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Standard Practice for Accelerated Laboratory Aging of Radial Passenger Car and Light Truck Tires through Load Range E for the Laboratory Generation of Belt Separation¹

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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 $\pm 1^\circ\text{C}$ 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 $60 \pm 1^\circ\text{C}$.

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 $23 \pm 5^\circ\text{C}$ 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 $60 \pm 1^\circ\text{C}$. If necessary, the oven thermostat set point may be adjusted up or down to maintain the test tire at $60 \pm 1^\circ\text{C}$.

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)