

METRIC

MIL-DTL-27686G
22 December 1997

SUPERSEDING
MIL-I-27686F
10 June 1991

DETAIL SPECIFICATION

INHIBITOR, ICING, FUEL SYSTEM

This specification is approved for use by all Departments and Agencies of the Department of Defense.

1. SCOPE

1.1 Scope. This specification covers the requirements for one type of fuel system icing inhibitor soluble in jet turbine fuels. Fuel System Icing Inhibitor is identified by NATO Code Number S-748 (see 1.2 and 6.7). This specification was thoroughly reviewed as a part of acquisition reform. While most of the requirements were converted to performance terms, due to the military-unique nature of the product (see 6.1) and the need for compatibility with deployed systems, it was determined that not all requirements could be converted. The issuance of this specification as "detail" is not intended to constrain technology advances in future systems.

1.2 Classification. The fluids are of the following type, as specified (see 6.7):

NATO Code No.	Description
S-748	Ethylene glycol monomethyl ether (EGME).

2. APPLICABLE DOCUMENTS

2.1 General. The documents listed in this section are specified in sections 3 and 4 of this specification. This section does not include documents cited in other sections or recommended for additional information or as examples. While every effort has been made to ensure the completeness of this list, document users are cautioned that they must meet all specified requirements documents cited in sections 3 and 4 of this specification, whether or not they are listed.

Beneficial comments (recommendations, additions, deletions) and any pertinent data which may be of use in improving this document should be addressed to: ASC/ENSI, Bldg 560, 2530 Loop Rd West, Wright-Patterson AFB OH 45433-7101, by using the Standardization Document Improvement Proposal (DD Form 1426) appearing at the end of this document, or by letter.

AMSC N/A

FSC 6850

DISTRIBUTION STATEMENT A. Approved for public release; distribution is unlimited.

MIL-DTL-27686G**2.2 Government documents**

2.2.1 Specifications and standards. The following specifications and standards form a part of this document to the extent specified herein. Unless otherwise specified, the issues of these documents are those listed in the issue of the Department of Defense Index of Specifications and Standards (DoDISS) and supplemented thereto, cited in the solicitation (see 6.2).

STANDARDS

FEDERAL

FED-STD-791	Lubricants, Liquid Fuels, and Related Products; Methods of Testing
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DEPARTMENT OF DEFENSE

MIL-STD-290	Packaging of Petroleum and Related Products
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(Unless otherwise indicated, copies of the standards listed above are available from the Standardization Document Order Desk, 700 Robbins Avenue, Building 4D, Philadelphia PA 19111-5094.)

2.3 Non-Government publications. The following documents form a part of this document to the extent specified herein. Unless otherwise specified, the issues of the documents which are DoD adopted are those listed in the issue of the *DoDISS* specified in the solicitation. Unless otherwise specified, the issues of documents not listed in the *DoDISS* are the issues of the documents cited in the solicitation (see 6.2).

AMERICAN SOCIETY FOR TESTING AND MATERIALS STANDARDS

ASTM D891	Standard Test Methods for Specific Gravity, Apparent, of Liquid Industrial Chemicals (DoD adopted)
ASTM D1078	Standard Test Method for Distillation Range of Volatile Organic Liquids (DoD adopted)
ASTM D1209	Standard Test Method for Color of Clear Liquids (Platinum-Cobalt Scale) (DoD adopted)
ASTM D1218	Standard Test Method for Refractive Index and Refractive Dispersion of Hydrocarbon Liquids (DoD adopted)
ASTM D1364	Standard Test Method for Water in Volatile Solvents (Fischer Reagent Titration Method) (DoD adopted)
ASTM D1613	Standard Test Method for Acidity in Volatile Solvents and Chemical Intermediates Used in Paint, Varnish, Lacquer, and Related Products (DoD adopted)
ASTM D2276	Standard Test Method for Particulate Contaminant in Aviation Fuel by Line Sampling (DoD adopted)
ASTM D4052	Standard Test Method for Density and Relative Density of Liquids by Digital Density Meter (DoD adopted)
ASTM D5452	Standard Test Method for Particulate Contamination in Aviation Fuels by Laboratory Filtration
ASTM E29	Standard Recommended Practice for Using Significant Digits in Test Data to Determine Conformance with Specifications (DoD adopted)
ASTM E70	Standard Test Method for pH of Aqueous Solutions with the Glass Electrode (DoD adopted)
ASTM E203	Standard Test Method for Water Using Volumetric Karl Fischer Titration (DoD adopted)

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ASTM E300
ASTM E1064

Sampling Industrial Chemicals, Practice for
Water in Organic Liquids by Coulometric Karl Fischer Titration, Test
Method for

(Application for copies should be addressed to the American Society for Testing and Materials, 100 Barr Harbor Drive, West Conshohocken PA 19428-2959; (610) 832-9500).

2.4 Order of precedence. In the event of a conflict between the text of this document and the references cited herein, the text of this document takes precedence. Nothing in this document, however, supersedes applicable laws and regulations unless a specific exemption has been obtained.

3. REQUIREMENTS

3.1 Materials. The inhibitor shall be composed entirely of ethylene glycol monomethyl ether (see 6.3) except for the required addition of an antioxidant, specified in 3.2, at a concentration of 50 to 150 parts per million by weight of active ingredient. The antioxidant shall be added immediately after processing and before the inhibitor is exposed to the atmosphere. The inhibitor shall conform to the requirements of table I when tested in accordance with the applicable tests specified therein (see 4.7).

3.2 Antioxidant. The antioxidant added to the inhibitor shall be one of the following:

- a. 2,6 ditertiary butyl, 4-methylphenol
- b. 2,4 dimethyl, 6-tertiary butylphenol
- c. 2,6 ditertiary butylphenol
- d. Mixed tertiary butylphenol composition:
 - 75 percent 2,6 ditertiary butylphenol
 - 10 to 15 percent 2,4,6 tritertiary butylphenol
 - 10 to 15 percent ortho-tertiary butylphenol.

3.3 Workmanship. The inhibitor shall be uniform in quality, clear, bright, and free from suspended and foreign matter (see 4.4.1).

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TABLE I. Properties of the inhibitor and test methods.

Property	Limit	ASTM Test Method
Acid number, mg KOH per gram (maximum)	0.09	D1613
Color, platinum cobalt (maximum)	15	D1209 ¹
Distillation:		D1078
Initial point (minimum)	123.5°C (254.3°F)	
Dry point (maximum)	125.5°C (257.9°F)	
Ethylene glycol (maximum, percent mass)	0.025	²
pH of 25 percent solution in water (25° ±2°C)	5.0 to 7.0	E70 ³
Specific gravity (20°/20°C)	0.963 to 0.967	D891 ^{1,4} or D4052
Refractive index (20°C)	1.4015 to 1.4025	D1218
Water (maximum, percent mass)	0.15	D1364 ¹ , E203, or E1064
Particulate matter mg/L	⁵	D2276 or D5452

¹ Referee Test Method² See 4.7.1.1.³ See 4.7.1.2.⁴ ASTM D891 method A or B⁵ To be reported - not limited

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4.1 Classification of inspections. The inspection requirements specified herein are classified as conformance inspection (see 4.2).

4.2 Conformance inspection. Test for acceptance of individual lots shall consist of test for all requirements specified in section 3. Quality conformance inspection shall include the test requirements herein.

4.2.1 Inspection lot. For acceptance purposes, individual lots shall be examined as specified herein and subjected to tests for all requirements cited in section 3.

4.2.1.1 Bulk lot. A bulk lot shall consist of an indefinite quantity of a homogeneous mixture of material offered for acceptance in a single isolated container.

4.2.1.2 Packaged lot. A packaged lot shall consist of an indefinite number of 208-liter (55-gallon) drums or smaller unit packages of identical size and type, offered for acceptance, and filled with a homogeneous mixture of material from a bulk lot.

4.3 Inspection. Inspection shall be in accordance with FED-STD-791, Method 9601.

4.4 Sampling plans

4.4.1 Sampling of inhibitor. Each bulk or packaged lot shall be sampled in accordance with ASTM E300. The samples shall be subjected to the examination of inhibitor specified in 4.6.1.1 and all tests specified under 4.7.

4.4.2 Sampling for inspection of filled containers. A random sample of filled containers shall be selected from each lot and shall be subjected to the examination of filled containers as specified in 4.6.1.3.

4.5 Inspection conditions. Requirements contained in table I are absolute, as defined in ASTM E29, and shall not be subjected to correction for test tolerances. The ASTM E29 shall be used to round all significant figures in all tests required by this specification.

4.6 Methods of inspection**4.6.1 Examination of product**

4.6.1.1 Examination of inhibitor. Samples selected in accordance with 4.4.1 shall be visually examined for compliance with 3.3.

4.6.1.2 Examination of empty containers. Before filled, each empty unit container shall be visually inspected for cleanliness (lack of foreign materials such as solids, corrosion products, water, or other sediments) and suitability. Container seams shall be inspected for evidence of metal corrosion, flux, solder, and such materials as would contaminate the product. Any container that does not meet these criteria shall be rejected.

4.6.1.3 Examination of filled containers. Samples taken as specified in 4.4 shall be examined for conformance to MIL-STD-290 with regard to fill, closure, sealing, leakage, packaging, packing, and markings.

MIL-DTL-27686G**4.7 Test methods**

4.7.1 Inhibitor properties. The inhibitor shall be tested in accordance with the test methods listed in table I and as specified in 4.7.1.1 through 4.7.1.2.

4.7.1.1 Ethylene glycol (percent by mass). The percent of ethylene glycol in the inhibitor shall be determined as specified in 4.7.1.1.1, 4.7.1.1.2 and 4.7.1.1.3 (titration method).

4.7.1.1.1 Reagents and materials. Unless otherwise indicated, all reagents shall be American Chemical Society reagent grade, or equivalent. References to water indicate distilled or deionized water. The following materials shall be prepared:

- a. Oxidizing reagents: To a solution of 5 grams (g) of periodic acid (HIO_4) in 200 milliliters (ml) of water, add 800 ml of glacial acetic acid. Store the solution in a dark, well-stoppered bottle.
- b. Potassium iodide: Twenty percent aqueous solution
- c. Sodium thiosulfate, standard 0.1N: Standardize by an accepted procedure
- d. Starch indicator solution: One percent aqueous.

4.7.1.1.2 Procedure. The following procedure shall be performed:

- a. Pipette 50 ml of the oxidizing reagent into each of four 500-ml iodine flasks. Reserve two of the flasks for the blank determination.
- b. Introduce 50 g of the sample, weighed to the nearest 0.1 g, into each of two flasks and swirl to effect solution.
- c. Allow the flasks to stand for 30 minutes at room temperature.
- d. While swirling, add 10 ml of 20-percent potassium iodide solution to each flask, in turn, immediately before titrating.
- e. Titrate the contents of each flask to a pale yellow color with 0.1 N sodium thiosulfate. Add 1 ml of starch indicator and titrate to the disappearance of the blue color.
- f. If the net titration is more than 20 ml, repeat the determination, using a smaller sample size.

4.7.1.1.3 Calculations. Calculate the concentration of ethylene glycol as:

$$\text{Weight percent of ethylene glycol} = \frac{(B-A)(N)(3.103)}{(S)}$$

Where A = ml of sodium thiosulfate required for the sample
 B = average ml of sodium thiosulfate required for the blank
 N = normality of sodium thiosulfate
 S = grams of sample.

4.7.1.2 pH of 25 percent solution in water. Twenty-five ml of the inhibitor shall be pipetted into a 100-ml volumetric flask. Add freshly boiled and cooled distilled water with a pH of 6.5 to 7.5 to fill the flask. The pH value shall be measured with a pH meter calibrated in accordance with ASTM E70. To avoid error caused by carbon dioxide in the air, the gas space over the solution shall be purged with carbon dioxide-free air.

MIL-DTL-27686G**5. PACKAGING**

5.1 Packaging. For acquisition purposes, the packaging requirements shall be as specified in the contract or order (see 6.2). When actual packaging of materiel is to be performed by DoD personnel, these personnel need to contact the responsible packaging activity to ascertain requisite packaging requirements. Packaging requirements are maintained by the Inventory Control Point's packaging activity within the Military Department or Defense Agency, or within the Military Department's System Command. Packaging data retrieval is available from the managing Military Department's or Defense Agency's automated packaging files, CD-ROM products, or by contacting the responsible packaging activity.

6. NOTES

(This section contains information of a general or explanatory nature that is helpful, but is not mandatory.)

6.1 Intended use. This inhibitor is intended for use as an anti-icing agent to be added to jet turbine engine fuels. Its use is required by military weapon systems only. This requirement is unique to military aircraft and engine designs.

6.2 Acquisition requirements. Acquisition documents must specify the following:

- a. Title, number, and date of this specification.
- b. Issue of DoDISS to be cited in the solicitation and, if required, the specific issue of individual documents referenced (see 2.2.1 and 2.3).
- c. Quantity desired.
- d. Type and size of the containers (see 5.1).
- e. Packaging requirements (see 5.1).
- f. Special markings (see 5.1).

6.2.1 Unit of purchase. Unit of purchase is the liter at 15°C (or the U.S. gallon at 60°F). When weight is used as the basis of quantity determination, table II will be used to determine quantity in liters at 15°C (or the U.S. gallon at 60°F).

TABLE II. Conversion factors.

Weight to Liters at 15°C (or to Gallons at 60°F)

If the specific gravity at 20°/20°C is:	To obtain liters at 15°C, divide kilograms by:	To obtain gallons at 60°F, divide pounds by:	To obtain gallons at 60°F, divide kilograms by:
0.963	0.966 kg/L	8.057 lb/gal	3.654/kg/gal
0.964	0.967	8.065	3.658
0.965	0.968	8.073	3.662
0.966	0.969	8.082	3.666
0.967	0.970	8.090	3.670

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6.3 Warning. Undiluted ethylene glycol monomethyl ether is both combustible and toxic. It is harmful if inhaled or absorbed through the skin. Acute vapor inhalation may cause eye and/or upper respiratory tract irritation. Acute CNS effects may include drowsiness, weakness, and shaking. In animal studies, death resulted from lung and kidney injury. Nonlethal ingested doses may produce muscular weakness, nausea, vomiting, confusion, metabolic acidosis, kidney failure, birth defects, and/or other adverse effects on pregnancy. Chronic dosing may produce toxic encephalopathy, chronic kidney disease, and damage to male reproductive organs. Before handling ethylene glycol monomethyl ether, consult appropriate safety and occupational health authorities.

6.4 Material Safety Data Sheets. Contracting officers will identify those activities requiring copies of completed Material Safety Data Sheets prepared in accordance with FED-STD-313. The pertinent Government mailing addresses for submission of data are listed in FED-STD-313.

6.5 Chemical synonyms and CAS Code. Synonyms for ethylene glycol monomethyl ether (EGME) include: 2-methoxyethanol, methyl cellosolve, Dowanol EM, ethylene glycol methyl ether, glycol monomethyl ether, and glycolmethyl ether. The Chemical Abstracts Registry (CAS) Number for this chemical is 000109864.

6.6 Subject term (keyword) listing.

Acid	Methylphenol
Antioxidant	Oxidizing reagent
Dimethyl	Periodic acid
Ditertiary butyl	Potassium iodide
Ethylene glycol monomethyl ether (EGME)	Sodium thiosulfate
Glacial acetic acid	Tertiary butylphenol

6.7 International standardization. Certain provisions of this specification are the subject of international standardization agreement ASCC Air Std 15/1 and STANAG 1135. When amendment, revision or cancellation of this specification is proposed which will affect or violate the international agreement concerned, the preparing activity will take appropriate reconciliation action through international standardization channels including departmental standardization offices, if required.

6.8 Changes from previous issue. Marginal notations are not used in this revision to identify changes with respect to the previous issue due to the extent of the changes. The changes are due to Acquisition Reform initiatives requiring Government specifications to be performance-based. These changes have no impact on the chemical, physical or performance requirements with respect to the previous issue.

Custodians:
 Army - AT
 Navy - AS
 Air Force - 11

Preparing activity:
 Air Force - 11
 (Project 6850-1225)

Review activities:
 Army - AV
 Air Force - 68
 DLA - GS, PS

STANDARDIZATION DOCUMENT IMPROVEMENT PROPOSAL

INSTRUCTIONS

1. The preparing activity must complete blocks 1, 2, 3, and 8. In block 1, both the document number and revision letter should be given.
2. The submitter of this form must complete blocks 4, 5, 6, and 7.
3. The preparing activity must provide a reply within 45 days from receipt of the form.

NOTE: This form may not be used to request copies of documents, not to request waivers, or clarification of requirements on current contracts. Comments submitted on this form do not constitute or imply authorization to waive any portion of the referenced document(s) or to amend contractual requirements.

I RECOMMEND A CHANGE:		1. DOCUMENT NUMBER MIL-DTL-27686G	2. DOCUMENT DATE (YYMMDD) 971222
3. DOCUMENT TITLE Inhibitor, Icing, Fuel System			
4. NATURE OF CHANGE (Identify paragraph number and include proposed rewrite, if possible. Attach extra sheets as needed.)			
5. REASON FOR RECOMMENDATION			
6. SUBMITTER			
a. NAME (Last, First, Middle Initial)		b. ORGANIZATION	
c. ADDRESS (Include Zip Code)		d. TELEPHONE (Include Area Code) (1) Commercial (2) DSN (If applicable)	7. DATE SUBMITTED (YYMMDD)
8. PREPARING ACTIVITY			
a. NAME Air Force Code 11 Technical Information & Documents Section		b. TELEPHONE (Include Area Code) (1) Commercial (937) 255-6295 (2) DSN (If applicable) 785-6295	
c. ADDRESS (Include Zip Code) ASC/ENSI 2530 Loop Road West Wright-Patterson AFB OH 45433-7101		IF YOU DO NOT RECEIVE A REPLY WITHIN 45 DAYS, CONTACT: Defense Quality and Standardization Office 5203 Leesburg Pike, Suite 1403, Falls Church VA 22041-3466 Telephone (703) 756-2340 DSN 289-2340	