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400 Commonwealth Dr., Warrendale, PA 15096

**AEROSPACE
MATERIAL
SPECIFICATION**

SAE AMS 3159D

**Issued 7-15-61
Revised 4-1-86**

Superseding AMS 3159C

Submitted for recognition as an American National Standard

**LEAK TEST SOLUTION
Liquid Oxygen Compatible**

1. SCOPE:

1.1 Form: This specification covers a gas-leak detecting compound compatible with liquid oxygen in the form of a liquid.

1.2 Application: Primarily for use in detecting leaks in liquid oxygen propulsion systems where a leak test solution (bubble fluid) is desirable.

2. APPLICABLE DOCUMENTS: The following publications form a part of this specification to the extent specified herein. The latest issue of Aerospace Material Specifications shall apply. The applicable issue of other documents shall be as specified in AMS 2350.

2.1 SAE Publications: Available from SAE, 400 Commonwealth Drive, Warrendale, PA 15096.

2.1.1 Aerospace Material Specifications:

AMS 2350 - Standards and Test Methods
AMS 2400 - Plating, Cadmium
AMS 2825 - Material Safety Data Sheets
AMS 4037 - Aluminum Alloy Sheet and Plate, 4.4Cu - 1.5Mg - 0.60Mn, 2024
-T3 Flat Sheet, -T351 Plate
AMS 4375 - Magnesium Alloy Sheet and Plate - 3.0Al - 1.0Zn (AZ31B-0)
Annealed and Recrystallized
AMS 4500 - Copper Sheet, Strip, and Plate, Soft Annealed (CDA110)
AMS 5040 - Steel Sheet and Strip, 0.15 max Carbon, Deep Forming Grade

2.2 ASTM Publications: Available from American Society for Testing and Materials, 1916 Race Street, Philadelphia, PA 19103.

ASTM D1173 - Foaming Properties of Surface-Active Agents
ASTM D1331 - Surface and Interfacial Tension of Solutions of Surface-Active Agents

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REAFFIRMED
10/91, 5/95

2.3 U.S. Government Publications: Available from Commanding Officer, Naval Publications and Forms Center, 5801 Tabor Avenue, Philadelphia, PA 19120.

2.3.1 Military Specifications:

MIL-P-116 - Preservation, Methods of

3. TECHNICAL REQUIREMENTS:

3.1 Material: The composition of the solution is optional with the manufacturer. It shall not contain oils, fats, or other materials capable of reacting with gaseous or liquid oxygen.

3.1.1 Leak Detecting Properties: This solution shall detect various sizes of leaks by a readily visible formation of foam or bubbles at the location of the leak when used on surfaces having temperatures between +35°F (+2°C) and +160°F (+70°C).

3.1.2 Appearance: The solution shall be essentially colorless. A light yellow color will be acceptable provided that the color is no deeper than that of a 0.2% aqueous solution of potassium chromate (K₂CrO₄).

3.1.3 Odor: The solution shall not produce objectionable odor.

3.1.4 Toxicity: The solution shall be free from vapors that are harmful or discomforting to personnel. The solution shall not irritate the skin.

3.1.5 Flammability: The solution and its evaporation residue shall be noncombustible.

3.1.6 Mold Growth: The solution shall not support mold growth within the container during use or storage.

3.2 Properties: Solution shall conform to the following requirements:

3.2.1 Turbidity: The solution shall be free of sediment and suspended matter when examined with transmitted light.

3.2.2 Evaporation Residue: The residue shall be not greater than 1.00% of the solution by weight when evaporated to dryness at a temperature not higher than 212°F (100°C) and dried to constant weight at a temperature not higher than 230°F (110°C).

3.2.3 Foaming Ability: Solution shall meet either of the following requirements; in case of dispute, results of the test of 3.2.3.1 shall govern.

3.2.3.1 The solution shall exhibit an initial foam height of not less than 200 mm and a foam height of 200 mm or more after standing for 5 min. + 0.5, determined in accordance with ASTM D1173 except that the temperature shall be 68° - 86°F (20° - 30°C).

3.2.3.2 The solution shall exhibit an initial foam volume of not less than 100 mL which shall persist to not less than 85 mL when tested as follows: Place 15 mL + 0.5 of the solution in a clean, dry, glass-stoppered 250 mL graduated glass cylinder; cylinder, stopper, and solution shall be at 68° - 86°F (20° - 30°C). Stopper the cylinder and shake by inversion, rotating the cylinder, in a vertical plane, about the mid-point of its longitudinal axis, without translational motion, for 1 min + 0.5 so that 30 inversions are completed; one inversion consists of rotating the cylinder 180 deg in one direction and then 180 deg in the opposite direction to its original, upright position. Place the cylinder on a table, remove the stopper, and wait 5 seconds. Determine the net volume of foam (total volume minus volume of liquid). This is the initial foam volume. Wait 5 min. + 0.5 and again determine the net volume of foam. This is the final foam volume.

3.2.4 Spreading and Wetting Ability: The solution shall have wetting and spreading properties as evidenced by a surface tension of less than 30 dynes per cm, determined in accordance with ASTM D1331, Method A.

3.2.5 pH Value: The pH value of the leak test solution shall be between 6 and 8.

3.2.6 Impact Sensitivity: The evaporation residue shall not be sensitive to impact when in contact with liquid oxygen and tested under hammer impact energy of 356 ft-lb per sq in. (748 kJ/m²) obtained by dropping a 20 lb (9.07 kg) weight onto a hammer having a diameter of 0.50 in. (12.7 mm) using a testing procedure acceptable to purchaser. The impact test sample shall be obtained by evaporating a sufficient quantity of solution to dryness as in 3.2.2 to produce not less than 0.010 in. (0.25 mm) thickness of residue under the hammer. An equivalent alternate procedure may be used when permitted by purchaser.

3.2.7 Corrosiveness: The solution shall not be corrosive to metals when tested in accordance with 3.2.7.1 through 3.2.7.3 using the metals specified in Table I.

TABLE I

| Metals | Surface and Condition |
|--|--|
| AMS 4037 Aluminum Alloy Sheet | Bare 2024-T3 |
| AMS 5040 Low Carbon Steel Sheet or Strip | Cadmium Plated in accordance with AMS 2400 |
| AMS 4500 Copper Sheet or Strip | Soft Annealed |
| AMS 4375 Magnesium Alloy Sheet | AZ31B-0 |

3.2.7.1 Two panels, approximately 0.040 x 2 x 4 in. (1.0 x 50 x 100 mm), shall be prepared of each metal specified in Table I. Panels shall exhibit clean uniform surfaces when examined under 10X magnification prior to test. Panels shall be degreased in trichloroethylene vapor. A clean bristle brush shall be used to apply leak test solution to one of each pair of panels. Approximately one-half of the area of each panel shall be covered with the solution in an irregular manner. Similar panels shall be placed together in sandwich style with the leak test solution between them.

3.2.7.2 The sandwiched panels shall be exposed individually in a horizontal position at alternate intervals of 16 hr in a humidity cabinet and 8 hr in air at approximately 100°F (38°C) for a total of 7 days. Humidity cabinet shall be maintained at $120^{\circ}\text{F} \pm 2$ ($50^{\circ}\text{C} \pm 1$) and 95 - 100% relative humidity.

3.2.7.3 Panels shall be washed with warm tap water and a bristle brush and dried with a clean cloth. Panel surfaces which were in contact with the leak test solution shall be examined under 10X magnification for corrosion. Staining of panels is acceptable.

3.3 Quality: The solution, as received by purchaser, shall be uniform in \emptyset quality and condition, homogeneous, and free from contaminants and foreign material detrimental to usage of the solution.

4. QUALITY ASSURANCE PROVISIONS:

4.1 Responsibility for Inspection: The vendor of the solution shall supply all \emptyset samples for vendor's tests and shall be responsible for performing all required tests. Results of such tests shall be reported to the purchaser as required by 4.5. Purchaser reserves the right to sample and to perform any confirmatory testing deemed necessary to ensure that the solution conforms to the requirements of this specification.

4.2 Classification of Tests: Tests to determine conformance to all technical \emptyset requirements of this specification are classified as acceptance tests and as preproduction tests and shall be performed prior to or on the initial shipment of solution to a purchaser, on each lot, when a change in material, processing, or both requires reapproval as in 4.4.2, and when purchaser deems confirmatory testing to be required.

4.2.1 For direct U.S. Military procurement, substantiating test data and, when \emptyset requested, preproduction test material shall be submitted to the cognizant agency as directed by the procuring activity, the contracting officer, or the request for procurement.

4.3 Sampling: Each lot of leak test solution shall be sampled to provide sufficient material to perform all required tests. The number of determinations for each requirement shall be as specified in the applicable test procedure or, if not specified therein, not less than three.

4.3.1 A lot shall be all solution produced in a single production run from the \emptyset same batches of raw materials under the same fixed conditions, or all material subjected to the same unit chemical or physical process intended to make the final solution homogeneous, and presented for vendor's inspection at one time.

4.4 Approval:

4.4.1 Sample solution shall be approved by purchaser before solution for production use is supplied, unless such approval be waived by purchaser. Results of tests on production solution shall be essentially equivalent to those on the approved sample.