SLOVENSKI STANDARD
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Zagotavljanje varnih proizvodov v vesoljski tehniki - Nadzorovanje onesnaženja z delci v sistemih vesoljskega plovila in čistih prostorih

Space product assurance - Particles contamination monitoring for spacecraft systems and cleanrooms

Raumfahrtproduktsicherung - Überwachung der Teilchenkontamination von Raumfahrzeugsystemen und Reinräumen

Assurance produit des projets spatiaux - Surveillance de la contamination aux particules des systèmes orbitaux et des salles blanches

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Space product assurance - Particles contamination monitoring for spacecraft systems and cleanrooms

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Table of contents

Figures

Tables

Foreword

This document (EN 16602-70-50:2015) has been prepared by Technical Committee CEN/CLC/TC 5 “Space”, the secretariat of which is held by DIN.

This standard (EN 16602-70-50:2015) originates from ECSS-Q-ST-70-50C.

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of an identical text or by endorsement, at the latest by July 2015, and conflicting national standards shall be withdrawn at the latest by July 2015.

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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

Particulate contaminants can be hazardous to spacecraft in a number of ways including failure of precision mechanisms, light absorption and scattering, points of high local electric field and associated electrostatic discharge, and noise on electrical contacts. It is therefore important to control, measure and verify the particulate contamination levels on spacecraft systems and the environments in which they reside, in order that an assessment can be made on any hazards that may be present as a result of such contamination.

The objective of this standard is to ensure that the particle monitoring of spacecraft systems and cleanrooms utilised in the production of such systems, is carried out in an appropriate manner, and is controlled both in terms of the precision of the measurements and the reproducibility of such measurements.

1
Scope

This standard defines the requirements and guidelines for the measurement of particulate contamination on the surfaces of spacecraft systems and those of the cleanrooms or other cleanliness controlled areas in which they reside.

This includes the measurement of particulate contamination that is present on the spacecraft or cleanroom surfaces via the use of representative witness samples placed in the vicinity of the spacecraft hardware, the direct measurement of particulate contamination levels on surfaces of spacecraft hardware from the direct surface transfer to adhesive tape-lift samples and particulate contaminant levels within fluids used for the cleaning or rinsing of such spacecraft system components and cleanroom surfaces. This standard also defines the methods to be used for the visual inspection of spacecraft system hardware for particulate contamination.

The measurement of airborne particulate contamination is not covered in this standard and ISO 14644 “Cleanrooms and associated controlled environments” is applicable in this case.

This standard does not cover particulate contamination monitoring for spacecraft propulsion hardware which is covered in ECSS-E-ST-35-06.

This standard may be tailored for the specific characteristic and constrains of a 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 16602-10-09	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
	ISO 14952-3	Space systems - Surface cleanliness of fluid systems - Part 3: Analytical procedures for the determination of nonvolatile residues and particulate contamination

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 apply.

3.2 Terms specific to the present standard

3.2.1 background count

measurement of the contamination levels produced by the measurement method (and associated apparatus) and the measurement environment as distinct from the inherent contamination level of the item to be measured

3.2.2 background subtraction

act of subtracting a background count from a measurement

3.2.3 black light illumination

illumination which predominantly produces light in the near UV region (310 nm to 400 nm)

3.2.4 bubble

volume of trapped gas encapsulated by another medium

3.2.5 cleanliness and contamination control plan

plan which defines the organized actions to control the level of contamination

3.2.6 cleanliness controlled area

area in which there are specific measures to control and monitor contamination which allows the counting of particles to be performed with sufficient accuracy as defined by the background count

3.2.7 cleanliness requirement specification

specification that defines the requirement for allowable contamination levels

3.2.8 cleanliness verification

activity intended to verify that the actual cleanliness conditions of the spacecraft system, the cleanrooms, and other environments in which the

spacecraft system will reside, are in conformance with the applicable specifications and other cleanliness requirements

3.2.9 compatible

not deteriorating the functionality, performance and integrity of any item or surface

3.2.10 contamination potential

potential amount of contaminant in the source which can produce contamination defined in terms of the obscuration factor per unit time

NOTE The obscuration factor per unit time can be expressed in [(mm²/m²)/h].

3.2.11 contamination sensitive

article which, if exposed to contamination, can be adversely affected in terms of its designed function

3.2.12 effective sample area

area on a surface that has been exposed to a contamination source

3.2.13 lint-free

resistant to fibre generation

3.2.14 membrane filter

polymer film with specific pore sizes, designed to separate particles from liquids or gases

3.2.15 non-shedding

resistant to particle generation

3.2.16 obscuration factor

ratio of the projected area of all particles to the total surface area on which they rest

3.2.17 particle

unit of matter with observable length, width and thickness

NOTE For the purposes of this standard the particles have typical dimensions of 0,1 μm to 1000 μm.

3.2.18 particulate contamination

airborne or surface contamination relating to particles

3.2.19 particle fallout

accumulated deposit of particulate matter on a surface

3.2.20 representative sample

sample which is designed to be the same as another item, either in physical form or the environment in which it resides, or both

3.2.21 ripple

topographical in-homogeneity usually in the form of a wave pattern

3.2.22 sensitive surface

surface that has a high probability of damage

3.2.23 spectral grade

measure of solvent purity determined from its absorption spectrum

NOTE Typically spectral grade solvents have a purity of greater than 99,5 %.

3.2.24 tape-lift

method of transferring particulate contamination from a surface with an adhesive tape

3.2.25 tape-lift sample

length of transparent adhesive tape that has been used for a tape lift and subsequently applied to a clean substrate to encapsulate any contamination

3.2.26 trained inspector

inspector certified by a third party certification body, or with proven on the job experience that is agreed with or recognized by the customer

3.2.27 ultrasonic bath

bath containing liquid and a transducer which produces ultrasonic waves which produce microscopic cavitation bubbles in the liquid which aids in the removal of particles from surfaces of an item placed in the liquid

NOTE Typical frequency of ultrasonic waves is from 15 kHz to 400 kHz.

3.2.28 visibly clean

absence of surface contamination when examined with a specific light source, angle of incidence and viewing distance using normal or magnified vision

NOTE 1 Different inspection methods are available, depending on:

- hardware to be inspected, in term of size and accessibility and sensitivity to contamination
- inspection distance
- light spectra (including UV), intensities and angles

NOTE 2 The “visibly clean” level roughly corresponds to an obscuration factor smaller than 300 mm^2/m^2

when inspected from a distance of 30 cm to 60 cm with an oblique white light of 540 lx to 1620 lx.

NOTE 3 Typical magnification levels range from 2x to 8x.

3.2.29 visibly clean standard

absence of surface contamination when examined under oblique white light of more than 540 lx and from a distance of 150 cm to 300 cm using normal vision

3.2.30 visibly clean sensitive

absence of surface contamination when examined under oblique white light of more than 540 lx and from a distance of 60 cm to 120 cm using normal vision

3.2.31 visibly clean highly sensitive

absence of surface contamination when examined under oblique white light of more than 1080 lx and from a distance of 15 cm to 45 cm using normal or magnified vision

3.2.32 visual inspection

act of examining an object under defined illumination and viewing conditions with normal or magnified vision

3.2.33 void

area devoid of matter

3.3 Abbreviated terms

The following abbreviations are defined and used within this standard:

Abbreviation	Meaning
C&CCP	cleanliness and contamination control plan
CRS	cleanliness requirement specification
IPA	isopropyl alcohol
ISO	International Organization for Standardization
LED	laser emitting diode
lx	lux
OF	obscuration factor
PCB	printed circuit board
PFO	particle fallout
UV	ultra-violet
UVA	ultra-violet (310 nm - 400 nm)

4
Particulate cleanliness monitoring requirements

4.1 Cleanliness requirement specification overview

ECSS-Q-ST-70-01 requires that the particulate contamination level applicable to spacecraft systems is defined in a cleanliness requirement specification (CRS). This standard also requires that the CRS explicitly defines the allowable levels of particulate contamination throughout the lifetime of the spacecraft, and that this levels are incorporated into the overall cleanliness budget for the spacecraft systems.

4.2 Cleanliness and contamination control plan

a. Particulate cleanliness and contamination control shall be planned in accordance with ECSS-Q-ST-70-01.

NOTE Cleanliness and Contamination Control Plan (C&CCP) identifies potential contamination sources, the effects that those sources have on the spacecraft systems in addition to identifying spacecraft systems which are contamination sensitive to particles.

b. Measurement methods specified in 5.1, 5.2 and 5.4 shall be employed in order to monitor and report particulate contamination levels.

5 Quantitative method requirements

5.1 Particles sampling from surfaces

5.1.1 Tape lift method

5.1.1.1 Introduction

This clause describes the tape-lift method to be used for the sampling of surfaces for the purpose of the determining particulate contamination levels, and the definition of the particle size distribution. In this case, the surface particulate is analysed using a direct transfer method, whereby a transparent adhesive tape is applied to the surface to be tested and the particles are transferred from the sample surface to the adhesive tape. The particles transferred to the tape are then analysed using an optical microscope.

An ASTM standard also exists, ASTM E1216-06, Standard practice for sampling for particulate contamination by tape-lift.

5.1.1.2 General requirements

a. Any counting of particles for the purpose of determining particulate contamination levels using the tape lift method shall be performed in a cleanliness controlled area.

b. Sensitive surfaces shall not be analysed using the tape lift method.

c. In the case where adhesive residue is removed from the surface subjected to the tape-lift test, the potential damage that can be caused by the cleaning of the surface shall be assessed prior to conducting the tape-lift test.

d. If the sensitivity of the surface to be tested is not known, the tape lift method shall not be used unless a trial tape-lift has been conducted on a representative sample with the same surface and shows the surface not to be a sensitive surface.

e. The application of force on contaminant particles, present on the surface, during the performing of the tape-lift test shall not damage the sampled surface.

f. In the case of surfaces described in 5.1.1.2b, a non-sensitive surface that has been subject to the same environmental conditions and is