

METRIC

MIL-DTL-5020E
19 February 2010
SUPERSEDING
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31 July 2003

DETAIL SPECIFICATION

LIQUID, COMPASS, AIRCRAFT

Reactivated after 19 February 2010 and may be used for new and existing designs and acquisitions.

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

1. SCOPE

1.1 Scope. This specification describes the characteristics and provides the requirements for a refined fraction of crude petroleum, intended for use in fluid-filled aircraft magnetic compasses.

1.2 Classification.

1.2.1 Military symbol. The product represented under this specification is identified by military symbol FDC.

1.2.2 NATO code. The product represented under this specification is identified by NATO code number S-712.

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 of this specification 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 of the documents cited in sections 3 and 4 of this specification, whether or not they are listed.

Comments, suggestions, or questions on this document should be addressed to Defense Supply Center Richmond, ATTN: DSCR-VEB, 8000 Jefferson Davis Highway, Richmond, VA 23297-5616, or e-mailed to STDZNMGT@dla.mil . Since contact information can change, you may want to verify the currency of this address information using the ASSIST database at https://assist.daps.dla.mil/ .

MIL-DTL-5020E

2.2 Government documents.

2.2.1 Standards. The following standards form a part of this document to the extent specified herein. Unless otherwise specified, the issues of these documents are those cited in the solicitation or contract.

FEDERAL STANDARD

FED-STD-791 - Testing Method of Lubricants, Liquid Fuels, and Related Products

DEPARTMENT OF DEFENSE STANDARD

MIL-STD-1916 - DoD Preferred Methods for Acceptance of Product

(Copies of these documents are available online at <https://assist.daps.dla.mil/> or from the Standardization Document Order Desk, 700 Robbins Avenue, Building 4D, Philadelphia, PA 19111-5094.)

2.2.2 Other government publications. The following other government publication forms a part of this document to the extent specified herein. Unless otherwise specified, the issue of this document is that cited in the solicitation or contract.

CODE OF FEDERAL REGULATIONS

29 CFR 1910 - Occupational Safety and Health Standards

(Copies of this document are available online at <http://www.gpoaccess.gov/cfr/> or from the Superintendent of Documents, P.O. Box 371954, Pittsburgh, PA 15250-7954.)

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 these documents are those cited in the solicitation or contract.

ASTM INTERNATIONAL

ASTM D56 - Standard Test Method for Flash Point by Tag Closed Cup Tester
ASTM D86 - Standard Test Method for Distillation of Petroleum Products at Atmospheric Pressure
ASTM D130 - Standard Test Method for Corrosiveness to Copper from Petroleum Products by Copper Strip Test
ASTM D156 - Standard Test Method for Saybolt Color of Petroleum Products (Saybolt Chromometer Method)

MIL-DTL-5020E

ASTM INTERNATIONAL - Continued

ASTM D445	- Standard Test Method for Kinematic Viscosity of Transparent and Opaque Liquids (the Calculation of Dynamic Viscosity)
ASTM D1319	- Standard Test Method for Hydrocarbon Types in Liquid Petroleum Products by Fluorescent Indicator Adsorption
ASTM D4057	- Standard Practice for Manual Sampling of Petroleum and Petroleum Products
ASTM E2072	- Standard Specification for Photoluminescent (Phosphorescent) Safety Markings

(Copies of these documents are available online at <http://www.astm.org/> or from ASTM International, 100 Barr Harbor Drive, P.O. Box C700, West Conshohocken, PA 19428-2959.)

2.4 Order of precedence. Unless otherwise noted herein or in the contract, 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 First article. When specified (see 6.2), a sample shall be subjected to first article inspection in accordance with 4.2.

3.2 Material. The liquid shall be a refined fraction of crude petroleum, filtered to be free of visible contamination, and entirely applicable and appropriate for the intended purpose.

3.3 Physical properties. The properties of the compass liquid shall conform to the requirements specified in table I and 3.4 when tested as specified in 4.5.

TABLE I. Compass liquid properties.

Characteristic		Specified
Copper corrosion (max.)		1a
Flash point °C (min.)		32.2
Distillation range end point °C (max.)		260
Reaction after oxidation		Neutral
Color, Saybolt (min.)	Original	+25
	After light stability test ¹	+21
	After oxygen stability test ²	+21
Kinematic viscosity (centistokes)	At 38 °C	0.90 to 1.15
	At 0 °C (max.)	2.30
Aromatics, vol % (max.)		10.0

¹ Requirements shall be met after 18 hours of exposure (see 4.4.2).

² See 4.4.3.

MIL-DTL-5020E

3.4 Liquid performance. The performance of the compass liquid shall conform to the following requirements.

3.4.1 Freezing point and cloudiness. When tested as specified in 4.4.4, the compass liquid shall not gel, crystallize, or solidify after being maintained at a temperature at or below -53.9°C for a time period of 30 minutes. At the end of the test, the turbidity or haze of the liquid shall not be greater than the turbidity standard for barium sulfate suspension as determined in 4.4.4.1.

3.4.2 Fluorescence. The fluorescence of the compass liquid shall not exceed 3.183 millicandela/m² (mcd/m²) as determined in accordance with 4.4.5.

3.5 Toxicity. The compass liquid shall have no adverse effect on the health of personnel when used for its intended purpose. The compass liquid shall not contain elements that produce noxious vapors or irritate personnel during formulation or use under conditions of adequate ventilation. Caution shall be exercised to avoid prolonged contact with the skin. Occupational Safety and Health Administration (OSHA) standards and guidelines shall be observed in accordance with 29 CFR 1910. Questions pertaining to any toxic effects of the liquid shall be referred by the procuring activity to the appropriate departmental medical service that will act as an advisor to the procuring activity.

3.6 Workmanship. The compass liquid shall be uniform in quality and shall meet all requirements of this specification.

4. VERIFICATION

4.1 Classification of inspections. The inspection requirements specified herein are classified as follows:

- a. First article inspection (see 4.2).
- b. Conformance inspection (see 4.3).

4.2 First article inspection. When first article inspection is required (see 3.1 and 6.2), the number and type of units shall be specified. Each submitted unit shall undergo the examination for defects specified in table II, the examinations specified in paragraphs 4.4.1 through 4.4.6, and the tests specified in 4.5. Any unit displaying any major defect shall be rejected. Any unit failing any of the tests in 4.5 shall be rejected.

4.3 Conformance inspection. Conformance inspection shall consist of the visual examination for defects listed in table II as well as the examinations of paragraphs 4.4.1 through 4.4.6. Unless otherwise specified (see 6.2), the manufacturer shall select the type of sampling plan (attribute, variable, or continuous) in accordance with MIL-STD-1916. The sample size shall be selected in accordance with verification level I of MIL-STD-1916.

MIL-DTL-5020E

TABLE II. Classification of defects.

Examination	Defect	Major
Contamination	Contamination is visible in the liquid	101
Color and precipitation determination for light stability	Saybolt color scale minimum value less than +21	102
	Precipitation is present after light stability test	103
Color and reaction determination for oxygen stability	Color and reaction not as specified	104
	Precipitation is present after oxygen stability test	105
Freezing point and cloudiness	Gelling, crystallization, or solidification of the liquid is present	106
	The turbidity of the compass liquid sample is greater than that of the turbidity standard	107
Fluorescence	Fluorescence exceeds 3.183 mcd/m ²	108
Filled container	Construction is defective	109
	Container is leaking	110
	Container is not filled to proper level	111

4.4 Examinations.

4.4.1 Test preparation. Measure two quarts of the liquid in accordance with the method described in ASTM D4057.

4.4.2 Color and precipitation determination for light stability. The following test procedures shall be performed.

a. Fill a Vycor[®] test tube, or an equivalent high temperature test tube, measuring approximately 25 millimeters (mm) outside diameter and 200 mm long with compass liquid.

b. Enclose the compass liquid in a Corex D[®] globe, or equivalent filtering globe, and expose it to the light of a 13-ampere carbon arc lamp using Atlas Fade-Ometer[®] No. 70 and No. 20 carbons, or equivalent.

c. Place the test tube in a vertical position 1 foot from the arc, or a distance recommended by the manufacturer of the test instrument as applicable, and in approximately the same horizontal plane. Make color determinations after exposure of 1, 4, and 18 hours.

d. Examine the sample for precipitation after the light stability test has been performed. There shall be no precipitation.

4.4.3 Color and reaction determination for oxygen stability. The following test procedures shall be performed.

MIL-DTL-5020E

- a. Fill a suitable glass container, such as an oil sample bottle, to nearly the top of the container with compass liquid and place it into a suitable metal bomb having an internal capacity of approximately one and one half times the external volume of the bottle.
- b. Arrange the metal bomb so that it can be tightly closed and charged with oxygen after the sample is in place. Then charge the bomb with oxygen at 95 to 100 pounds per square inch pressure at room temperature.
- c. Test the metal bomb for leaks. If the test displays no leaks then place the bomb in a suitable bath maintained at 95 °C to 100 °C for 6 hours.
- d. Cool the metal bomb in cold water and remove the sample. Subject the sample to the Saybolt color and oxidation reaction tests in this specification.
- e. Examine the sample for the presence of precipitation after the oxygen stability test has been performed. There shall be no precipitation.

4.4.4 Freezing point and cloudiness. The following test procedures shall be performed.

4.4.4.1 Preparation of barium sulfate turbidity standard. The following test procedures shall be performed.

- a. Pour 25 milliliters (mL) of a 0.00322-molar solution of barium chloride into a 250 mL volumetric flask. Add 200 mL of distilled water and 25 mL of 0.50 *N* sulfuric acid.
- b. Shake the solution well to ensure complete precipitation and pour it into a 4-ounce bottle. Stopper the bottle and use the suspension within one-half hour after preparation as the turbidity standard.

4.4.4.2 Storage of compass liquid for examination. A sample of the compass liquid shall be placed into a clean 4-ounce sample bottle that has previously been dried in an oven at 100 °C for not less than 24 hours. The bottle shall be tightly stoppered and stored at a temperature at or below -53.9 °C for 30 minutes.

4.4.4.3 Examination of cloud samples. The following examination procedures shall be performed.

- a. After 30 minutes, remove the sample from storage and shake it vigorously for 10 seconds.
- b. Examine the sample to ensure that there is no evidence of gelling, crystallization, or solidification of the liquid, and that the turbidity of the compass liquid sample is not greater than that of the standard as specified in 4.4.4.1.
- c. Shake the turbidity standard vigorously within five minutes prior to making any comparisons. If frosting interferes with the turbidity evaluation, the bottle containing the compass liquid may be quickly dipped into a 50/50 (by volume) mixture of glycerin-methanol, previously cooled to the storage temperature.

MIL-DTL-5020E

d. Ensure that no more than one minute has elapsed between removing the compass liquid sample from the low temperature storage and completing the test.

4.4.5 Fluorescence. The following measuring procedures shall be performed using an illuminometer or low-brightness photometer capable of accurately measuring ultraviolet light in the spectral region of 365 nanometers (nm). The illuminometer or photometer shall have the capability of taking brightness or luminance measurements at a 45-degree angle of incidence, or the manufacturer of the test system shall provide an equivalent method for brightness measurement.

a. Place the sample in an absorption cell constructed of non-fluorescent glass having a 10 mm light path through the liquid and an inside diameter of 32 mm.

b. Measure the brightness at a 45-degree angle to the plane of the flat surface at the absorption cell. The illumination shall be incident at a 45-degree angle to the plane of the flat surface of the absorption cell and shall approach the sample at right angles to the direction of observation. A non-fluorescent white paper backing may be used behind the cell to create better field uniformity.

c. Excite the specimen in this position with ultraviolet light of 365 nm wavelength until it reaches a constant brightness. The proper intensity of the light source and specimen shall be determined with the aid of a pre-calibrated reference standard designed for ultraviolet light intensity calibration. The method of calibrating the light source intensity shall be one acceptable to the customer. The luminance or brightness value shall be reported in mcd/m² as referenced in ASTM E2072.

4.4.6 Examination of filled containers. Each sample container shall be examined for defective construction, evidence of leakage, and net content.

4.5 Tests. Tests shall be performed in accordance with the applicable methods specified in table III to determine conformance with the requirements specified in 3.3.

TABLE III. Test methods for inspections.

Characteristic	ASTM International	FED-STD-791
Copper corrosion	ASTM D130	-
Flash point	ASTM D56	-
Distillation	ASTM D86	-
Reaction after oxidation	-	5101
Color	ASTM D156	-
Kinematic viscosity	ASTM D445	-
Aromatic content	ASTM D1319	-

MIL-DTL-5020E

5. PACKAGING

5.1 Packaging. For acquisition purposes, the packaging requirements shall be as specified in the contract or order (see 6.2). When packaging of materiel is to be performed by DoD or in-house contractor personnel, these personnel need to contact the responsible packaging activity to ascertain packaging requirements. Packaging requirements are maintained by the Inventory Control Point's packaging activities within the Military Service or Defense Agency, or within the military service's system commands. 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 may be helpful, but is not mandatory.)

6.1 Intended use. This specification is intended for use in fluid-filled military aircraft magnetic compasses.

6.2 Acquisition requirements. Acquisition documents should specify the following:

- a. Title, number, and date of this specification.
- b. When first article inspection is required (see 3.1 and 4.2).
- c. Number and type of units required for first article inspection (see 4.2).
- d. Sampling plan, if different (see 4.3).
- e. Packaging requirements (see 5.1).
- f. Hazardous material identification and MSDS (see 6.4).
- g. Activities requiring a copy of the MSDS (see 6.4).

6.3 Recommended packaging. It is recommended that the aircraft compass liquid be packaged in one quart and one gallon containers chemically resistant to the solvent effects of the liquid.

6.4 Material safety data sheet (MSDS). Contracting officers will identify those activities requiring copies of the completed MSDS prepared in accordance with FED-STD-313 and meeting the requirements of 29 CFR 1910.1200. The pertinent government mailing addresses for submission of the data are listed in FED-STD-313, and 29 CFR 1910.1200 requires that the MSDS for each hazardous chemical used in an operation must be readily available to personnel using the material. Contracting officers will identify the activities requiring copies of the MSDS (see 6.2).

6.5 International standardization agreement implementation. This specification implements NATO STANAG 1135, "Interchangeability of Fuels, Lubricants and Associated Products Used by the Armed Forces of the North Atlantic Treaty Nations", and ASCC AIR STD 15/9, "Interchangeability Chart of Standardized Aviation Fuels, Lubricants and Allied Products". When amendment, revision, or cancellation of this specification is proposed, the preparing activity must coordinate the action with the U.S. National Point of Contact for the international standardization agreement, as identified in the ASSIST database at <https://assist.daps.dla.mil/>.

MIL-DTL-5020E

6.6 Subject term (key word) listing.

Distillate
Hydrocarbon
Isoparaffin
Magnetic
Mineral spirits
Naphtha
Petroleum
Solvent

6.7 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.

Custodians:
Army - AV
Navy - AS
Air Force - 11
DLA - GS

Preparing Activity:
DLA - GS3

(Project 6810-2010-001)

NOTE: The activities listed above were interested in this document as of the date of this document. Since organizations and responsibilities can change, you should verify the currency of the information above using the ASSIST database at <https://assist.daps.dla.mil/>.