



# Standard Test Method for Ignition Sensitivity of Materials to Gaseous Fluid Impact<sup>1</sup>

This standard is issued under the fixed designation G 74; 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 ( $\epsilon$ ) indicates an editorial change since the last revision or reapproval.

## 1. Scope

1.1 This method describes a technique to determine the relative sensitivity of materials to dynamic pressure impacts by gases such as oxygen, air, or blends of gases containing oxygen.

1.2 This method describes the test apparatus and test procedures that may be employed in the evaluation of materials for use in gases under dynamic pressure operating conditions up to gage pressures of 10 000 psi (69 MPa) at ambient temperature.

1.3 This method is primarily a test for ranking of materials. This method is not necessarily valid for determination of the sensitivity of the materials in an “as-used” configuration since the material sensitivity may be altered because of changes in material configuration, usage, and environment. This method can be employed to provide batch-to-batch acceptance data. Acceptability of any material may be based on its performance at a particular test pressure, or test pressure may be varied to determine the reaction threshold of a material, as specified by the user.

1.4 The criteria used for the acceptance, retest, and rejection of materials for any given application shall be determined by the user and are not fixed by this method.

1.5 *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.* For specific precautions see Section 7.

## 2. Referenced Documents

### 2.1 ASTM Standards:

D 1193 Specification for Reagent Water<sup>2</sup>

G 63 Guide for Evaluating Non-Metallic Materials for Oxygen Service<sup>3</sup>

G 93 Practice for Cleaning Methods and Cleanliness Levels for Material and Equipment Used in Oxygen-Enriched Environments<sup>3</sup>

<sup>1</sup> This method is under the jurisdiction of ASTM Committee G4 on Compatibility and Sensitivity of Materials in Oxygen Enriched Atmospheres and is the direct responsibility of Subcommittee G04.01 on Test Methods.

Current edition approved Sept. 10, 2001. Published January 2002. Originally published as G74–82. Last previous edition G74–82(1996)<sup>1</sup>.

<sup>2</sup> *Annual Book of ASTM Standards*, Vol 11.01.

<sup>3</sup> *Annual Book of ASTM Standards*, Vol 14.04.

MNL36 Safe Use of Oxygen and Oxygen Systems: Guidelines for Oxygen System Design, Materials Selection, Operations, Storage, and Transportation<sup>4</sup>

### 2.2 Military Standards:<sup>5</sup>

MIL-D-16791-E Detergent, General Purpose (Liquid, Non-ionic)

MIL-0-27210E, Amendment 1-Oxygen, Aviator’s Breathing, Liquid and Gas

## 3. Summary of Method

3.1 The gaseous impact test system is designed to expose material specimens or small components/elements to high-velocity (dynamic) gaseous impact environments. The basic configuration consists of a high-pressure accumulator, a high-speed pressurization (impact) valve, test system pressurization lines, test chamber/fixture, test chamber purge and vent systems, and a valve sequencer/control device. Fig. 1 is a schematic of a typical test system.

3.2 The general procedure is to prepare the test specimen, record significant pretest data, and place the test specimen in the test chamber. The test specimen is then subjected to sequential gaseous impacts by alternately opening and closing the test chamber pressurization (impact) and vent valves. The test data obtained may include test chamber pressures and temperatures, test chamber pressure rise times, pressurization and vent valve actuation times, and sequence times. The test specimen is then removed and examined for any significant changes and evidence of reactions. Pertinent data are recorded. The test is repeated using a fresh specimen for each impact test cycle until the desired user-selected criteria are met.

## 4. Significance and Use

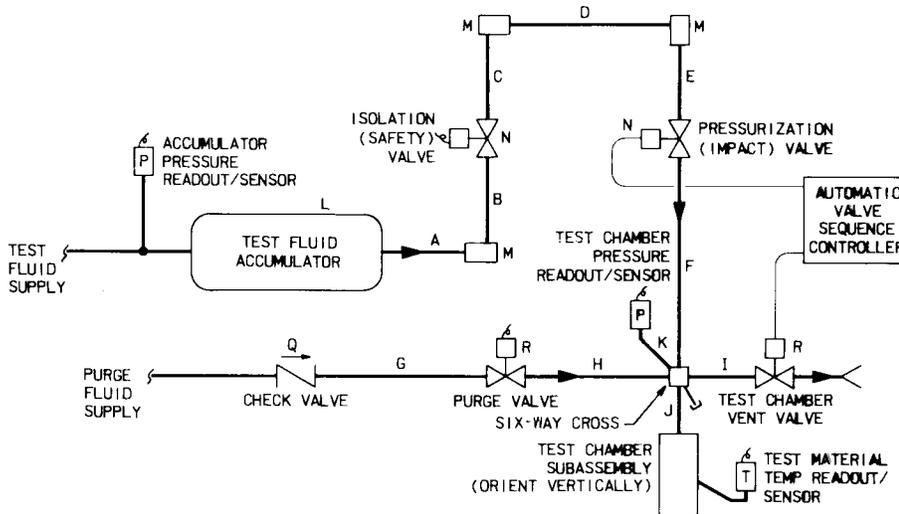
4.1 This test evaluates the relative sensitivity of materials to dynamic pressure impacts by various gaseous fluid media (may include mixtures of gases).

4.2 Any change or variations in test specimen configurations, thickness, preparation, and cleanliness may cause a significant change in impact sensitivity/reaction.

4.3 A reaction is indicated by an abrupt increase in test specimen temperature or by obvious changes in odor, color, or material appearance, or a combination thereof, as observed

<sup>4</sup> Available from ASTM, 100 Barr Harbor Drive, West Conshohocken, PA 19428.

<sup>5</sup> Available from Standardization Documents Order Desk, Bldg. 4 Section D, 700 Robbins Ave., Philadelphia, PA 19111-5094, Attn: NPODS.



**Equipment List:**

- A-K See Fig. Fig. 2
- L High-pressure Dwg 4-2219 (or equal)
- M High-pressure Catalog 60-22HF9 (or equal); orient as indicated
- N Flodyne P/N 5A170 (or equal)
- P Teledyne Taber Model 2101 (or equal)
- Q Circle Seal P/N VC1009A (or equal)
- R Flodyne P/N 2A170 (or equal)

**FIG. 1 Gaseous Impact Test System Schematic**

during post test examinations. Odor alone is not considered positive evidence that a reaction has occurred.

4.4 Suggested criteria for test completion at a given pressure are:

- 4.4.1 Each specimen is subjected to five impacts.
- 4.4.2 A material passes if no reactions occur in 20 successive samples.
- 4.4.3 A material fails if one reaction occurs in a maximum of 20 or fewer successive samples.
- 4.5 Materials may be ranked by the maximum pressure (pressure threshold) at which they pass the test.
- 4.6 Material acceptance may be on the basis of passing at a selected pressure.

**5. Apparatus**

5.1 A typical gaseous impact test system used for determining the sensitivity of materials to gaseous impact (adiabatic compression) is schematically depicted in Fig. 1. Details of this typical test system are depicted in Figs. 2-5. The major test system components are described as follows:

5.1.1 The accumulator provides gaseous test fluid storage and is recharged to the desired test pressure (potential energy head). The capacity requirement is dependent on the test chamber and line size and the number of impacts required per test sequence. It is sized to limit static head loss to less than 4 % of initial pressure during any test sequence.

5.1.2 The test chamber shall be pressurized from the base line pressure value (normally atmospheric ambient pressure) to 95 % of test pressure in not less than 10 nor more than 50 ms. This range is not to be construed to be an acceptable variation in any one system, but is the pressure rise time range permitted among different systems. The average pressure rise time of a given system shall vary not more than  $\pm 20$  % at a given test

pressure during the operational life of the system nor vary more than  $\pm 3$  ms for a given test set of 20 impacts.

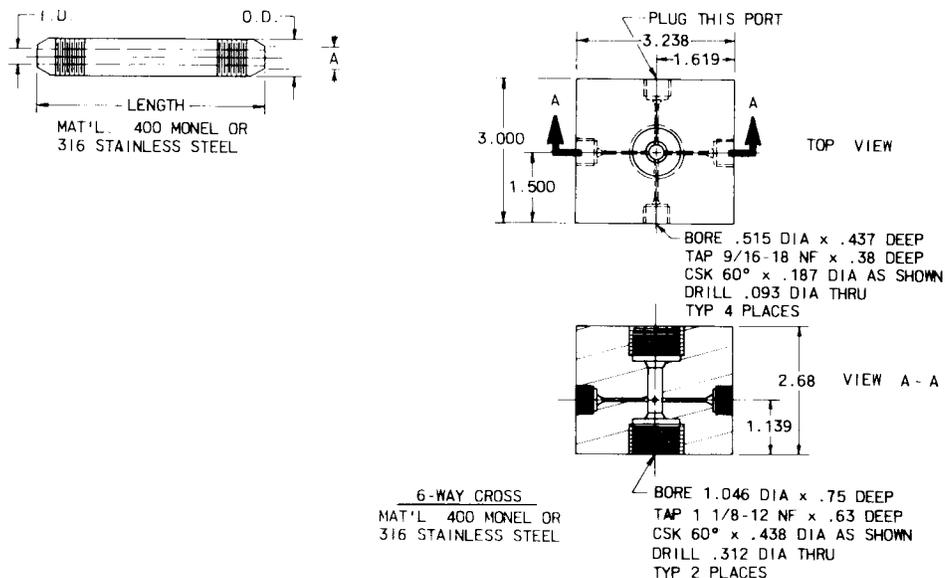
5.1.3 The fluid lines between the accumulator and pressurization valve shall be sized to minimize flow losses and enable pressurization of test chamber in accordance with 5.1.2. These lines shall contain an isolation valve to provide a safety factor for system operation. The isolation valve shall have a flow factor at least equal to the pressurization (impact) valve.

5.1.4 The test chamber vent valve shall be sized to allow the test chamber pressure to decay to atmospheric pressure between impacts.

NOTE 1—The ability of a given gaseous impact test system to rank materials is based on two basic parameters: the test chamber pressurization rate and the accumulator pressure. There may be variations in the test chamber pressurization rate of different test systems at a given test (accumulator) pressure; however, the test chamber pressurization rate of a given test system shall be maintained within the limits specified in 5.1.2-5.1.4. If these limits are maintained, a test system should be able to rank materials. For example, a properly functioning test system should rank most batches of chloroprene rubbers below most batches of vinylidene fluoride hexafluoropropylene rubbers, which should rank below most batches of polytetrafluoroethylene polymers. This ranking cannot, however, be considered absolute due to material batch differences imposed by contamination, differences in types and amounts of mold release agents, differences in cures, etc.

5.1.5 The inside diameter and the length of the pressurization line to the test chamber are critical. This section also contains a six-way cross for purge, vent, and instrumentation line connections. All line sections between the accumulator and the test chamber shall be straight and smooth to minimize flow losses. Dimensions of the lines and six-way cross for a typical test system are shown in Fig. 2.

5.1.6 The gaseous impact test chamber subassembly is configured to hold and position the test specimen. It also



Line	OID		OD		Length		A	
	in.	mm	in.	mm	in.	mm	in.	mm
A	5/16	7.9	9/16	14.3	4.50	114.3	0.375	9.5
B	5/16	7.9	9/16	14.3	12.25	311.2	0.375	9.5
C	5/16	7.9	9/16	14.3	11.96	303.8	0.375	9.5
D	5/16	7.9	9/16	14.3	10.95	278.1	0.375	9.5
E	5/16	7.9	9/16	14.3	3.88	98.6	0.375	9.5
F	5/16	7.9	9/16	14.3	4.00	101.6	0.375	9.5
G	1/16	1.6	1/4	6.4	2.43	61.7	0.125	3.2
H	3/32	2.4	1/4	6.4	5.30	134.6	0.125	3.2
I	3/32	2.4	1/4	6.4	2.25	57.2	0.125	3.2
J	5/16	7.9	9/16	14.3	5.37	136.4	0.125	3.2
K	3/32	2.4	1/4	6.4	2.20	55.9	0.125	3.2

FIG. 2 Test Chamber Purge, Pressurization, and Vent Lines

contains a thermocouple to monitor the test specimen temperature. Other requisites include the ability to readily install and remove the test specimen. Details of a typical test chamber are depicted in Figs. 3-5.

5.2 The test specimen instrumentation and control requirements include the following equipment:

5.2.1 An automatic, remote valve sequencer which controls the opening and closing of the test chamber pressurization (impact) and vent valves during the test so that each impact/vent cycle will be completed in identical, prescribed time periods. It is preset to perform a prescribed number of impact/vent cycles.

5.2.2 Test specimen instrumentation and data requirements include test fluid and test specimen temperatures, system static pressure, and chamber pressures. Additional data may include pressurization (impact) rate or pressure rise time and vent valve actuation and timing, and should include response times required of the instrumentation.

## 6. Reagents and Materials

6.1 *Alkaline Cleaner*, for test chambers, plumbing, and specimen substrates, consisting of a solution of 15 g of sodium hydroxide (NaOH), 15 g of trisodium phosphate (Na<sub>3</sub>PO<sub>4</sub>), and 1 L of distilled or deionized water.

6.2 *Deionized or Distilled Water*, conforming to Specification D 1193, Type IV.

6.3 *Detergent*—A noncorrosive, oxygen-compatible cleaner in the concentration used, conforming to MIL-D-16791E.

6.4 *Gaseous Oxygen*, conforming to MIL-O-27210E, Amendment 1, Federal Specification BB-O-925, Type 1, or oxygen of 99.5 % purity. Oxygen of higher purity may be used, if desired.

6.5 *Gases* used to dilute oxygen for testing in atmospheres other than pure oxygen should have a purity at least equal to that specified for the oxygen component.

## 7. Safety Precautions

7.1 This may be a hazardous test. The test cell shall be constructed of fire- and shrapnel-resistant materials in a manner that shall provide protection from the effects of test system component rupture or fire which could result from test specimen reaction or failure of a test system component.

7.2 A pressure isolation valve shall be installed in the line between the accumulator and the pressurization (impact) valve (reference Fig. 1). This valve may be either manually or remotely operated and will provide for personnel protection during specimen loading and unloading operations.

7.3 **Caution**—Approved eye protection shall be worn in the test area at all times. Other protective equipment such as gloves and ear protection shall be required if the system vent is adjacent to the test system.

7.4 No personnel shall be permitted in the test cell when

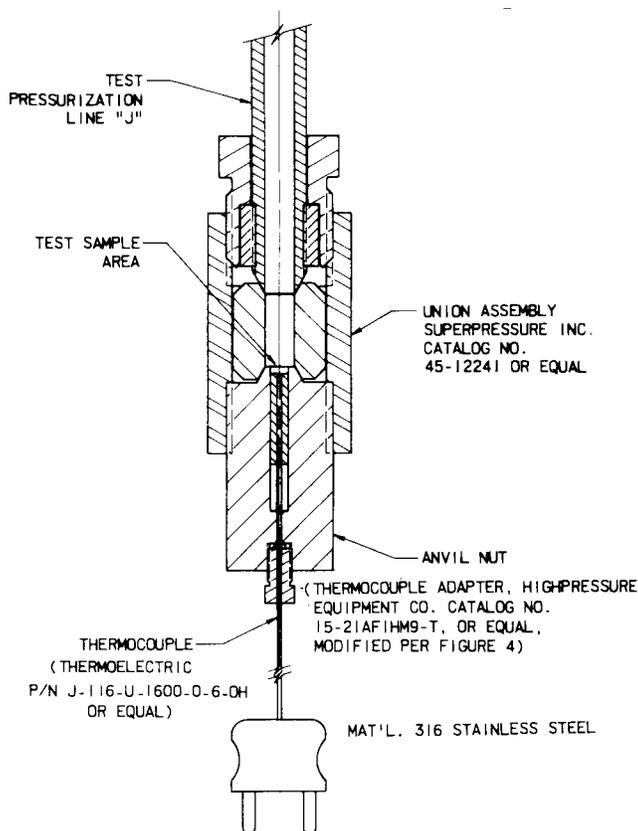


FIG. 3 Test Chamber Subassembly

remotely controlled valves are operated or when testing is in progress.

7.5 The housekeeping and maintenance characteristics of the test area shall be considered for both safety and cleanliness aspects.

#### 7.6 Oxygen:

**Warning!** Oxygen vigorously accelerates combustion.

Keep oil and grease away. Do not use oil or grease on regulators, gages, or control equipment.

Use only with equipment conditioned for oxygen service by carefully cleaning to remove oil, grease, and other combustibles.

Keep combustibles away from oxygen and eliminate ignition sources.

Keep surfaces clean to prevent ignition or explosion, or both, on contact with oxygen.

Always use a pressure regulator. Release regulator tension before opening cylinder valve.

All equipment and containers used must be suitable and recommended for oxygen service.

Never attempt to transfer oxygen from cylinder in which it is received to any other cylinder. Do not mix gases in cylinders.

Do not drop cylinder. Make sure cylinder is secured at all times.

Keep cylinder valve closed when not in use.

Stand away from outlet when opening cylinder valve.

For technical use only. Do not use for inhalation purposes.

Keep cylinder out of sun and away from heat.

Keep cylinder from corrosive environment.

Do not use cylinder without label.

Do not use dented or damaged cylinders.

7.6.1 See Compressed Gas ASSOCIATION BOOKLETS G-4 and G-4.1 for details of safe practice in the use of oxygen.

## 8. Test Specimens

8.1 Test the specimens in a thickness of  $0.060 \pm 0.005$  in. ( $1.52 \pm 0.13$  mm) (standard thickness), or in the end-use thickness if less than 0.055 in. (1.40 mm). If specimens are tested in a thickness other than  $0.060 \pm 0.005$  in., note the deviation. The specimens shall be representative of the as-used condition. The as-used condition may be either the new installed condition, or where preferable, the condition that exists at any time in the service life.

8.2 Maintain specimens clean at all times. Prepare and handle the specimens with new, visibly clean, vinyl surgical gloves or equivalent. Do not touch the materials or specimens with bare hands during or after the cleaning process.

8.3 Typical preparation procedures for various materials are as follows:

8.3.1 Sheet stock materials shall be in  $0.060 \pm 0.005$ -in. ( $1.52 \pm 0.13$ -mm) thickness and prepared as  $\frac{3}{16}$ -in. (4.76-mm)-diameter disks.

8.3.2 Apply coatings and paint in end-use thickness onto clean  $0.060 \pm 0.005$ -in.-thick by  $\frac{3}{16}$ -in.-diameter ( $1.52 \pm 0.13$  by 4.76-mm), Type 316 stainless steel substrates. Cure applied material in accordance with the manufacturer's recommendations. Record cured coating thickness and application and cure procedure for test reporting purposes.

8.3.3 Prepare specimens of O-rings having a material diameter of  $\frac{3}{16}$  in. (4.76 mm) or more in  $0.060 \pm 0.005$ -in. thickness by  $\frac{3}{16}$ -in. ( $1.52 \pm 0.13$  by 4.76-mm) diameter. Prepare O-rings having a material diameter of less than  $\frac{3}{16}$  in. in  $\frac{3}{16}$ -in.-long segments.

8.3.4 For tests of greases and semisolid material, fill the sample area of the test chamber subassembly to a depth of  $0.060 \pm 0.005$  in. ( $1.52 \pm 0.13$  mm).

8.3.5 Irregular materials may be prepared in any configuration that can be accommodated in the specimen area of the test chamber. Document the resultant specimen and installation configurations for test reporting.

8.4 Test specimen cleaning procedures are as follows:

8.4.1 Clean solid specimens, coatings, paints, and O-rings by rinsing with distilled or deionized water or an oxygen-compatible solvent that is compatible with the test material at test condition. Wash with detergent, then rinse with distilled or deionized water and dry using a filtered (25- $\mu$ m absolute or smaller filter rating) inert gas or air purge. If the specimen cannot be wetted with any cleaning solution, blow the specimens clean using filtered (25- $\mu$ m absolute or smaller filter rating) inert gas or air.

8.4.2 Clean Type 316 stainless steel substrates on which coating and paint samples are to be applied by immersing the substrates in an alkaline cleaner (see 6.1) for a minimum of 15 min at 20 to 35°C. Follow the immersion with a thorough rinse in running tap water, followed by a thorough rinse in distilled or deionized water. Perform a water break test during the rinsing step to verify that organic material has been removed from the surface. Blow dry the substrate with a clean, dry,



anvil nut in accordance with the manufacturer's recommendations until leaktight. Assure that required static pressure head is available at accumulator.

9.2.3 Ensure that all instrumentation is operating properly.

9.2.4 Clear the test cell area of personnel.

9.2.5 Open the vent valve until the chamber pressure sensor indicates atmospheric pressure; then close the vent valve.

9.2.6 Open the pressure isolation valve.

9.2.7 The following operations shall be controlled with an automatic valve sequencer to minimize valve timing/sequence changes. A typical gaseous impact test cycle is shown in Fig. 6.

9.2.7.1 Verify that the instrumentation systems are operational; then open the vent valve. After preset duration (which allows the chamber pressure to decay to atmospheric), close the vent valve.

9.2.7.2 Open the cycle pressurization (impact) valve.

9.2.7.3 Close the pressurization (impact) valve after preset duration.

9.2.7.4 Monitor instrumentation for reaction indication.

9.2.7.5 Repeat 9.2.7.1-9.2.7.4 until the desired number of test cycles (impacts) have been completed (normally, five).

9.2.8 Close the pressure isolation valve.

9.2.9 Ensure that the test chamber pressure and temperature conditions are stabilized and indicate that the test chamber may

be vented. Open the vent valve and pressurization (impact) valve. Allow the test chamber to vent to atmospheric pressure; then close the pressurization (impact) valve.

9.2.10 Remove the anvil nut and test specimen residue and examine for evidence of reaction. Record all observations on a permanent record form such as a data sheet, Fig. 7.

9.2.11 Repeat the procedure of Section 9 at the user-determined test pressures until the test series is completed.

## 10. Report

10.1 The test report shall include the following information and data:

10.1.1 The type of material, trade name/number, manufacturer, and the batch or lot number, if known,

10.1.2 Summary of preparation (mixing proportions, cure time and temperature, post-cure cleaning procedures and date prepared), if known,

10.1.3 Sample configuration (size, shape, etc.) and weight,

10.1.4 Condition of material prior to test if specimen cleaning in accordance with 8.4 is not performed,

10.1.5 Number of specimens tested,

10.1.6 Test conditions (test cell ambient temperature, test static (head) pressure),

10.1.7 Test media,

10.1.8 Evidence of reactions,

10.1.9 Number of reactions observed versus number of specimens tested, and

10.1.10 Pertinent observations or comments of the test agency.

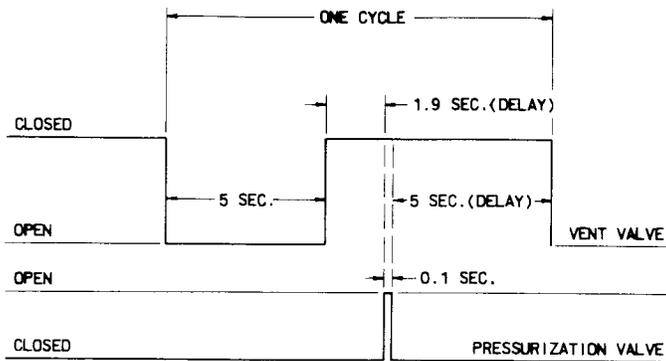
10.2 The following information is required if different from the specified method: system operation data (valve timing, vent times, test system description).

## 11. Precision and Accuracy

11.1 Precision and accuracy of this method have not been determined at this time.

## 12. Keywords

12.1 gaseous fluid impact; ignition sensitivity; oxygen enriched environment



NOTE 1—Tolerance on individual times is  $\pm 10\%$  but total cycle time shall be  $12 \pm 0.1$  s.

FIG. 6 Gaseous Impact Test System Standard Operational Profile (Typical of one Pressurization Cycle)

