

# **USCAR Inflator Technical Requirements and Validation**

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# USCAR INFLATOR TECHNICAL REQUIREMENTS AND VALIDATION

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## Change Log

This Change Log lists all approved changes implemented in this document since the last published version. For the original release of the document the Change Log is empty.

Revisions are to be based on relevant experience and changes to the application environments of the participating OEMs. All changes to the document are to be decided upon by a joint USCAR committee as appointed by the participating OEMs and ratified by their respective organizations.

Paragraph Affected	Description of Change	Date
5.2.3.7.2 Item 1d	Change slope reporting requirement to be consistent with slope requirement in Table 3.2.7A	5/28/2002 USCAR Committee  S Stram M Quade L Knowlden
3.2.2.1	Stable production processes of a minimum of 1 year at a minimum of 500K/yr run rate, has been established. In no case shall the inflator structural margin fall below 1.35 as calculated per Section 5.2.4.2 <i>Structural Burst Test</i> .	
2.0	Updated to require the latest version of referenced documents	
3.1.1	over the deployment temperature range of -40°C to +85°C	
Appendix D	Reporting charts and notes revised to be consistent with Table 3.2.3.2.3.B	
3.2.4	The inflator shall produce no 'bag luminescence' visible in standard video (standard frame rate), using an uncoated bag per program direction, or Appendix A Table IV G-1, other than item c.	
Table 3.2.7.B	$\pm 12.5\%$ at $P_{75\% \text{ of peak}}$ or use $\pm 12.5\%$ of $T_{75\% \text{ of peak}}$	
5.1.2	Temperature tolerance from $\pm 3^\circ\text{C}$ to $\pm 2^\circ\text{C}$	
5.2.4.7.3	Temperature chamber, capable of maintaining $-40^\circ\text{C}$ to $+85^\circ\text{C}$ to $+90^\circ\text{C}$ .  Apply temperature cycle of 11 hours total <u>twice</u> during each axis of vibration testing  Condition inflator for a minimum of $270 \pm 5$ minutes at $80^\circ\text{C}$ to $90^\circ\text{C}$ .  Perform visual and audio inspection of the Inflator during and after the conditioning procedure. All visual and audio discrepancies <u>shall</u> be documented and reported to the Responsible Vehicle Engineering Organization.	
5.2.4.7.4	1. Condition Inflator for a minimum of 288 hours with temperatures of $-40^\circ\text{C}$ , $23^\circ\text{C}$ , and $90^\circ\text{C}$ and with 95% <del>maximum</del> minimum RH according to Figure 5.2.4.8.4.A, <i>Humidity/Thermal Cycle</i> .	
5.2.4.7.6	For dual stage inflators with initiators located at opposite ends of the inflator, perform drop <del>once</del> twice with each initiator in down position. The third orientation drop <u>shall</u> be dropped twice in the direction perpendicular to the axis of the both initiators (center pin to center pin) for a total of 6 drops for all orientations.	
5.2.4.9	$P_{\min} = (P_{\text{nominal}} - P_{\text{tolerance}})$ at $-30^\circ\text{C}$ to $-40^\circ\text{C}$	
Appendix A Section IVD	Condition 9 12 inflators	
Appendix A Section IV H	(if previous 2 reverse fire second stage only deployments ignite the primary stage  Requirement: The inflators <u>shall</u> meet the functional requirements of the body of this specification. The inflators <u>shall</u> not fail structurally. Otherwise, data is for informational purposes only.	
5.2.4.7	Addition of High Heat/Humidity Aging Test. Also see test matrices in appendix B for resulting inflator quantities	
Appendix D	100 ft3 Effluent Reporting Table. Added Apportionment column to table.	June 10, 2004 USCAR Committee S Stram M Quade L Knowlden

## USCAR INFLATOR TECHNICAL REQUIREMENTS AND VALIDATION

Paragraph Affected	Description of Change	Date
1.1	(Text added) Pretensioners are covered as a reference only. (Text Deleted) Pretensioners are covered only in respect to their effluents as included in Section 3.2.3, Effluents and their autoignition performance as included in Section 3.2.5, Autoignition, High Temperature Oven Performance/Autoignition of Heat Aged Inflators	8/28/2012 USCAR Committee H Lewis (Ford) J Chascsa (Ford) J Boyle (Chrysler) L Knowlden (GM)
1.2	(Text added) Any information in this specification for pretensioners is intended as reference only and does not set performance and/or content requirements. (Text Deleted) Specific design elements are not limited except by the performance and reliability requirements contained herein.	
	(Underline/Bold added) <u>Shall Requirements</u> : The inflator is required to meet all <u>shall</u> requirements. The use of "shall" in this document denotes a binding provision that <b>must</b> be met unless a deviation is granted by the Responsible Vehicle Engineering Organizations.	
	(Text modified) <u>Should Requirements</u> : <u>Should</u> requirements are to provide preferred requirements where absolute compliance is not required. "Should" denotes a <b>preference or desired</b> conformance which, if not met, must be accepted by the Responsible Vehicle Engineering Organizations. The final determination of the subject performance requirement <u>shall</u> be made by the Responsible Vehicle Engineering Organizations.	
3.1.3	(Text added) All prototype parts must be representative of production intent. Any differences must be identified with rational for equivalence.	
3.1.6.3	(Text added) In addition, the Inflator Supplier <u>shall</u> provide the inflator initial onset rate (e.g. using the small vented tank, initial onset chamber, nozzle exit pressure or other equivalent method) if requested by the Responsible Vehicle Engineering Organization.	
3.1.6.4	(Text added) (i.e. DOT, CTC, TUV, BAM, CE, etc.)  <i>Note, in 2007 EU published Pyrotechnic Directive 2007/23/EC which replaced in 2009 the local BAM-approval requirement. Any module now requires a CE-label. For all new inflators as of April 2013, the CE-conform labels have to be used. Omission of correct approval may prohibit shipping and importation to certain markets.</i>	
3.1.6.5	(Text modified) Examples of the inflator performance in a baseline module <u>shall</u> be demonstrated if requested by the responsible Engineering Organization. This demonstration <u>shall</u> be done in a dynamic test configuration (i.e. drop tower, pendulum, linear impactor, or other equivalent device) in an existing and well characterized module that meets the criteria of Appendix A Inflator Pre-source Qualification (QFS) section IV G, Table 1, Module Configuration.	

Paragraph Affected	Description of Change	Date
3.2.2.1	(Text added) The reliability and confidence interval shall be reported on the data used to calculate the structural margin.	
TABLE 3.2.3.1 A FLOW CHART OF EFFLUENT EVALUATION	Human Testing deleted	
3.2.3.2	(Text added and modified) Effluents measured in any of the various evaluations should be corrected to STP (Standard Temperature and Pressure) correcting for the dilution affects of tests done at higher altitudes. (STP for the purposes of this specification is 295K and 1.0 atm)  Upon deployment, the 'in vehicle' gaseous and particulate effluent levels from the full Frontal System (all frontal restraint devices including Driver, Passenger and Knee Bolster airbags, etc.) <u>shall</u> not exceed the full 'in vehicle' limits established for listed effluents per table 3.2.3.2.3.B Effluent Gas Limits (20 min Time Weighted Average), unlisted effluents (where determined to be present), and particulates.	
3.2.3.2	(Text added) <u>Note: Compliance of the effluent data shall be evaluated by use of the average(s) of each group of tests (minimum of 3 data points for each series) .</u>	
3.2.3.2.1	(Text modified, pretensioner deleted) <u>Note: Compliance of the effluent data shall be evaluated by use of the average(s) of each group of tests (minimum of 3 data points for each series) .</u>	
3.2.3.2.2	(Text modified, pretensioner deleted) In addition, upon deployment in a 100 ft <sup>3</sup> chamber, the Driver Inflator, Passenger Inflator, Side Inflator(s), and Knee inflators , <u>should</u> not exceed apportioned limits for Unlisted compounds.	
<b>Table 3.2.3.2.3.A Recommended Effluent Apportionment</b>	Table modified to: delete Pretensioners, Inflatable belts add Center Side Airbag  Notes modified as follows: <i>Note: Due to the nature of most crashes Frontal and Side restraint systems will not fire together without substantial 'opening' occurring to the occupant compartment. This opening, or ventilating of the occupant compartment allows the combined side and frontal apportionment to exceed 100%.</i>  Note: In cases where the sum of the frontal or side restraint systems apportionments will exceed 1 (one) the apportioned fractions <u>shall</u> be normalized by adding the smallest fractions for each airbag noted above and then normalizing to equal 1, by the responsible engineering organization.	
<b>Table 3.2.3.2.3.B Effluent Gas Limits (20 min Time Weighted Average)</b>	Table modified from Ammonia 35.0ppm to Ammonia 50.0ppm.	
<b>Table 3.2.3.3.1.A Effluent Particulate Limits Airborne (100<sup>ft</sup> chamber)</b>	Table modified deleting soluble/insoluble and Azide requirements	
3.2.3.3.2	(Text modified) 3. The total ballistic tank wash particulate of each <u>shall</u> not exceed 1.0 g, at room temperature, 4. The pH of the tank wash solution, diluted to 1000 ml, <u>shall</u> be determined and reported. The pH <u>shall</u> fall in the range of 4-11.0. 7. Chemical species that have reacted post deployment such as some carbonates and hydrated salts etc. shall be corrected and reported as the un-reacted original weight.	

Paragraph Affected	Description of Change	Date
3.23.4	(Text added) Human Test Criteria deleted. Also Appendix H "Human Test Proceedure" is deleted	
3.2.4	(Text modified) Inflators, during the time immediately post deployment (10 seconds to 2 minutes minimum), with an external ignition source applied, at temperatures of +23C and +85C as given in Section 5.2.3.6, Open Air Test:  a. <u>shall not</u> have flames of any length or duration from the applied external ignition source.	
3.2.7	Inflator slope requirement changed to reporting/reference only Inflator P90% requirement added as either/or to supplement T90% requirement	
3.2.10.2	(Text modified) Following deployment of the primary stage, a delayed ignition (or deactivation) of the secondary stage beyond 150 seconds in an ambient test (in a manner that will not cause hazard, decrease the protection of the system to the occupant(s), or cause audible alarm to occupants or emergency personnel) <u>shall</u> be permissible only as agreed to by the Responsible Vehicle Engineering Organizations.  Note deleted	
5.2.3.7.4	(Text added) Repeat step 1 with an additional approximately 500 ml of deionized or distilled water to equal less than 1000 ml of total liquid. Take special care to assure all openings, bulkheads, , seals and internal walls of the tank are thoroughly rinsed and clean.	

## 1. INTRODUCTION:

### 1.1 Scope:

This specification establishes the performance, and validation requirements for the inflator assembly used in airbag modules. Seatbelt Pretensioners are covered as a reference only.

### 1.2 Preface Definitions:

**Inflator:** For the purposes of this specification, an inflator is a device that delivers a defined quantity or volume of gas with a defined mass flow, at a required reliability and repeatability to a cushion or chamber in order to directly provide occupant restraints as defined by the intended customer engineering group(s). Specific design elements are not limited except by the performance and reliability requirements contained herein.

**Pretensioner:** For the purposes of this specification a pretensioner is a device that delivers a defined quantity or volume of gas with a defined mass flow at a required reliability and repeatability to the mechanical buckle and/or retractor device in order to remove belt length in the seat belt system, thereby providing increased occupant restraints as defined by the ntended customer engineering group(s). Any information in this specification for pretensioners is intended as reference only and does not set performance and/or content requirements.

**Degradation (following environmental conditioning):** The term "degraded" refers to a change in ballistic performance that falls outside of the reference window established by a virgin control group per Section 3.2.7, Inflator Performance and Variability Limits (i.e. DV/PV baseline group) after conditioning per Section 5.2.3.7, Closed Tank Test of this document. In addition, a failure of the inflator to meet any other requirement as stated in this document after environmental conditioning shall also be defined as degradation.

**Tailorable:** The ability to tune slope, onset, output (peak pressure), and output ratio (dual stage inflators) independently to meet the various program requirements.



Variability: The term "variability" refers to performance variation within a group of inflators that falls outside of the reference window established by a virgin control group (i.e. DV/PV baseline group) per Section 3.2.7, Inflator Performance and Variability Limits of this document.

Shall Requirements: The inflator is required to meet all shall requirements. The use of "shall" in this document denotes a binding provision that **must** be met unless a deviation is granted by the Responsible Vehicle Engineering Organizations. Deviations to "shall" requirements will only be considered and, if approved, granted by the Responsible Vehicle Engineering Organizations after evaluating appropriate available technologies and balancing all Module and restraint system performance considerations.

Should Requirements: Should requirements are to provide preferred requirements where absolute compliance is not required. "Should" denotes a **preference or desired** conformance which, if not met, must be accepted by the Responsible Vehicle Engineering Organizations. The final determination of the subject performance requirement shall be made by the Responsible Vehicle Engineering Organizations.

Responsible Vehicle Engineering Organization: Refers to the group(s) that are sponsoring the qualification. In the case where specific shall and/or should requirements must be altered to accommodate specific technologies, the supplier shall obtain acceptance of the altered test plan, from representatives of each OEM where the inflator is intended to be used.

QFS: QFS refers to 'Qualified for Sourcing' and is synonymous with 'Bookshelving'. The procedure for attaining QFS status for an inflator is detailed in Appendix A.

For additional definitions see the Glossary (Appendix E).

### 1.3 Changes to this Document:

This document is to be considered a living document. Revisions are to be based on relevant experience and changes to the application environments of the participating OEMs. All changes to the document are to be decided upon by a joint USCAR committee as appointed by the participating OEMs and ratified by their respective organizations.

## 2. APPLICABLE DOCUMENTS:

SAE J 1794 Restraint System Effluent Test Procedure (Dec. 2, 1996)  
ISO Guide 25 Lab Certification  
J2238 Airbag Inflator Ballistic Tank Test Procedure  
J211-2 Instrumentation for Impact Tests  
USCAR Initiator Specification  
MIL STD 810  
QS9000

In the case of new releases of the listed reference documents the latest version shall be applicable except where direct conflicts with this document take place. In the case of a direct conflict this document shall supercede and the previous version of the referenced document(s) shall be applicable