tires are to be disposed of after the completion of testing and analysis, do so in accordance with local regulations.

10. Report

10.1 Statement that the tests were made in accordance with this standard.

11. Precision and Bias

11.1 Precision and bias studies are to be conducted at a later date.

12. Keywords

12.1 accelerated laboratory aging; belt separation; oven; oven aging; roadwheel; tire

APPENDIX

(Nonmandatory Information)

X1. ROADWHEEL DATA LOG

X1.1 See Fig. X1.1.

Roadwheel Test Data Log

All Roadwheel Testing to be conducted in accordance with ***ASTM F551***

Internal ID Number: _____

Manufacturers ID Number: _____

Brand/Model: _____

Size: _____

Load Range: _____

Cold Inflation Pressure: _____

Rim Material: Steel Aluminum _____

Rim Width _____ inches

Initial Test Pressure: _____ kPa (psi)

Test Speed: _____ km/h (mph)

Test Load: _____ N (lbs)

Additional Test or Tire Comments:

	Date	Time	Ambient Temp	Tech ID
Conditioning Start				

	Date	Time	Pressure (kPa)	Tech ID
Test Start				
Check @ 1 hour				

FIG. X1.1 Example Format using a 600 h DCT with Minimum Required Information

Check Point	Date	Time	Pressure (kPa)		Resume Time	Comments: Inspection / Tire Condition	Tech ID
			As found	Adjusted			
24 hours							
48 hours							
72 hours							
96 hours							
120 hours							
144 hours							
168 hours							
192 hours							
216 hours							
240 hours							
264 hours							
288 hours							
312 hours							
336 hours							
360 hours							
384 hours							
408 hours							
432 hours							
456 hours							
480 hours							
504 hours							
528 hours							
552 hours							
576 hours							
600 hours							

Duration at Test End:	Hours	Kilometers	**Test Result**	

Visual End of Test Conditions:	**Comments:**

FIG. X1.1 Example Format using a 600 h DCT with Minimum Required Information *(continued)*

RELATED MATERIAL

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Docket NHTSA-2005-21276 - ASTM Technical Papers Phase 1 Close-out Report, Phase 2 Close-out Report, and Validation Phase Summary Report

Federal Register Vol. 67, No 43, Tuesday, March 5, 2002 page 10068 Paragraph 6. "Aging Effects"