



Designation: F 371 – 83 (Reapproved 1994)^{e1}

Standard Test Method for Compatibility of Materials with Liquid Oxygen (Reaction Intensity Method)¹

This standard is issued under the fixed designation F 371; 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.

^{e1} NOTE—Section 14 was added editorially in September 1994.

1. Scope

1.1 This test method covers the determination of the relative reactivity of materials with liquid oxygen under impact using the AFAPL impact tester. It is designed to yield an evaluation of the potential fire or explosive hazard of the material in contact with liquid oxygen under impact energy only, and shall not be used to predict such hazard from other forms of energy.

1.2 *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:

C 145 Specification for Solid Load-Bearing Concrete Masonry Units²

D 2512 Test Method for Compatibility of Materials with Liquid Oxygen (Impact Sensitivity Threshold and Pass-Fail Technique)³

D 2540 Test Method for Drop-Weight Sensitivity of Liquid Monopropellants³

2.2 Military Standards:⁴

MIL-P-25508E Propellant, Oxygen

MIL-T-27602B Trichloroethylene, Oxygen Propellant Compatible

MIL-C-81302C Cleaning Compound Solvent Trichlorotrifluoroethane

3. Summary of Test Method

3.1 A sample of the material is placed in a specimen cup, precooled and covered with liquid oxygen, and placed in the

cup holder located in the anvil region of the impact tester. The plummet is dropped from a fixed height of 1100 mm (43.3 in.), for a total of 3 blank drops and 20 test drops, each on a fresh specimen. On each drop, duplicate measurements are made of the peak pressure of the air shock wave from the impact area. In addition, notation is made of any flashes, burning or post-drop evidence of reaction.

NOTE 1—Other modes of operation of impact testers are described in Test Method D 2540 and Test Method D 2512. The former describes the “up-and-down” technique for the 50 % point, and the latter the “threshold technique,” for approximately the 5 % point.

4. Apparatus

4.1 AFAPL Impact Tester:⁵

4.1.1 *ABMA-Type Drop-Weight Apparatus* (Fig. 1), consisting of three guide rails capable of maintaining vertical alignment under repeated shock conditions, a 9.07 ± 0.02 -kg (20 ± 0.05 -lb) plummet weight, a fourth rail which supports an electromagnet for holding or releasing the plummet, a solenoid-operated safety catch to support the plummet when the magnet is not energized, and a base plate.

4.1.2 *Foundation*—A rigid 0.61 by 0.61 by 0.61-m (2 by 2 by 2-ft) (minimum) reinforced concrete block conforming to Specification C 145. Four stainless steel foundation bolts protruding from the concrete block are used to fasten the tester base plate to the block.

4.1.3 *Anvil Region Assembly*, consisting of an anvil plate, a specimen cup holder, and a striker pin guide (Fig. 2).

4.1.4 *Striker Pins and Specimens Cups*, stainless steel, which may be reused (cleaned and refinished, if necessary) until their dimensions no longer meet the drawing specifications (Figs. 3 and 4).

4.1.5 *Specimen Cup Sleeves*, aluminum, which are pressed into position, are used only once, and then discarded (Fig. 4).

4.1.6 *Reaction Intensity Measuring Systems*—Two identical but independent reaction intensity measuring systems (Fig. 1 and Fig. 5) are employed for obtaining peak pressure measurements in the air shock waves produced by reactions. Each system consists of a shock wave probe which serves to capture

¹ This test method is under the jurisdiction of ASTM Committee F-7 on Aerospace and Aircraft and is the direct responsibility of Subcommittee F07.02 on Propellant Technology. ASTM Committee D-2 on Petroleum Products and Lubricants maintains a continued interest in this test method and will make use of it in the future.

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² *Annual Book of ASTM Standards*, Vol 04.05.

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

⁴ Available from Standardization Documents Order Desk, Bldg. 4 Section D, 700 Robbins Ave., Philadelphia, PA 19111-5094, Attn: NPODS.

⁵ Drawings of the AFAPL impact tester will be furnished at nominal cost from ASTM Headquarters, 100 Barr Harbor Dr., PO Box C700, West Conshohocken, PA 19428-2959. Order Adjunct ADJF0371.

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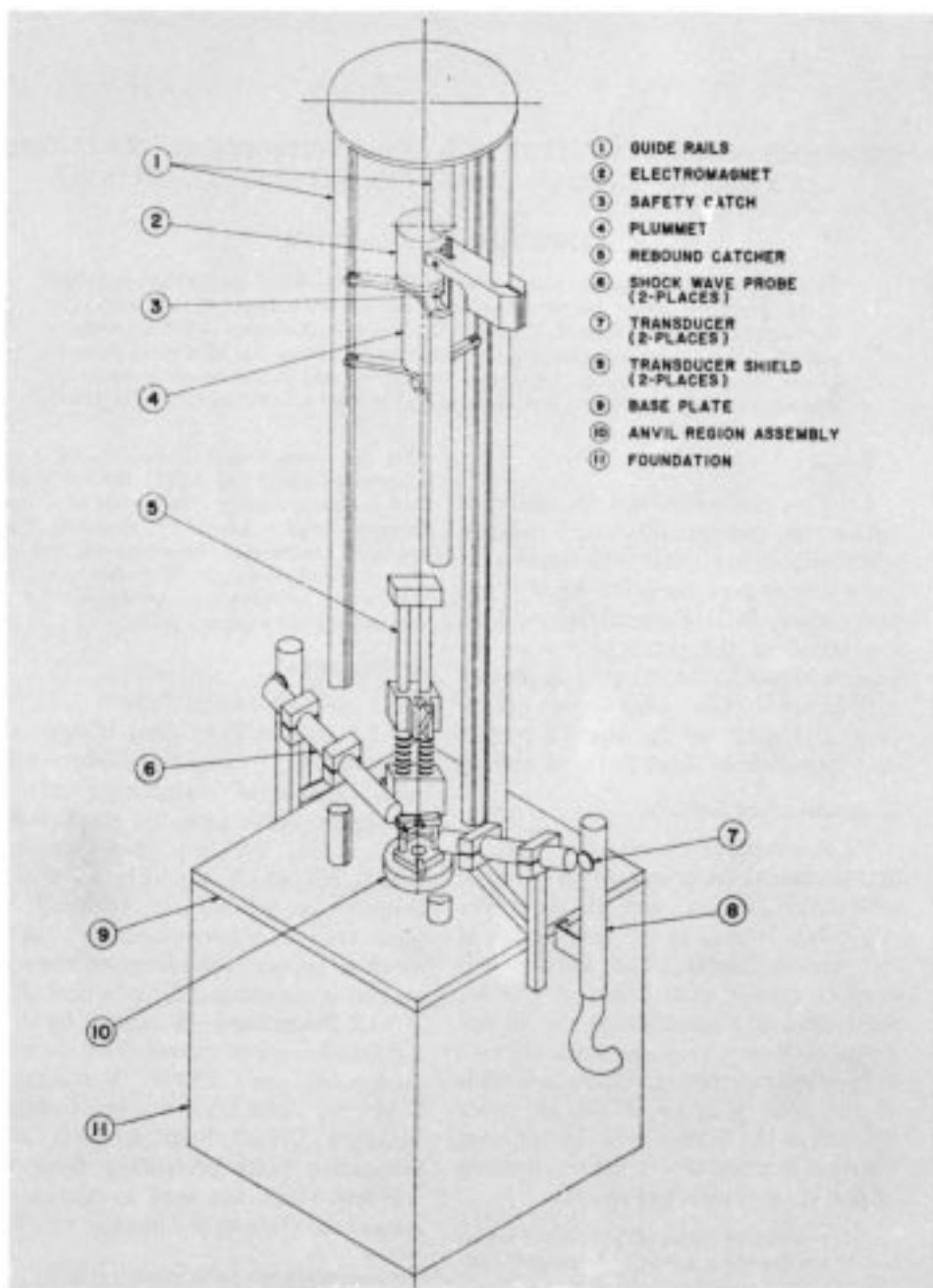


FIG. 1 AFAPL Impact Tester

a portion of the shock wave and guide it essentially unchanged to a remote point of measurement, a piezoelectric transducer, a low-noise transducer cable, a charge amplifier, and a peak pressure meter for obtaining a voltage reading corresponding to the peak pressure of the shock wave. The use of two measuring systems, which are located directly opposite each other, allows a more accurate measurement of directional reactions. The use of the shock wave probes allows the transducers to be shielded from the extraneous effects of violent reactions

4.1.7 *Shock Wave Probes*, each consisting of a stainless steel tube 406 mm (16 in.) long and 44.5 mm (1.75 in.) in inside diameter.

4.1.8 *Pressure Transducers*,⁶ two.

4.1.9 *Low-Noise Cables*.⁷

4.1.9.1 It is *essential* that the electronic portion of the measuring system located in the test cell (the transducers and cables) be fully protected from the effects of violent reactions. Such protection is afforded as follows: (1) The transducer shall

⁶ Kistler Model 606L, available from Kistler Instrument Corp., 8989 Sheridan Dr., Clarence, NY 14031, or equivalent, has been found satisfactory for this purpose.

⁷ Kistler Model 131M, available from Kistler Instrument Corp., 8989 Sheridan Dr., Clarence, N. Y. 14031, or equivalent, has been found satisfactory for this purpose.

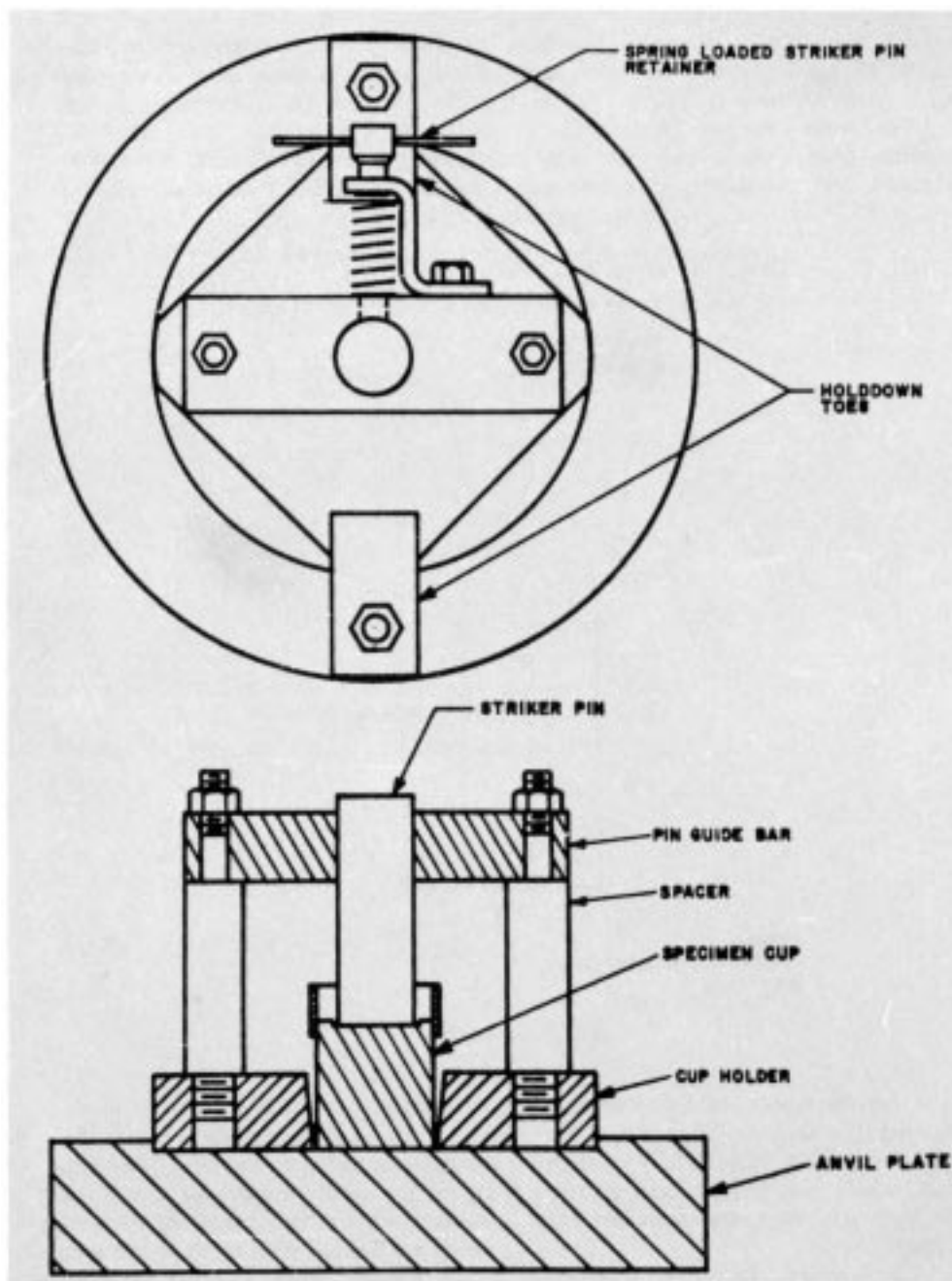


FIG. 2 Anvil Region Assembly

be mounted with rubber O-rings to reduce the influence of vibrations from the impacting plummet. The entire transducer, except for the diaphragm, shall be enclosed within the mounting device so that the air shock waves can reach nothing but the diaphragm, and (2) the low-noise cable shall be enclosed in a rigid metal or PVC tubing since any movement of the cable due to air shock waves or flying particles will produce extraneous signals.

4.1.10 *Charge Amplifiers*,⁸ on the OUTPUT side of the

charge amplifier, use a 50-Hz cutoff filter.⁹

4.1.11 *Peak Pressure Meters* to allow rapid reading of the shock wave peak pressure. The circuit diagram for this instrument is shown in Fig. 6.

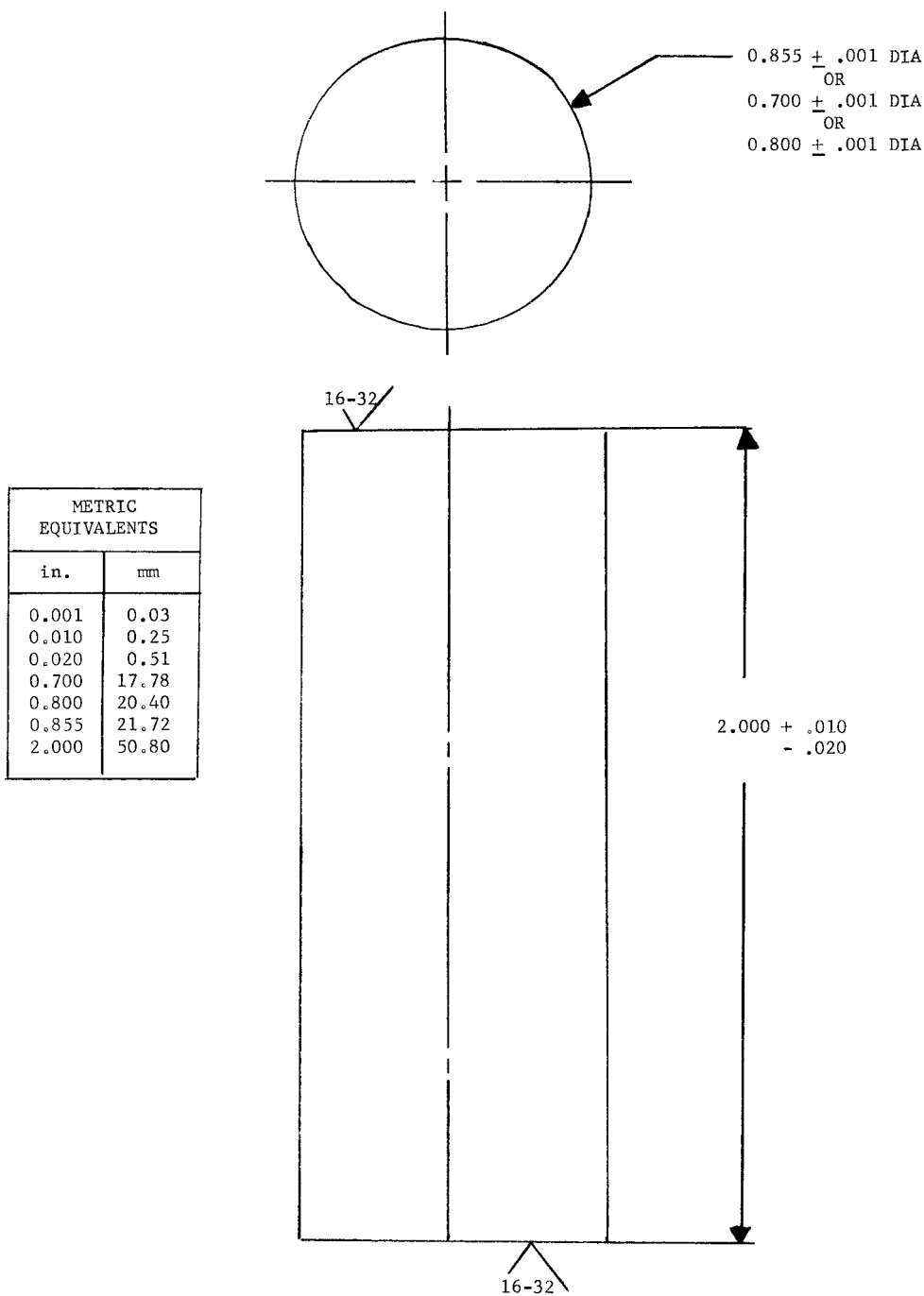
4.1.12 *Rebound Catcher* (Fig. 1) to catch the plummet after its initial impact since the allowance of secondary impacts would reduce the control of ignition stimuli.

4.1.13 *Test Cell*, for housing the impact tester. The floor shall be constructed of concrete and the walls of reinforced

⁸ Kistler Model 504, available from Kistler Instrument Corp., 8989 Sheridan Dr., Clarence, N. Y. 14031, or equivalent, has been found satisfactory for this purpose.

⁹ Kistler Model 544A50, available from Kistler Instrument Corp., 8989 Sheridan Dr., Clarence, N. Y. 14031, or equivalent, has been found satisfactory for this purpose.

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MATERIAL:
17-4 PH STAINLESS STEEL
HEAT TREAT:
CONDITION H-900

FIG. 3 Striker Pin

concrete or metal to provide protection from explosion or fire hazards. The cell shall be provided with a shatter-proof observation window and shall be darkened sufficiently to permit observation of flashes. (The operator shall be located in a darkened area outside the test cell.) Continuous ventilation shall provide fresh air to the test cell. Construction of the cell shall be such that it can be kept thoroughly clean.

4.1.14 *Freezing Tray* serving as a container for the pre-cooling of striker pins and specimen cups containing the test

specimens. A stainless steel tray with a cover, similar to a hospital surgical tray, may be used. The design and dimensions are not critical, except that it must be about 51 mm (2 in.) deep and large enough to hold about 30 pins and 30 cups with room to allow easy handling of the pins and cups by means of forceps. If desired, two smaller freezing trays may be used, one for the pins and one for the cups. The use of asbestos insulation under and around the sides of the tray or trays will retard liquid oxygen boiloff. The tray or trays shall be placed on a table in