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# Standard Test Methods for Determining Physical Properties of Inflatable Restraint Cushions<sup>1</sup>

This standard is issued under the fixed designation D 5645; 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 ( $\epsilon$ ) indicates an editorial change since the last revision or reapproval.

## 1. Scope

1.1 These test methods cover the procedures used to evaluate the physical properties of driver-side and passenger-side inflatable restraint cushions.

1.2 The physical properties included by these test methods are seam strength, resistance to internal pressures greater than deployment pressures, and the leak rate of inflation gases at less than intended inflation pressures.

1.2.1 For ease of reference, the Summary of Test Method, Scope, Apparatus, Sampling, Procedure, and Precision and Bias sections are listed separately for each of the three physical properties of these test methods:

Property	Section
Seam Strength	9
Cushion Overpressurization	10
Leak Rate	11

1.3 Procedures and apparatus other than those stated in these test methods may be used by agreement between the purchaser and the supplier with the specific deviations from the standard acknowledged in the report.

1.4 The values stated in either SI units or inch-pound units are to be regarded separately as standard. The values stated in each system are not exact equivalents; therefore, each system must be used independent of the other.

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.* Specific precautionary statements are given in Section 6.

## 2. Referenced Documents

### 2.1 ASTM Standards:

D 123 Terminology Relating to Textiles<sup>2</sup>

D 1683 Test Method for Failure in Sewn Seams of Woven Fabrics<sup>2</sup>

## 3. Terminology

### 3.1 Definitions:

3.1.1 *cushion, n—*for inflatable restraints, the inflatable fabric envelope portion of a module.

3.1.2 *cushion overpressurization, n—*for inflatable re-

*straints*, the process of overinflating a cushion at internal pressures greater than design deployment pressures; bag burst.

3.1.3 *deployment, n—*for inflatable restraints, the sequence of events related to the activation of a module.

3.1.4 *inflatable restraint, n—*a vehicular safety device designed to cushion an occupant or equipment during collision; airbag.

3.1.5 *inflator, n—*for inflatable restraints, a device for generating and directing expansion gases into a cushion.

3.1.6 *leak rate, n—*for inflatable restraints, the steady-state rate of flow of an inflation gas through the entire cushion surface area at less than intended deployment pressures.

3.1.7 *module, n—*for inflatable restraints, an assembly composed of an inflator, a cushion, a mounting device, a trigger, and a cover.

3.1.8 *standard atmosphere for testing textiles, n—*an atmosphere for testing in which the air is maintained at a relative humidity of  $65 \pm 2\%$  and at a temperature of  $21 \pm 1^\circ\text{C}$  ( $70 \pm 2^\circ\text{F}$ ).

3.1.9 For definitions of other textile terms used in these test methods refer to Terminology D 123.

## 4. Significance and Use

4.1 Seam strength testing is used for design validation and in conjunction with lot acceptance.

4.2 Cushion overpressurization testing may be used in conjunction with design and production validation, manufacturing process control, lot acceptance, or a combination thereof.

4.2.1 Sources of variation in Cushion overpressurization testing procedures include orifice size, attachment fixture, method of attachment, presence or absence of internal bladder, accumulator size and pressure, transducer type and location, and presence or absence of vent plugs. All sources of setup variation should be addressed in the applicable part specification.

4.2.2 In accordance with the applicable specification, cushions may be pressurized without bursting to determine their resistance to a fixed level of high internal pressure, or they may be subjected to increasing pressures to determine their ultimate bursting strength.

4.3 Leak rate testing may be used in conjunction with design and production validation manufacturing process control, lot acceptance, or a combination thereof.

4.3.1 Leak rate testing is performed to detect large holes or cuts, skip stitches, open seams, or other abnormalities that might affect the flow rate of air through a cushion. Sources of variation in leak rate testing include orifice size, attachment fixture, method of attachment, accumulator size and pres-

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<sup>2</sup> Annual Book of ASTM Standards, Vol 07.01.

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sure, transducer type and location, and presence or absence of vent plugs. All sources of variation should be addressed in the applicable part specification.

4.3.1.1 Care must be given not to rely heavily on leak rate testing as a process control for seam integrity because the low-pressure nature of leak rate testing limits its significance. Because leak rate testing is a nondestructive test, seams should experience only minor stress, and practical considerations of pressure vessel volumes required to create steady-state flow rates result in low internal cushion pressures. Under low internal pressure, this procedure may not detect the difference between the leak rate of a properly constructed cushion and one containing a small hole or seam anomaly.

4.4 Unless otherwise specified by agreement between the purchaser and the supplier, these test methods shall constitute the conditions, procedures, and equipment by which inflatable restraints are tested for seam strength, cushion overpressurization, and leak rate testing. It is intended to be used as a guideline in establishing a written part specification or print. The specification or agreement of purchaser and supplier may deviate from the test methods described herein when (based on experience) considerations of equipment, cushion design, or other factors dictate otherwise.

## 5. Interferences

5.1 The pressure transducer and pickup tube within the mounting fixture must be mounted in a position that does not interfere with the unfolding cushion.

5.2 The pressure versus time data is subject to recording anomalies and electronic noise. The data should be digitally filtered to obtain the underlying smooth pressure curve prior to data analysis.

## 6. Hazards

6.1 Personnel conducting cushion overpressurization testing in the same room as the testing unit must be equipped with the appropriate safety equipment and safety training. Examples of the necessary safety equipment include, but are not limited to, ear protection, equipment shielding, and safety glasses. Proper written safety procedures shall be provided to all test personnel for compliance with standard industry practices. There shall be compliance to all applicable OSHA safety standards.

## 7. Equipment Calibration

7.1 For inflatable restraints, all test equipment used in accordance with these test methods shall be certified for calibration annually by an independent agency or equipment manufacturer whose results are traceable to National Institute of Science and Technology (NIST) or other national standards laboratory. The test parameters of the equipment shall be tested within the operating ranges covered in the cushion specification or equivalent document.

## 8. Conditioning

8.1 Unless otherwise specified by agreement between the purchaser and the supplier or unless conducted directly in conjunction with production, conditioning of specimens for leak rate testing, seam strength testing, and cushion overpressurization testing shall be at the standard atmosphere for testing textiles for at least 4 h prior to test.

## 9. Test Method for Seam Strength

### 9.1 Scope:

9.1.1 This test method covers the measurement of the maximum sewn seam strength which can be achieved in woven fabrics when a force is applied perpendicular to the seam. The grab test procedure in Test Methods D 1683, that are used to measure breaking force and elongation of textile fabrics, shall be used in conjunction with this test method for measuring seam strength.

9.1.2 This test method is restricted to sewn seams that are obtained from a previously sewn cushion.

9.1.3 This test method is used when a resistance to a force, a breaking force to rupture, a minimum elongation, or a combination thereof are required to determine the sewn seam strength, seam slippage, or seam integrity of a particular fabric for inflatable restraint use.

9.2 *Summary of Test Method*—Test specimens containing seams are taken from inflatable restraint cushions at specified seam locations and are destructively tested under laboratory conditions to determine seam strength.

9.3 *Apparatus—Tensile Testing Machine*, either a constant rate of extension (CRE) or a constant rate of traverse (CRT) type, that is designed for the tensile forces anticipated, that is operated at a rate of  $300 \pm 10$  mm/min ( $12 \pm 0.5$  in./min), that has a force range selected such that the anticipated break occurs between 10 and 90 % of full-scale load, and that has jaws and grip faces as agreed upon between the purchaser and the supplier.

### 9.4 Sampling:

9.4.1 Seam strength testing is a destructive test and therefore necessitates sampling procedures if used in conjunction with lot acceptance.

9.4.2 For acceptance testing, the lot size is the quantity of cushions sewn in one production day or as agreed upon between the purchaser and the supplier.

9.4.3 For acceptance testing, take at random the number of cushions directed in an applicable material specification or other agreement between the purchaser and the supplier. Consider the cushions to be the primary sampling units.

9.4.4 For seam strength testing, seam-containing portions of sampled cushions constitute the test specimens.

9.4.5 Select specimens from cushions at locations on the cushion seam(s) where the greatest stresses are anticipated, as indicated in the cushion specification or equivalent. In seams involving woven fabric, this is usually where the warp or filling yarns are parallel to the seam. Cushion design may indicate other stress points of concern.

9.4.6 Unless otherwise specified for driver-side cushions, specimens selected for seam strength testing are taken from the perimeter seam at the 0 rad ( $0^\circ$ ), 0.79 rad ( $45^\circ$ ), and 1.57 rad ( $90^\circ$ ) positions, relative to the warp direction of the fabric in the front panel.

9.4.7 For the passenger-side cushions, select specimens from seam locations as directed in an applicable cushion specification or other agreement between the purchaser and the supplier.

NOTE 1—Avoid selecting specimens from areas of the cushion where the seams exhibit sharp radius turns. During seam strength testing, these