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FIELD ARTILLERY GUIDED MISSILE SYSTEM
REDSTONE

MT-M44J
TECHNICAL MEMORANDUM
PROPERTIES OF JP-5 FUEL

by W. J. Hangen

CHRYSLER CORPORATION
MISSILE OPERATIONS

FIELD ARTILLERY GUIDED MISSILE SYSTEM

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TECHNICAL MEMORANDUM

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by

W. J. Hangen

MATERIALS LABORATORY DEPARTMENT

4 December 1957

CWO 200037

CHRYSLER CORPORATION MISSILE OPERATIONS

ABSTRACT

This memorandum was written to document the physical properties of MIL-F-5624C (JP-5) fuel and to determine the compatibilities of various engineering materials with this fuel. Evidence is contained herein to support the recommendation for the qualification of individual vendor's elastomer compounds for specific missile fuel application through controlled immersion tests.

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PROPERTIES OF JP-5 FUEL

OBJECT

To determine the compatibilities of various engineering materials with this fuel.
To document the physical properties of MIL-F-5624C (JP-5) fuel.

CONCLUSIONS

The physical properties of JP-5 fuel can vary considerably yet still lie within the military specification (MIL-F-5624C).

Parker Fuelube, Carbowax 1500, and MIL-L-6032 lubricants are compatible with JP-5 fuel.

No corrosion is promoted by contact of JP-5 fuel with metallics.

Teflon, fluorosilicone rubber, polyethylene, Buna N, and Kel-F elastomers are compatible with JP-5 fuel.

Definite upper and lower limits of flammability exist for mixtures of air and JP-5 vapor.

RECOMMENDATIONS

The qualification of individual vendor's elastomer compounds for specific missile fuel applications, through controlled immersion tests, should be made mandatory.

DISCUSSION

Introduction

MIL-F-5624C (JP-5) fuel, hereafter referred to as JP-5, was established to control the properties of a special blending component for use in naval aircraft operations. This component resembles a high-flashpoint kerosene. Jp-5 was selected by North American Aviation as the fuel for their S3-D liquid propellant rocket engine (JUPITER powerplant). It is felt that documentation concerning military specification, the envelope of variation obtained from commercial products, and compatibilities of various engineering materials with the fuel should be consolidated for easy reference.

Applicable Specifications

The applicable military specification for this fuel, MIL-F-5624C, Fuel, Aircraft and Jet Engine Grades JP-3, JP-4, and JP-5, is included as an Appendix.

Variations of Physical Properties

It is important to understand that variations of physical properties of a fuel can or do occur although still remaining within the limits of the specifications set forth. These variations must be considered when designing, developing, or modifying the particular power plant and related storage and launching and handling equipment for the fuel. In order to provide an indication of the variation of these properties, several tables and graphs have been included. Table I illustrates variations for the physical properties of JP-5 samples as obtained by NACA. Table II shows variations obtained by the Bureau of Mines. Variations of other physical properties such as viscosity and vapor pressure are presented in Figures 1 through 6.

Compatibility of Lubricants with JP-5 Fuel

In order to determine suitable lubricants for use in contact with JP-5 fuel, immersion tests were performed on lubricant-coated glass slides in the fuel. The immersion period was 72 hours at 75 F with close observation being kept for the first six hours and periodic visual checks thereafter until the total 72 hours of the test time had elapsed. Those lubricants that appeared satisfactory by visual inspection were checked for consistency change by working the sample on the slide manually, and comparing it to control samples. Results of these tests are tabulated in Table III. Of the lubricants tested by Missile Operations Materials Laboratory, Carbowax 1500 and Parker Fuelube were the only ones found to be compatible with JP-5 fuel.

The Engineering Materials Section, Structures and Mechanics Laboratory, ABMA, has reported that gasoline resistant grease corresponding to MIL-L-6032 is compatible with JP-5 and is satisfactory for use with rubber O-rings.

Compatibility of Elastomers with JP-5 Fuel

Various elastomer samples were subjected to 72 hour immersion at 75 F in JP-5 fuel. Measurements of hardness change and volume swell were used as a criterion of compatibility. From the data presented in Tables IV and V, it is evident that Teflon, fluorosilicone rubber, polyethylene, Kel-F elastomers and the specialized Buna N stocks are compatible with JP-5 fuel to the extent that they may be used as O-rings, gaskets, and seals providing they meet other service requirements for particular applications. Considering other properties, the Buna N materials are the most favorable for O-ring applications. Although Allpax Sheet Packing is not elastomeric in nature, it is frequently used in gasket applications, therefore it was included under this category.

In gasket and O-ring applications, shrinkage of a material when contacted with a fluid is not tolerable inasmuch as sealing properties are reduced more extensively than a comparable swelling would produce. Therefore, materials which shrink, as exemplified by the vinyl plastisol in Table V, cannot be used for this application.

Usually, elastomer specifications alone do not guarantee resistance to a specific fluid by all conforming materials. Qualification of individual vendor's compounds for specific missile fuel applications, through controlled immersion tests, should be made mandatory.

An example of two compounds meeting the same specification but not performing the same under a specific fluid immersion is the AMS 3305 material listed in Tables IV and V. Here, there is a volume swell difference of 33 per cent and a hardness difference of 12 Shore A units after comparable immersion tests. Conceivably, this could occur in practically every case where a general specification is used on an engineering drawing call-out without the backup of immersion tests in the specific fluid for qualification and acceptance.

Compatibility of Metallics with JP-5 Fuel

Various metallics were subjected to immersion in JP-5 fuel at ambient laboratory temperatures for ten months. None of the samples showed evidence of corrosion by visual inspection. (Table VI) The samples were clean and bright at the beginning of the test and remained so for the duration of the test with the exception of the brass sample which took on a very slight dullness. This slight dulling was due to the slight mercaptan content of the JP-5. No corrosive problems with metallics due to contact with JP-5 should be encountered during any phase of the life of the missile.

Sealants, Threading Compounds, and Packing Compatible with JP-5 Fuel

The Engineering Materials Section, Structures and Mechanics Laboratory, ABMA, has conducted extensive tests on sealants, threading compounds, and packing materials for use in JP-5 systems. The sealants which they recommend for use are John Crane Plastic Lead Seal #1 and KS-44, a compound developed by the Engineering Materials Section, ABMA, which is satisfactory for use with rubber O-rings. X-Pando threading compound and John Crane #177J7 packing compound were determined to be compatible with JP-5 fuel.

Flammability Limits of JP-5 Fuel

At any given temperature and pressure, there is a lean (lower) limit for a hydrocarbon, which represents the minimum concentration of the hydrocarbon in air or oxygen required for combustion, and below which, flame cannot propogate. Similarily there is a rich (upper) limit which defines the maximum amount of fuel in air that will support combustion.

Lean and rich limit fuel concentrations can be calculated using the following equations:

$$L = \frac{1.87 \times 10^6}{q_n \ M} \qquad R = L + \frac{143}{M^{0.7}}$$

M = Molecular weight
q_n = Net heat of combustion, Btu/lb.
L = Lean-limit concentration, volume per cent
R = Rich-limit concentration, volume per cent

These equations were derived from pure-hydrocarbon data but are applicable to jet fuels such as JP-5. The equation requires heats of combusition and molecular weight was estimated from charts in Reference 5. Calculated values of the flammability limits of JP-5 in air are presented in Table VII.

REFERENCES

1. Barnett, H. C. and Hibbard, R. R., "Properties of Aircraft Fuels," NACA TN-3276, August 1956.

2. Blade, O. C., "National Annual Survey of Aviation Fuels, Bureau of Mines Information Circular 7747," 1955, March 1956.

3. Blade, O. C., "National Annual Survey of Aviation Gasoline and Aviation Jet Fuel, 1954 Production," Bureau of Mines Report of Investigations 5132, April 1955.

4. "Fuel, Aircraft Turbine and Jet Engine Grades JP-3, JP-4, and JP-5," MIL-F-5624C, 18 May 1955.

5. Maxwell, J. B., Data Book on Hydrocarbons, Second Edition, D. Van Nostrand Company, Incorporated, 1951.

6. Riehl, W. A., "Sealants, Lubricants, Threading Compounds and Packing for JUPITER Missile Systems," Structures and Mechanics Laboratory, ABMA. Technical Note NR-N-61, 23 May 1957.

TABLE I

VARIATIONS OF PHYSICAL PROPERTIES OF JP-5 FUEL SAMPLES*

Properties	Number of Fuels Averaged	Minimum	Maximum	Arithmetic Average
A. S. T. M. distillation D86-52, degrees Fahrenheit				
Percentage evaporated				
Initial point	22	312	376	359
10	64	356	411	390
20	19	391	416	404
50	31	414	444	428
90	46	456	527	475
End point	61	479	460	511
Freezing point, degrees Fahrenheit	35	-80	-40	-49
Aromatics, percent by volume	63	7.4	22.0	15.8
Bromine number	63	0.5	5.0	2.2
Total sulfur, percent by weight	61	0.023	0.49	0.15
Mercaptan sulfur, percent by weight	35	0.0002	0.003	0.0014
Existent gum, mg/100 ml	47	0.1	6.4	2.2
Potential gum, mg/100 ml	57	0.3	17.1	4.4
Heat of combustion, Btu/lb	59	18,436	18,634	18,522
Aniline-gravity product	59	4710	6607	5534
Gravity, 60/60 F				
Specific	62	0.808	0.842	0.827
degrees API	--	43.6	36.6	39.6
Aniline point, degrees Fahrenheit	44	128	153	139
Viscosity, centistokes at -40 F	52	10.1	19.7	16.1
Flash point, degrees Fahrenheit	52	125	159	147

*Reprinted from NACA Technical Note 3276, (Reference 1).

TABLE II

INSPECTION DATA JP-5 FUEL*
(Analysis of Products for Commercial Use)

Inspection Test	1953	1954		1955
Number of fuels	1	2**		3
Gravity, degrees API	37.3	37.8	41.0	39.8
Distillation temp, degrees Fahrenheit				
10 per cent evaporation	397	384	395	392
50 per cent evaporation	432	418	424	428
90 per cent evaporation	491	470	480	485
400 - F point, per cent evaporation	---	27.5	16	17.0
Reid vapor pressure, lbs	0.5	0	--	--
Freezing point, degrees Fahrenheit	-54	<40	-59	<40
Viscosity, kinematic, -40 F, cs	19.4	12.1	13.36	13.20
Water tolerance, ml	0.0	0.0	0.0	0.0
Aniline point, degrees Fahrenheit	136	129	146	144.4
Aniline-gravity constant	5,073	4,876	5,986	5,747
Bromine number, gm Br/100 gm	4.3	3.7	0.80	3.10
Sulfur				
Total, wt per cent	0.46	0.33	0.075	0.167
Mercaptan	0.003	0.001	0.001	0.0012
Aromatic content, volume percent	8.3	20.3	15.13	12.0
Olefin content	--	0.9	0.87	3.1
Smoke point	--	21	21	22.0
Smoke volatility index	--	33	27.7	29.1
Gum				
Existent:				
Air-jet, 400 F, mg./100 ml.	3	2	--	--
Steam-jet, 450 F, mg./100 ml.	2	1	1.0	0.9
16-hr Accelerated:				
Air-jet, 400 F.	5	2	--	--
Steam-jet,	4	1	2.0	1.6
Heat of combustion, net, Btu/lb.	18,474	18,391	18,569	18,525
Hydrogen-carbon ratio	0.159	0.157	0.151	0.148

* Reprinted from Bureau of Mines Information Circular 7747, (Reference 2).

** As only two samples are represented, average values were not computed.

TABLE III

COMPATIBILITY OF LUBRICANTS WITH JP-5 FUEL

(72 Hour Immersion at 75° F)

Material	Remarks
Parker fuelube	No appreciable change in properties after 72 hours.
Carbowax 1500	No appreciable change in properties after 72 hours.
Standard supermil grease 8723 (MIL-G-3278)	Partial dissolving with increased consistency after 72 hours.
Dag dispersion 217 (MIL-T-5542B)	Considerable pitting and hardening after 24 hours.
Cox Compound (MIL-T-5542B)	Poor adhesion and loss of grease-like properties after 48 hours.
Rectorseal 15 (MIL-T-5542B)	Pitting, poor adhesion after 24 hours.
Parker sealube	Viscosity greatly reduced, apparent absorption of fuel after 6 hours.
Dow Corning DC-55	Poor adhesion, considerable loss of consistency after 72 hours.
Dow Corning DC-33, light	Considerable loss of consistency, partial dissolving after 72 hours.
Dow Corning DC-33, medium	Considerable loss of consistency, partial dissolving after 72 hours.
Dow Corning DC-33, heavy	Partial loss of consistency, partial dissolving after 72 hours.
Cenco stopcock lubricant	Considerable dissolving after 24 hours.
Cenco vacuum wax	Completely dissoved after 72 hours.
Sargent stopcock lubricant	Completely dissovled after 72 hours.
Dow Corning high vacuum grease	Considerable dissolving after 24 hours.
Dow Corning stopcock grease	Completely dissolved after 72 hours.
Lubriseal	Completely dissolved after 72 hours.
Apiezon "L" grease	Considerable dissolving after 24 hours.
Apiezon "N" grease	Considerable dissolving after 6 hours.

TABLE IV

ELASTOMER HARDNESS CHANGES INDUCED BY JP-5 FUEL

Material	Original Hardness Shore Durometer Scale	Hardness After 72 hr. Immersion at 75 F Shore Durometer Scale	Change Shore Durometer Units
Allpax sheet packing	75D	58D	-17D
MIL-G15510 (Buna N)	87A	78A	- 9A
MIL-P-5516, class B (Buna N)	73A	65A	- 8A
MIL-R-5847, type I	60A	43A	-17A
MIL-R-5847, type II	63A	50A	-13A
Flurorosilicone rubber (LS-53)	66A	65A	- 1A
Silicone rubber (All purpose stock)	17D	12D	- 5D
Teflon	58D	58D	None
Polyethylene	72D	72D	None
Kel-F elastomer (5500 - 800)	50D	50D	None
Kel-F elastomer (3700 - 335)	69A	69A	None
Kel-F elastomer (3700 - 72)	67A	67A	None
AMS 3305 (MLR 19308)	86A	78A	- 8A
AMS 3305 (MLR 18875)	75A	55A	-20A
MIL-R-3065, grade SC 420 AB (Neoprene)	50A	40A	-10A
Vinyl Plastisol (Microsol black)	75A	80A	+ 5A
Hydropol	85A	Too soft to measure	----
Tygon (S-22-1)	80A	78A	- 2A

TABLE V

ELASTOMER VOLUME CHANGES INDUCED BY JP-5 FUEL

Material	Per cent Volume Swell after 72-Hour Immersion at 75°F
Allpax sheet packing	20.2
MIL-G-5510 (Buna N)	11.6
MIL-P-5516, class B (Buna N)	16.3
MIL-R-5847, type I	153.0
MIL-R-5847, type II	135.0
Flurorosilicone rubber (LS-53)	6.5
Silicone rubber (all purpose stock)	60.0
Teflon	None
Polyethylene	9.3
Kel-F elastomer (5500 - 800)	0.7
Kel-F elastomer (3700 - 335)	1.4
Kel-F elastomer (3700 - 72)	0.7
AMS 3305 (MLR 19308)	60.8
AMS 3305 (MLR 18875)	94.0
MIL-R-3065, grade SC 420 AB (Neoprene)	59.4
Vinyl Plastisol (Microsol black)	-2.9
Hydropo[illegible]	160.0
Tygon (S [illegible]2-1)	None

TABLE VI

METALLIC CORROSION INDUCED BY JP-5 FUEL

Material	Visual Corrosion After 10 Months Immersion at Ambient Laboratory Temperatures
HK31 Magnesium	None
5052 Aluminum	None
2024 Aluminum (Alclad)	None
5086 Aluminum	None
6061 Aluminum	None
430 Stainless steel	None
302 Stainless steel	None
Brass	None
RC-70 Titanium	None
41042-T Titanium	None
4130 Low alloy steel	None
Nickel plate on 4130 steel	None
Chromium plate on 4130 steel	None

TABLE VII

CALCULATED FLAMMABILITY LIMITS OF JP-5 FUEL IN AIR

	Volume Percent		Fuel-Air Ratio	
	Lean	Rich	Lean	Rich
Minimum volitility	0.57	4.38	0.035	0.28
Average volitility	0.060	4.53	0.035	0.28
Maximum volitility	0.62	4.68	0.035	0.28

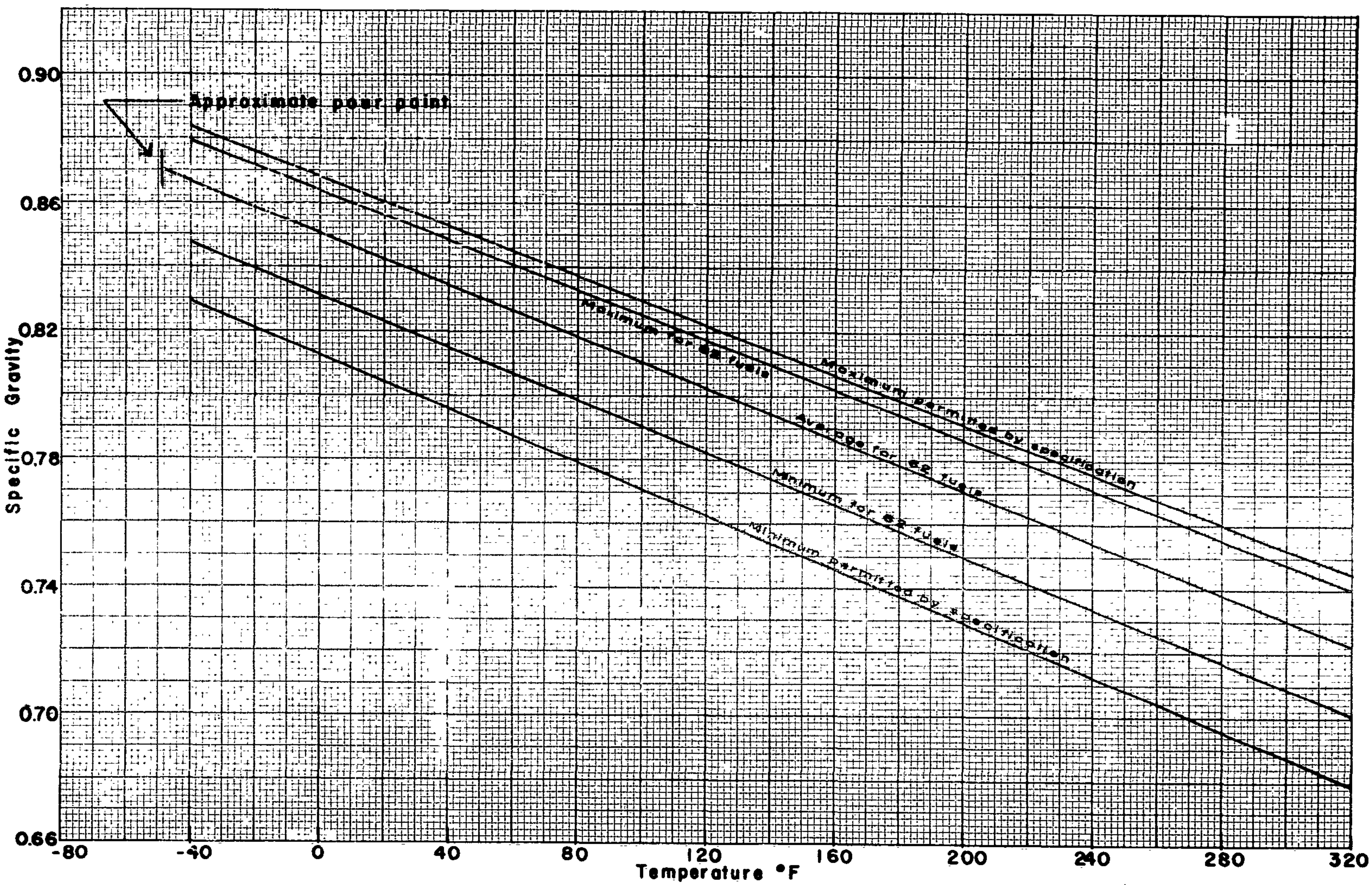

Figure 1—Variation of specific gravity with temperature of MIL-F-5624C (JP-5) Fuel. (Ref. 1)

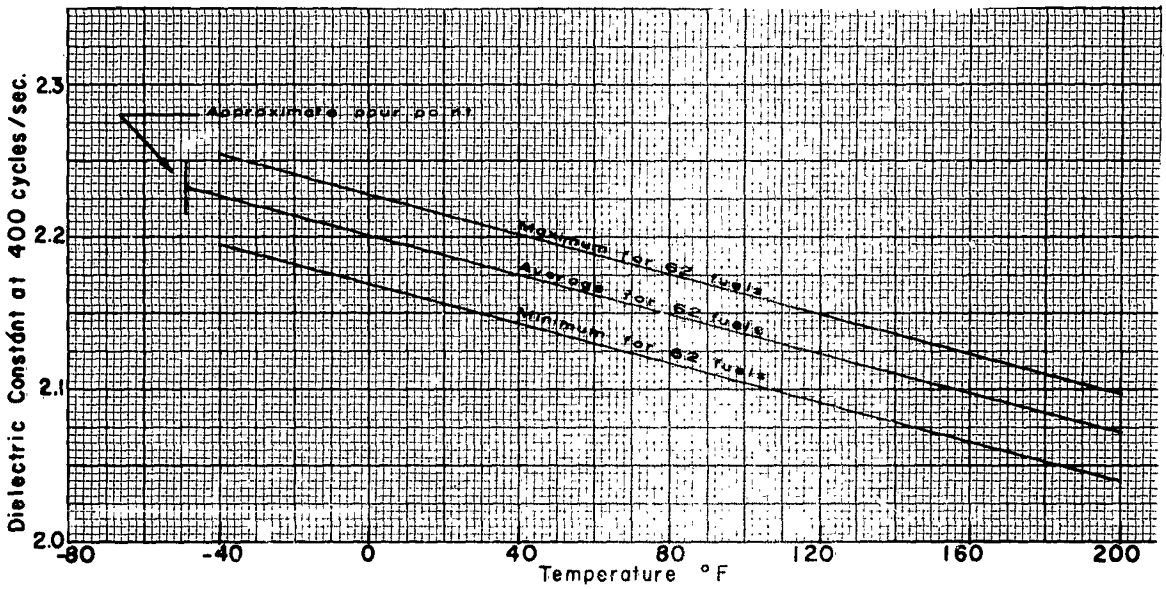

Figure 2—Variation of dielectric constant with temperature of MIL-F-5624C (JP-5) fuel. (Ref. 1)

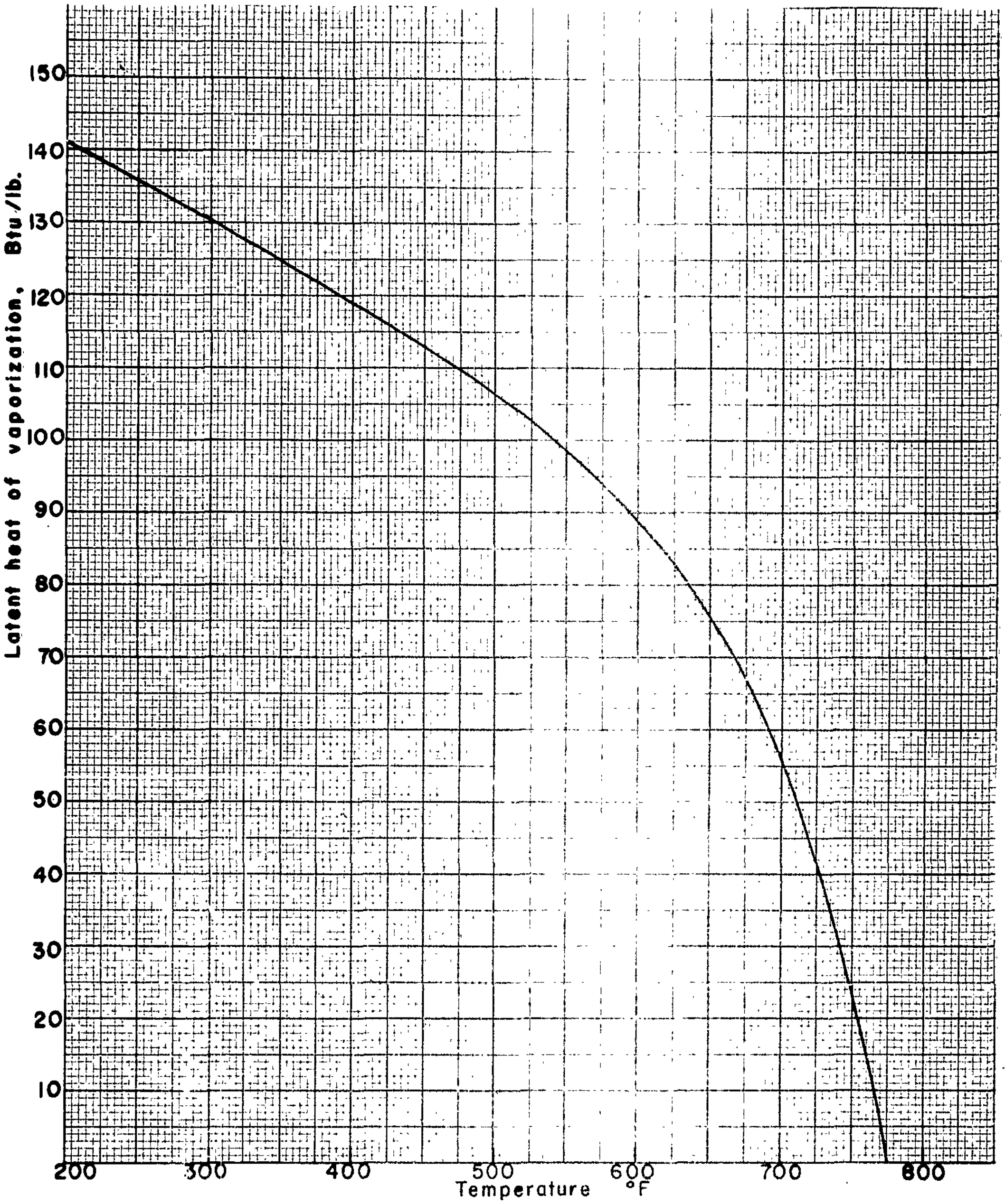

Figure 3—Variation of latent heat of vaporization with temperature of MIL-F-5624C (JP-5) fuel (Ref. 1)

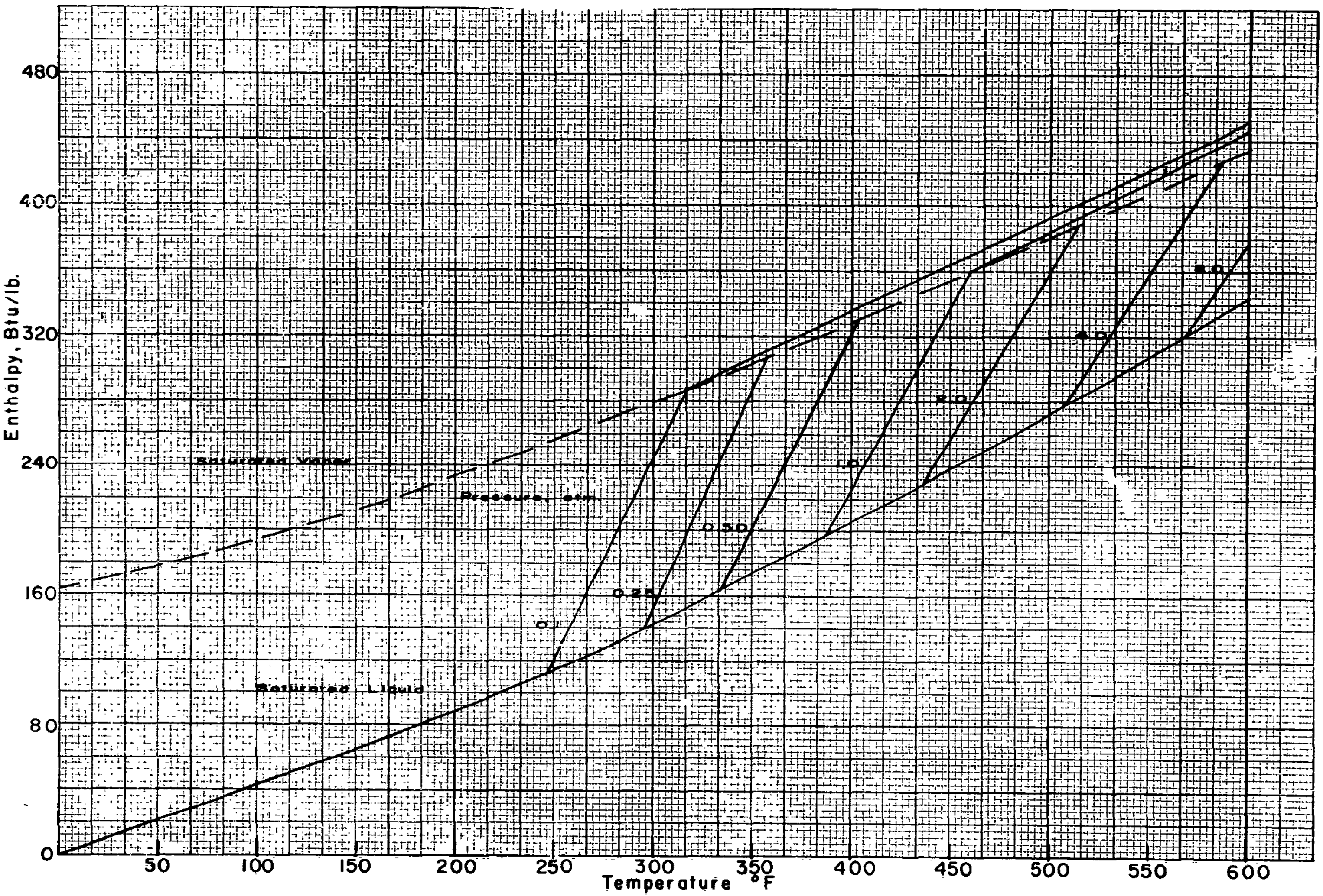

Figure 4—Enthalpy diagram for average quality of MIL-F-5624C (JP-5) fuel (Ref. 1)

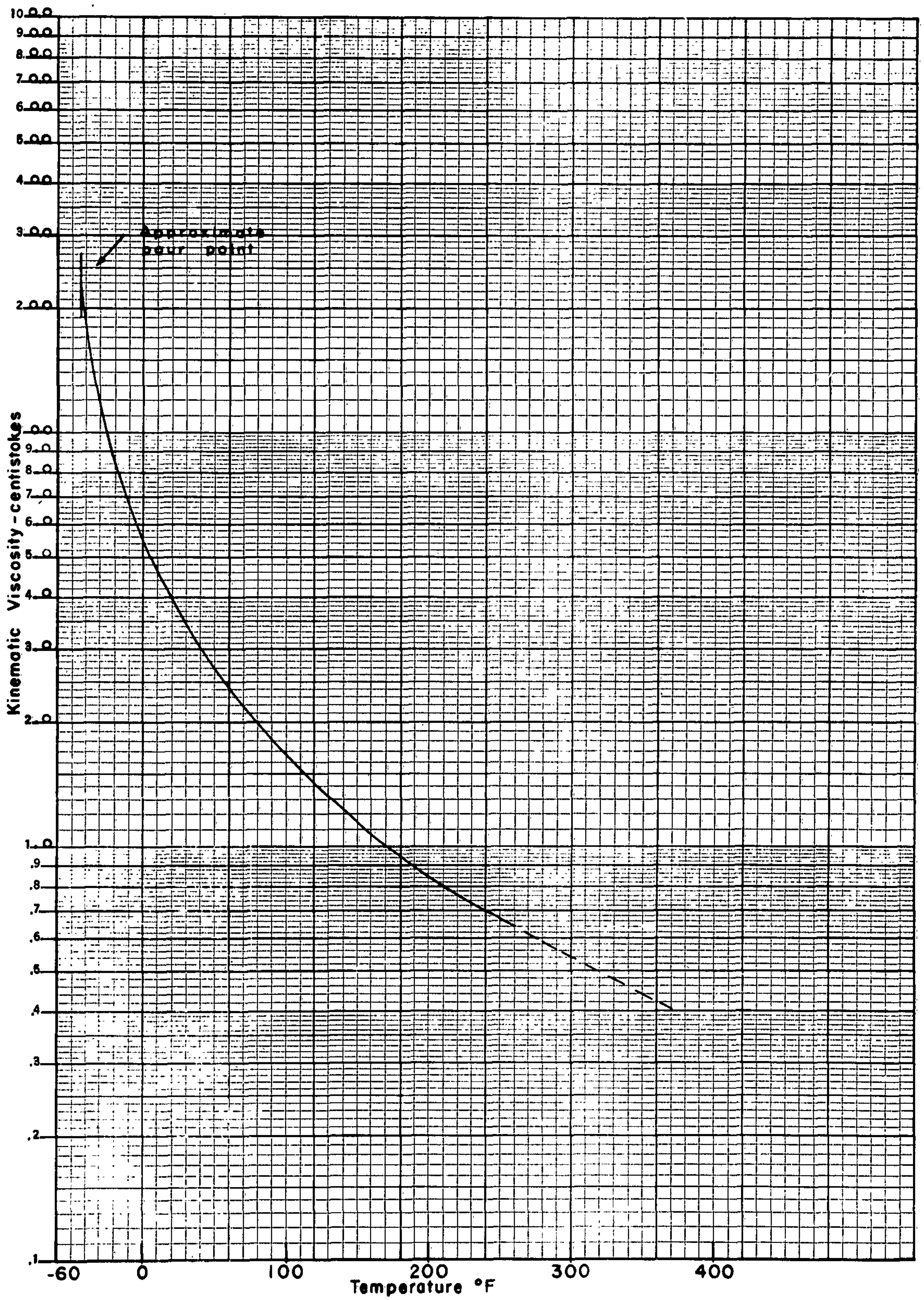

Figure 5—Viscosity - temperature relation of MIL-F-5624C (JP-5) fuel. (Ref. 1)

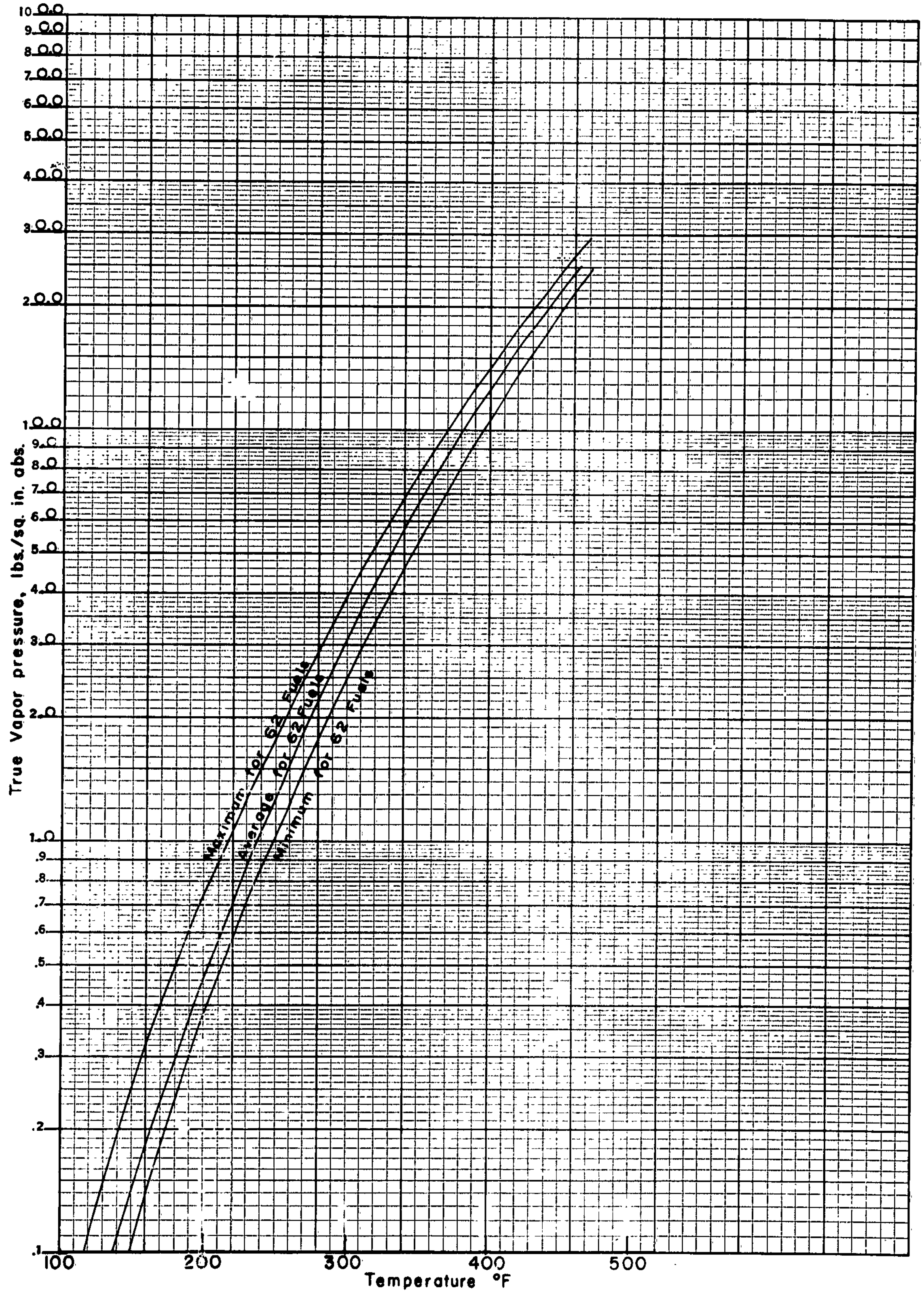

Figure 6 — Variation of vapor pressure with temperature of MIL-F-5624C (JP-5) Fuel. (Ref. 1)

APPENDIX

MIL-F-5624C
18 MAY 1955
Superseding
MIL-F-5624B
7 December 1953

MILITARY SPECIFICATION

FUEL, AIRCRAFT TURBINE AND JET ENGINE
GRADES JP-3, JP-4, AND JP-5

This specification has been approved by the Department of Defense for use of the Departments of the Army, the Navy, and the Air Force.

1. SCOPE

1.1 Scope.- This specification covers aircraft turbine and jet engine fuels.

1.2 Classification.- Engine fuels shall be of the following grades, as specified (see 6.2.):

Grade	NATO symbol	Description
JP-3	None	High vapor pressure type
JP-4	F-40	Low vapor pressure type (NATO description: wide-cut, gasoline type)
JP-5	F-42	High flash-point kerosene type

2. APPLICABLE DOCUMENTS

2.1 The following specifications and standard, of the issue in effect on date of invitation for bids, form a part of this specification to the extent specified herein:

SPECIFICATIONS

Federal

VV-L-791	Lubricants, Liquid Fuels, and Related Products; Methods of Inspection, Sampling, and Testing
PPP-D-729	Drums: Metal, 55-Gallons (for Shipment of Noncorrosive Materials)

Military

MIL-I-25017	Inhibitor, Corrosion, for Aircraft Engine Fuels

STANDARDS

MIL-STD-129	Marking for Shipment and Storage

(Copies of specifications, standards, drawings, and publications required by contractors 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 document forms a part of this specification. Unless otherwise indicated, the issue in effect on date of invitation for bids shall apply.

Interstate Commerce Commission

49 CFR 71-78 Interstate Commerce Commission Rules and Regulations for the Transportation of Explosives and other Dangerous Articles

(The Interstate Commerce Commission Regulations are now a part of the Code of Federal Regulations (1949 Edition Revised 1950) available from the Superintendent of Documents, Government Printing Office, Washington 25, D. C. Orders for the above publication should cite "49 CFR 71-78 (Rev. 1950)."

3. REQUIREMENTS

3.1 Material.- The fuel shall consist completely of hydrocarbon compounds except as otherwise specified herein, or as duly approved by the military service for whom the material is procured.

3.2 Chemical and physical requirements.- The chemical and physical requirements of the fuel shall conform to those listed in table I when tested in accordance with the applicable test methods specified therein.

3.2.1 Corrosion.- There shall be no evidence of corrosion and not more than a slight tarnish of the copper strip when tested in accordance with the procedure outlined in 4.3.2.2.

3.2.2 Water reaction.- The fuel shall separate sharply from the water layer, and there shall be no evidence of an emulsion, precipitate, or suspended matter, within or upon either layer. Neither layer shall have changed in volume by more than 1 milliliter.

3.2.3 Heat of combustion.- The heat of combustion determination may be waived at the option of the Inspector if the aniline-gravity product of the fuel is not less than 5,250 for grades JP-3 and JP-4, or not less than 4,500 for grade JP-5. The aniline-gravity product is defined as the product of the gravity of the fuel in degrees API and the aniline point of the fuel in degrees Fahrenheit, as determined by Method 3601 of Specification VV-L-791, entitled "Aniline point and mixed aniline point."

NOTE: Method B (U-Tube) of test Method 3601 entitled "Aniline point and mixed aniline point" in Specification VV-L-791 will be used for Referee tests.

3.2.4 Smoke volatility index.- The smoke volatility index shall be computed from the following equation:

$$\text{S.V.I.} = \text{S.P.} + \left[0.42 \times \text{Volume percent boiling under } 400^\circ\text{F } (204.4^\circ\text{C})\right]$$

Where:

S.V.I. = Smoke volatility index
S.P. = Smoke point in millimeters as determined by Method 2107 of Specification VV-L-791

TABLE I Chemical and physical requirements and test methods

Requirements	Fuel: Grade JP-3 NATO symbol - none	Fuel: Grade JP-4 NATO symbol F-40	Fuel: Grade JP-5 NATO symbol F-42	Test method: Specification VV-L-791
Distillation:				1001 1/
Initial boiling point	2/	2/	2/	
Fuel evaporated, 10 percent min at	2/	2/	400°F (204.4°C)	
Fuel evaporated, 20 percent min at	240°F (115.6°C)	290°F (143.3°C)	2/	
Fuel evaporated, 50 percent min at	350°F (176.7°C)	370°F (187.8°C)	2/	
Fuel evaporated, 90 percent min at	470°F (243.3°C)	470°F (243.3°C)	2/	
End point	2/	2/	550°F (287.8°C)	
Percent evaporated @ 400°F (204.4°C)	2/	2/		
Residue, vol percent max	1-1/2	1-1/2	1-1/2	
Distillation loss, vol percent max	1-1/2	1-1/2	1-1/2	
Gravity °API - min (specific gravity, max)	50.0 (0.780)	45.0 (0.802)	36.0 (0.845)	401
Gravity °API - max (specific gravity, min)	60.0 (0.739)	57.0 (0.751)	48.0 (0.788)	401
Existent gum, mg/100 ml, max	7	7	7	3302
Potential gum, mg/100 ml, max	14	14	14	3354 or 3355 3/
Sulfur, total, percent wt max	0.4	0.4	0.4	5201 4/
Mercaptan - sulfur percent wt max 5/	0.005	0.005	0.005	5204
Reid vapor pressure, psi, min (gm/cm^2, min)	5.0 (351.6)	2.0 (140.6)		1201
Reid vapor pressure, psi, max (gm/cm^2, max)	7.0 (492.2)	3.0 (210.9)		1201
Freezing point, °F, max	-76	-76	-40	1411
Thermal value (see 3.2.3)				
Heat of combustion (lower or net) BTU/lb min	18,400	18,400	18,300	2502
or Aniline-gravity product, min	5,250	5,250	4,500	3601
Viscosity, centistokes at -30°F(-34.4°C), max			16.5	305
Aromatics, vol percent max	25.0	25.0	25.0	3703
Olefins, vol percent max 6/	5.0	5.0	5.0	3703
Smoke point, mm min	2/	2/	20.0	2107 7/
Explosiveness, percent max			50	1151
Smoke Volatility index, min (see 3.2.4)	54.0	54.0		
Corrosion	(see 3.2.1)	(see 3.2.1)	(see 3.2.1)	5313 8/
Water reaction	(see 3.2.2)	(see 3.2.2)	(see 3.2.2)	3251
Flash point, min			140°F (60.0°C)	1102

1/ See 4.3.2.1 for exception to Method 1001 of Specification VV-L-791.
2/ To be reported - not limited.
3/ When conducting Referee test, Method 3354 will be used. In either test, the aging period shall be 16 hours.
4/ Either volumetric or gravimetric method may be used, except that the gravimetric method will be used for Referee test.
5/ The mercaptan-sulfur determination may be waived at the option of the Inspector if the fuel is considered "sweet," when tested in accordance with Method 5203 of Specification VV-L-791.
6/ May be reported as Bromine Number when specified by the military service for whom the material is procured. (Maximum 5.0 when tested by Method 3701 of Specification VV-L-791.)
7/ See 4.3.2.3 for exception to Method 2107 of Specification VV-L-791.
8/ See 4.3.2.2 for exception to Method 5313 of Specification VV-L-791.

3.3 Additives.- The additives listed herein may be used singly or in combination, in amounts not to exceed those specified.

3.3.1 Anti-oxidants.- The following active inhibitors may be added separately or in combination to the fuel in total concentration not in excess of 8.4 pounds of inhibitor (not including weight of solvent) per 1,000 barrels of fuel (9.1 gm/100 US gal, 24 mg/liter or 109 mg/imp. gal) in order to prevent the formation of gum:

(a) 2,6-ditertiary butyl 4-methyl phenol
(b) N,N' Disecondary butyl paraphenylenediamine
(c) 2,4-dimethyl-6 tertiary-butylphenol

3.3.2 Metal deactivator.- A metal deactivator, N,N'-disalicylidene-1, 2-propanediamine, - may be added in an amount not to exceed 2 pounds of active ingredient per 1,000 barrels of fuel (2.2 gm/100 US gal, 3.7 mg/liter or 26 mg/imp. gal.)

3.3.3 Corrosion inhibitor.- An approved corrosion inhibitor shall be added. The corrosion inhibitor which shall be furnished under this specification shall be a product which has been tested and has passed the Qualification tests as specified in Specification MIL-I-25017. The amount added shall be as listed in QPL-25017 (latest revision). The contractor shall maintain and, upon request, shall make available to the Government, evidence that all inhibitor products used are equal in every respect to the product qualified under Specification MIL-I-25017.

3.4 Containers.- The fuel shall be delivered in bulk or packaged as specified by the procuring activity. When 55-gallon drums are used, they shall be in accordance with Specification PPP-D-729. (See 5.2 and 6.2.)

3.5 Workmanship.- The fuel shall be free from undissolved water, sediment, and suspended matter. No substances of known dangerous toxicity under usual conditions of handling and use shall be added except as specified herein.

4. QUALITY ASSURANCE PROVISIONS

4.1 General.- All the tests required herein for the testing of fuels are classified as Acceptance tests, for which necessary sampling techniques and methods of testing are specified in this section.

4.2 Sampling.- Sampling shall be in accordance with Specification VV-L-791.

4.2.1 When required, a 1-gallon sample, taken in accordance with Specification VV-L-791, shall be forwarded to the laboratory designated by the procuring activity for subjection to the tests specified herein.

4.3 Tests.-

4.3.1 Examination of product.- Each container of fuel may be examined to determine conformance with this specification.

4.3.2 Testing.- Unless otherwise specified by the military service for whom the material is procured, inspection shall be in accordance with Method 9601 of Specification VV-L-791, entitled "Inspection requirements." Tests as specified in 3.2 shall be conducted in accordance with Specification VV-L-791, using applicable methods as listed in table I, except for the following.

4.3.2.1 Distillation.- The Distillation test shall be conducted in accordance with Method 1001.7, entitled "Distillation of gasoline, naphtha, kerosene, and similar petroleum products," of Specification VV-L-791. The low-range distillation thermometer shall be used, and the board used under the distillation flask shall have an opening 1-1/2 inches in diameter for all grades.

4.3.2.2 Corrosion.- The Corrosion test shall be conducted at nominal 212°F (100°C) using Air-Well bath in accordance with Method 5313, entitled "Free and corrosive sulfur," of Specification VV-L-791, except that the fuel sample shall not be dried as specified in 6.2 of Method 5313, entitled "Tests at nominal 212°F (100°C)."

4.3.2.3 Smoke point.- The Smoke point test shall be conducted in accordance with Method 2107, entitled "Smoke point," of Specification VV-L-791, except that paragraph 8(b) shall read: "Reproducibility.- Results obtained in different laboratories should not differ from each other by more than 10 percent of the Mean smoke point."

4.3.2.4 Water reaction.- The Water reaction test shall be conducted in accordance with Method 3251, entitled "Water tolerances of aircraft fuels" of Specification VV-L-791. In addition, the following procedures shall be observed:

(a) The sample will be allowed to settle undisturbed on a vibration-free surface for a maximum period of 5 minutes.
(b) The sample will not be swirled during or at the end of the 2-minute agitation period.

4.4 Rejection and retest.- Material not conforming to the requirements of this specification shall be rejected. Rejected material shall not be resubmitted without furnishing full particulars concerning previous rejection and measures taken to overcome defects.

5. PREPARATION FOR DELIVERY

5.1 Application.- The requirements of Section 5 apply only to direct purchases by or direct shipments to the Government.

5.2 Packaging and packing.- The 55-gallon drums do not require any overpacking for domestic and overseas shipment. (See 3.4.)

5.3 Marking of shipments.- Shipping containers shall be marked in accordance with Standard MIL-STD-129. The nomenclature shall be as follows: Fuel, Aircraft, Turbine and Jet Engine, Grade _*_, Specification MIL-F-5624C. In addition, the information required by Code of Federal Regulations 49CFR 71-78 shall appear on each individual container and on all shipping containers.

*Insert applicable Grade and NATO symbol.

6. NOTES

6.1 Intended use.- The fuel covered by this specification is intended for use in aircraft engines other than reciprocating types.

6.2 Ordering data.- Requisitions, contracts, or orders should specify the following:

(a) Grade of fuel required. (See 1.2 and 5.3.)
(b) Size of container desired. (See 3.4.)
(c) Whether fuel is to be packaged and packed for overseas shipment. (See 5.2.)

6.2.1 The material will be purchased by volume, the unit being a US gallon at 60°F (15.5°C).

6.3 Definitions.-

6.3.1 Barrel.- A barrel as specified herein will contain 42 US gallons.

6.4 Precautions for mixing inhibitors.- To prevent any possible reaction between the concentrated forms of different corrosion inhibitors, the fuel supplier is cautioned not to commingle corrosion inhibitors prior to their addition to the fuel.

Custodians:
Army - Ordnance Corps
Navy - Bureau of Aeronautics
Air Force

Other interest:
Army - EQT
Navy - Sh