Designation: F2838 – 10

Standard Practice for Accelerated Laboratory Aging of Radial Passenger Car and Light Truck Tires through Load Range E for the Laboratory Generation of Belt Separation[1]

This standard is issued under the fixed designation F2838; 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.

1. Scope

1.1 This practice describes a method to laboratory age a new tire in an oven to produce changes in certain chemical and physical properties at the belt edges similar to those of tires in-service (see Appendix X1).

1.2 This practice is a precursor to conducting an ASTM standard roadwheel test method for laboratory generation of belt separation in radial passenger car and light truck tires.

1.3 This practice may not produce representative chemical and physical property changes in any part of the tire except the belt edge.

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

1.5 *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 8.

2. Referenced Documents

2.1 *ASTM Standards:*[2]

ASTM SI10 - 02 IEEE/ASTM SI 10 American National Standard for Use of the International System of Units (SI): The Modern Metric System

F538 Terminology Relating to the Characteristics and Performance of Tires

G128 Guide for Control of Hazards and Risks in Oxygen Enriched Systems

2.2 *Other Standards:*

ANSI/ISO/IEC 17025 General requirements for the competence of testing and calibration laboratories[3]

Compressed Gas Association (CGA) Standard for Valve Connections V-1[4]

EIGA IGA 04/09/E Fire Hazards of Oxygen and Oxygen Enriched Atmospheres

RMA Volume 4 Tire Service Manual[5]

Tire and Rim Association (T&RA) Year Book[6]

European Tyre and Rim Technical Organisation (ETRTO) Standards Manual

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

ISO 4000 Passenger Car Tyres and Rims[7]

3. Terminology

3.1 *Definitions:*

3.1.1 *age, v*—to apply conditions so as to promote change of material properties.

3.1.1.1 *Discussion*—For a tire, this can be done on a roadwheel, in a laboratory oven, in service, etc.

3.1.2 *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.

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

3.1.3.1 *Discussion*—See Appendix X1 for more details.

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

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

[4] Available from Compressed Gas Association (CGA), 4221 Walney Rd., 5th Floor, Chantilly, VA 20151-2923, http://www.cganet.com.

[5] Available from Rubber Manufacturers Association (RMA), 1400 K St., NW, Suite 900, Washington, DC 20005, http://www.rma.org.

[6] Available from Tire and Rim Association, Inc. (TRA), 175 Montrose West Ave., Suite 150, Copley, OH 44313, http://www.us-tra.org.

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

3.1.5 *aging, thermal oxidative, n*—the process whereby chemical and physical material properties of a tire change with exposure to heat and oxygen.

3.1.6 *belt, in a tire, n*—a breaker that substantially restricts the carcass in a circumferential direction. **F538**

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

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

3.1.9 *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).

3.1.10 *hot inflation pressure, n*—the gauge pressure of a tire after equilibration in an oven, measured between 60 and 80 min after removal from oven.

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 *oven, n*—a chamber designed for heating tires in a controlled manner.

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

3.1.14 *tire, oven-aged, n*—a tire that has been subjected to accelerated laboratory aging in an elevated temperature environment (see 3.1.2).

4. Summary of Practice

4.1 This standard practice requires the use of an oven (as specified in 6.1) to conduct accelerated laboratory aging of a tire. This requires a defined inflation pressure, inflation gas, oven temperature, and time period.

4.2 This standard practice was developed to be used to prepare tires for conducting an ASTM standard test method for laboratory generation of belt separation in radial passenger car and light truck tires. Use of this practice for other applications would require validation.

5. Significance and Use

5.1 This standard practice establishes a method for conducting accelerated laboratory aging of radial passenger or light truck tires, or both, in an oven.

5.2 The goal of this practice is to define a scientifically valid protocol for the accelerated laboratory aging of a tire such that certain of its material properties correlate to those of in-service tires (see Appendix X1). This practice does not establish performance limits or tolerances for tire specifications.

6. Apparatus

6.1 Use of an oven is specified in this section, defining the requirements such that tires may be exposed to a controlled temperature. Provisions for monitoring other environmental conditions (for example, humidity) are also recommended.

6.1.1 Oven configuration shall be such that tires may be positioned without contacting other tires or oven walls, ceiling or floor.

6.1.2 Autonomous oven temperature monitoring devices shall be located within the oven such that the thermal history for each tire can be characterized.

6.1.3 Oven temperature control mechanisms (including the thermostat) shall be calibrated within ±1°C per the latest requirements of ANSI/ISO/IEC 17025.

6.1.4 Ovens large enough for tires may have a temperature gradient within them. A thermal map shall be developed for the oven intended to be used for the laboratory aging of tires, to identify positions or regions which are too hot or cold to be usable, or to identify the need to reduce the thermal gradient. See 11.4 for temperature tolerances.

6.1.4.1 At steady-state conditions, the temperature gradient within the usable oven space shall be stable. A stable temperature gradient can be achieved by, amongst other things, having proper thermal insulation in the oven, appropriate circulation, and having the door(s) adequately sealed.

7. Reagents and Materials

7.1 An oxygen/nitrogen gas mixture of (50.0 % O_2 / 50.0 % N_2 with a ±2 % analytical uncertainty) shall be used with a maximum moisture content of 200 ppm.

8. Hazards

8.1 *Hazards During Tire Oven Aging*—The possibility of a catastrophic loss of air pressure from the tire shall be anticipated throughout the procedure. (**Warning—**Such a pressure loss may be accompanied by fragments having a high energy level being thrown from the tire as well as a pressure wave radiating from the tire. Adequate safeguards for fire and personal protection as well as over-pressure ventilation shall be provided at all times.)

8.2 *Hazards During Tire Oxygen/Nitrogen Gas Mixture Filling and Replenishment:*

8.2.1 *Regulators and Fittings*—Oxygen rated hoses and fittings shall be used. The fittings and regulators shall conform to the Compressed Gas Association Standard V-1 requirements for compressed gases with enriched oxygen concentrations, for example CGA-296. The hose shall have a working pressure above the tire inflation pressure specified in this standard. The hose shall be kept clean and undamaged and should be compatible with the specified oxygen concentration.

8.2.2 *Storage of Gas Cylinders*—Gas cylinders shall be stored per OSHA guidelines.

8.2.3 *Filling and Venting of Tires*—Venting and filling tires shall be done in a well ventilated area, away from any ignition sources. Persons who have been exposed to oxygen enriched atmosphere should avoid ignition sources until well ventilated, at least 15 min, per EIGA IGA 04/09/E recommendation.

8.2.4 *Static Electrical Isolation of Tire/Wheel Assemblies*—The tire/wheel assembly shall be electrically grounded during fill/vent to prevent any static discharge.

9. Sampling and Specimens

9.1 All of the tires in a sample lot shall have the desired production plant and date codes and similar storage and temperature history exposure. Tires must be free of molding or other defects.

9.2 New tires (not previously used or inflated) shall be used in this standard practice and shall be selected so that they are no less than 2 weeks and no greater than 39 weeks from time of manufacture.

9.3 Test tires shall be mounted on wheels for testing, of the measuring rim width, if available. The same wheel should be used for both oven aging and roadwheel testing without dismounting, to prevent any damage incurred through removal of the tire from the wheel. If the appropriate rim size is not available, the operator shall use an alternate size per current published standards. Refer to the current published standards of T&RA, ETRTO, JATMA, or ISO 4000 for lists of standardized wheel widths for applicable tire dimensions.

9.4 Record the manufacturer's identification, brand name, tire identification number, size, load range, specified cold inflation pressure, and type of tire.

10. Preparation of Apparatus

10.1 *Preparation for Tire Oven Aging*—The target oven space temperature shall be 60 ± 1°C.

11. Procedure

11.1 *Tire Mounting and Tire Inflation Preparation Prior to Tire Oven Aging:*

11.1.1 Test tires are to be mounted on wheels of the proper rim bead seat diameter with clean, smooth surfaces in the bead seat areas, particularly in the vicinity of the weld. Wheel rim flanges must be free of sharp edges or scuffs that could damage the tire during mounting. Bead seat diameters must be verified using a certified disc tape (a.k.a. ball tape) and be acceptable according to an applicable standard such as the T&RA Yearbook. Painted steel is the material of choice for the test wheels due to the low permeation rates. If another wheel material must be used, then precautions are to be taken to insure against fill gas permeation through the wheel material. For the example of non-ferrous wheels, the tester shall paint the wheel between the bead seats to reduce the fill gas permeation rate from the wheel, or the manufacturer must certify them to be leak free via helium inspection. Tires should be mounted on the wheels that will be used for roadwheel testing to avoid damaging the tire bead area.

11.1.2 Any tires mounted on light alloy wheels should be noted in the Observation/Comments fields of the appropriate data log.

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

11.1.4 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.

11.1.5 Mount the tire on the wheel using air according to RMA Volume 4.

11.1.6 Inflate the tire/wheel assembly to the desired starting pressure with air as specified in Table 1. The test tire, after being mounted on a test rim and inflated to the applicable test pressure, shall remain at the ambient temperature of the test room for at least 24 h prior to testing.

11.1.7 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 must be checked for leaks.

11.1.8 Using the oxygen/nitrogen gas mixture, inflate the tires as follows:

11.1.8.1 Vent air-filled tire to atmospheric pressure,

11.1.8.2 Inflate to the cold inflation pressure (measured at 23 ± 5°C laboratory ambient temperature) specified in Table 1,

11.1.8.3 Vent back to atmospheric pressure,

11.1.8.4 Inflate to the specified cold inflation pressure,

11.1.8.5 Vent back to atmospheric pressure, and

11.1.8.6 Inflate to the specified cold inflation pressure.

11.1.9 After confirming that the tire/wheel assembly is free from leaks and filled with the gas mixture, fit the valve with a sealing cap.

11.2 *Tire Oven Aging:*

11.2.1 The target tire temperature during oven aging shall be 60 ± 1°C. If necessary, the oven thermostat set point may be adjusted up or down to maintain the test tire at 60 ± 1°C.

11.2.2 Place tires in the equilibrated oven and ensure that the tires are a minimum of 50 mm (2 in.) apart to facilitate even heat transfer and to assure that no tires are load bearing (other than their own assembly weight).

11.2.3 Remove the tire from the oven 6 ± 2 h after the start of oven aging and allow it to cool for 60 min. Measure tire inflation pressure between 60 and 80 min after removal from oven and record in the appropriate data log. This pressure shall then be referred to as the hot inflation pressure and becomes the target tire inflation for subsequent, periodic hot inflation pressure checks and top-offs.

11.2.4 The target oven duration shall be seven weeks (1176 ± 4 h).

11.3 *Periodic Hot Inflation Pressure Check and Top-Off Method:*

11.3.1 Seven days after the start date and time (±6 h), remove the tire from the oven.

11.3.2 Measure tire inflation pressure between 60 and 80 min after removal from oven, and record on the appropriate data log.

TABLE 1 Inflation Pressure Corresponding to Maximum Load

Standard Load, LL, SL (ISO)	240 kPa (35 psi)	
Extra Load (XL), XL (ISO) Reinforced	280 kPa (41 psi)	
"LT" and "C" Type Tires	Tire Load Rating	Inflation Pressure Corresponding to Maximum Load
Cross Section ≤295 mm (11.5 in.)	C	350 kPa (50 psi)
	D	450 kPa (65 psi)
	E	550 kPa (80 psi)
Cross Section >295 mm (11.5 in.)	C	250 kPa (35 psi)
	D	350 kPa (50 psi)
	E	450 kPa (65 psi)

11.3.3 Visually inspect the tire, and continue oven aging only if it is free of obvious anomalies.

11.3.4 If the hot inflation pressure is within 1 % of the pressure measured in step 11.2.3 no filling gas/pressure adjustments should be made. If the pressure is greater than 1 % below, adjust the inflation pressure of the tire by adding any necessary oxygen/nitrogen gas mixture to increase the pressure to the target hot inflation pressure setting (±1 %) for that tire.

11.3.5 Do not over-inflate the tire beyond the hot inflation pressure setting with the intention of releasing the excess tire pressure as this will affect the oxygen/nitrogen balance in the tire cavity.

11.3.6 Replace tire in equilibrated oven.

11.3.7 Every subsequent fourteen days after the seven day check, repeat the steps in 11.3 until the tire has been aged in the oven for the full 7 week time period.

11.3.8 If during any pressure check, the tire has been outside the oven more than 145 min, increase the total oven aging time for that tire by the duration it was outside the oven.

11.4 *Oven Temperature Variation*—The target tire temperature during oven aging shall be 60 ± 1°C, excluding the periodic pressure checks and top-offs and return to steady state temperature. If this target tire temperature is not maintained, the test should be repeated with a new tire. One exception allowed is an unintended interruption resulting in low tire temperatures (for example, loss of electrical power), in which case the total oven aging time shall be increased by the duration the oven was interrupted.

11.5 *Post Tire Oven Aging Inspection and Storage:*

11.5.1 At the end of the 7 week target oven aging period, plus any additional time adjustments, remove the tire from the oven and allow it to cool for a minimum of 3 h.

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

11.5.3 After recording of final inflation pressure (11.5.2), visually inspect the tire for any evidence of anomalies. Remove valve core and deflate tire.

11.5.4 Using air as the filling medium, inflate the tires as follows:

11.5.4.1 Inflate to the cold inflation pressure (measured at 23 ± 5°C laboratory ambient temperature) specified in Table 1,

11.5.4.2 Vent back to atmospheric pressure,

11.5.4.3 Inflate to the specified cold inflation pressure,

11.5.4.4 Vent back to atmospheric pressure, and

11.5.4.5 Inflate to the storage pressure shown in Table 2.

11.5.5 Place tire in a clean, dry, enclosed storage area away from ozone sources per the RMA Tire Care and Safety Guide with a maximum temperature of 38°C. Record date, time, inflation pressure, and technician identification. It is recommended that tires not be stored for periods greater than 3 months between tire oven aging and any subsequent roadwheel durability testing.

12. Report

12.1 Statement that the tests were made in accordance with Practice F2838.

12.2 Source and complete markings of the test tire.

12.3 Designations of the wheel used in the test conducted, including wheel material.

12.4 Tire oven aging data log.

12.5 Total actual oven time, and tire oven aging index (if utilized) for the test tire.

13. Keywords

13.1 accelerated laboratory aging; belt separation; durability; endurance; oven; oven aging; oxygen-nitrogen gas mixture; roadwheel; tire; tire oven aging

TABLE 2 Storage Conditions

NOTE 1—Do not exceed tire sidewall maximum pressure.

	Storage Inflation
Passenger Tires	140 kPa (20 psi)
Light Truck Tires	240 kPa (35 psi)

ANNEX

(Mandatory Information)

A1. TIRE OVEN AGING DATA LOG

A1.1 See Table A1.1.

TABLE A1.1 Tire Oven Aging Data Log

Oven Temperature Set Point						
Oven Number/ID						
Specified Cold Inflation Pressure						
Hot Inflation Pressure Setting						
Tire ID						
Temperature Monitor ID						
	Date	Time	Technician ID	Measured Oven Temperature	Measured Inflation Pressure as Found (60 to 80 min after removal from oven)[A]	Pressure Adjusted To
Start						
4 to 8 h						
1 week						
3 weeks						
5 weeks						
7 weeks						
Observations/Comments						

[A] After one, three, and five weeks of laboratory oven aging. Upon test completion wait 3 h for complete cool down.

APPENDIXES

(Nonmandatory Information)

X1. NHTSA PHOENIX TIRE AGING STUDY

X1.1 Tire material properties were obtained from data generated in the NHTSA Phoenix Tire Aging Study, Phase 1. For the tire types studied by ASTM in the ASTM program, the available NHTSA Phoenix Tire Aging Study material property data was used, which consisted exclusively of data collected from tires in on-road positions.

X2. BACKGROUND

X2.1 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.

X2.2 As tire wear life has increased over the years, interest in the aging of a tire's internal components has increased. "… 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." The ASTM F09.30 Subcommittee's goal was to develop a scientifically valid, short duration aged tire durability test standard, which correlates to in-service aging. Short duration is defined as the minimum duration test possible which correlates to the aged state and mechanisms driving this state. The scope of this work is limited to radial passenger car and light truck tires through Load Range E. This standards development subcommittee conducted research in order to determine appropriate accelerated laboratory aging conditions which correlate material property changes produced in the laboratory with those observed in service. The ASTM Subcommittee defined multiple research steps to follow in the development of the test standard. The research was developed to evaluate means to conduct accelerated laboratory aging of tires and considered both statically aging tires in an oven as well as dynamically aging tires on a roadwheel. The conclusion of the research was that tires should be statically aged in an oven within a specified range of times and temperatures.

RELATED MATERIAL

Satterfield, J., "Overview of Aged Tire Durability Standard Development," SAE Session Code: AC4 Presentation No. 2008-01-1489, Apr. 14, 2008.

McNutt, J., Waddell, W., and Kohler, J., "Development for an Aged Tire Durability Standard - Accelerated Laboratory Static Aging," SAE Paper No. 2008-01-1493.

McNutt, J., Waddell, W., and Kohler, J., "Development for an Aged Tire Durability Standard - Accelerated Laboratory Dynamic Aging," SAE Paper No. 2008-01-0149.

Waddell, W., Kohler, J., and McNutt, J., "Development for an Aged Tire Durability Standard - Determination of Time and Temperature Parameters for Accelerated Laboratory Static Aging," SAE Paper No. 2008-01-1492.

Kohler, J., McNutt, J., and Waddell, W., "Development for an Aged Tire Durability Standard - Reinflation Study for Accelerated Laboratory Aging," SAE Paper No. 2008-01-1491.

Stalnaker, D.O., Altman, R.G., Howland, D.L., and Popio, J.A., "Development for an Aged Tire Durability Standard - Stepped-up Load Roadwheel Evaluation," SAE Paper No. 2008-01-150.

Altman, G., Howland, D.L., Popio, J.A., and Stalnaker, D.O., "Development for an Aged Tire Durability Standard - Rationale for Steady State DOE," SAE Paper No. 2008-01-1495.

Altman, G., Howland, D.L., Popio, J.A., and Stalnaker, D.O., "Development for an Aged Tire Durability Standard - Steady State DOE," SAE Paper No. 2008-01-1493.

Altman, G., Howland, D.L., Popio, J.A., and Stalnaker, D.O., "Development of an Aged Tire Durability Standard - Comparison of Stepped-Up Load and Steady State DOE Results," SAE Paper No. 2008-01-1494.

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

Bridgestone United States Patent Number 6,119,513 of September 19, 2000.

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