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AMERICAN SOCIETY FOR TESTING AND MATERIALS
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Standard Practice for Evaluating the Performance of Inflatable Restraint Modules[1]

This standard is issued under the fixed designation D 5428; 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 the procedures and conditions used to evaluate the physical performance of inflatable restraint modules and module components during and after deployment.

1.2 The physical performance characteristics that may be obtained by this practice are internal cushion pressures determined by instrumentation, cushion geometries determined by high-speed photography, and material integrity determined by visual inspection.

1.3 This practice is applicable to driver and passenger side inflatable restraint modules.

1.4 Procedures and apparatus other than those stated in this practice may be used by agreement between the purchaser and the supplier with the specific deviations from the practice acknowledged in the report.

1.5 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.

1.6 *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.*

2. Referenced Documents

2.1 *ASTM Standards:*
D 123 Terminology Relating to Textiles[2]
2.2 *Federal Standard:*[3]
CFR 49 Code of Federal Regulations
2.3 *SAE Standard:*[4]
J211 Instrumentation for Impact Test

3. Terminology

3.1 *Definitions:*

3.1.1 *breakout pressure, n—for inflatable restraints,* the pressure level during deployment which ruptures the module cover.

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

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 *maximum inflation pressure, n—for inflatable restraints,* the maximum internal cushion pressure occurring after breakout pressure.

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

3.2 For definitions of other terms used in this practice, refer to Terminology D 123.

4. Summary of Practice

4.1 Inflatable restraint modules are mounted into a test stand that allows for deployments under conditions that duplicate or closely resemble the conditions in a vehicle.

4.2 Instrumentation within the test stand charts inflation pressures versus time. High-speed photography visually captures changing cushion geometries over time.

4.3 Module deployments are reviewed for pressure and time relationships, cushion geometries at one or more times during the cycle, and post-inflation material analysis.

5. Significance and Use

5.1 This practice is intended to be a general guideline for repetitive testing, safe conduct of tests, and accurate data collection for inflatable restraints.

5.2 This practice may be used by the purchaser and the supplier to establish the criteria by which inflatable restraint modules will be tested by the supplier to determine whether a lot of material is acceptable for shipment to the purchaser.

5.3 Unless otherwise specified by agreement between the purchaser and the supplier, this practice shall constitute the test conditions, procedures, and equipment by which inflatable restraint modules are deployed for testing. It is intended to be

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[2] *Annual Book of ASTM Standards,* Vol 07.01.
[3] Available from the Superintendent of Documents, U.S. Government Printing Office, Washington, DC 20525.
[4] Available from the Society of Automotive Engineers, 400 Commonwealth Drive, Warrendale, PA 15096-0001.

used as a guideline in establishing a written material specification or equivalent agreement between the purchaser and the supplier. The specification may deviate from the practices described herein when (based on experience) considerations of fabric properties, material handling equipment, or inflatable restraint system design dictate otherwise.

6. Interferences

6.1 The pressure transducer and pickup tube must be mounted in a position which does not interfere with the unfolding cushion.

6.2 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.

7. Apparatus

7.1 *Mounting Fixture*, suitable for simulating as closely as possible the physical features of the location of a module mounted in a vehicle. See A1.1.

7.2 *Pressure Transducer and Pickup Tube*, suitable for measuring pressures inside the cushion from 0 to 689 kPa (0 to 100 psi), mounted in a static or low-pressure area in the module that does not interfere with cushion deployment, and capable of withstanding the temperatures of the conditioning chamber. See A1.2.

7.3 *Film or Tape Video System*, suitable for recording the changing geometry of the cushion during deployment at 1000 or more frames per second, and capable of being synchronized precisely with a firing pulse.

7.4 *Data Acquisition System*, suitable for recording the output of a pressure transducer versus elapsed time of deployment. See A1.3.

7.5 *Conditioning Chamber*, suitable for maintaining the temperature of a module in a range between −55°C (−67°F) and 120°C (248°F) with a tolerance of ±2°C (±4°F). See A1.4.

7.6 *Electrical Firing Pulse Source*, suitable for actuating the inflator and able to communicate with recording devices dependent on an electrical starting signal. See A1.5.

7.7 *Lighting System*, suitable for high-resolution photography.

7.8 For inflatable restraints, all measurement equipment used in accordance with the procedures referenced in this practice 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 material specification or equivalent document.

8. Hazards

8.1 Code of Federal Regulations 49 classifies inflatable restraint inflators which incorporate pyrotechnic devices as Explosive Class C or Flammable Solid.

8.2 Test facilities for conducting tests on pyrotechnic devices must comply with all local and state building codes. A proper floor plan should include a physical barrier between test personnel and the device under test. In addition, a temperature-controlled environment is important for test accuracy, and a room fan is required to vent smoke and particulates from the test bay.

8.3 In consideration of safety for test personnel working with inflatable restraint devices, personnel involved in module deployments must be equipped with the appropriate equipment and safety training. Examples of the necessary safety equipment include; remote firing systems, equipment shielding, laboratory clothing, safety glasses, gloves, and electrostatic grounding straps. Proper written safety procedures shall be followed in accordance with standard ordinance and pyrotechnic industry practices. All applicable OSHA safety standards shall be identified and complied with.

9. Sampling

9.1 Assembly deployment is a destructive test and therefore necessitates sampling procedures if used in conjunction with lot acceptance. The sampling plan shall be determined by agreement between the purchaser and the supplier.

10. Temperature Conditioning

10.1 Assembly deployment is a destructive test and therefore necessitates sampling procedures if used in conjunction with lot acceptance. The sampling plan shall be determined by agreement of purchaser and supplier. Module assemblies are conditioned at cold, ambient, or hot temperatures prior to deployment. Unless otherwise specified, the conditioning temperatures are: −30°C (−22°F) for cold, 22°C (72°F) for ambient, and 80°C (176°F) for hot. Use a temperature tolerance of ±2°C (±5°F) and condition for a minimum of 4 h to ensure establishment of moisture equilibrium. Assemblies shall be placed in the conditioning chamber in a manner that allows free air movement and no direct contact with the chamber walls.

10.2 A conditioned module shall be deployed within 3 min of removal from the conditioning chamber. If the 3-min limit is exceeded, the module shall be reconditioned for 10 min for every minute past the 3-min limit.

11. Procedure

11.1 Condition the module in accordance with 10.1 and 10.2 at the temperature specified for the test.

11.2 Perform all system calibrations.

11.3 Verify proper framing rate, camera settings, and lighting intensity levels.

11.4 Enter the test serial number into recording portions of the data acquisition and video systems.

11.5 Record the laboratory ambient temperature.

11.6 In accordance with A1.1, mount the conditioned module onto the test stand making sure all fastening systems are secure.

11.7 Verify that the test firing leads are grounded prior to connecting them to the inflator initiator.

11.8 Close the door to the test bay and turn on the warning light before arming the deployment switch.

11.9 Connect the cable for supplying firing current to the inflator deployment switch.

11.10 Review the checklist to ensure all prior listed actions