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Space systems — Fluid characteristics, sampling and test methods —

Part 7:
Hydrazine propellant

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

Partie 7: Hydrazine (ergol)

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Foreword

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International Standards are drafted in accordance with the rules given in the ISO/IEC Directives, Part 2.

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 15859-7 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.

Space systems — Fluid characteristics, sampling and test methods —

Part 7: Hydrazine propellant

1 Scope

This part of ISO 15859 specifies limits for the composition and physical properties of anhydrous hydrazine (N_2H_4) and establishes the sampling and test requirements applicable for the verification of the anhydrous hydrazine composition.

This part of ISO 15859 is applicable to anhydrous hydrazine propellant, intended for use as fuel in propellant systems of space systems as well as in both flight hardware and ground facilities, systems, and equipment, of the following grades.

- Standard: normal production and quality control (suitable for most uses).
- Monopropellant: normal product with strict control of specified impurities (to be specified only for monopropellant catalytic engines where extended life of the catalyst is desired).
- High purity: special production with strict control of specified impurities.

This part of ISO 15859 is applicable to influents only within the specified limits herein. Hydrazine may be of the liquid type.

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 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
⟨standard grade⟩ undissolved solids retained on a filter paper with a 10-µm nominal and 40-µm absolute rating

3.2
particulate
⟨monopropellant and high purity grades⟩ undissolved solids retained on a filter paper with a 2-μm nominal and 10-μm absolute rating

3.3
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 physical properties

4.1 Chemical composition

Unless otherwise provided in an applicable technical specification, the chemical composition of hydrazine 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

Composition		Limits		
		Standard grade	**Mono-propellant grade**	**High purity grade**
Hydrazine	Mass fraction, %, min.	98	98,3	99,0
Water	Mass fraction, %, max.	1,5	1,2	1,0
Ammonia	Mass fraction, %, max.	—	—	0,3
Particulate	mg/l, max.	10	1,0	1,0
Chloride	Mass fraction, %, max.	—	0,000 5	0,000 5
Aniline	Mass fraction, %, max.	—	0,50	0,003
Iron	Mass fraction, %, max.	—	0,002	0,000 4
Nonvolatile residue	Mass fraction, %, max.	—	0,005	0,001
Carbon dioxide	Mass fraction, %, max.	—	0,003	0,003
Other volatile carbonaceous components[a]	Mass fraction, %, max.	—	0,02	0,005

[a] Total as monomethylhydrazine (MMH), unsymmetrical dimethylhydrazine (UDMH) and alcohol.

4.2 Physical properties

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

5 Procurement

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

6 Fluid sampling

CAUTION — Hydrazine, in the liquid or vapour form, is flammable fuel, highly reactive in contact with an oxidant, toxic, and volatile. Care should be taken in the handling and storage of hydrazine to prevent contact with the human body and with materials that are not compatible with hydrazine.

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 hydrazine delivered to the flight vehicle interface shall be sampled and verified by the supplier responsible for providing the hydrazine 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 or the flight vehicle interface.

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 hydrazine 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 procedure.

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.

6.9 Rejection

When any sample of the fluid tested in accordance with Clause 7 fails to conform to the requirements specified herein, 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 hydrazine. If required, alternate test methods are described in 7.3 to 7.12. 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 hydrazine.

7.2 Parameters of analysis

The parameters for analytical techniques contained in 7.3 to 7.12 are the following:

a) purity and impurity contents shall be expressed as a percentage by mass (mass fraction, %) unless otherwise specified;

b) calibration standards containing the applicable liquid components may be required to calibrate the analytical instruments used to determine the limiting characteristic levels of fluid;

c) 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;

d) analytical equipment shall be operated in accordance with the manufacturer's instructions.

7.3 Hydrazine purity

The hydrazine purity shall be determined by a gas chromatography method. This method may be used not only for hydrazine but also for the determination of water, ammonia, aniline, and other volatile carbonaceous components. (See Annex A.) The analyser shall be capable of separating and detecting the component with a sensitivity of 10 % of the specified maximum amount of the component. The analyser shall be calibrated at appropriate intervals by the use of calibration standards.

7.4 Water content

The water content shall be determined by a gas chromatographic method, such as that described in 7.3.

7.5 Ammonia content

The ammonia content shall be determined by a gas chromatographic method, such as that described in 7.3.

7.6 Particulate matter content

The particulate matter content shall be determined by a gravimetric measurement method. A known volume of fuel is filtered through a preweighed test membrane filter and the increase in membrane filter mass is 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.

7.7 Chloride content

The chloride content shall be determined by one of the following methods.

a) By an ion chromatographic method.

b) By a colorimetric method with mercury thiocyanate.

c) By a potentiometric method using chloride-specific electrode.

d) By a silver nitrate titration potentiometric method.

The chloride content cannot be measured directly in the liquid hydrazine sample but from a nonvolatile residue after dissolving it in an aqueous acid solution.

7.8 Aniline content

The aniline content shall be determined by one of the following methods.

a) By a gas chromatography method such as that described in 7.3.

b) By an ultraviolet spectrophotometric method for the monopropellant grade hydrazine.

7.9 Iron content

The iron content shall be determined by one of the following methods.

a) By an atomic absorption method.

b) By a colorimetric method.

c) By an inductively coupled argon plasma emission spectrometric method.

The iron content cannot be measured directly in the liquid hydrazine sample but can be measured either from a solution of hydrazine in water or a nonvolatile residue after dissolving it in an aqueous acid solution.

7.10 Nonvolatile residue (NVR) content

The nonvolatile residue content shall be determined by a gravimetric measurement method in accordance with the following procedure. A measured sample is gradually evaporated using a suitable heat source in a fume hood. The difference in mass before and after evaporation is calculated as the nonvolatile residue.

7.11 Carbon dioxide content

The sample shall be injected into a strong acid in order to absorb the hydrazine and ammonia components and liberate carbon dioxide. The carbon dioxide content shall then be determined by one of the following procedures.

a) By a gas chromatographic method. The technique utilized shall be specific for the separation and analysis of carbon dioxide.

b) By an infrared analysis method.

c) By a specific CO_2 coulometric method.

7.12 Other volatile carbonaceous component content

The content of other volatile carbonaceous components shall be determined by a gas chromatographic method such as that described in 7.3. The other components to be measured are usually monomethylhydrazine (MMH), unsymmetrical dimethylhydrazine (UDMH), and alcohols (methyl and isopropylalcohols). The analyser shall be capable of separating and detecting these components.

Annex A
(informative)

Gas chromatography (GC) applications

Gas chromatography (GC) should be used as the reference or preferred method to analyse some hydrazine impurities, for example, water and ammonia contents, aniline content (for the high purity grade), other volatile carbonaceous material, and carbon dioxide contents for hydrazine purity control.

Table A.1 summarizes the applications of these methods for hydrazine.

Table A.1 — Application of GC

Component	GC with TCD detector, on Tenax GC [a] or PEG 1540 column (or equivalent)	GC with FID detector, on Tenax GC or Apiezon L/AT200 [a] or wide bore (Carbowax 20M [a]) capillary column (or equivalent)	GC with FID detector, on Tenax GC or PEG 1540 or PEG 400 column (or equivalent)	GC with TCD detector and cryogenic trap, on charcoal or Porapak [a] column (or equivalent)
Hydrazine purity	X	—	—	—
Water	X	—	—	—
Ammonia	X	—	—	—
Aniline (high purity)	—	X	—	—
Other volatile carbonaceous components	—	—	X	—
Carbon dioxide	—	—	—	X

TCD = thermal conductivity detector

PEG = polyethlylene glycol

FID = Flame ionization detector

“X” indicates that the method can be used.

“—” indicates that the method is not used.

[a] Tenax GC®, Apiezon®L/AT200, Carbowax® 20M and Porapak® are examples of suitable products available commercially. This information is given for the convenience of users of this part of ISO 15859 and does not constitute an endorsement by ISO of this product.

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