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AMERICAN SOCIETY FOR TESTING AND MATERIALS
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Standard Test Method for Yield Stress of Heterogeneous Propellants by Cone Penetration Method[1]

This standard is issued under the fixed designation D 2884; 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 test method[2] covers determination of the yield stress of heterogeneous propellants, both of the gel and emulsion types, containing from 0 to 70 % solid additives.

1.2 The values stated in SI units are to be regarded as the standard. In cases where materials, products, or equipment are available in inch-pound units only, SI units are omitted.

1.3 *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 2507 Definitions of Terms Relating to Rheological Properties of Gelled Rocket Propellants[3]

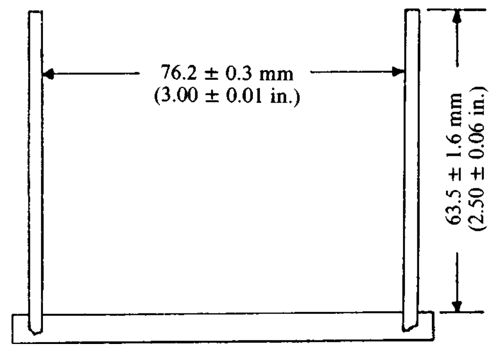
3. Terminology

3.1 *Definitions of Terms Specific to This Standard:*

3.1.1 *penetration of a propellant, n*—The depth, in tenths of a millimetre that a standard cone penetrates the sample under prescribed conditions of weight, time, and temperature.

3.1.2 *unworked penetration, n*—the penetration at 298 K (77°F) of a sample of the propellant which has received only the minimum disturbance in transfer from the sample can to a grease worker cup or dimensionally equivalent container. This shall be 76.2 ± 0.3 mm (3 ± 0.01 in.) in inside diameter and 63.5± 1.6 mm (2.5 ± 0.06 in.) deep, as shown in Fig. 1.

3.1.3 The conversion of penetration to yield stress has not been corrected for the displacement of the sample by the submerged portion of the cone. For this reason cup diameter is critical, and any deviation from 76.2 ± 0.3 mm (3 ± 0.01 in.) must be reported as a nonstandard condition.



NOTE 1—This cup is dimensionally equivalent to the grease worker cup.

FIG. 1 Penetrometer Cup

3.1.4 *yield stress*—the maximum shear stress that can be applied without causing permanent deformation (see Definitions D 2507).

Specifically in this test method, it is the weight of the 30-g mass cone-test rod assembly in dynes, corrected for buoyancy, divided by the calculated wetted area of the cone (that is, the area of the cone in contact with the propellant after the 5-s drop period).

4. Summary of Test Method

4.1 The penetration is determined at 298 K (77°F) by releasing the cone-test rod asembly from the penetrometer and allowing the assembly to drop for 5 s. The cone will be essentially at rest in less than this time, so that exact timing is not critical.

5. Significance and Use

5.1 The yield stress is a measure of the forces required to initiate and maintain flow from a storage vessel. If all the factors are constant, the propellant with the lower yield stress can be removed more completely from the vessel.

6. Apparatus

6.1 *Penetrometer*, to measure the penetration of the standard cone in the propellant. The cone assembly or the table of the penetrometer shall be adjustable to enable accurate placement of the cone on the level surface of the propellant while

[1] This test method is under the jurisdiction of ASTM Committee D-2 on Petroleum Products and Lubricantsand is the direct responsibility of Subcommittee D02.11on Engineering Science of High Performance Fluids and Solids. ASTM Committee F-7 on Aerospace Industry Methods maintains a continued interest in this test method and will make use of it in the future.

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[2] This test method is identical in substance with the JANNAF method, "Heterogeneous Propellant Characterization, Part III, Procedure for Measuring Yield Stress of Heterogeneous Propellants," published by the Chemical Propulsion Information Agency, July 1969, Johns Hopkins University, Applied Physics Laboratory, Johns Hopkins Rd., Laurel, MD 20810.

[3] *Annual Book of ASTM Standards*, Vol 15.03.

maintaining a zero reading on the indicator. The cone should fall, when released, without appreciable friction for at least 42.0 mm but not more than 60.0 mm so the cone will not hit the bottom of the container. The instrument shall be provided with leveling screws to maintain the cone shaft in a vertical position and a spirit level to determine the attitude of the instrument.

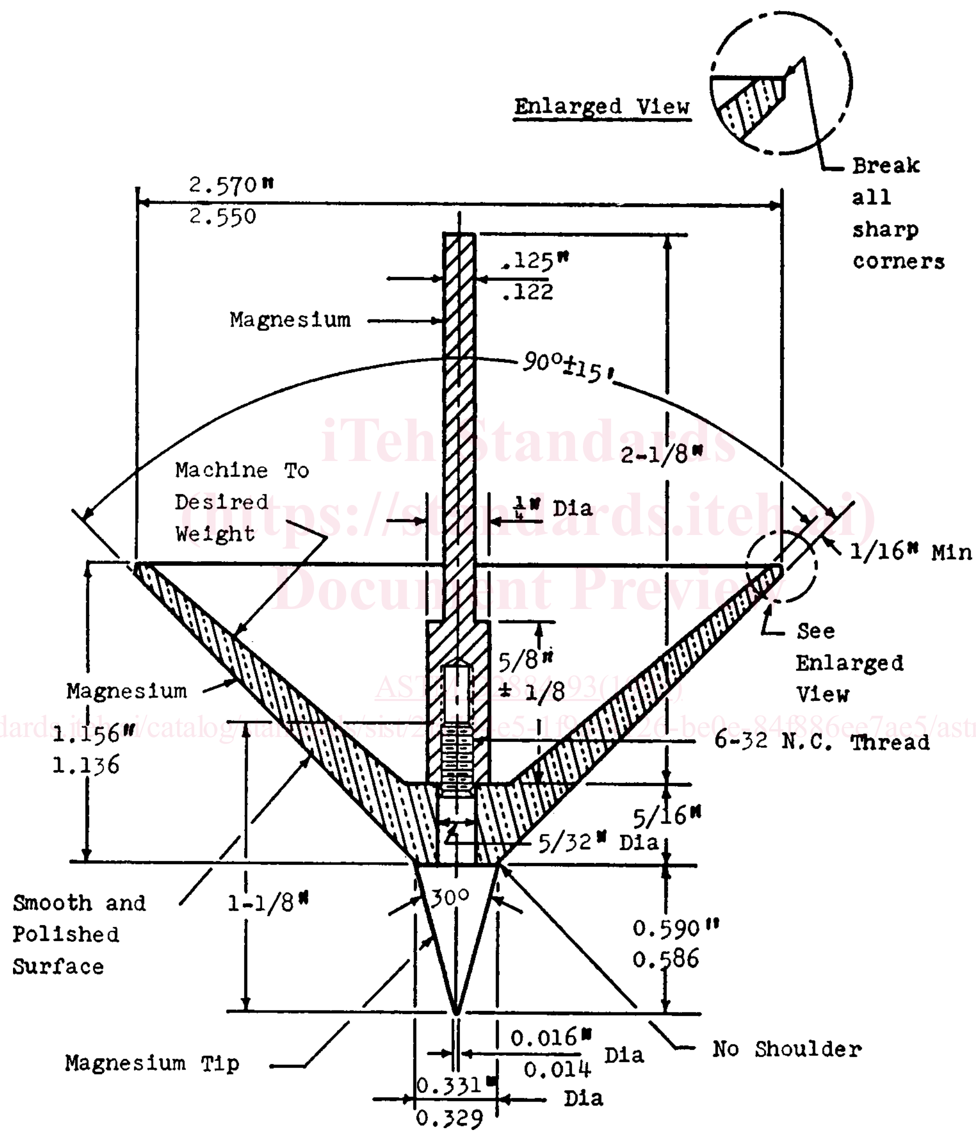
6.1.1 A 15-g test rod shall be substituted for the regular 47.5-g rod in accordance with the manufacturer's instructions.

6.2 *Cone*, of the dimensions shown in Fig. 2.

NOTE 1—Some cones have correct dimensions and weight (15.0 g) but react with hydrazine gels. The user should plan to have one made to order.

6.3 *Grease Worker Cup*, or equivalent container. The cup shall be made of material known to be compatible with all propellants which are to be tested in it. Construction may be two-piece as shown in Fig. 1, using a silver solder or braze which meets the compatibility requirement to seal the joint. Several users have had cups machined in one piece from bar stock, or from a rough casting.

6.4 *Water Bath*, capable of regulation to 298 ± 0.5 K (77 ± 1°F). For unworked penetrations, means must be provided for



NOTE 1—Tolerances on all fractional dimensions shall be ¹⁄₁₆ in.
NOTE 2—The total mass of the cone shall be 15.00 + 0.05 g and the total mass of its movable attachments shall be 15.00 ± 0.05 g.
NOTE 3—Table of Metric Equivalents

in.	mm	in.	mm	in.	mm	in.	mm
0.014	0.356	⅛	3.18	0.331	8.407	1.136	28.854
0.016	0.406	⁵⁄₃₂	3.98	0.586	14.884	1.156	29.362
¹⁄₁₆	1.59	¼	6.35	0.590	14.986	2⅛	53.98
0.122	3.10	⁵⁄₁₆	7.94	⅝	15.88	2.550	64.77
0.125	3.18	0.329	8.357	1⅛	28.575	2.570	65.28

FIG. 2 Magnesium Penetrometer Cone