**SLOVENSKI STANDARD**
**SIST EN 16602-70-05:2015**

**01-januar-2015**

---

**Zagotavljanje varnih proizvodov v vesoljski tehniki - Odkrivanje organsko onesnaženih površin z infrardečo spektroskopijo**

Space product assurance - Detection of organic contamination surfaces by infrared spectroscopy

Raumfahrtproduktsicherung - Detektion von organischen Kontaminationen auf Oberflächen mit Infrarotspektroskopie



Assurance produit des projets spatiaux - Détection des surfaces de contamination organique par spectroscopie infrarouge



**Ta slovenski standard je istoveten z: EN 16602-70-05:2014**

---

**ICS:**

| | | |
|---|---|---|
| 49.140 | Vesoljski sistemi in operacije | Space systems and operations |

**SIST EN 16602-70-05:2015 en,fr,de**

EUROPEAN STANDARD

NORME EUROPÉENNE

EUROPÄISCHE NORM

# EN 16602-70-05

October 2014

ICS 49.140

English version

# Space product assurance - Detection of organic contamination surfaces by infrared spectroscopy

Assurance produit des projets spatiaux - Détection des surfaces de contamination organique par spectroscopie infrarouge

Raumfahrtproduktsicherung - Detektion von organischen Kontaminationen auf Oberflächen mit Infrarotspektroskopie

This European Standard was approved by CEN on 20 March 2014.

CEN and CENELEC members are bound to comply with the CEN/CENELEC Internal Regulations which stipulate the conditions for giving this European Standard the status of a national standard without any alteration. Up-to-date lists and bibliographical references concerning such national standards may be obtained on application to the CEN-CENELEC Management Centre or to any CEN and CENELEC member.

This European Standard exists in three official versions (English, French, German). A version in any other language made by translation under the responsibility of a CEN and CENELEC member into its own language and notified to the CEN-CENELEC Management Centre has the same status as the official versions.



CEN and CENELEC members are the national standards bodies and national electrotechnical committees of Austria, Belgium, Bulgaria, Croatia, Cyprus, Czech Republic, Denmark, Estonia, Finland, Former Yugoslav Republic of Macedonia, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Latvia, Lithuania, Luxembourg, Malta, Netherlands, Norway, Poland, Portugal, Romania, Slovakia, Slovenia, Spain, Sweden, Switzerland, Turkey and United Kingdom.



**CEN-CENELEC Management Centre:**
**Avenue Marnix 17, B-1000 Brussels**



Ref. No. EN 16602-70-05:2014 E

# Table of contents

## Figures





## Tables

# Foreword

This document (EN 16602-70-05:2014) has been prepared by Technical Committee CEN/CLC/TC 5 “Space”, the secretariat of which is held by DIN.

This standard (EN 16602-70-05:2014) originates from ECSS-Q-ST-70-05C.

This European Standard shall be given the status of a national standard, either by publication of an identical text or by endorsement, at the latest by April 2015, and conflicting national standards shall be withdrawn at the latest by April 2015..

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. CEN [and/or CENELEC] shall not be held responsible for identifying any or all such patent rights.

This document has been prepared under a mandate given to CEN by the European Commission and the European Free Trade Association.



This document has been developed to cover specifically space systems and has therefore precedence over any EN covering the same scope but with a wider domain of applicability (e.g. : aerospace).



According to the CEN-CENELEC Internal Regulations, the national standards organizations of the following countries are bound to implement this European Standard: Austria, Belgium, Bulgaria, Croatia, Cyprus, Czech Republic, Denmark, Estonia, Finland, Former Yugoslav Republic of Macedonia, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Latvia, Lithuania, Luxembourg, Malta, Netherlands, Norway, Poland, Portugal, Romania, Slovakia, Slovenia, Spain, Sweden, Switzerland, Turkey and the United Kingdom.

# Introduction

One or more of the following organic substances can contaminate spacecraft materials and hardware, as well as vacuum chambers:

- Volatile condensable products of materials out-gassing under vacuum.
- Volatile condensable products of off-gassing materials.
- Back-streaming products from pumping systems.
- Handling residues (e.g. human grease).
- Residues of cleaning agents.
- Non-filtered external pollution.
- Creep of certain substances (e.g. silicones).



There are several methods for identifying organic species, such as mass spectrometry, gas chromatography and infrared spectroscopy, or a combination of these methods. Infrared spectroscopy, which is the most widely used, is a simple, versatile and rapid technique providing high resolution qualitative and quantitative analyses. The technique is therefore baseline for the present Standard.

# 1 Scope

This Standard defines test requirements for detecting organic contamination on surfaces using direct and indirect methods with the aid of infrared spectroscopy.

The Standard applies to controlling and detecting organic contamination on all manned and unmanned spacecraft, launchers, payloads, experiments, terrestrial vacuum test facilities, and cleanrooms.

The following test methods are covered:

- Direct sampling of contaminants
- Indirect sampling of contaminants by washing and wiping



Several informative annexes are included to give guidelines to the following subjects:



- Qualitative and quantitative interpretation of spectral data
- Calibration of infrared equipment
- Training of operators
- Use of molecular witness plates
- Collecting molecular contamination
- Contact test to measure the contamination transfer of materials
- Immersion test to measure the extractable contamination potential of materials
- Selection criteria for test equipment

This standard may be tailored for the specific characteristics and constraints of space project in conformance with ECSS-S-ST-00.

# 2
# Normative references

The following normative documents contain provisions which, through reference in this text, constitute provisions of this ECSS Standard. For dated references, subsequent amendments to, or revision of any of these publications do not apply. However, parties to agreements based on this ECSS Standard are encouraged to investigate the possibility of applying the more recent editions of the normative documents indicated below. For undated references, the latest edition of the publication referred to applies.

| EN reference | Reference in text | Title |
|---|---|---|
| EN 16601-00-01 | ECSS-S-ST-00-01 | ECSS system – Glossary of terms |
| EN 16602-10 | ECSS-Q-ST-10 | Space product assurance – Product assurance management |
| EN 16602-10-09 | ECSS-Q-ST-10-09 | Space product assurance – Nonconformance control system |
| EN 16602-20 | ECSS-Q-ST-20 | Space product assurance – Quality assurance |
| EN 16602-70-01 | ECSS-Q-ST-70-01 | Space product assurance – Cleanliness and contamination control |

# 3 Terms, definitions and abbreviated terms

## 3.1 Terms defined in other standards

For the purpose of this Standard, the terms and definitions from ECSS-S-ST-00-01 and ECSS-Q-ST-70-01 apply, in particular for:

**controlled area**

## 3.2 Terms specific to the present standard

### 3.2.1 absorbance, *A*



logarithm to the base 10 of the reciprocal of the transmittance

[ASTM-E-131]



NOTE The term absorbance is also widely used for the negative log of the ratio of the final to the incident intensities of processes other than transmission, such as attenuated total reflection and diffuse reflection.



### 3.2.2 absorption

transfer of infrared energy to the molecules present within the pathway of the radiation

### 3.2.3 absorptivity

absorbance divided by the product of the concentration of the substance and the sample path length

NOTE 1 Absorptivity = $A/(l\,C)$, where $A$ is the absorbance, $C$ is the concentration of the substance and $l$ is the sample path length. The unit normally used are cm for $l$, and kg m$^{-3}$ for $C$.

NOTE 2 The equivalent IUPAC term is "specific absorption coefficient".

[adapted from ASTM-E-131]

### 3.2.4 attenuated total reflection

reflection that occurs when an absorbing coupling mechanism acts in the process of total internal reflection to make the reflectance less than unity

[ASTM-E-131]

### 3.2.5 diffuse reflection

reflection in which the flux is scattered in many directions by diffusion at or below the surfaces

[ASTM-E-131]

### 3.2.6 Fourier transformation

mathematical process used to convert an amplitude-time spectrum to an amplitude-frequency spectrum or vice versa

[ASTM-E-131]

### 3.2.7 infrared spectroscopy

spectroscopy in the infrared region of the electromagnetic spectrum, i.e. with wavelength range from approximately 0,78 µm to 1 000 µm (wave number range 12 820 $cm^{-1}$ to 10 $cm^{-1}$)

[adapted from ASTM-E-131]



### 3.2.8 molar absorptivity, ε

product of the absorptivity and the molecular weight of the substance



NOTE The equivalent IUPAC term is “molar absorption coefficient”.

[adapted from ASTM-E-131]

### 3.2.9 radiant power, *P*

amount of energy transmitted in the form of electromagnetic radiation per unit time

NOTE 1 Unit for radiant power is Watts.

NOTE 2 Radiant power should not be confused with intensity (*I*), which is the radiant energy emitted within a time period per unit solid angle (measured in Watts per steradian).

### 3.2.10 reflectance, *R*

ratio of the radiant power reflected by the sample to the radiant power incident on the sample

[ASTM-E-131]

### 3.2.11 specific area

diameter of the infrared beam at the window location

NOTE It is expressed as the ratio of the beam diameter over the area. For example, 7 mm/0,38 $cm^2$, 10 mm/0,79 $cm^2$ or 12 mm/1,13 $cm^2$.

### 3.2.12 transmittance, *T*

ratio of the radiant power transmitted by the sample to the radiant power incident on the sample

[ASTM-E-131]

### 3.2.13 wave number, $\bar{\nu}$

number of waves per unit length

NOTE 1 The unit for wave number is $cm^{-1}$. In terms of this unit, the wave number is the reciprocal of the wavelength, λ ( where λ is expressed in cm).

NOTE 2 The wave number is normally used as the X-axis unit of an IR spectrum.

[adapted from ASTM-E-131]



## 3.3 Abbreviated terms

For the purpose of this Standard, the abbreviated terms from ECSS-S-ST-00-01 and the following apply:



| Abbreviation | Meaning |
|---|---|
| **ASTM** | American Society for Testing and Materials |
| **ATR** | attenuated total reflection |
| **AU** | absorbance unit |
| **DOP** | dioctylphthalate, synonym bis (2-ethylhexyl) phthalate |
| **DRIFT** | diffuse reflection infrared Fourier transform |
| **DTGS** | deuterated triglycine sulphate IR detector |
| **ESD** | electrostatic discharge |
| **FTIR** | Fourier transform infrared (spectrometry) |
| **IES** | Institute of Environmental Sciences |
| **IPA** | isopropyl alcohol |
| **IR** | Infrared |
| **IUPAC** | International Union of Pure and Applied Chemistry |
| **ISO** | International Organization for Standardization |
| **MCT** | mercury cadmium telluride IR detector |
| **NVR** | non-volatile residue |

| | |
|---|---|
| **PTFE** | Polytetrafluoroethylene |
| **QCM** | quartz crystal microbalance |
| **RI** | refractive index |
| **S/N** | signal to noise ratio |
| **UV** | Ultraviolet |
| **VCM** | volatile condensable material |

# 4
# Principles

Infrared qualitative analysis is carried out by functional group identification, or by comparison of the IR absorption spectra of unknown materials with those of known reference materials, or both. It is therefore possible to determine structural information about the molecules of contaminants. In some cases, the source of the contamination can be detected.

Infrared quantitative analysis of levels of contaminants is based on the Lambert-Beer's (henceforth referred to as Beer's) law and requires calibration.

Infrared spectroscopy monitoring is used to verify that the stringent contamination and cleanliness controls applied to spacecraft materials and associated equipment are met. The most common methods for measuring contamination are:



- Direct methods
  IR-transparent windows used as witness plates (e.g. $CaF_2$, ZnSe, Ge) are placed in situ, for example, inside a vacuum facility, clean-room or spacecraft. Contamination of the windows is then analysed (without further treatment) using an IR spectrophotometer.



- Indirect methods
  The contaminants on the surface to be tested are collected by means of a concentration technique, for example by washing or wiping a larger surface. Such a surface can also be a witness plate, which is removed after exposure and treated in the same way. The resultant contaminated liquid or tissue is then processed, and finally an IR-transparent or a reflective window containing the contaminants is analysed with the aid of an IR spectrophotometer.

The direct method has demonstrated higher reliability because the sample does not require transfer from the witness plate and therefore reducing the error for quantification. The indirect method allows sample concentration and can therefore provide higher sensitivity.