



Standard Test Method for Shock Sensitivity of Liquid Monopropellants by the Card-Gap Test¹

This standard is issued under the fixed designation D 2539; 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 In considering the handling properties of a liquid propellant, serious consideration is given to the possibility of hazard initiated by hydrodynamic shock. The consequences of such a shock may include: (1) nonpropagating explosion, (2) propagating but low-velocity detonation, and (3) propagating high-velocity detonation. All three are hazards; the test described herein is useful for one hazard only, namely propagating high-velocity detonation.

1.2 *This standard should be used to measure and describe the properties of materials, products, or assemblies in response to heat and flame under controlled laboratory conditions and should not be used to describe or appraise the fire hazard or fire risk of materials, products, or assemblies under actual fire conditions. However, results of this test may be used as elements of a fire risk assessment which takes into account all of the factors which are pertinent to an assessment of the fire hazard of a particular end use.*

1.3 *This standard does not purport to address all of the safety problems, 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.*

1.4 The values stated in SI units are to be regarded as the standard. The values given in parentheses are for information only.

2. Summary of Test Method

2.1 This test method gives an evaluation of the sensitivity of a high-energy liquid propellant in terms of a stack of plastic cards inserted between a sample of liquid and a standard booster charge of high explosive. The sensitivity value is taken as the number of cards required to attenuate the booster shock just enough that the liquid detonates in 50 % of the trials. For an unknown liquid, 15 to 25 shots (requiring up to 1000 mL of

liquid) can be needed to define its sensitivity value. Because of the destructive nature of the test, a sufficient supply of expendable parts must be available before a sensitivity determination is attempted.

2.2 The card-gap test described is a measure of the hydrodynamic shock required to produce a stable, high-velocity detonation in a 1-in. standard steel pipe. Because of the large sample size subjected to this detonability test, the test is not to be done in the laboratory. The advantages of the card-gap test are its practical scale, reproducibility, and moderate material cost. The interpretation of results of the test is a matter of considerable judgment. While a propellant may show a low sensitivity in the card-gap test, this does not preclude the possibility of other dangers. On the other hand, a very high card-gap sensitivity does not always preclude the usability of such a liquid propellant, since it is possible that suitable engineering design can incorporate preventative measures against propagation of detonation. It is known that the degree of confinement, size, and material of the container, among other parameters, influence detonation propagation; therefore, the results of any specific test may be highly apparatus-dependent.

NOTE 1—Gap tests for determining explosive sensitivity are new. A technique of using paper cards for the gap materials and steep pipe for containers was developed in England at the Explosives Research and Development Establishment. The version described herein is essentially the Naval Ordnance Laboratory modification. The test is valuable because it yields reproducible data and it has been found that results of different investigators show close agreement.

3. Significance and Use

3.1 The property measured is the tendency of a propellant to undergo a high-order detonation when subjected to a given hydrodynamic shock. One limitation of the test is the difficulty of applying it to materials under conditions where the vapor pressure exceeds 1 atm.

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4. Apparatus

4.1 *Cup*—The liquid under test is held in a cylindrical steel cup, closed at the bottom by a thin, flat diaphragm. It shall be fabricated as follows (Fig. 1):

¹ This test method is under the jurisdiction of ASTM Committee F-7 on Aerospace Industry Methods and is the direct responsibility of Subcommittee F07.02 on Propellant Technology.

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This test method is identical in substance with the Card Gap Test for Shock Sensitivity of Liquid Monopropellants recommended by the Interagency Chemical Rocket Propulsion Group, and published by the Chemical Propulsion Information Agency, Test No. 1, March 1960.