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Space systems — Fluid characteristics, sampling and test methods —

Part 8:
Kerosine propellant

Systèmes spatiaux — Caractéristiques, échantillonnage et méthodes d'essai des fluides —

Partie 8: Kérosène (carburant)

Reference number
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Foreword

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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 document 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

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 purpose of ISO 15859 is to establish uniform requirements for the components, sampling and test methods of fluids used in the servicing of launch vehicles, spacecraft and ground support equipment. The fluid composition limits specified 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 are intended to be applied by any operator. The fluid sampling and test methods are acceptable methods for verification of the fluid composition limits.

INTERNATIONAL STANDARD **ISO 15859-8:2004(E)**

Space systems — Fluid characteristics, sampling and test methods —

Part 8:
Kerosine propellant

1 Scope

This part of ISO 15859 specifies limits for the composition of kerosine and establishes the sampling and test requirements applicable for the verification of the kerosine composition.

This part of ISO 15859 is applicable to kerosine propellant intended for use in fuel in propellant systems of space systems as well as in both flight hardware and ground support facilities, systems and equipment. It may be applied to influent or effluent kerosine.

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.

2 Normative references

The following referenced documents are indispensable for the application of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

ISO 3012, *Petroleum products — Determination of thiol (mercaptan) sulfur in light and middle distillate fuels — Potentiometric method*

ISO 3014, *Petroleum products — Determination of the smoke point of kerosine*

ISO 9000, *Quality management systems — Fundamentals and vocabulary*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in ISO 9000 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 test
analysis performed on the fluid in the container, or a sample thereof, which is representative of the supply, permitting the verification of fluid composition limits

4 Chemical composition and chemical and physical properties

4.1 Chemical composition

Unless otherwise provided in an applicable technical specification, the chemical composition 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 — Composition limits

Component		Limit
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[a]
Aromatics	Volume fraction, %, max.	5,0
Olefins	Volume fraction, %, max.	2,0
Particulate matter	mg/l, max	1,5

[a] The mercaptan-sulfur determination may be waived at the option of the customer if the fuel is considered "sweet."

4.2 Chemical and physical properties

The propellant shall be a clear and bright homogeneous liquid when examined visually by transmitted light. 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 2 when tested in accordance with the applicable test methods.

Table 2 — 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.	0,801
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
Smoke point	mm, min.	25,0
Copper strip corrosion	max.	[a]
Water reaction		[b]
Flashpoint	min.	43,3 °C
Aniline point	°C	[a]
Copper corrosion test for 3 h at 100 °C		[a]

[a] To be reported; not limited.
[b] See 4.3 for requirements.

4.3 Water reaction

When tested as specified in Table 1 and Clause 7, the propellant shall separate sharply from the water layer. In addition, neither layer shall change in volume by more than 1 ml.

4.4 Additives

4.4.1 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.

4.4.2 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 mass of solvent) per 375 l of fuel in order to prevent the formation of gum:

a) 2,6-ditertiarybutyl-4-methyl phenol;

b) *N*,*N*′-disecondarybutyl paraphenylenediamine;

c) 2,4-dimethyl-6-tertiarybutyl phenol;

d) 2,6-ditertiarybutyl phenol.

4.4.3 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.

4.4.4 Dye

A dye, methyl derivative of azobenzene-4-azo-2-naphthol, may be added in an amount which shall not exceed 14 g per 3 750 l of fuel.

5 Procurement

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

6 Fluid sampling

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. Harmful if swallowed and/or aspirated into the lungs. Can cause skin irritation upon prolonged or repeated contact.

6.1 Plan

In order to ensure that the fluid composition complies with the limits specified in this part of ISO 15859, 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. Sampling activities and test methods shall comply with all safety regulations and rules applicable to that task. This plan shall specify

- the sampling points,
- the sampling procedures,
- the sampling frequency,
- the sample size,
- the number of samples,
- the test methods, and
- the responsibilities of any involved operator.

6.2 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 his/her or any other resources suitable for the performance of the verification tests specified herein unless otherwise directed by the customer.

6.3 Sampling points

Unless otherwise specified, sampling shall be conducted at the fluid storage site.

6.4 Sampling frequency

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

6.5 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.

6.6 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.

6.7 Storage container

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

6.8 Liquid samples

Liquid samples shall be a typical specimen from the liquid kerosine supply. 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.) For safety reasons, the sample container and sampling system shall have a rated service pressure at least equal to the pressure in the supply container.

c) By connecting the container being sampled directly to the analytical equipment using suitable pressure regulation to prevent overpressurizing this equipment.

6.9 Rejection

When any sample of the fluid tested in accordance with Clause 7 fails to conform to the requirements specified in this part of ISO 15859, the fluid represented by the sample shall be rejected. Disposal of the rejected fluid shall be specified by the customer.

7 Test methods

7.1 General

The supplier will ensure, by standard practice, the quality level of kerosine. If required, alternate test methods are described in 7.3 to 7.19. Other test methods not listed in this part of ISO 15859 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.

7.2 Parameters of analysis

The parameters for analytical techniques contained in 7.3 to 7.19 are the following:

a) calibration of 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.

7.3 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.

7.4 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.

7.5 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 ml.

7.6 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.

7.7 Sulfur content

The sulfur content shall be determined by a lamp method, as follows.

a) The 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. Sulfur oxides 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 methods described are equivalent within the limits of precision of the method.

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

7.8 Mercaptan-sulfur content

The mercaptan-sulfur content shall be determined by a potentiometric method, as follows.

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.

7.9 Freezing point

The freezing point shall be determined by the following procedure.

a) The 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.

7.10 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.

7.11 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.

7.12 Aromatics content

The content of aromatics 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 fraction (%) of each hydrocarbon type is calculated from the length of each zone in the column.

A gas chromatograph/mass spectrometer (GC-MS) may be used as an alternative method to determine aromatics content.

7.13 Olefins content

The olefins content shall be determined by the procedure described in 7.12.

7.14 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 ml.

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

7.15 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.

7.16 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.

7.17 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.

7.18 Aniline point

The aniline point shall be determined by placing specific volumes of aniline 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 aniline point.

7.19 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.

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