



Space systems — Fluid characteristics, sampling and test methods —

Part 8: Kerosene propellant

*Systèmes spatiaux — Caractéristiques des fluides, échantillonnage et méthodes d'essai —
Partie 8: Kérosène (carburant)*

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Foreword

ISO (the International Organization for Standardization) is a worldwide federation of national standards bodies (ISO member bodies). The work of preparing International Standards is normally carried out through ISO technical committees. Each member body interested in a subject for which a technical committee has been established has the right to be represented on that committee. International organizations, governmental and non-governmental, in liaison with ISO, also take part in the work. ISO collaborates closely with the International Electrotechnical Commission (IEC) on all matters of electrotechnical standardization.

International Standards are drafted in accordance with the rules given in the ISO/IEC Directives, Part 3.

The main task of technical committees is to prepare International Standards. Draft International Standards adopted by the technical committees are circulated to the member bodies for voting. Publication as an International Standard requires approval by at least 75 % of the member bodies casting a vote.

Attention is drawn to the possibility that some of the elements of this part of ISO 15859 may be the subject of patent rights. ISO shall not be held responsible for identifying any or all such patent rights.

ISO 15859-8 was prepared by Technical Committee ISO/TC 20, *Aircraft and space vehicles*, Subcommittee SC 14, *Space systems and operations*.

ISO 15859 consists of the following parts, under the general title *Space systems — Fluid characteristics, sampling, and test methods*:

- *Part 1: Oxygen*
- *Part 2: Hydrogen*
- *Part 3: Nitrogen*
- *Part 4: Helium*
- *Part 5: Nitrogen tetroxide propellants*
- *Part 6: Monomethylhydrazine propellant*
- *Part 7: Hydrazine propellant*
- *Part 8: Kerosine propellant*
- *Part 9: Argon*
- *Part 10: Water*
- *Part 11: Ammonia*
- *Part 12: Carbon dioxide*
- *Part 13: Breathing air*

Introduction

This International Standard specifies limits for the chemical and physical properties of kerosine and establishes the fluid sampling and test methods for kerosine propellant intended for use as a fuel in propellant systems of space systems. The purpose of this International Standard is to establish uniform requirements for the composition of kerosine and the sampling and test methods for kerosine used in the servicing of launch vehicles, spacecraft, and ground support equipment.

Fluid operations at a spaceport or launch site may involve a number of operators and supplier/customer interfaces, from the fluid production plant to the delivery to the launch vehicle or spacecraft. The fluid composition limits specified in this International Standard are intended to define the purity and impurity limits of the fluid for loading into the launch vehicle or spacecraft. The fluid sampling and test methods included in this International Standard are intended to be applied by any operator. The fluid sampling and test methods presented in this International Standard are acceptable methods for verification of the fluid composition limits.

Space systems — Fluid characteristics, sampling and test methods —

Part 8: Kerosene propellant

1 Scope

This part of ISO 15859 specifies limits for the composition of kerosene and defines the fluid sampling and applicable test methods for verification of kerosene composition. This International Standard establishes acceptable test and sampling requirements. This part of ISO 15859 applies to sampling and test methods for kerosene propellant used in both flight hardware and ground support facilities, systems, and equipment. This International Standard may be applied to influent or effluent kerosene.

This part of ISO 15859 is applicable to any sampling operation required to ensure that, when the fluid enters the launch vehicle or spacecraft, the fluid composition complies with the limits provided hereafter or with any technical specification agreed to for a particular use.

CAUTION — Kerosene propellant is a combustible liquid and a fire hazard. Care should be taken in the handling and storage of kerosene propellant to prevent contact with ignition sources.

2 Normative references

The following normative documents contain provisions which, through reference in this text, constitute provisions of this part of ISO 15859. For dated references, subsequent amendments to, or revisions of, any of these publications do not apply. However, parties to agreements based on this part of ISO 15859 are encouraged to investigate the possibility of applying the most recent editions of the normative documents indicated below. For undated references, the latest edition of the normative document referred to applies. Members of ISO and IEC maintain registers of currently valid International Standards.

ISO 8402:1994, *Quality management and quality assurance — Vocabulary*.

ISO 3012:1991, *Gasoline, kerosene and distillate fuels — Determination of mercaptan sulfur — Potentiometric method*.

ISO 3014:1993, *Petroleum products — Determination of the smoke point of kerosene*.

3 Terms and definitions

For the purposes of this part of ISO 15859, the terms and definitions given in ISO 8402 and the following apply:

3.1

particulate matter

undissolved solids retained on a filter paper with a 10 µm nominal and 40 µm absolute rating

3.2

verification tests

analyses performed on the fluid in the container, or a sample thereof, which is representative of the supply

4 Chemical and physical properties

4.1 Limits

Unless otherwise provided in an applicable technical specification, the chemical and physical properties of kerosine propellant delivered to the flight vehicle interface shall be in accordance with the limits given in Table 1 when tested in accordance with the applicable test methods.

Table 1 –Chemical and physical properties

Property		Limit
Distillation	Initial boiling point	a
	Fuel evaporated, 10 %	185 °C to 210 °C
	Fuel evaporated, 50 % at °C	a
	Fuel evaporated, 90 % at °C	a
	End point, max.	274 °C
	Residue, volume fraction, %, max.	1,5
	Distillation loss, volume fraction, %, max.	1,5
Specific gravity	max.	0,815
	min.	0,799
Existent gum	mg/100 mL, max.	7
Potential gum, 16 h aging	mg/100 mL, max.	14
Sulfur	total mass fraction, %, max.	0,05
Mercaptan-sulfur	mass fraction, %, max.	0,005 ^b
Freezing point	°C, max.	-37,8
Thermal value: net heat of combustion	MJ/kg, min.	43,031
Viscosity	mm ² /s at -34,4 °C, max.	16,5
Aromatics	volume fraction, %, max.	5,0
Olefins	volume fraction, %, max.	2,0
Smoke point	mm, min.	25,0
Copper strip corrosion	max.	a
Water reaction		c
Flashpoint	min.	43,3 °C
Aniline point	°C	a
Particulate matter	max.	1,5 mg/L
Copper corrosion test for 3 h at 100 °C		a
<p>^a To be reported; not limited.</p> <p>^b The mercaptan-sulfur determination may be waived at the option of the customer if the fuel is considered "sweet."</p> <p>^c See 4.2 for requirements.</p>		

4.2 Water reaction

When tested as specified in Table 1 and Clause 6, the propellant shall separate sharply from the water layer. In addition, neither layer shall change in volume by more than 1 mL.

4.3 Additives

4.3.1 Type and amount

The additives listed in this clause may be used singly or in combination, in amounts which shall not exceed those specified. No substance of known dangerous toxicity under usual conditions of handling and use shall be added except as specified herein. The type and amount of each additive used shall be reported.

4.3.2 Antioxidants

The following active inhibitors may be added separately or in combination to the propellant in total concentration not in excess of 9 g of inhibitor (not including weight of solvent) per 375 L of fuel in order to prevent the formation of gum.

- a) 2, 6-ditertiary butyl 4-methyl phenol;
- b) N, N' disecundary butyl paraphenylenediamine;
- c) 2, 4-dimethyl-6 tertiary-butyl phenol;
- d) 2, 6-ditertiary butyl phenol.

4.3.3 Metal deactivator

A metal deactivator, N, N'-disalicylidene-1, 2-propanediamine, may be added in an amount which shall not exceed 2,1 g of active ingredient per 375 L of fuel.

4.3.4 Dye

The propellant shall be a homogenous liquid when examined visually by transmitted light.

4.4 Qualitative properties

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

4.5 Procurement

The kerosine specified in Clause 1 should be procured in accordance with an applicable national standard.

5 Fluid sampling

5.1 Plan

In order to ensure that the fluid composition complies with the limits specified in this International Standard, a fluid sampling plan should be established by all the involved operators, from the production to the space vehicle interface and approved by the final user. Such plan shall specify:

- the sampling points;
- the sampling procedures;

- the sampling frequency;
- the sample size;
- the number of samples;
- the test methods;
- the responsibilities of any involved operator.

CAUTION — Kerosine propellant is a combustible liquid and a fire hazard. Care should be taken in the handling and storage of kerosine propellant to prevent contact with ignition sources.

5.2 Responsibility for sampling

Unless otherwise provided in an applicable technical specification, the kerosine delivered to the flight vehicle interface shall be sampled and verified by the supplier responsible for providing the kerosine to the flight vehicle. The supplier may use its own or any other resources suitable for the performance of the verification tests specified herein unless otherwise directed by the customer.

5.3 Sampling points

Unless otherwise specified, sampling shall be conducted at the fluid storage site or the flight vehicle interface.

5.4 Sampling frequency

Sampling shall be annually or in accordance with a time agreed upon by the supplier and the customer.

5.5 Sample size

The quantity in a single sample container shall be sufficient to perform the analysis for the limiting characteristics. If a single sample does not contain a sufficient quantity to perform all of the analyses for the required quality verification test, additional samples shall be taken under similar conditions.

5.6 Number of samples

The number of samples shall be in accordance with one of the following:

- a) one sample per storage container;
- b) any number of samples agreed upon by the supplier and the customer.

5.7 Storage container

Unless otherwise provided by the applicable sampling plan, the fluid storage container shall not be refilled after the time the sample is taken.

5.8 Liquid samples

Liquid samples shall be a typical specimen from the liquid kerosine supply. For safety reasons, the sample container and sampling system must have a rated service pressure at least equal to the pressure in the supply container. Samples shall be obtained in accordance with one of the following:

- a) by filling the sample container and storage containers at the same time, on the same manifold, and under the same conditions and with the same procedures;

- b) by withdrawing a sample from the supply container through a suitable connection into the sample container. No pressure regulator shall be used between the supply and the sample containers (suitable purge and drain valves are permissible);
- c) by connecting the container being sampled directly to the analytical equipment using suitable pressure regulation to prevent overpressurizing this equipment.

5.9 Rejection

When any sample of the fluid tested in accordance with Clause 6 of this International Standard fails to conform to the requirements specified herein, the fluid represented by the sample shall be rejected. Disposition of the rejected fluid shall be specified by the customer.

6 Test methods

6.1 General

The supplier will ensure, by standard practice, the quality level of kerosine. If required, alternate test methods are described in clause 6 of this International Standard. Other test methods not listed in this International Standard are acceptable if agreed upon between the supplier and the customer.

These tests are a single analysis or a series of analyses performed on the fluid to ensure the reliability of the storage facility to supply the required quality level. This can be verified by analysis of representative samples of the fluid from the facility at appropriate intervals as agreed upon between supplier and the customer. Tests may be performed by the supplier or by a laboratory agreed upon between the supplier and the customer.

The analytical requirements for the tests shall include the determination of all limiting characteristics of kerosine.

6.2 Parameters of analysis

The parameters for analytical techniques contained in this section are:

- a) calibration gas standards containing the applicable gaseous components may be required to calibrate the analytical instruments used to determine the limiting characteristic levels of fluid;
- b) if required by the customer, the accuracy of the measuring equipment used in preparing these standards shall be traceable to an established institute for standards;
- c) analytical equipment shall be operated in accordance with the manufacturer's instructions;
- d) analytical methods not listed in this International Standard are acceptable if agreed upon between the supplier and the customer.

6.3 Kerosine distillation

The kerosine shall be distilled by using a 100 mL sample under prescribed conditions that are appropriate to its nature. Systematic observations of thermometer readings and volumes of condensate are made, and from these data, the results of the test are calculated and reported.

6.4 Specific gravity

The specific gravity shall be determined by observing a freely floating hydrometer and noting the graduation nearest to the apparent intersection of the horizontal plane surface of the liquid with vertical scale of the hydrometer, after temperature equilibrium has been reached. The temperature of the sample is read from a separate accurate thermometer in the sample or from the thermometer, which is an integral part of the hydrometer.

6.5 Existent gum content

The existent gum content shall be determined by a jet evaporation method, wherein a measured sample is under controlled conditions of temperature and flow of air or steam. The resulting residue is weighed and reported as milligrams per 100 millilitres.

6.6 Potential gum content

The potential gum content shall be determined by a potential residue method. In this method a sample is oxidized under prescribed conditions in a bomb filled with oxygen. The amounts of soluble gum, insoluble gum, and precipitate formed are weighed.

6.7 Sulfur content

The sulfur content shall be determined by a lamp method, wherein:

- a) sample is burned in a closed system, using a suitable lamp and an artificial atmosphere composed of 70 % carbon dioxide and 30 % oxygen to prevent formation of nitrogen oxides. The oxides of sulfur are absorbed and oxidized to sulfuric acid by means of hydrogen peroxide solution, which is then flushed with air to remove dissolved carbon dioxide. Sulfur as sulfate in the absorbent is determined acidimetrically by titration with standard sodium hydroxide solution, or gravimetrically by precipitation as barium sulfate;
- b) alternatively, the sample may be burned in air, the sulfur as sulfate in the absorbent being determined by precipitation as barium sulfate for weighing;

NOTE In the absence of acid-forming or base-forming elements, other than sulfur, results by the volumetric and gravimetric finishes described are equivalent within the limits of precision of the method.

- c) for sulfur contents below 0,01 mass % it is necessary to determine the sulfate content in the absorber solution turbidimetrically as barium sulfate.

6.8 Mercaptan-sulfur content

The mercaptan-sulfur content shall be determined by a potentiometric method, wherein:

- a) the hydrogen sulfide has been removed;
- b) the hydrogen sulfide-free sample is dissolved in an alcoholic sodium acetate titration solvent and titrated potentiometrically with silver nitrate solution, using as an indicator the potential between a glass reference electrode and a silver-silver sulfide indicating electrode. Under these conditions, the mercaptan-sulfur is precipitated as silver-mercaptide and the end point of the titration is shown by a large change in cell potential.

This method shall be performed in accordance with ISO 3012.

6.9 Freezing point

The freezing point shall be determined by the following procedure:

- a) sample is transferred to a tube, which is immersed in a refrigerant bath;
- b) the sample is stirred and the temperature is noted at which crystals form during cooling and warming.

6.10 Thermal value

The thermal value shall be determined by a bomb calorimeter procedure. The heat of combustion is determined by burning a weighed sample in an oxygen bomb calorimeter under controlled conditions. The heat of combustion is

computed from temperature observations before, during, and after combustion, with proper allowance for thermochemical and heat transfer corrections. Either isothermal or adiabatic calorimeter jackets can be used.

6.11 Viscosity

The viscosity shall be determined by measuring the time in seconds for a fixed volume of liquid to flow under gravity through the capillary of a calibrated viscometer under a reproducible driving head and at a closely controlled temperature. The kinematic viscosity is the product of the measured time and the calibration constant of the viscometer.

6.12 Aromatics content

The aromatics content shall be determined by a fluorescent indicator adsorption method, wherein approximately 0,75 mL of sample is introduced into a special glass adsorption column packed with activated silica gel. A small layer of the silica gel contains a mixture of fluorescent dyes. When all the sample has been adsorbed on the gel, alcohol is added to desorb the sample down the column. The hydrocarbons are separated according to their adsorption affinities into aromatics, olefins, and saturates. The fluorescent dyes are also separated selectively, with the hydrocarbon types, and make the boundaries of the aromatic, olefin, and saturate zones visible under ultraviolet light. The volume percentage of each hydrocarbon type is calculated from the length of each zone in the column.

A gas chromatograph/mass spectrometer may be used as an alternative method to determine aromatics content.

6.13 Olefins content

The olefins content shall be determined by the procedure described in 6.12.

6.14 Smoke point

The smoke point shall be determined by burning a sample in an enclosed wick-fed lamp that is calibrated daily against pure hydrocarbon blends of known smoke point. The maximum height of the flame that can be achieved with the test fuel without smoking is estimated to the nearest 0,5 millimetre.

The procedure for this test method shall be in accordance with ISO 3014.

6.15 Copper strip corrosion

Detection of copper corrosion shall be determined by a standard copper strip tarnish test method, where a polished copper strip is immersed in a given sample quantity of kerosine and heated for a characteristic time. At the end of this period, the copper strip is removed, washed, and compared with a copper strip corrosion standard.

6.16 Water reaction

The water reaction of the fuel shall be determined by shaking a sample of the fuel, using a standardized technique, at room temperature with a phosphate buffer solution. The change in volume of the aqueous layer, the appearance of the interface, and the degree of separation of the two phases are taken as the water reaction of the fuel.

6.17 Flash point

The flash point shall be determined by one of the following standard test methods:

- a) by a nonequilibrium method using a Pensky-Martens closed tester;
- b) by an equilibrium method using a closed cup apparatus.

6.18 Anline point

The anline point shall be determined by placing specific volumes of anline and kerosine sample in a tube and mixing mechanically. The mixture is heated at a controlled rate until the two phases become miscible. The mixture is then cooled at a controlled rate and the temperature at which the two phases separate is recorded as the anline point.

6.19 Particulate matter content

The particulate matter content shall be determined by a gravimetric measurement using a field monitor to filter a sample or by a laboratory filtration. A known volume of fuel is filtered through a preweighed test membrane filter in a field monitor and the increase in membrane filter mass determined after washing and drying. The change in mass of a control membrane filter located immediately below the test membrane filter is also determined. The particulate matter contaminant is determined from the increase in mass of the test membrane filter relative to the control membrane filter.