Designation: D5428 – 08 (Reapproved 2013)

Standard Practice for Evaluating the Performance of Inflatable Restraint Modules[1]

This standard is issued under the fixed designation D5428; 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:*[2]
D123 Terminology Relating to Textiles
D6799 Terminology Relating to Inflatable Restraints

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:*

3.2 For all terminology relating to D13.20, Inflatable Restraints, refer to Terminology D6799.

3.2.1 The following terms are relevant to this standard: breakout pressure, cushion, deployment, inflatable restraint, inflator, maximum inflation pressure, module

3.3 For all other terms related to textiles, see Terminology D123.

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 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

[1] This practice is under the jurisdiction of ASTM Committee D13 on Textiles and is the direct responsibility of Subcommittee D13.20 on Inflatable Restraints.

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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 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.

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 are completed before firing the module.

11.11 Deploy the module and note the response of the data acquisition system to verify successful deployment.

11.12 Turn on the test bay exhaust fan to remove fumes or smoke.

11.13 Remove the module from the test stand.

12. Analysis of Results

12.1 *Video:*

12.1.1 Visually inspect the video data taken of the cushion at various times during the deployment, comparing the actual cushion geometries to the standard profile described in the material specification or other equivalent agreement.

12.2 *Pressure versus Time Plot:*

12.2.1 Digitize and filter the analog data in accordance with Section 10 of SAE J211.

12.2.2 Compare the digitized and filtered data to the specified profile of pressure versus time, noting key indicators that include, but are not limited to, the magnitude and time of breakout pressure and maximum inflation pressure.

12.3 *Component Material Analysis:*

12.3.1 Visually inspect the physical condition of the module and its components, comparing them to standard post-deployment conditions described in the material specification or other equivalent agreement.

12.3.2 Items for visual inspection include, but are not limited to, retention of general cushion integrity, seam integrity, mounting device integrity, inflator integrity, and signs of abnormal stress to the cushion fabric.

13. Conformance

13.1 The test results of the module deployment must conform to allowable ranges listed in the applicable material specification or other agreement between the purchaser and the supplier in order to warrant release of the shipment of module assemblies.

13.2 Nonconformity shall be reported by the supplier to the purchaser in writing. A lot that fails to conform to module deployment requirements as specified or as otherwise agreed upon may only be released for shipment upon written consent of the purchaser.

14. Report

14.1 State that the module or module lot was tested in accordance with ASTM Practice D5428 for evaluating the performance of inflatable restraint modules. Describe the module sampled and the method of sampling used.

14.2 The purchaser and the supplier shall determine the exact form of the laboratory report. Unless otherwise specified, the form shall provide the following information:

14.2.1 Applicable specification or reference to agreement between the purchaser and the supplier describing module deployment requirements,

14.2.2 Description or designation of the test,

14.2.3 Conditioning temperature,

14.2.4 Module designation,

14.2.5 Identification of lot and lot samples,

14.2.6 Specification or performance parameters,

14.2.7 Results of each evaluation,

14.2.8 Name of tester,

14.2.9 Date of test, and

14.2.10 Deviations from standard practice procedures and apparatus.

14.3 Report pressure versus time graphically with pressure along the vertical axis and time along the horizontal axis. Note the magnitude and time of breakout pressure and maximum inflation pressure.

14.4 Report results of video analysis as either conformity or nonconformity of the inflated cushion geometry to fit within a maximum allowable geometry at a specified time during the deployment as described in the material specification or equivalent document.

14.5 Report results of the visual inspection of the components as conformity or nonconformity to normally expected conditions of post-deployment components as described in the material specification or equivalent document.

15. Precision and Bias

15.1 The precision and bias of the procedure in Practice D5428 for plotting pressure versus time for video analysis, and for component material analysis is being determined.

16. Keywords

16.1 airbag; cushion; deployment; dynamic performance; inflatable restraint; module

ANNEX

(Mandatory Information)

A1. Detailed Description of Apparatus

A1.1 *Mounting Fixture*—The module test fixture shall allow for the easy but secure attachment of the module assembly in accordance with the intent of the test, both driver and passenger side. It shall hold the module secure during the entire deployment in an orientation and manner consistent with the intended vehicle installation of the module and the objective of the test, and with a level of support similar to that in the intended vehicle with respect to the steering wheel, steering column, and instrument panel. The module shall be oriented for free deployment of the cushion.

A1.2 *Pressure Transducer*—The pressure transducer shall be mounted to the module with a rigid wall pick-up tube inside the cushion in order to measure internal cushion pressure. The pressure transducer and the pick-up tube shall be mounted in a position that does not interfere with the unfolding cushion, and shall be rated for the temperature and pressure expected during the test.

A1.3 *Data Acquisition System*—A data acquisition system shall be provided to measure and record the pressure versus time output of the pressure transducer. Filter requirements, data sampling rate, transducer frequency response, and amplifier frequency response shall be such that minimal effect on accuracy of the data occurs. Overall accuracy of the data acquisition system shall be within ±3 %.

A1.4 *Temperature Conditioning Chambers*—Chambers should be provided to acclimate modules prior to testing, and shall be explosion resistant for the safety of the test personnel. Chamber capabilities shall extend from −55°C (−67°F) to 120°C (248°F) to include any special test requirements. The chamber shall be capable of providing uniform temperature with variations not to exceed ±2°C (±4°F).

A1.5 *Firing Pulse/Stimulus* —The level and duration of the firing pulse or stimulus shall be as specified by the customer or the manufacturer. The firing pulse or stimulus and equipment specification shall be recorded, including magnitude and duration for the event.