

MIL-P-26694B(USAF)  
30 June 1967  
 SUPERSEDING  
 MIL-P-26694A(USAF)  
 23 April 1964  
 MIL-P-45734(ORD)  
 24 March 1961

MILITARY SPECIFICATION  
 PROPELLANT, uns-DIMETHYLHYDRAZINE - JET FUEL

1. SCOPE

1.1 This specification covers uns-dimethylhydrazine - jet fuel  
 $((\text{CH}_3)_2\text{NNH}_2$  - JP-4) propellant.

1.2 Classification. Jet fuel propellant shall be of the following types:

Type I - 40% UDMH - 60% JP-4  
 Type II - 17% UDMH - 83% JP-4

2. APPLICABLE DOCUMENTS

2.1 The following documents of the issue in effect on date of invitation for bids or request for proposal, form a part of the specification to the extent specified herein.

SPECIFICATIONS

Federal

PPP-D-700	Drums; Metal, 55-Gallon (For Acid and Corrosive Liquids)
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Military

MIL-T-5624	Turbine Fuel, Aviation, Jet Fuel, Grades JP-4 and JP-5
MIL-P-25604	Propellant, uns-Dimethylhydrazine
MIL-P-27401	Propellant, Pressurizing Agent, Nitrogen

STANDARDS

Federal

FED. TEST METHOD STD No. 791	Lubricants, Liquid Fuels, and Related Products; Method of Testing
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FSC 9130

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**Military**

MIL-STD-105

Sampling Procedures and Tables  
for Inspection by Attributes

MIL-STD-290

Packaging, Packing and Marking  
of Petroleum and Related Products

(Copies of specifications, standards, drawings, and publications required by suppliers in connection with specific procurement functions should be obtained from the procuring activity or as directed by the contracting officer.)

2.2 Other publications. The following documents form a part of this specification to the extent specified herein. Unless otherwise indicated, the issue in effect on date of invitation for bids or request for proposal shall apply.

**American Society for Testing and Materials Publications**

ASTM Standards, Parts 17, 18, and 30

(Application for copies should be addressed to the American Society for Testing and Materials, 1916 Race Street, Philadelphia, Pennsylvania 19103.)

**Consolidated Classification Committee Uniform Freight  
Classification Rules**

(Application for copies should be addressed to the Consolidated Classification Committee, 202 Chicago Union Station, Chicago, Illinois 60606.)

Interstate Commerce Commission 49 CFR 71-90 - Interstate Commerce Commission Rules and Regulations for the Transportation of Explosives and other Dangerous Articles.

(Application for copies should be addressed to the Superintendent of Documents, Government Printing Office, Washington, D. C. 20402.)

2.2.1 Technical society and technical association specifications and standards are generally available for reference from libraries. They are also distributed among technical groups and using Federal agencies.

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### 3. REQUIREMENTS

3.1 Chemical and physical properties. The uns-dimethylhydrazine (UDMH) propellant conforming to MIL-P-25604 and JP-4 jet fuel conforming to MIL-T-5624 shall be used in this propellant mixture. The chemical and physical properties of the mixture shall conform to those listed in table I when tested in accordance with the applicable test method.

3.2 Limiting values. 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 place of figures used in expressing the limitation value, in accordance with the rounding-off method of the Recommended Practices for Designating Significant Places in Specified Limiting Values (ASTM Designation: E29).

3.3 Drum inspection. Drums containing propellant shall be free from defects and leakage when inspected in accordance with 4.1.1.

3.4 Filter. A filter with a 10-micron nominal and 40 micron absolute rating shall be installed between the blender's plant system and the container to be filled for delivery.

3.5 Qualitative. The propellant shall be a clear homogeneous liquid when examined visually by transmitted light.

### 4. QUALITY ASSURANCE PROVISIONS

4.1 Responsibility for inspection. Unless otherwise specified in the contract or purchase order, the supplier is responsible for the performance of all inspection requirements as specified herein. Except as otherwise specified, the supplier may utilize his own facilities or any commercial laboratory acceptable to the Government. The Government reserves the right to perform any of the inspections set forth in the specification where such inspections are deemed necessary to assure supplies and services conform to prescribed requirements.

4.1.1 Inspection of filled drums. Each filled drum selected in accordance with 4.4.2.1.3 shall be examined for defects of the drum and the closure for evidence of leakage, and weighed to determine the amount of the contents for proper filling.

4.2 Classification of tests. The inspection and testing of the propellant shall be classified as quality conformance tests.

4.3 Test conditions. The test conditions are described under the individual tests to which they apply.

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Table I

## Chemical and Physical Properties

Properties	Limits Type I	Limits Type II	Test Paragraph
uns-Dimethylhydrazine content (percent by weight)	40.0 $\pm$ 1.0	17.0 $\pm$ 0.3	4.5.2
JP-4 jet fuel (percent by weight)	59.0 min	83.0 $\pm$ 0.3	4.5.2
Distillation (degrees F)			4.5.3
10 percent point	155 max	245 max	
35 percent point	170 max		
50 percent point	300 max	340 max	
70 percent point	370 max		
90 percent point	470 max	466 max	
Density @ 77°F (25°C) (Grams per milliliters)	0.788 max 0.746 min	0.792 max 0.749 min	4.5.4
No phase separation at (degrees F)	-65.0 max		4.5.5
Particulate (6.3.1)(milligrams per liter)	10 max	10 max	4.5.6

4.4 Quality conformance tests. Quality conformance tests shall consist of:

- (a) Individual test . . . . . 4.4.1
- (b) Sampling tests . . . . . 4.4.2

4.4.1 Individual test. The propellant shall be subject to the following test as described under 4.5.

Examination of product . . . . . 4.5.1

4.4.2 Sampling tests. The propellant shall be selected in accordance with 4.4.2.1 and subjected to the following tests as described under 4.5.

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- (a) uns-Dimethylhydrazine content . . . . . 4.5.2
- (b) Distillation . . . . . 4.5.3
- (c) Density . . . . . 4.5.4
- (d) Phase separation . . . . . 4.5.5
- (e) Particulate . . . . . 4.5.6

4.4.2.1 Sampling plan.

4.4.2.1.1 Lot. A lot shall consist of propellant blended by one manufacturer and transferred in shipping containers within any one 24-hour period (6.2).

4.4.2.1.2 Sample. A sample shall consist of not less than 1000 milliliters (ml) of propellant obtained in any suitable vessel. Unless otherwise specified, quality conformance tests shall be made upon each sample taken directly from the shipping containers. When required, a 1000 ml sample shall be forwarded to a laboratory designated by the procuring activity for subjection to the quality conformance tests specified herein.

4.4.2.1.3 Drums. The number of drums selected from each lot shall be in accordance with MIL-STD-105 Inspection Level S-3. If more than one lot is represented in a shipment, then each lot represented shall be considered as a separate shipment for sampling purposes. The contents of each selected drum shall be thoroughly mixed by rolling and inverting immediately prior to sampling.

4.4.2.1.4 Tanks. A single composite sample, thoroughly mixed, of propellant shall be taken from each tank truck and railroad tank car as follows: (a) one-third of the sample quantity shall be taken within one foot of the bottom, (b) one-third near the mid-point, and (c) one-third within one foot of the surface.

4.5 Test methods.

4.5.1 Examination of product. The propellant sample (4.4.2.1.2) shall be visually examined while performing the particulate test (4.5.6) to determine compliance with the requirement specified in 3.5.

4.5.2 uns-Dimethylhydrazine content. The UDMH content of the sample shall be determined by the following method for Type I and Type II.

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4.5.2.1 Preparation of sample. Pipette 50 ml of 1 N hydrochloric acid into a 100-ml calibrated volumetric flask. Stopper the flask and weigh to the nearest 0.0001 gram. Cool the flask and its contents in a dry ice-acetone bath for at least 20 seconds. While swirling, pipette 6.7 ml of the sample to the contents of the flask. Do not permit the pipette tip to touch the 1 N hydrochloric acid. Stopper the flask, wipe dry, and allow the solution to come to ambient temperature. Weigh accurately obtaining the prepared sample weight by difference. Dilute to the 100 ml mark with 1 N hydrochloric acid and thoroughly mix the solution. Aliquots of the prepared sample shall be used for iodate titration of propellant sample.

4.5.2.2 Procedure. Pipette a 25 ml aliquot of the prepared sample into a 250-ml beaker containing 75 ml of cooled 12 N hydrochloric acid. Chill the solution to 23°F (minus 5°C) in a dry ice-acetone bath atop a magnetic stirrer. Place the beaker in position for titration. Immerse the calomel and platinum electrodes in the solution and prevent the electrodes from contacting the rotating rod of the magnetic stirrer. Maintain the temperature of the solution at 32° plus or minus 9°F (0° plus or minus 5°C) by adding small amounts of dry ice to the bath. Titrate the sample potentiometrically with the standard 0.10 M potassium iodate ( $\text{KIO}_3$ ), with continuous stirring, until the yellow coloration of iodine chloride starts to appear. This color change will occur at about 0.6 volt. Add the titrant dropwise and observe the change in potential on the potentiometer. The end point will occur in the range of 0.64 to 0.75 volt where the potential increases will vary sharply. The solution will be light yellow at the end point. The titration should be completed within 5 minutes.

4.5.2.3 Calculation. The UDMH content shall be calculated by the following formula:

$$\text{UDMH, percent by weight} = \frac{\text{ml KIO}_3 \times \text{molarity KIO}_3 \times 60.10 \times 4 \times 100 \times 2}{1000 \times \text{sample weight in grams}}$$

4.5.2.4 Reagents and equipment. The following reagents and equipment shall apply as test conditions of 4.5.2:

(a) Reagents:

(1) Hydrochloric acid: 1 N. Dilute 83 ml of concentrated ACS reagent grade hydrochloric acid to 1000 ml with distilled water.

(2) Hydrochloric acid: 12 N, concentrated ACS reagent grade (37 wt percent).

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(3) Potassium iodate: primary ACS standard, dried at 356°F (180°C).

(4) Potassium iodate standard solution: 0.10 Molar. Dissolve 42.804 grams of dried primary ACS standard potassium iodate in distilled water in a 2000-ml volumetric flask and dilute to the mark. The molarity can be calculated by the following equation:

$$\text{Molarity KIO}_3 = \frac{\text{grams KIO}_3 \times \text{KIO}_3 \text{ assay}}{21.402 \times \text{dilution volume, ml}}$$

(b) Equipment:

- (1) Pipette: 25 ml capacity, volumetric.
- (2) Flask: volumetric, 100 ml capacity.
- (3) Bath: dry ice-acetone.
- (4) Beaker: 250 ml capacity.
- (5) Magnetic stirrer: with polytetrafluoroethylene coated rod.
- (6) Potentiometer: Beckman pH meter, model H-2, or equivalent.
- (7) Electrode: calomel.
- (8) Electrode: platinum.
- (9) Thermometer: aniline point, minus 36.5° to plus 107.5°F (minus 38° to plus 42°C) in 0.5° divisions, 51 mm immersion, ASTM No. 33F or equivalent.
- (10) Flask: volumetric, 2000 ml capacity.
- (11) Burette: 50 ml, graduated in 0.1 ml divisions.

4.5.3 Distillation. The distillation range of the sample shall be determined by the following method for Type I and Type II.

4.5.3.1 Procedure. The test equipment shall be prepared and assembled in accordance with figure 1. Prior to assembly, equipment glassware shall be clean and dry. Connect the side arm of a 200-ml distillation flask to a Liebig condenser with a tightly fitted cork stopper. Adjust the apparatus so that the neck of the flask is vertical and the side arm extends into the condenser a distance of 25 to 50 millimeters (mm). Assemble a vacuum adapter on the lower end

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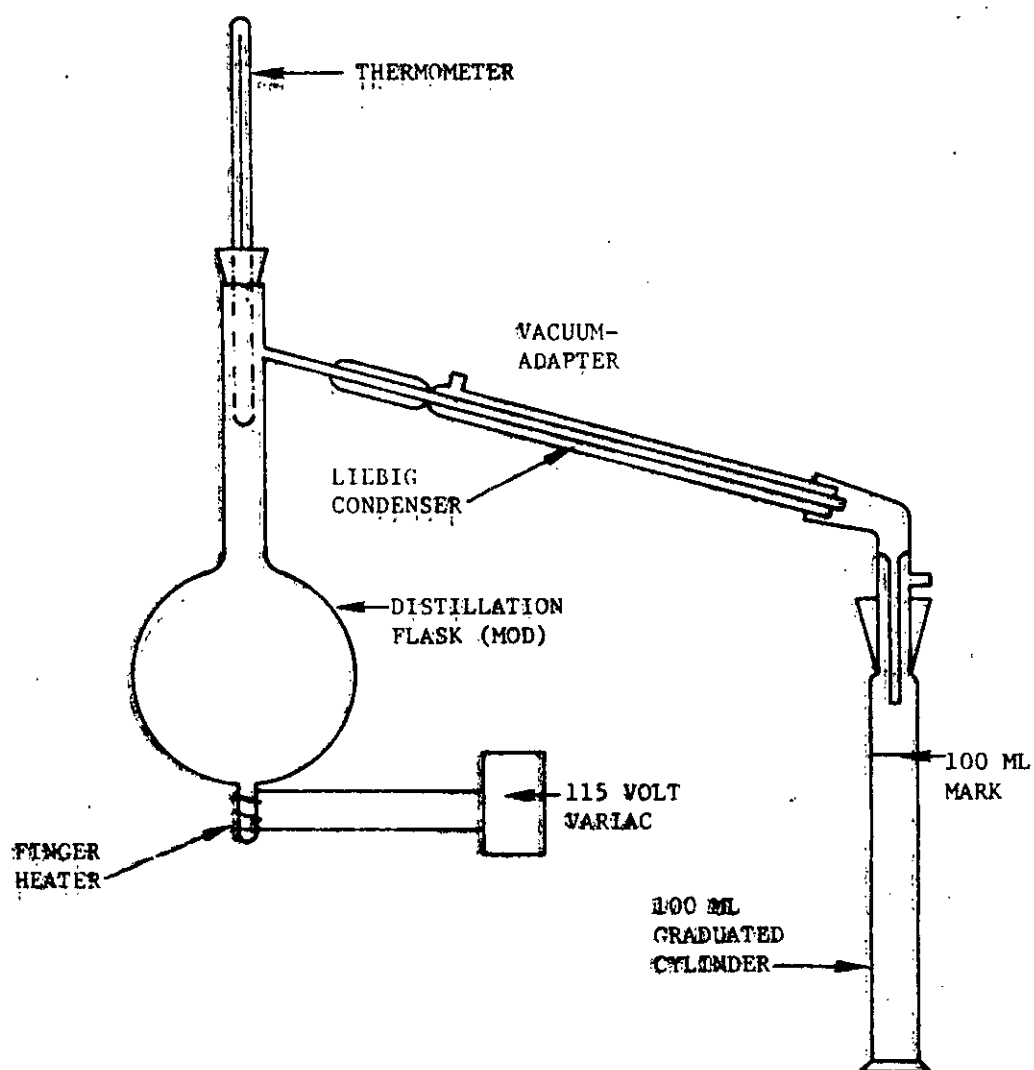


Figure 1. Distillation Range Apparatus



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of the condenser. Pour 100 ml of the sample into a graduate and transfer sample into the flask. Allow the graduate to drain for 5 to 10 seconds. Do not permit the sample to enter the side arm of the flask. Place one boiling chip in the flask. Insert a calibrated thermometer into the neck of the flask through a tightly fitted compatible stopper. The thermometer shall be centered and extended so that the upper end of the bulb is 5 mm below the bottom of the side arm. Place the undried graduate on the lower end of the vacuum adapter. Read and record the barometric pressure. The flask shall be heated at a rate so that the first distillation drop falls from the condenser within 5 minutes. Adjust the heat to insure that distillation proceeds at a rate of 4 to 5 ml per minute (approximately 2 drops per second). Record the readings of the thermometer to 0.2°F (0.1°C) at the 10, 35, 50, 70, and 90 ml distillate volumes. Continue distillation until the apparent dry point is obtained. Read and record the recovery volume. Cool the flask to ambient temperature and measure the residue by transferring to a 5 ml graduated cylinder. Subtract the sum of the recovery volume plus the residue from 100 ml and record the difference as distillation loss. When losses of 3 percent or over occur, a check distillation shall be made to determine whether distillation rate was too rapid.

4.5.3.2 Distillation temperature calculation. The distillation temperatures of sample 10, 35, 50, 70, and 90 ml points shall be corrected by the following formulas:

(a) Fahrenheit reading:

$$C_f = 0.00012 (760-P) (460 + t_f)$$

(b) Centigrade reading:

$$C_o = 0.00012 (760-P) (273 + t_o)$$

Where:

$C_f$  and  $C_o$  = the correction to be added to the observed temperature  $t_f$  and  $t_o$ , respectively.

P = the actual barometric pressure in millimeters of mercury.

4.5.3.3 Equipment. The following equipment shall apply as test conditions of 4.5.3:

(a) Flask: distillation, 200 ml capacity. Modified by attaching a length of 15 mm outside diameter pyrex tubing to the bottom center of the flask and sealing at a 45 mm length. Seal two small projections with flattened heads to the sides of the finger at top and bottom to hold the heating element in place.

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(b) Heater: No. 24 wire, nichrome resistance, silicone insulation. Wind 9.7 feet of the wire having a total resistance of 16 ohms directly around the flask finger.

(c) Condenser: Liebig, pyrex, West modification, integral, water cooled with 24/40 ground glass joint, 400 mm length.

(d) Adapter: vacuum, pyrex, with 24/40 ground glass joint. Modify adapter to insure that the distillate will enter the graduate receiver at a point 25 mm below the joint but above the 100 ml mark and run down the side of the graduate.

(e) Cylinder: graduated, with 24/40 ground glass joint, 100 ml capacity.

(f) Thermometer: solvent distillation, 48° to 102°C in 0.2°C division, 100 mm immersion (ASTM No. 39C or equivalent).

(g) Boiling chips, silicon carbide.

(h) Cylinder: graduated, 0.1 ml divisions, 5 ml capacity.

4.5.4 Density. The density of the sample shall be determined in accordance with Method 402.2 of Federal Test Method Standard No. 791 (ASTM D941-55) for the Type I and Type II.

4.5.5 Phase separation. The phase separation of the sample shall be determined by the following method for Type I only.

4.5.5.1 Procedure. The test equipment shall be prepared and assembled in accordance with figure 2. Prior to assembly, pipette 20 ml of the sample into the test tube. Immerse the tube containing the sample into a dry ice-acetone bath until two distinct liquid phases form and remain after stirring. Withdraw the tube from the bath and observe the phase separation. Transfer the tube into the phase separation bath as specified in 4.5.5.1.1. Adjust the thermometer to the 76 mm immersion mark. Stir frequently and permit the sample to warm up gradually at a rate of 1.8°F (1°C) per minute. Record the temperature to the nearest 1°F (0.5°C) immediately after complete disappearance of sample opalescence. This temperature, corrected for thermometer error and calibrated as specified in 4.5.5.1.2, shall be taken as the point of phase separation. This point coincides with the formation of two phases when the sample is stirred and gradually cooled to the point where two phases just occur.

4.5.5.1.1 Phase separation bath. Prepare the phase separation bath by pouring acetone in an unsilvered dewar flask to a depth of about 100 mm and stir at a moderate rate. The bath temperature shall

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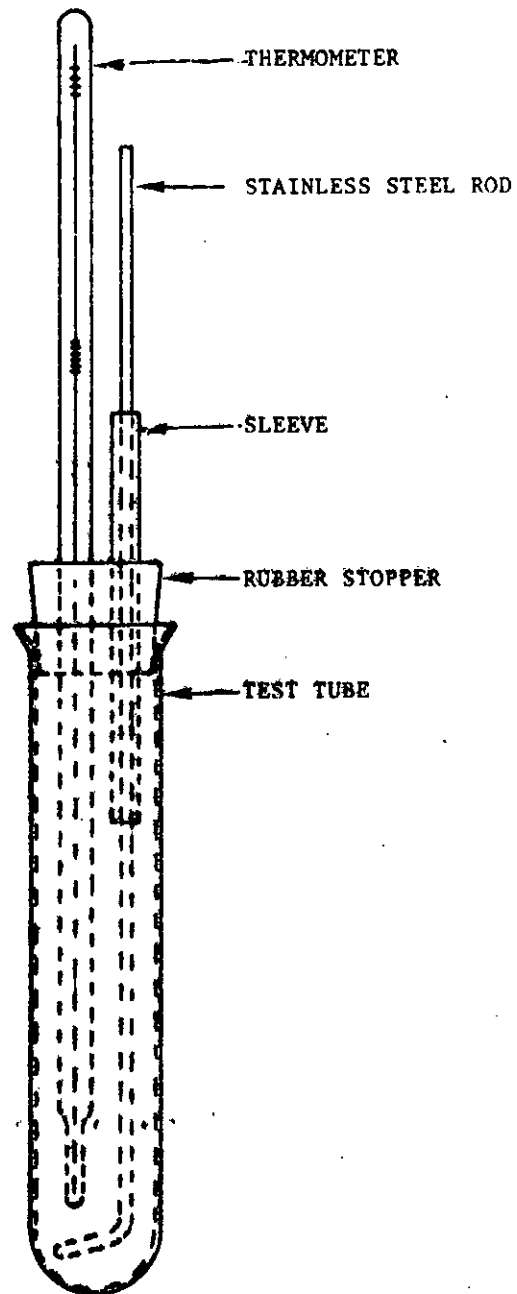


Figure 2. Phase Separation Apparatus

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be lowered by adding small amounts of dry ice until the temperature has been reduced to minus 80° to minus 83°F (minus 62° to minus 64°C).

4.5.5.1.2 Thermometer calibration. Calibrate the thermometer by checking the melting point using the center cut of redistilled chloroform by the capillary tube melting point method as specified in 4.5.5.1.2.1. The melting point of chloroform is minus 82°F (minus 63.5°C). The difference between the observed melting point and minus 82°F (minus 63.5°C) is the correction to be applied to the thermometer reading to convert it to the true temperature.

4.5.5.1.2.1 Procedure. Draw a portion of chloroform into a clean, dry hypodermic syringe. Wipe the needle clean and insert to the bottom of a melting point capillary tube. Avoid getting chloroform on upper portion of the tube. Withdraw the needle and immediately seal the tube by applying a sharp flame to side of tube about 1 centimeter (cm) from the open end. Remove the open end portion. Avoid contaminating the chloroform with combustion gases during sealing operation. Attach the sealed tube to a thermometer with a rubber band to insure that the chloroform is adjacent to the center of the thermometer bulb. Freeze the chloroform in the tube by placing the thermometer and tube in a dry ice-acetone bath. If necessary, tap the tube lightly or blow air through the bath to induce freezing. Transfer the frozen chloroform with attached thermometer quickly into the phase separation bath as specified in 4.5.5.1.1. Adjust the thermometer to the 76 mm immersion mark. Observe the melting of the chloroform through the dewar flask side against a strongly illuminated background. Limit the temperature rise rate to 1.8°F (1°C) per minute maximum and preferably to 1°F (0.5°C) per minute in the melting point range. Record the temperature to 0.2°F (0.1°C) at which the chloroform becomes completely liquid. The observed point is the melting point temperature of chloroform and shall be used for thermometer calibration as specified in 4.5.5.1.2.

4.5.5.2 Reagents and equipment. The following reagents and equipment shall apply as test conditions of 4.5.5:

(a) Reagents:

(1) Chloroform: melting point minus 82°F (minus 63.5°C), ACS reagent grade.

(b) Equipment:

(1) Pipette: 25 ml capacity.

(2) Test tube: 25 mm by 150 mm.

(3) Bath: dry ice-acetone.

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(4) Stirring rod: stainless steel rod approximately 10 inches by 1/8 inch with a loop approximately 3/4 inch diameter at the stirrer end. The rod shall fit into a sleeve approximately 4 inches long to provide a snug fit for the 1/8 inch rod stirrer.

(5) Stirrer: reciprocating.

(6) Thermometer: low cloud and pour, minus 112° to plus 70°F in 2.0° divisions, 76 mm immersion (ASTM No. 6F or equivalent).

(7) Flask: dewar, unsilvered. Inside dimensions approximately 80 mm by 150 mm.

(8) Hypodermic syringe: tuberculin, small size.

(9) Tube: capillary, 1.5 mm to 2.0 mm by 90 mm.

(10) Hypodermic needle: spinal, stainless steel, 20 gage, 3-1/2 inches long.

4.5.6 Particulate. The propellant sample, Types I and II shall be tested for contamination in accordance with ASTM Designation D-2276-65T, Method A, with the following exceptions (4.5.6.1).

4.5.6.1 Mix the sample thoroughly by shaking the sample container. Immediately pour 500 ml of the sample into a clean 500-ml graduated cylinder. Use this 500 ml of propellant for the particulate analysis.

4.5.6.2 Use a filter disc of polyethylene membrane, solvent resistant, plain, white,  $10 \pm 3$  microns, 47 mm diameter instead of the filter specified in Method 2276-65T.

4.5.6.3 The drying oven temperature shall be 158°F (70°C) instead of the 194°F (90°C) specified in Method 2276-65T.

4.5.6.4 Filtered isopropyl alcohol shall be used for rinsing the sample bottle and filter holder instead of petroleum ether specified in Method 2276-65T.

4.6 Preparation for delivery inspection. The preservation, packaging, packing and marking for shipment and storage of the propellant shall be inspected to determine compliance with the requirements of section 5.

4.7 Rejection. When any sample of propellant fails to conform to the requirements specified herein, the entire lot represented shall be rejected.

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## 5. PREPARATION FOR DELIVERY

5.1 Preservation and packaging. Preservation and packaging shall be level A (6.2).

5.1.1 Level A. Unless otherwise specified, the propellant shall be packaged in drums, tank cars, or tank trucks which shall comply with the requirements of the Interstate Commerce Commission 49 CFR 71-90 or other Government specifications. Unit quantities shall be as specified by the contract or order.

5.1.1.1 Drums. Drums shall conform to the requirements of ICC-5C-304 or ICC-5C-347 (stainless steel) with openings not exceeding 2.3 inches in diameter or PPP-D-700, Type II.

5.1.1.2 Tank cars. Tank cars shall conform to the requirements of ICC-103C-W.

5.1.1.3 Cargo tanks. Cargo tanks shall conform to the requirements of one of the following: MC 300-307 or MC 310-312 with approved safety valves and no bottom outlets.

5.1.2 Gaskets. Gaskets used to seal container openings shall be polytetrafluoroethylene or other material compatible with the propellant and approved for use by the procuring activity. The contractor shall assure that all gaskets are serviceable and furnish new gaskets when necessary so that a tight seal is assured.

5.1.3 Filling. The contractor shall perform inspection on all containers provided with inspection ports. Unless leased by the Government, the contractor shall perform cleaning of contractor owned containers to insure that all containers are free from contamination, and suitable for shipment and storage.

5.1.4 Ullage atmosphere. After filling containers in accordance with Interstate Commerce Commission Regulations, the space above the liquid level shall be filled with contractor furnished nitrogen conforming to MIL-P-27401, Type I at atmospheric pressure.

5.2 Marking. In addition to any special marking required by the contract or order, containers shall be marked in accordance with MIL-STD-290 including lot, batch, or control number. The nomenclature shall be as follows: PROPELLANT, uns-DIMETHYLHYDRAZINE - JET FUEL TYPE I or TYPE II (as appropriate).

5.2.1 Labeling. Each container shall be labeled with a red label for flammable liquids required by regulations or statutes without exception. An additional label impervious to climatic conditions shall contain the following information in read letters:

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**WARNING! FLAMMABLE**

HAZARDOUS LIQUID AND VAPOR  
MAY BE HARMFUL IF ABSORBED  
THROUGH SKIN OR INHALED

Store and use in well ventilated areas.

Do not store near oxidizing materials or strong oxidants.

Electrically ground containers and handling equipment.

In case of contact with either skin or eyes, immediately flush with water for 15 minutes and obtain medical attention. Contaminated clothing should be immediately removed, washed before reuse.

**6. NOTES**

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

6.2 Ordering data. Procurement documents for Type I and Type II propellant should specify the following:

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

(b) Method of shipment, type and capacity of containers.

(c) Quantity by weight in pounds (avoirdupois).

(d) Drums specified in Section 5 are suitable for Military Air Transportation. Commercial Air Transportation is prohibited.

(e) Two copies of the test report, signed by the Contractor's representative listing values obtained on all tests (quantitative values where method provides) shall accompany each shipment delivered to the consignee.

**6.3 Definition.**

6.3.1 Particulate. The undissolved solids retained on a 10-micron filter membrane.

Custodian:

Air Force 12

Review activities:

Air Force 19, 68

Preparing activity:

Air Force 12

Project No. 9130-0023

Reviewer/user information is current as of the date of this document. For further coordination of changes to this document, draft circulation should be based on the information in the current DoD Index of Specifications and Standards.

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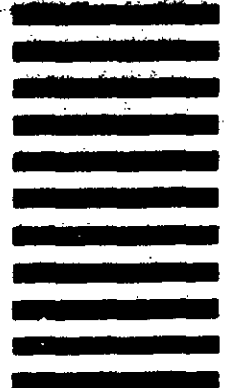
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