

Space product assurance — Thermal vacuum outgassing test for the screening of space materials

The European Standard EN 14091:2002 has the status of a
British Standard

ICS 49.025.01; 49.140

National foreword

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The UK participation in its preparation was entrusted to Technical Committee ACE/68, Space systems and operations, which has the responsibility to:

- aid enquirers to understand the text;
- present to the responsible European committee any enquiries on the interpretation, or proposals for change, and keep the UK interests informed;
- monitor related international and European developments and promulgate them in the UK.

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Raumfahrtproduktsicherung - Thermal-Vakuum-Ausgastest für die Auswahl von Raumfahrtmaterialien

This European Standard was approved by CEN on 22 December 2001.

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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 member into its own language and notified to the Management Centre has the same status as the official versions.

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Foreword

This document EN 14091:2002 has been prepared by CMC.

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of an identical text or by endorsement, at the latest by August 2002, and conflicting national standards shall be withdrawn at the latest by August 2002.

It is based on a previous version¹⁾ originally prepared by the ECSS product assurance working group, reviewed by the ECSS Technical Panel and approved by the ECSS Steering Board. The European Cooperation for Space Standardization (ECSS) is a cooperative effort of the European Space Agency, National Space Agencies and European industry associations for the purpose of developing and maintaining common standards.

This standard is one of the series of space standards intended to be applied together for the management, engineering and product assurance in space projects and applications.

Requirements in this standard are defined in terms of what shall be accomplished, rather than in terms of how to organize and perform the necessary work. This allows existing organizational structures and methods to be applied where they are effective, and for the structures and methods to evolve as necessary without rewriting the standards.

The formulation of this standard takes into account the existing ISO 9000 family of documents.

Annexes A and B are informative.

According to the CEN/CENELEC Internal Regulations, the national standards organizations of the following countries are bound to implement this European Standard: Austria, Belgium, Czech Republic, Denmark, Finland, France, Germany, Greece, Iceland, Ireland, Italy, Luxembourg, Malta, Netherlands, Norway, Portugal, Spain, Sweden, Switzerland and the United Kingdom.

¹⁾ ECSS-Q-70-02A

Introduction

The acceleration of the outgassing process results from exposure to vacuum at an elevated temperature. The method described in this standard gives reliable data for the outgassing properties of materials at 125 °C. However, some materials have different kinetics at other temperatures. Nevertheless, comparisons are possible at other temperatures, provided that the kinetics of the outgassing phenomena are similar (defined activation energy of similar magnitude for the materials to be compared). Furthermore, the measurement of contamination potential is comparative and strictly valid only for collectors at 25 °C with similar sticking coefficients.

A basic screening test method is detailed in this standard. The data obtained are not intended to be used for contamination predictions; however, some worst-case analyses can be made with the test data, the masses of the relevant materials and the view factors with respect to contamination-sensitive elements.

1 Scope

This European Standard specifies a thermal vacuum test to determine the outgassing properties of materials proposed for use in the fabrication of spacecraft and associated equipment, for vacuum facilities used for flight hardware tests and for certain launcher hardware.

This standard covers the following:

- critical design parameters of the test system;
- critical test parameters such as temperature, time, pressure;
- material sample preparation;
- conditioning parameters for samples and collector plates;
- presentation of the test data;
- acceptance criteria;
- certification of test systems and their operators by audits and round robin tests.

The test described in this standard is applicable for all unmanned spacecraft, launchers, payloads, and experiments. The test is also valid for external hardware of inhabited space systems and for hardware to be used in terrestrial vacuum test facilities.

The acceptance criteria for a material, based upon the outgassing test data, depends upon the application and location of the material and can be more severe than the standard requirements as given in 7.2.

2 Normative references

This European Standard incorporates by dated or undated reference, provisions from other publications. These normative references are cited at the appropriate places in the text, and the publications are listed hereafter. For dated references, subsequent amendments to or revisions of any of these publications apply to this European Standard only when incorporated in it by amendment or revision. For undated references the latest edition of the publication referred to applies (including amendments).

EN 13701, *Space systems - Glossary of terms*.

EN 14097, *Space product assurance — Nonconformance control system*.

ECSS-Q-20, *Space product assurance — Quality assurance*.

ECSS-Q-70, *Space product assurance — Materials, mechanical parts and processes*.

ISO 14644-1:1999, *Cleanrooms and associated controlled environments — Part 1: Classification of air cleanliness*.

3 Terms, definitions and abbreviated terms

3.1 Terms and definitions

For the purposes of this European Standard, the terms and definitions given in EN 13701 and ECSS-Q-70 and the following 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

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

[ISO 14644-1:1999]

3.1.3

collected volatile condensable material (CVCN)

quantity of outgassed matter from a test specimen that condenses on a collector maintained at a specific temperature for a specific time

NOTE CVCN is expressed as a percentage of the initial specimen mass and is calculated from the condensate mass determined from the difference in mass of the collector plate before and after the test.

3.1.4

outgassing

release of gaseous species from a specimen under high vacuum conditions

3.1.5

quartz crystal microbalance (QCM)

device for measuring small quantities of mass deposited on a quartz crystal using the properties of a crystal oscillator

3.1.6

recovered mass loss (RML)

total mass loss of the specimen itself without the absorbed water ($RML = TML - WVR$)

NOTE The RML is introduced because water is not always seen as a critical contaminant in spacecraft materials.

3.1.7

sticking coefficient

probability that a molecule, colliding with a surface, stays on that surface before thermal re-evaporation of that molecule occurs

3.1.8

total mass loss (TML)

total mass loss of material outgassed from a specimen that is maintained at a specific constant temperature and operating pressure for a specified time

NOTE TML is calculated from the mass of the specimen as measured before and after the test and is expressed as a percentage of the initial specimen mass.

3.1.9

water vapour regained (WVR)

mass of the water vapour regained by the specimen after the optional reconditioning step

NOTE WVR is calculated from the differences in the specimen mass determined after the test for TML and CVCN and again after exposure to atmospheric conditions and 65 % relative humidity at room temperature (22 ± 3 °C).