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PERFORMANCE SPECIFICATION

PROPELLANT, HYDRAZINE - uns-DIMETHYLHYDRAZINE (50% N_2H_4 – 50% UDMH)

Comments, suggestions, or questions on this document should be addressed to AFPA/PTPT 2430 C Street, Bldg 70, Area B, Wright-Patterson AFB OH 45433-7632 or e-mailed to. AFPA.PTPS@us.af.mil. Since contact information can change, you may want to verify the currency of this address information using the ASSIST Online database at https://assist.dla.mil.

AMSC N/A FSC 9135

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 hydrazine – uns-dimethylhydrazine (Aerozine 50 / A-50) propellant.

2. APPLICABLE DOCUMENTS

2.1 General. The documents listed in this section are specified in sections 3 or 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 documents cited in sections 3 or 4 of this specification, whether or not they are listed.

2.2 Government documents.

2.2.1 Specifications, standards, and handbooks. The following specifications, standards and handbooks 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.

DEPARTMENT OF DEFENSE SPECIFICATIONS

MIL-PRF-25604	Propellant, uns-Dimethylhydrazine
MIL-PRF-26536	Propellant, Hydrazine
MIL-PRF-27407	Propellant Pressurizing Agent, Helium

(Copies of these documents are available online at http://quicksearch.dla.mil).

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 D2276	Standard Test Method for Particulate Contaminant in Aviation Fuel by Line Sampling (DoD adopted)
ASTM E29	Standard Practice for Using Significant Digits in Test Data to Determine Conformance with Specifications (DoD adopted)

(Copies of these documents are available online at http://www.astm.org or ASTM International, 100 Barr Harbor Drive, 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 (except for related specification

sheets), 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 Chemical and physical properties. The propellants, hydrazine conforming to MIL-PRF-26536 and uns-dimethylhydrazine conforming to MIL-PRF-25604, shall be used in this propellant mixture. The chemical and physical properties of the propellant mixture shall conform to those listed in Table I when tested in accordance with the applicable test methods.

3.2 Limiting values. The following applies to all specified limits in this specification: For purposes of determining conformance with these requirements, an observed value or a calculated value shall be rounded off "to the nearest unit" in the last right-hand digit used in expressing the specification limit according to the rounding-off method of ASTM Practice E29 Standard Practice for Using Significant Digits in Test Data to Determine Conformance with Specifications.

3.3 Filter. A filter with a rating of at least 10 micrometer (µm) nominal and 40 µm absolute rating shall be installed between the manufacturer's plant system and the container to be filled for delivery.

3.4 Qualitative. The propellant shall be colorless, homogenous liquid when examined visually by transmitted light.

TABLE I. *Chemical and physical properties.*

Properties	Limits	Test Paragraph
Hydrazine (% by weight)	51 ± 0.8 min	4.3.2
UDMH (% by weight) (1)	47 min	4.3.2
Water (%t by weight)	1.8 max	4.3.2
Total hydrazine, UDMH, and amines (% by weight)	98.2 min	4.3.2
Particulate (mg/L)	10 max	4.3.3
Note: 1 uns-dimethylhydrazine (UDMH)		

4. VERIFICATION

4.1 Classification of inspections. The inspections shall be classified as quality conformance inspections.

4.2 Quality conformance inspection. Unless otherwise specified (6.2), each filled shipping container shall be considered a lot and shall be sampled. Each sample shall be subjected to the visual examination described in 4.3.1 for conformance to 3.4 and to the tests specified in Table I.

4.2.1 Sample. A sample consists of not less than 600 milliliters (mL) of propellant. Unless otherwise specified, quality conformance tests shall be made on the sample of propellant taken directly from the shipping container. When required, the sample shall be forwarded to a laboratory designated by the procuring activity for subjection to the quality conformance tests specified herein. The glass narrow

mouth bottles intended for sampling shall be specially cleaned and handled according to the procedure described in ASTM D2276 Section 10 with the exception listed in 4.3.3d of this specification.

4.2.2 Rejection. When any sample of the propellant tested in accordance with 4.3 fails to conform to the requirements specified herein, the entire lot represented by the sample shall be rejected.

4.3 Test methods.

4.3.1 Examination of product. The propellant shall be visually examined to ensure that the material conforms to 3.4. The examination shall be conducted after a representative aliquot of the sample has been transferred to a clear glass vessel and compared to the same type vessel containing the same volume of purified water.

4.3.2 Hydrazine - uns-dimethylhydrazine assay and water. The hydrazine, UDMH and water content of the sample shall be determined by the Gas Chromatographic method described in Appendix A.

. 4.3.3 Particulate. The A-50 propellant sample shall be tested gravimetrically for particulate contamination in accordance with ASTM D2276, with the following exceptions:

a. Mix the sample thoroughly without exposure to air. Immediately pour 500 mL of the sample into a clean 500 mL graduated cylinder. Use this 500mL of propellant for the particulate analysis.

b. Pass the 500 mL sample aliquot through a Mitex disc polytetrafluoroethylene (PTFE) hydrophobic, 10 µm, 0.47 millimeters (mm) diameter, white filter or equivalent.

c. The oven temperature shall be set at 70°C (158°F).

d. Filtered American Chemical Society (ACS) reagent grade isopropyl alcohol shall be used for rinsing the sample bottle and filter holder instead of petroleum ether specified in ASTM D2276. Use a suitable solvent resistant filter disc with an absolute rating of at least 1.0 µm. Wet the filter with the filtered isopropyl alcohol prior to filtering the sample.

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 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. The propellant described by this specification is intended for use as a fuel in rocket engines.

6.2 Acquisition requirements. Acquisition documents must specify the following:

a. Title, number, and date of this specification.

b. Type and capacity of containers.

c. Quantity by weight in pounds.

d. When a different sampling plan is required (4.2).

e. Packaging requirements (5.1).

6.3 Safety Data Sheets. Contracting officers will identify those activities that require copies of completed Safety Data Sheets (SDS) prepared in accordance with the 29CFR1910.1200.

6.4 Subject term (key word) listing.

Fuel
Rocket engine

6.5 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.

HYDRAZINE - UDMH ASSAY AND WATER

A.1 SCOPE

A.1.1 Scope. This Appendix describes a Gas Chromatographic method for the determination of hydrazine, UDMH and water content in the sample. This Appendix is a mandatory part of the specification. The information contained herein is intended for compliance.

A.2 METHOD

A.2.1 Gas chromatographic method.

A.2.1.1 Procedure. A 60 meter (m) x 0.53 mm, 1.00 µm film thickness Agilent DB-Wax capillary column, a Thermal Conductivity Detector (TCD), with a split injector and a glass wool packed split liner shall be used. Table A-1 provides a summary of the critical operating parameters. These parameters may vary depending on GC system, detector brands, and column length and may be adjusted to optimize component resolution.

TABLE A-1. *GC and method parameters*

PARAMETER	CONDITION
Injector Port Temp.	150 °C
Injection Mode	Split injection
Sample Volume	1 µL
Split Ratio	1:50
Carrier Gas	He
Control Flow	10 mL/min
Control Mode	Flow
TCD Detector Temp.	210 °C
Equilibration Time	2.00 min
Initial Temp.(T_0)	60 °C
Initial Time (t_0)	3.00 min
Rate (1)	10 °C/min
Final Temp. (T_{f1})	100 °C
Final Time (t_{f1})	0.00 min
Rate (2)	20 °C/min
Final Temp. (T_{f2})	185 °C
Final Time (t_{f2})	3.75 min

Allow the instrument to stabilize, condition the column and perform check runs by processing three consecutive injections of 1 - 2 µL of sample. The checks must meet the quality control criteria in A.2.1.2.

The elution order of possible sample components is as follows (dimethylamine and methylamine co-elute):

Air > ammonia > dimethylamine/methylamine > UDMH > water > hydrazine > N-nitrosodimethylamine (NDMA)

A.2.1.2 Quality control. The following performance criteria must be met for fuel purity analysis,

GC replicate analyses (3 consecutive)	RSD[a] ≤ 10 %

a. RSD = Standard Deviation * 100% / Mean

A.2.1.3 Calibration. Obtain the normalization factors for each component by observing the areas produced by a specially prepared mixture, designated the reference standard. Prepare the standard with freshly distilled components assayed by the gas chromatographic procedure of their respective specifications; N_2H_4 MIL-PRF-26536 and UDMH MIL-PRF-25604. The composition of the mixture should be approximately 51 percent (%) N_2H_4, 48 % UDMH, and 1% H_2O. Weigh each component to 0.1 milligram (mg). The order of addition in the standard preparation shall be UDMH, N_2H_4 and H_2O. Calculate the actual composition as follows:

$$UDMH\ \% = \frac{W_{UDMH} \times assay_{UDMH}}{Total\ weight}$$

$$N_2H_4\ \% = \frac{W_{N_2H_4} \times assay_{N_2H_4}}{Total\ weight}$$

$$H_2O\ \% = \frac{\left(W_{H_2O} \times 100\right) + \left(W_{N_2H_4} \times \%H_2O\right) + \left(W_{UDMH} \times \%H_2O\right)}{Total\ weight}$$

where,

$W_{N_2H_4}, W_{UDMH}, W_{H_2O}$ = The weight of each of the components.

$W_{N_2H_4} \times \%H_2O$ = The weight of N_2H_4 times the percent H_2O determined in the assay as per MIL-PRF-26536.

$W_{UDMH} \times \% H_2O$ = The weight of UDMH times the percent H_2O determined in the assay as per MIL-PRF-25604.

Analyze the referenced standard in according to A.2.1.1. Calculate the normalization factors as follows:

$$K_{UDMH} = \frac{\%UDMH \times A_{N_2H_4}}{\%N_2H_4 \times A_{UDMH}}$$

$$K_{H_2O} = \frac{\%H_2O \times A_{N_2H_4}}{\%N_2H_4 \times A_{H_2O}}$$

where,

K_{H_2O} , K_{UDMH} = The normalization factors for H_2O and UDMH

$A_{N_2H_4}$, A_{UDMH}, A_{H_2O} = The measured areas of the N_2H_4, UDMH, and H_2O peaks multiplied by their signal attenuation factors.

A.2.1.4 Calculations.

$$\%N_2H_4 = \frac{A_{N_2H_4}}{\sum A_i K_i} \times 100$$

$$\%UDMH = \frac{A_{UDMH} K_{UDMH}}{\sum A_i K_i} \times 100$$

$$\%H_2O = \frac{A_{H_2O} K_{H_2O}}{\sum A_i K_i} \times 100$$

where,

$A_{N_2H_4}$, A_{UDMH}, A_{H_2O} = The measured areas of the N_2H_4, UDMH, and H_2O peaks multiplied by their signal attenuation factors.

K_{UDMH}, K_{H_2O} = The normalization factors for UDMH and H_2O.

$\sum A_i K_i$ = The sum of all the measured peak areas in the chromatogram multiplied by their respective signal attenuation factors and

normalization factors.

Assumptions: The normalization factor for N_2H_4 = 1.000. The normalization factors for trace volatile impurities = K_{UDMH}.

A.2.1.5 Equipment.

a Gas chromatograph equipped with a TCD and a split injector.

b. Agilent ChemStation or equivalent.

c. A 60 m x 0.53 mm ID and 1 µm film thickness DB-wax capillary column (Agilent P/N 125-7062 or equivalent).

d. Glass wool packed split liner (Restek P/N 23309 or equivalent).

CONCLUDING MATERIAL

Custodians:
Navy – AS
Air Force – 68
DLA – PS

Preparing Activity
Air Force – 68
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