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Space systems — Contamination and cleanliness control

Systèmes spatiaux — Contrôle de la contamination et de la propreté

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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.

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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.

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ISO 15388 was prepared by Technical Committee ISO/TC 20, *Aircraft and space vehicles*, Subcommittee SC 14, *Space systems and operations*.

Introduction

This International Standard addresses the preferred programme elements recommended for contamination and cleanliness control of space systems. This document is written in general terms as a baseline for developing and implementing the control programme. It may be cited as a baseline within a statement of work and/or for assuring proposal precision and contractor performance. The users are responsible for integrating the elements of this document appropriate to their programme needs.

The purpose of contamination and cleanliness control is to prevent the degradation of the performance of space systems due to particulate and molecular contamination (including biocontamination), and to ensure the mission objectives are achieved.

Space systems — Contamination and cleanliness control

1 Scope

This International Standard establishes general requirements for contamination and cleanliness control to be applied, at all tiers of supply, to the development of space systems including ground processing facilities, ground support equipment, launch vehicles, spacecraft, payloads, and ground processing and on-orbit operations. It also provides guidelines for the establishment of a contamination and cleanliness control programme.

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 14624-3, *Space systems — Safety and compatibility of materials — Part 3: Determination of off-gassed products from materials and assembled articles*

ISO 14644-1, *Cleanrooms and associated controlled environments — Part 1: Classification of air cleanliness*

ISO 14644-2, *Cleanrooms and associated controlled environments — Part 2: Specifications for testing and monitoring to prove continued compliance with ISO 14644-1*

ISO 14644-3, *Cleanrooms and associated controlled environments — Part 3: Metrology and test methods*

ISO 14644-4, *Cleanrooms and associated controlled environments — Part 4: Design, construction and start-up*

ISO 14644-5:2004, *Cleanrooms and associated controlled environments — Part 5: Operations*

ISO 14698-1, *Cleanrooms and associated controlled environments — Biocontamination control — Part 1: General principles and methods*

ISO 14698-2, *Cleanrooms and associated controlled environments — Biocontamination control — Part 2: Evaluation and interpretation of biocontamination data*

ISO 14951-3, *Space systems — Fluid characteristics — Part 3: Nitrogen*

ISO 14951-9, *Space systems — Fluid characteristics — Part 9: Argon*

ISO 14952 (all parts), *Space systems — Surface cleanliness of fluid systems*

ISO 15859-3, *Space systems — Fluid characteristics, sampling and test methods — Part 3: Nitrogen*

ISO 15859-9, *Space systems — Fluid characteristics, sampling and test methods — Part 9: Argon*

ASTM E 595, *Standard Test Method for Total Mass Loss and Collected Volatile Condensable Materials from Outgassing in a Vacuum Environment*

ECSS-Q-70-02, *Space product assurance — Thermal vacuum test for the screening of space materials*

UN Treaty on Principles Governing the Activities of States in the Exploration and Use of Outer Space, Including the Moon and Other Celestial Bodies, Article IX, 10 Oct. 1967

3 Terms and definitions, abbreviations

3.1 Terms and definitions

For the purposes of this document, the following terms and definitions apply.

3.1.1
bakeout
activity of increasing the temperature of hardware to accelerate its outgassing rates with the intent of reducing the content of molecular contaminants within the hardware

NOTE Bakeout is usually performed in a vacuum environment but may be done in a controlled atmosphere.

3.1.2
bioaerosol
dispersed biological agents (e.g. viable particles, allergens, toxins or biologically active compounds of microbial origin) in a gaseous environment

3.1.3
biocontamination
contamination of materials, devices, individuals, surfaces, liquids, gases or air with viable particles

3.1.4
classification of airborne particle concentrations
level (or the process of specifying or determining the level) of airborne particulate cleanliness, expressed in terms of an ISO Class N which represents maximum allowable concentrations (in particles/m^3) for the particle size considered

NOTE The concentrations are determined as specified in ISO 14644-1.

3.1.5
clean bench
table or bench top working surface where a filtered airflow is concentrated across the bench top

NOTE These bench tops have an established classification of maximum allowable airborne contaminants.

3.1.6
clean hood
work area with a workbench, overhead dust deflector and sideboards, and a self-contained filtering unit for airflow to the work area

NOTE These hoods have an established classification of maximum allowable airborne contaminants.

3.1.7
cleanliness level
established maximum allowable amount of contamination in a given area or volume, or on a component

NOTE The term may also apply to the predicted or measured extent of contamination.

3.1.8
cleanliness requirement specification
CRS
document that defines and identifies the spacecraft items and the environmental areas which are sensitive to contamination, the acceptable contamination levels at BOL and at EOL and the applicable contamination environment

3.1.9
cleanroom
room in which the concentration of airborne particles is controlled, and which is constructed and used in a manner to minimize the introduction, generation and retention of particles inside the room, and in which other relevant parameters, e.g. temperature, humidity and pressure, are controlled as necessary

3.1.10
cleanroom garments
clothing designed, manufactured and worn specifically to prevent contamination of hardware by personnel working in the cleanroom

NOTE It include all items worn by personnel, such as coveralls, frocks, gloves, boots, finger cots and beard covers.

3.1.11
clean zone
dedicated space in which the concentration of airborne particles is controlled, and which is constructed and used in a manner to minimize the introduction, generation, and retention of particles inside the zone and in which other relevant parameters, e.g. temperature, humidity and pressure are controlled as necessary

NOTE This zone may be open or enclosed and may or may not be located within a cleanroom.

3.1.12
collected volatile condensable material
CVCM
mass that outgasses from a material and subsequently condenses on a collector, expressed as a percentage of the initial specimen mass

3.1.13
contaminant
any unwanted molecular or particulate matter that could affect or degrade the relevant performance or lifetime of the hardware to which it is attached

3.1.14
contaminate
introduce a contaminant

3.1.15
contamination
addition of contaminants to materials, fluids or surfaces

3.1.16
contamination and cleanliness control programme
any organized effort to establish and achieve acceptable cleanliness and contamination levels during all phases of the space system project

3.1.17
contamination analysis document
report of the analyses and results that are used to determine cleanliness requirements and contamination profiles and budgets

3.1.18
contamination and cleanliness control plan
CCCP
document that describes how to implement a contamination and cleanliness control programme, as either an independent document or a part of the consolidated project plan

3.1.19
contamination budget
allowable levels of cleanliness of hardware at each phase of ground and flight operations

3.1.20
contamination profile
contamination-related conditions in each phase of ground and flight operations

NOTE 1 These includes airborne particulate cleanliness classes, pressure, humidity, temperature, number of personnel engaged in operations, cleaning activities, outlines of facilities and so on.

NOTE 2 The contamination profile is part of the CCCP.

3.1.21
cross-contamination
transfer of contaminants from one surface or component to another

NOTE Transfer may occur by migration along a surface, by physical contact, airborne as an aerosol, or as a gas or molecular matter.

3.1.22
debris
solid objects with their largest dimension greater than approximately 1 mm (1 000 µm) in size

3.1.23
electrostatic discharge
ESD
rapid, spontaneous transfer of electrostatic charge between bodies that have different electrostatic potentials

3.1.24
fibre
particle having a length-to-diameter aspect ratio of 10 or greater

3.1.25
generally clean
free from manufacturing residue, dirt, oil, grease, processing debris or other extraneous contamination

NOTE This level can be achieved by washing, wiping, blowing, vacuuming, brushing or rinsing.

3.1.26
ground support equipment
GSE
non-flight systems, equipment or devices necessary to support the operations of transporting, receiving, handling, assembly, inspection, test, checkout, servicing, launch and recovery of a space system at launch, landing or retrieval sites

3.1.27
interface control document
ICD
specification that describes the characteristics that must be controlled at the boundaries between systems, subsystems and other elements

3.1.28
microorganism
microscopical individual constituted to carry out life functions

NOTE 1 This includes organisms such as bacteria, protozoa, yeasts, moulds, fungi, algae and organisms that depend upon other life forms for reproduction such as viruses and parasites.

NOTE 2 Multicellular organisms and agglomerations of microorganisms may be visible to the unaided eye.

3.1.29
microscopical
visible only under a microscope

3.1.30
molecular contamination
contamination due to deposition of molecules on surfaces or their presence in gases or liquids

3.1.31
occupancy states of cleanrooms

3.1.31.1
as-built
condition where the installation is complete with all services connected and functioning but with no equipment, materials, or personnel present

3.1.31.2
at-rest
condition where the installation is complete with equipment installed and operating in a manner agreed between the customer and supplier, but with no personnel present

3.1.31.3
operational
condition where the installation is functioning in the specified manner, with the specified number of personnel present and working in the manner agreed upon

3.1.32
offgassing
evolution of gaseous products from a liquid or solid material into an atmosphere

NOTE This is a special definition for outgassing for the application described in ISO 14624-3.

3.1.33
outgassing
evolution of gaseous species from a material, usually in a vacuum

NOTE Outgassing also occurs in higher-pressure environments.

3.1.34
particle
unit of solid or liquid matter with observable size

NOTE See also 3.1.37.

3.1.35
particle concentration
⟨on surface⟩ number of particles per unit area

3.1.36
particle concentration
⟨by volume⟩ number of particles per unit volume of fluid

3.1.37
particle size
a) apparent maximum linear dimension of a particle in the plane of observation as observed with instruments such as optical, electron or atomic force microscopes

b) equivalent diameter of a particle detected by automatic instrumentation

NOTE The equivalent diameter is the diameter of a reference sphere having known properties and producing the same response in the sensing instrument as the particle being measured. Other methods of defining size may be used but are dependent upon the measurement technique.

3.1.38
particulate contamination
contamination due to deposition of particles on surfaces or suspension of particles in fluids

3.1.39
precision clean
cleaning of hardware by approved engineering methods to meet quantitative cleanliness criteria

3.1.40
responsible organization
organization that is responsible for the contamination and cleanliness control programme and is provided with the authority and resources needed for carrying out the programme