Designation: D 1655 – 07ε1

An American National Standard

Standard Specification for Aviation Turbine Fuels[1]

This standard is issued under the fixed designation D 1655; the number immediately following the designation indicates the year of original adoption or, in the case of revision, the year of last revision. A number in parentheses indicates the year of last reapproval. A superscript epsilon (ε) indicates an editorial change since the last revision or reapproval.

This standard has been approved for use by agencies of the Department of Defense.

ε[1] NOTE—Trademark information was added to the Table 2 footnotes editorially in November 2007.

1. Scope*

1.1 This specification covers the use of purchasing agencies in formulating specifications for purchases of aviation turbine fuel under contract.

1.2 This specification defines specific types of aviation turbine fuel for civil use in the operation and certification of aircraft and describes fuels found satisfactory for the operation of aircraft and engines. The specification can be used as a standard in describing the quality of aviation turbine fuels from the refinery to the aircraft.

1.3 This specification does not include all fuels satisfactory for aviation turbine engines. Certain equipment or conditions of use may permit a wider, or require a narrower, range of characteristics than is shown by this specification.

1.4 Aviation turbine fuels defined by this specification may be used in other than turbine engines that are specifically designed and certified for this fuel.

1.5 This specification no longer includes wide-cut aviation turbine fuel (Jet B). FAA has issued a Special Airworthiness Information Bulletin which now approves the use of Specification D 6615 to replace Specification D 1655 as the specification for Jet B and refers users to this standard for reference.

1.6 The values stated in SI units are to be regarded as standard. No other units of measurement are included in this standard.

2. Referenced Documents

2.1 *ASTM Standards:* [2]

D 56 Test Method for Flash Point by Tag Closed Cup Tester

D 86 Test Method for Distillation of Petroleum Products at Atmospheric Pressure

D 93 Test Methods for Flash Point by Pensky-Martens Closed Cup Tester

D 129 Test Method for Sulfur in Petroleum Products (General Bomb Method)

D 130 Test Method for Corrosiveness to Copper from Petroleum Products by Copper Strip Test

D 156 Test Method for Saybolt Color of Petroleum Products (Saybolt Chromometer Method)

D 240 Test Method for Heat of Combustion of Liquid Hydrocarbon Fuels by Bomb Calorimeter

D 323 Test Method for Vapor Pressure of Petroleum Products (Reid Method)

D 381 Test Method for Gum Content in Fuels by Jet Evaporation

D 445 Test Method for Kinematic Viscosity of Transparent and Opaque Liquids (and Calculation of Dynamic Viscosity)

D 1094 Test Method for Water Reaction of Aviation Fuels

D 1266 Test Method for Sulfur in Petroleum Products (Lamp Method)

D 1298 Test Method for Density, Relative Density (Specific Gravity), or API Gravity of Crude Petroleum and Liquid Petroleum Products by Hydrometer Method

D 1319 Test Method for Hydrocarbon Types in Liquid Petroleum Products by Fluorescent Indicator Adsorption

D 1322 Test Method for Smoke Point of Kerosine and Aviation Turbine Fuel

D 1405 Test Method for Estimation of Net Heat of Combustion of Aviation Fuels

D 1660 Method of Test for Thermal Stability of Aviation Turbine Fuels[3]

D 1840 Test Method for Naphthalene Hydrocarbons in Aviation Turbine Fuels by Ultraviolet Spectrophotometry

D 2276 Test Method for Particulate Contaminant in Aviation Fuel by Line Sampling

D 2386 Test Method for Freezing Point of Aviation Fuels

D 2622 Test Method for Sulfur in Petroleum Products by

[1] This specification is under the jurisdiction of ASTM Committee D02 on Petroleum Products and Lubricants and is the direct responsibility of Subcommittee D02.J0.01 on Jet Fuel Specifications.

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[2] For referenced ASTM standards, visit the ASTM website, www.astm.org, or contact ASTM Customer Service at service@astm.org. For *Annual Book of ASTM Standards* volume information, refer to the standard's Document Summary page on the ASTM website.

[3] Withdrawn.

***A Summary of Changes section appears at the end of this standard.**

Wavelength Dispersive X-ray Fluorescence Spectrometry
D 2624 Test Methods for Electrical Conductivity of Aviation and Distillate Fuels
D 2887 Test Method for Boiling Range Distribution of Petroleum Fractions by Gas Chromatography
D 3120 Test Method for Trace Quantities of Sulfur in Light Liquid Petroleum Hydrocarbons by Oxidative Microcoulometry
D 3227 Test Method for (Thiol Mercaptan) Sulfur in Gasoline, Kerosine, Aviation Turbine, and Distillate Fuels (Potentiometric Method)
D 3240 Test Method for Undissolved Water In Aviation Turbine Fuels
D 3241 Test Method for Thermal Oxidation Stability of Aviation Turbine Fuels (JFTOT Procedure)
D 3242 Test Method for Acidity in Aviation Turbine Fuel
D 3338 Test Method for Estimation of Net Heat of Combustion of Aviation Fuels
D 3343 Test Method for Estimation of Hydrogen Content of Aviation Fuels
D 3701 Test Method for Hydrogen Content of Aviation Turbine Fuels by Low Resolution Nuclear Magnetic Resonance Spectrometry
D 3828 Test Methods for Flash Point by Small Scale Closed Cup Tester
D 3948 Test Method for Determining Water Separation Characteristics of Aviation Turbine Fuels by Portable Separometer
D 4052 Test Method for Density and Relative Density of Liquids by Digital Density Meter
D 4057 Practice for Manual Sampling of Petroleum and Petroleum Products
D 4171 Specification for Fuel System Icing Inhibitors
D 4176 Test Method for Free Water and Particulate Contamination in Distillate Fuels (Visual Inspection Procedures)
D 4294 Test Method for Sulfur in Petroleum and Petroleum Products by Energy-Dispersive X-ray Fluorescence Spectrometry
D 4306 Practice for Aviation Fuel Sample Containers for Tests Affected by Trace Contamination
D 4529 Test Method for Estimation of Net Heat of Combustion of Aviation Fuels
D 4809 Test Method for Heat of Combustion of Liquid Hydrocarbon Fuels by Bomb Calorimeter (Precision Method)
D 4865 Guide for Generation and Dissipation of Static Electricity in Petroleum Fuel Systems
D 4952 Test Method for Qualitative Analysis for Active Sulfur Species in Fuels and Solvents (Doctor Test)
D 4953 Test Method for Vapor Pressure of Gasoline and Gasoline-Oxygenate Blends (Dry Method)
D 5001 Test Method for Measurement of Lubricity of Aviation Turbine Fuels by the Ball-on-Cylinder Lubricity Evaluator (BOCLE)
D 5006 Test Method for Measurement of Fuel System Icing Inhibitors (Ether Type) in Aviation Fuels
D 5190 Test Method for Vapor Pressure of Petroleum Products (Automatic Method)
D 5191 Test Method for Vapor Pressure of Petroleum Products (Mini Method)
D 5452 Test Method for Particulate Contamination in Aviation Fuels by Laboratory Filtration
D 5453 Test Method for Determination of Total Sulfur in Light Hydrocarbons, Spark Ignition Engine Fuel, Diesel Engine Fuel, and Engine Oil by Ultraviolet Fluorescence
D 5972 Test Method for Freezing Point of Aviation Fuels (Automatic Phase Transition Method)
D 6045 Test Method for Color of Petroleum Products by the Automatic Tristimulus Method
D 6379 Test Method for Determination of Aromatic Hydrocarbon Types in Aviation Fuels and Petroleum Distillates—High Performance Liquid Chromatography Method with Refractive Index Detection
D 6469 Guide for Microbial Contamination in Fuels and Fuel Systems
D 6615 Specification for Jet B Wide-Cut Aviation Turbine Fuel
D 7153 Test Method for Freezing Point of Aviation Fuels (Automatic Laser Method)
D 7154 Test Method for Freezing Point of Aviation Fuels (Automatic Fiber Optical Method)
E 29 Practice for Using Significant Digits in Test Data to Determine Conformance with Specifications

2.2 *Energy Institute Standards:*[4]
IP 225 Copper Content of Aviation Turbine Fuel
IP 227 Silver Corrosion of Aviation Turbine Fuel
IP 540 Determination of the existent gum content of aviation turbine fuel — Jet evaporation method

2.3 *ANSI Standard:*[5]
ANSI 863 Report of Test Results

2.4 *Other Standard:*[6]
Defence Standard 91-91 Issue 5 (DERD 2494) Turbine Fuel, Aviation Kerosine Type, Jet A-1

3. General

3.1 This specification, unless otherwise provided, prescribes the required properties of aviation turbine fuel at the time and place of delivery.

4. Classification

4.1 Two types of aviation turbine fuels are provided, as follows:

4.1.1 *Jet A and Jet A-1*—Relatively high flash point distillates of the kerosine type.

4.2 Jet A and Jet A-1 represent two grades of kerosine fuel that differ in freezing point. Other grades would be suitably identified.

[4] Available from Energy Institute, 61 New Cavendish St., London, WIG 7AR, U.K.
[5] Available from American National Standards Institute (ANSI), 25 W. 43rd St., 4th Floor, New York, NY 10036.
[6] Available from Procurement Executive DFS (Air), Ministry of Defence, St. Giles Court 1, St. Giles High St., London WC2H 8LD.

4.3 This specification previously cited the requirements for Jet B. Requirements for Jet B fuel now appear in Specification D 6615.

5. Materials and Manufacture

5.1 Aviation turbine fuel, except as otherwise specified in this specification, shall consist of refined hydrocarbons derived from conventional sources including crude oil, natural gas liquid condensates, heavy oil, shale oil, and oil sands. The use of jet fuel blends, containing components from other sources, are only permitted on a specific, individual basis (see Annex A1).

5.1.1 Fuels used in certified engines and aircraft are ultimately approved by the certifying authority subsequent to formal submission of evidence to the authority as part of the type certification program for that aircraft and engine model. Additives to be used as supplements to an approved fuel must also be similarly approved on an individual basis (see X1.2.4 and X1.10.1).

5.2 *Additives*—May be added to each type of aviation turbine fuel in the amount and of the composition specified in Table 2 or the following list of approved material:[7]

5.2.1 Other additives are permitted under 5.1 and 7.1. These include fuel system icing inhibitor, other antioxidants, inhibitors, and special purpose additives. The quantities and types must be declared by the fuel supplier and agreed to by the purchaser. Only additives approved by the aircraft certifying authority are permitted in the fuel on which an aircraft is operated.

5.2.1.1 Biocidal additives are available for controlled usage. Where such an additive is used in the fuel, the approval status of the additive and associated conditions must be checked for the specific aircraft and engines to be operated.

5.2.1.2 *Fuel System Icing Inhibitor*:

(1) Diethylene Glycol Monomethyl Ether (DiEGME), conforming to the requirements of Specification D 4171, Type III, may be used in concentrations of 0.10 to 0.15 volume %.

(2) Test Method D 5006 may be used to determine the concentration of DiEGME in aviation fuels.

5.3 Guidance material is presented in Appendix X2 concerning the need to control processing additives in jet fuel production.

6. Detailed Requirements

6.1 The aviation turbine fuel shall conform to the requirements prescribed in Table 1.

6.2 Test results shall not exceed the maximum or be less than the minimum values specified in Table 1. No allowance shall be made for the precision of the test methods. To determine conformance to the specification requirement, a test result may be rounded to the same number of significant figures as in Table 1 using Practice E 29. Where multiple determinations are made, the average result, rounded in accordance with Practice E 29, shall be used.

7. Workmanship, Finish and Appearance

7.1 The aviation turbine fuel specified in this specification shall be visually free of undissolved water, sediment, and suspended matter. The odor of the fuel shall not be nauseating or irritating. No substance of known dangerous toxicity under usual conditions of handling and use shall be present, except as permitted in this specification.

8. Sampling

8.1 Because of the importance of proper sampling procedures in establishing fuel quality, use the appropriate procedures in Practice D 4057.

8.2 A number of jet fuel properties, including thermal stability, water separation, electrical conductivity, and others, are very sensitive to trace contamination, which can originate from sample containers. For recommended sample containers, refer to Practice D 4306.

9. Report

9.1 The type and number of reports to ensure conformance with the requirements of this specification shall be mutually agreed upon by the seller and the purchaser of the aviation turbine fuel.

9.2 A suggested form for reporting inspection data on aviation turbine fuels is given in Appendix X3.

10. Test Methods

10.1 Determine the requirements enumerated in this specification in accordance with the following ASTM test methods.

10.1.1 *Density*—Test Method D 1298 or D 4052.

10.1.2 *Distillation*—Test Method D 86. For Jet A and Jet A-1, Test Method D 2887 can be used as an alternate with the limits listed in Table 1. In case of dispute, Test Method D 86 shall be the referee method (see X1.6.1.1).

10.1.3 *Flash Point*—Test Method D 56 or D 3828.

10.1.4 *Freezing Point*—Test Method D 5972, D 7153, D 7154, or D 2386. Test Methods D 5972 and D 7153 are the referee methods. An interlaboratory study (RR: D02–1572[8]) that evaluated the ability of freezing point methods to detect jet fuel contamination by diesel fuel determined that Test Methods D 5972 and D 7153 provided significantly more consistent detection of freeze point changes caused by contamination than Test Methods D 2386 and D 7154.

10.1.5 *Viscosity*—Test Method D 445.

10.1.6 *Net Heat of Combustion*—Test Method D 4529, D 3338, or D 4809.

10.1.7 *Corrosion (Copper Strip)*—Test Method D 130.

10.1.8 *Total Acidity*—Test Method D 3242.

10.1.9 *Sulfur*—Test Method D 1266, D 2622, D 4294, or D 5453.

10.1.10 *Mercaptan Sulfur*—Test Method D 3227.

10.1.11 *Water Reaction*—Test Method D 1094.

10.1.12 *Existent Gum*—Test Method D 381 or IP 540. Test Method D 381, using steam jet operating conditions, shall be the referee test method.

[7] Supporting data (Guidelines for Approval or Disapproval of Additives) have been filed at ASTM International Headquarters and may be obtained by requesting Research Report RR: D02-1125.

[8] Supporting data have been filed at ASTM International Headquarters and may be obtained by requesting Research Report RR: D02–1572.

TABLE 1 Detailed Requirements of Aviation Turbine Fuels[A]

Property		Jet A or Jet A-1	ASTM Test Method[B]
COMPOSITION			
Acidity, total mg KOH/g	max	0.10	D 3242
1. Aromatics, vol %	max	25	D 1319
2. Aromatics, vol %	max	26.5	D 6379
Sulfur, mercaptan,[C] mass %	max	0.003	D 3227
Sulfur, total mass %	max	0.30	D 1266, D 2622, D 4294, or D 5453
VOLATILITY			
Distillation: one of the following requirements shall be met.			
1. Physical Distillation			D 86[D]
Distillation temperature, °C:			
10 % recovered, temperature	max	205	
50 % recovered, temperature		report	
90 % recovered, temperature		report	
Final boiling point, temperature	max	300	
Distillation residue, %	max	1.5	
Distillation loss, %	max	1.5	
2. Simulated Distillation			D 2887
Distillation temperature, °C			
10% recovered, temperature	max	185	
50 % recovered, temperature		report	
90 % recovered, temperature		report	
Final boiling point, temperature	max	340	
Flash point, °C	min	38[E]	D 56 or D 3828[F]
Density at 15°C, kg/m^3		775 to 840	D 1298 or D 4052
FLUIDITY			
Freezing point, °C	max	–40 Jet A[G] –47 Jet A-1[G]	D 5972, D 7153, D 7154, or D 2386
Viscosity –20°C, mm^2/s[H]	max	8.0	D 445
COMBUSTION			
Net heat of combustion, MJ/kg	min	42.8[I]	D 4529, D 3338, or D 4809
One of the following requirements shall be met:			
(*1*) Smoke point, mm, or	min	25	D 1322
(*2*) Smoke point, mm, and	min	18	D 1322
Naphthalenes, vol, %	max	3.0	D 1840
CORROSION			
Copper strip, 2 h at 100°C	max	No. 1	D 130
THERMAL STABILITY			
JFTOT (2.5 h at control temperature of 260°C min)			
Filter pressure drop, mm Hg	max	25[J]	D 3241
Tube deposits less than		3[K] No *Peacock* or *Abnormal* Color Deposits	
CONTAMINANTS			
Existent gum, mg/100 mL	max	7	D 381, IP 540
Microseparometer,[L] Rating			D 3948
Without electrical conductivity additive	min	85	
With electrical conductivity additive	min	70	
ADDITIVES		See 5.2	
Electrical conductivity, pS/m		[M]	D 2624

[A] For compliance of test results against the requirements of Table 1, see 6.2.
[B] The test methods indicated in this table are referred to in Section 10.
[C] The mercaptan sulfur determination may be waived if the fuel is considered sweet by the doctor test described in Test Method D 4952.
[D] D 86 distillation of jet fuel is run at Group 4 conditions, except Group 3 condenser temperature is used.
[E] A higher minimum flash point specification may be agreed upon between purchaser and supplier.
[F] Results obtained by Test Methods D 3828 may be up to 2°C lower than those obtained by Test Method D 56, which is the preferred method. In case of dispute, Test Method D 56 will apply.
[G] Other freezing points may be agreed upon between supplier and purchaser.
[H] 1 mm^2/s = 1 cSt.
[I] For all grades use either Eq 1 or Table 1 in Test Method D 4529 or Eq 2 in Test Method D 3338. Test Method D 4809 may be used as an alternative. In case of dispute, Test Method D 4809 shall be used.
[J] Preferred SI units are 3.3 kPa, max.
[K] Tube deposit ratings shall always be reported by the Visual Method; a rating by the Tube Deposit Rating (TDR) optical density method is desirable but not mandatory.
[L] At point of manufacture.
[M] If electrical conductivity additive is used, the conductivity shall not exceed 600 pS/m at the point of use of the fuel. When electrical conductivity additive is specified by the purchaser, the conductivity shall be 50 to 600 pS/m under the conditions at point of delivery.

$$1\ \text{pS/m} = 1 \times 10^{-12}\ \Omega^{-1}\ m^{-1}$$

TABLE 2 Detailed Requirements for Additives in Aviation Turbine Fuels

Additive	Dosage
Fuel Performance Enhancing Additives	
Antioxidants[A,B]	24.0 mg/L max[C]
One of the following:	
2,6 ditertiary-butyl phenol	
2,6 ditertiary-butyl-4-methyl phenol	
2,4 dimethyl-6-tertiary-butyl-phenol	
75 % minimum, 2,6 ditertiary-butyl phenol plus 25 % maximum mixed tertiary and tritertiary butyl-phenols	
55 % minimum 2,4 dimethyl-6-tertiary-butyl phenol plus 15 % minimum 2,6 ditertiary-butyl-4-methyl phenol, remainder as monomethyl and dimethyl tertiary-butyl phenols	
72 % minimum 2,4 dimethyl-6-tertiary-butyl phenol plus 28 % maximum monomethyl and dimethyl-tertiary-butyl-phenols	
Metal Deactivator[A]	
N,N-disalicylidene-1,2-propane diamine	
On initial blending	2.0 mg/L max[C,D]
After field reblending cumulative concentration	5.7 mg/L max
Fuel System Icing Inhibitor[E]	0.10 vol % min
Diethylene Glycol Monomethyl Ether (see Specification D 4171)	0.15 vol % max
Fuel Handling and Maintenance Additives	
Electrical Conductivity Improver[F]	
Stadis 450[G]	
On initial blending	3 mg/L max
After field reblending, cumulative concentration	5 mg/L max
If the additive concentration is unknown at time of retreatment, additional concentration is restricted to 2 mg/L max	
Leak Detection Additive	1 mg/kg max
Tracer A (LDTA-A)[H]	
Biocidal Additives[E,I]	
Corrosion Inhibitor/Lubricity Improvers[J]	
One of the following:	
Apollo PRI-19	23 mg/L max
HiTEC 580	23 mg/L max
Octel DCI-4A	23 mg/L max
Nalco 5403	23 mg/L max

[A] The active ingredient of the additive must meet the composition specified.
[B] Supporting data have been filed at ASTM International Headquarters and may be obtained by requesting Research Report RR: D02:1125.
[C] Active ingredient (not including weight of solvent).
[D] If copper contamination is suspected, initial treatment may exceed 2.0 mg/L but cumulative total must be below 5.7 mg/L.
[E] The quantity must be declared by the fuel supplier and agreed to by the purchaser.
[F] If electrical conductivity improver is used, the conductivity shall not exceed 600 pS/m at the point of use of the fuel. When electrical conductivity additive is specified by the purchaser, the conductivity shall be 50 to 600 pS/m under the conditions at point of delivery.

$$1\ \text{pS/m} = 1 \times 10^{-12}\ \Omega^{-1} m^{-1}$$

[G] Stadis 450 is a registered trademark marketed by Innospec Inc., Innospec Manufacturing Park, Oil Sites Road, Ellesmere Port, Cheshire, CH65 4EY, UK.
[H] Tracer A (LDTA-A) is a registered trademark of Tracer Research Corp., 3755 N. Business Center Dr., Tucson, AZ 85705.
[I] Biocidal additives are available for controlled usage. Where such an additive is used in the fuel, the approval status of the additive and associated conditions must be checked for the specific aircraft and engines to be operated.
[J] More information concerning minimum treat rates of corrosion inhibitor/lubricity improver additives is contained in X1.10.2.

10.1.13 *Thermal Stability*—Test Method D 3241.

10.1.14 *Aromatics*—Test Method D 1319 or D 6379. Test Method D 1319 shall be the referee test method.

10.1.15 *Smoke Point*—Test Method D 1322.

10.1.16 *Naphthalene Content*—Test Method D 1840.

10.1.17 *Electrical Conductivity*—Test Method D 2624.

11. Keywords

11.1 aviation turbine fuel; avtur; Jet A; Jet A-1; jet fuel; turbine fuel

ANNEX

(Mandatory Information)

A1. FUELS FROM NON-CONVENTIONAL SOURCES

A1.1 Introduction

A1.1.1 Jet fuels containing synthetic hydrocarbons have been previously allowed under Specification D 1655. However, the fraction of these hydrocarbons was not limited, and there were no requirements or restrictions placed on either these hydrocarbons or the final blend. It has been recognized that synthetic blends represent a potential departure from experience and from key assumptions on which the fuel property requirements defined in Table 1 have been based.

A1.1.2 The longer-term strategy is to revise Specification D 1655 to fully encompass fuels from non-conventional sources, but this has yet to be defined. As an interim solution, it has been deemed necessary to recognize, on an individual basis, fuels from non-conventional sources whose performance complies with the intent of this specification.

A1.2 *Acceptable Fuels from Non-Conventional Sources*—The SASOL semi-synthetic fuel, a blend of conventionally produced kerosine and a synthetic kerosine and specified in Defence Standard 91-91/Issue 5, dated Feb. 8, 2005, is recognized as meeting the requirements of Specification D 1655.

APPENDIXES

(Nonmandatory Information)

X1. PERFORMANCE CHARACTERISTICS OF AVIATION TURBINE FUELS

X1.1 Introduction

X1.1.1 This appendix describes the performance characteristics of aviation turbine fuels. A more detailed discussion of the individual test methods and their significance is found in ASTM Manual No. 1.[9] Additional information on aviation turbine fuel and its properties is found in ASTM's MNL 37, *Fuels and Lubricants Handbook: Technology, Properties, Performance, and Testing*[10] and the *Handbook of Aviation Fuel Properties*.[11]

X1.2 Significance and Use

X1.2.1 Specification D 1655 defines two grades of jet fuel for civil use. Limiting values for the two grades of fuel covered are placed on fuel properties believed to be related to the performance of the aircraft and engines in which they are most commonly used.

X1.2.2 The safe and economical operation of aircraft requires fuel that is essentially clean and dry and free of any contamination prior to use. It is possible to measure a number of jet fuel characteristics related to quality.

X1.2.3 The significance of standard tests for fuel properties may be summarized for convenience in terms of the technical relationships with performance characteristics as shown in Table X1.1.

X1.2.4 The acceptability of additives for use must ultimately be determined by the engine and aircraft type certificate holder and must be approved by his certifying authority. In the United States of America, the certifying authority is the Federal Aviation Administration.

X1.3 Thermal Stability

X1.3.1 Stability to oxidation and polymerization at the operating temperatures encountered in certain jet aircraft is an important performance requirement. The thermal stability measurements are related to the amount of deposits formed in the engine fuel system on heating the fuel in a jet aircraft. Commercial jet fuels should be thermally stable at a fuel temperature as high as 163°C (325°F). Such fuels have been demonstrated to have inherent storage stability.

X1.3.2 In 1973, Test Method D 3241, JFTOT, replaced Method of Test D 1660, known as the ASTM Coker, for the determination of oxidative thermal stability. (See CRC Report 450, dated 1969 and revised in 1972. See also Bert and Painter's SAE paper 730385.[12]). Today, a single pass/fail run with the tube temperature controlled at 260°C is used to ensure compliance with the specification minimum requirements. For a more complete characterization of a fuel's thermal stability, a *breakpoint* can be obtained. The breakpoint is the highest tube temperature at which the fuel still passes the specification requirements of tube deposit color and pressure differential. Normally, obtaining a breakpoint requires two or more runs at differing tube temperatures. Breakpoints are therefore not used for quality control, but they serve mostly for research purposes.

[9] *Manual on Significance of Tests for Petroleum Products* , MNL 1, ASTM International, 2003.

[10] MNL 37, *Fuels and Lubricants Handbook: Technology, Properties, Performance, and Testing*, Eds., Totten, George E., Westbrook, Steven R., and Shah, Rajesh J., ASTM International, W. Conshohocken, PA, 2003.

[11] *Handbook of Aviation Fuel Properties*, Third Edition, *CRC Report 635*, Coordinating Research Council, Atlanta, GA, 2004.

[12] Bert, J. A., and Painter, L., "A New Fuel Thermal Stability Test (A Summary of Coordinating Research Council Activity)," SAE Paper 730385, Society of Automotive Engineers, Warrendale, PA, 1973.