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Ersatz für  
DIN EN 14091:2003-06

**Raumfahrtproduktsicherung –  
Thermo-Vakuum-Ausgasungstest für die Auswahl von  
Raumfahrtmaterialien;  
Englische Fassung EN 16602-70-02:2014**

Space product assurance –  
Thermal vacuum outgassing test for the screening of space materials;  
English version EN 16602-70-02:2014

Assurance produit des projets spatiaux –  
Essai de dégazage sous vide thermique pour sélection des matériaux d'un projet spatial;  
Version anglaise EN 16602-70-02:2014

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## **Nationales Vorwort**

Dieses Dokument (EN 16602-70-02:2014) wurde vom Technischen Komitee CEN/CLC/TC 5 „Raumfahrt“ erarbeitet, dessen Sekretariat vom DIN (Deutschland) gehalten wird.

Das zuständige deutsche Normungsgremium ist der Arbeitsausschuss NA 131-10-01 AA „Interoperabilität von Informations-, Kommunikations- und Navigationssystemen“ im DIN-Normenausschuss Luft- und Raumfahrt (NL).

Dieses Dokument ersetzt DIN EN 14091:2003-06.

Dieses Dokument (EN 16602-70-02:2014) basiert auf ECSS-Q-ST-70-02C.

Dieses Dokument enthält unter Berücksichtigung des DIN-Präsidialbeschlusses 1/2004 nur die englische Originalfassung von EN 16602-70-02:2014.

Dieses Dokument wurde speziell zur Behandlung von Raumfahrtsystemen erarbeitet und hat daher Vorrang vor jeglicher Europäischer Norm, da es denselben Anwendungsbereich hat, jedoch über einen größeren Geltungsbereich (z. B. Luft- und Raumfahrt) verfügt.

## **Änderungen**

Gegenüber DIN EN 14091:2003-06 wurden folgende Änderungen vorgenommen:

- a) Norm-Nummer geändert;
- b) keinerlei Änderungen des Textes.

## **Frühere Ausgaben**

DIN EN 14091: 2003-06

## Nationaler Anhang NA (informativ)

### Begriffe, Symbole und Normen

#### 3 Begriffe, Symbole und Abkürzungen

##### 3.1 Begriffe aus anderen Normen

Für die Anwendung dieses Dokuments gelten die Begriffe und Definitionen nach ECSS-S-ST-00-01 und ECSS-Q-ST-70.

##### 3.2 Für diese Norm spezifische Begriffe

###### 3.2.1

###### **Ausheizen**

Aktivität, bei der die Temperatur eines Bauteils erhöht wird, um die Ausgasgeschwindigkeit zu erhöhen mit dem Zweck, den Anteil molekularer Verunreinigungen innerhalb des Bauteils zu verringern

ANMERKUNG Das Ausheizen erfolgt üblicherweise im Vakuum, darf aber auch in einer kontrollierten Atmosphäre durchgeführt werden.

###### 3.2.2

###### **Reinraum**

Raum, in dem die Konzentration luftgetragener Partikeln geregelt wird, der so konstruiert und verwendet wird, dass die Anzahl der in den Raum eingeschleppten bzw. im Raum entstehenden und abgelagerten Partikeln kleinstmöglich ist, und in dem andere reinheitsrelevante Parameter wie Temperatur, Feuchte und Druck nach Bedarf geregelt werden

[ISO14644-6]

###### 3.2.3

###### **gesammelte flüchtige, kondensierbare Bestandteile (CVCM)**

Menge der aus einer Probe ausgegasten Materie, die an einem Kollektor kondensiert, der für eine festgelegte Zeit bei einer festgelegten Temperatur gehalten wird

ANMERKUNG Die CVCM werden in Prozent der Ausgangsmasse der Probe angegeben und werden aus der kondensierten Masse berechnet, die aus der Massedifferenz der Kollektorplatte vor und nach dem Test bestimmt wird.

###### 3.2.4

###### **Ausgasen**

Freisetzen gasförmiger Phasen aus einer Probe unter Hochvakuumbedingungen

###### 3.2.5

###### **Quarzmikrowaage (QCM)**

Gerät zur Messung kleiner Mengen einer Masse, die auf einem Quarzkristall abgeschieden wird, unter Verwendung der Eigenschaften eines Schwingquarzes

###### 3.2.6

###### **verbleibender Masseverlust (RML)**

totaler Masseverlust der Probe selbst, ohne das absorbierte Wasser

ANMERKUNG 1 Folgende Gleichung gilt:  $RML = TML - WVR$ .

ANMERKUNG 2 Der Begriff RML wird eingeführt, weil Wasser nicht immer als kritische Verunreinigung bei Raumfahrtwerkstoffen angesehen wird.

### 3.2.7

#### Haftwert

Wahrscheinlichkeit, dass ein Molekül, das mit einer Oberfläche kollidiert, auf dieser Oberfläche bleibt, bevor die thermale Wiederverdampfung des Moleküls eintritt

### 3.2.8

#### totaler Masseverlust (TML)

totaler Masseverlust des Werkstoffs, der aus einer Probe ausgast, die für eine festgelegte Zeit bei einer festgelegten konstanten Temperatur und einem festgelegten konstanten Druck gehalten wird

ANMERKUNG Der TML wird aus der Masse der Probe, die vor und nach dem Test bestimmt wird, berechnet und wird als prozentualer Anteil der Ausgangsmasse der Probe angegeben.

### 3.2.9

#### aufgenommener Wasserdampf (WVR)

Masse des Wasserdampfes, der von der Probe nach der wahlweisen Rekonditionierung aufgenommen wurde

ANMERKUNG Der WVR wird aus den Differenzen der Probenmasse berechnet, die nach dem Test für den TML und für die CVCM und erneut nach der Exposition unter atmosphärischen Bedingungen und bei 65 % relativer Luftfeuchte bei Raumtemperatur von  $(22 \pm 3) ^\circ\text{C}$  bestimmt wird.

## 1.1 Abkürzungen

Für die Anwendung dieser Norm gelten die Abkürzungen nach ECSS-S-ST-00-01 und die folgenden Abkürzungen.

| Abkürzung | Bedeutung                                             |                                               |
|-----------|-------------------------------------------------------|-----------------------------------------------|
| CVCM      | Gesammelte kondensierbare flüchtige Bestandteile      | (en: collected volatile condensable material) |
| EOL       | Ende der Lebensdauer                                  | (en: end-of-life)                             |
| IR        | Infrarot                                              | (en: infrared)                                |
| MIC       | Werkstoffidentifikationskarte<br>Werkstoff-Datenblatt | (en: materials identification card)           |
| PTFE      | Polytetrafluorethylen                                 | (en: polytetrafluorethylene)                  |
| QCM       | Quarzkristall-Mikrowaage                              | (en: quartz crystal microbalance)             |
| RH        | Relative Luftfeuchte                                  | (en: relative humidity)                       |
| RML       | Masseverlust ohne Wasser                              | (en: recovered mass loss)                     |
| RT        | Raumtemperatur                                        | (en: room temperature)                        |
| TML       | Gesamtmassenverlust                                   | (en: total mass loss)                         |
| VCM       | flüchtiges kondensierbares Material                   | (en: volatile condensable material)           |
| WVR       | Aufgenommener Wasserdampf                             | (en: water vapour regained)                   |

English version

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

Assurance produit des projets spatiaux - Essai de dégazage sous vide thermique pour sélection des matériaux d'un projet spatial

Raumfahrtproduktsicherung - Thermo-Vakuum-Ausgasungstest für die Auswahl von Raumfahrtmaterialien

This European Standard was approved by CEN on 13 March 2014.

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## Table of contents

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|                                                             |           |
|-------------------------------------------------------------|-----------|
| <b>Foreword .....</b>                                       | <b>4</b>  |
| <b>Introduction.....</b>                                    | <b>5</b>  |
| <b>1 Scope.....</b>                                         | <b>6</b>  |
| <b>2 Normative references .....</b>                         | <b>7</b>  |
| <b>3 Terms, definitions and abbreviated terms.....</b>      | <b>8</b>  |
| 3.1 Terms defined in other standards .....                  | 8         |
| 3.2 Terms specific to the present standard .....            | 8         |
| 3.3 Abbreviated terms.....                                  | 9         |
| <b>4 Test overview.....</b>                                 | <b>11</b> |
| 4.1 Test process description .....                          | 11        |
| 4.2 Acceptance limits.....                                  | 14        |
| <b>5 Requirements.....</b>                                  | <b>15</b> |
| 5.1 General requirements .....                              | 15        |
| 5.2 Preparatory conditions.....                             | 15        |
| 5.2.1 Hazards, health and safety precautions .....          | 15        |
| 5.2.2 Material samples .....                                | 16        |
| 5.2.3 Facilities.....                                       | 18        |
| 5.2.4 Equipment.....                                        | 18        |
| 5.3 Test procedure .....                                    | 20        |
| 5.3.1 General requirements .....                            | 20        |
| 5.3.2 Test process for general spacecraft application ..... | 20        |
| 5.4 Reporting of test data .....                            | 23        |
| 5.5 Acceptance limits.....                                  | 24        |
| 5.5.1 General requirements .....                            | 24        |
| 5.5.2 Acceptance limits for a retest of the material .....  | 24        |
| 5.5.3 Acceptance limits for application of a material.....  | 25        |
| 5.6 Quality assurance .....                                 | 27        |
| 5.6.1 Data .....                                            | 27        |
| 5.6.2 Calibration.....                                      | 27        |

|                                                                                |                                                         |           |
|--------------------------------------------------------------------------------|---------------------------------------------------------|-----------|
| 5.7                                                                            | Audit of the Micro-VCM test apparatus .....             | 27        |
| 5.7.1                                                                          | General .....                                           | 27        |
| 5.7.2                                                                          | Initial audit of the system (acceptance) .....          | 28        |
| 5.7.3                                                                          | Annual regular review (maintenance) of the system ..... | 29        |
| 5.7.4                                                                          | Special review .....                                    | 30        |
| <b>Annex A (normative) Materials identification card (MIC) - DRD .....</b>     |                                                         | <b>31</b> |
| <b>Annex B (normative) Micro-VCM worksheet - DRD .....</b>                     |                                                         | <b>34</b> |
| <b>Annex C (normative) Micro-VCM datasheet - DRD .....</b>                     |                                                         | <b>37</b> |
| <b>Annex D (normative) Thermal vacuum outgassing test report - DRD .....</b>   |                                                         | <b>40</b> |
| <b>Annex E (normative) Certificate of conformity for Micro-VCM - DRD .....</b> |                                                         | <b>42</b> |
| <b>Bibliography.....</b>                                                       |                                                         | <b>44</b> |

## Figures

|                                                                         |    |
|-------------------------------------------------------------------------|----|
| Figure 4-1: Flow chart of preparation and initial measurements.....     | 11 |
| Figure 4-2: Flow chart of test process.....                             | 12 |
| Figure 4-3: Parameters for sample .....                                 | 13 |
| Figure 4-4: Parameters for collector plate.....                         | 13 |
| Figure 5-1: Micro-VCM equipment.....                                    | 20 |
| Figure A-1 : Example of filled MIC .....                                | 33 |
| Figure B-1 : Example of filled in Micro-VCM worksheet .....             | 36 |
| Figure C-1 : Example of filled in Micro-VCM datasheet.....              | 39 |
| Figure E-1 : Example of a certificate of conformity for Micro-VCM ..... | 43 |

## Tables

|                                                  |    |
|--------------------------------------------------|----|
| Table B-1 : Outgassing screening properties..... | 35 |
|--------------------------------------------------|----|

## Foreword

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This document (EN 16602-70-02:2014) has been prepared by Technical Committee CEN/CLC/TC 5 "Space", the secretariat of which is held by DIN.

This standard (EN 16602-70-02:2014) originates from ECSS-Q-ST-70-02C.

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 supersedes EN 14091:2002.

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

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The kinetics of an outgassing process is influenced by vacuum and temperature conditions.

The method described in this Standard gives reliable data for material screening use exclusively. The nominal temperature for the screening test, as described in this standard is 125 °C. Results from the nominal screening test can be used for the screening of materials that have an operational temperature below 50 °C, especially if they are exposed for an extended period of time (in the order of weeks and above).

# 1

## Scope

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This Standard describes a thermal vacuum test to determine the outgassing screening 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, 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 outgassing and condensation acceptance criteria for a material depend upon the application and location of the material and can be more severe than the standard requirements as given in clause 5.5.3.1.

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

## 2

# Normative references

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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 |

## Terms, definitions and abbreviated terms

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### 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 apply.

### 3.2 Terms specific to the present standard

#### 3.2.1 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.

#### 3.2.2 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 14644-6]

#### 3.2.3 collected volatile condensable material (CVCM)

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

NOTE CVCM 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.

#### 3.2.4 outgassing

release of gaseous species from a specimen under high vacuum conditions

### 3.2.5 quartz crystal microbalance (QCM)

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

### 3.2.6 recovered mass loss (RML)

total mass loss of the specimen itself without the absorbed water

NOTE 1 The following equation holds:  
$$\text{RML} = \text{TML} - \text{WVR}.$$

NOTE 2 The RML is introduced because water is not always seen as a critical contaminant in spacecraft materials.

### 3.2.7 sticking coefficient

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

### 3.2.8 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.

### 3.2.9 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 CVCM and again after exposure to atmospheric conditions and 65 % relative humidity at room temperature ( $22 \pm 3$  °C).

## 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                                 |
|--------------|-----------------------------------------|
| CVCM         | collected volatile condensable material |
| EOL          | end-of-life                             |
| IR           | infrared                                |
| MIC          | materials identification card           |
| PTFE         | polytetrafluorethylene                  |
| QCM          | quartz crystal microbalance             |
| RH           | relative humidity                       |

|     |                               |
|-----|-------------------------------|
| RML | recovered mass loss           |
| RT  | room temperature              |
| TML | total mass loss               |
| VCM | volatile condensable material |
| WVR | water vapour regained         |

# 4

## Test overview

### 4.1 Test process description

Figure 4-1 and Figure 4-2 are included as a guide to the test procedures. The sequence for the test is given in the flow chart (Figure 4-2).

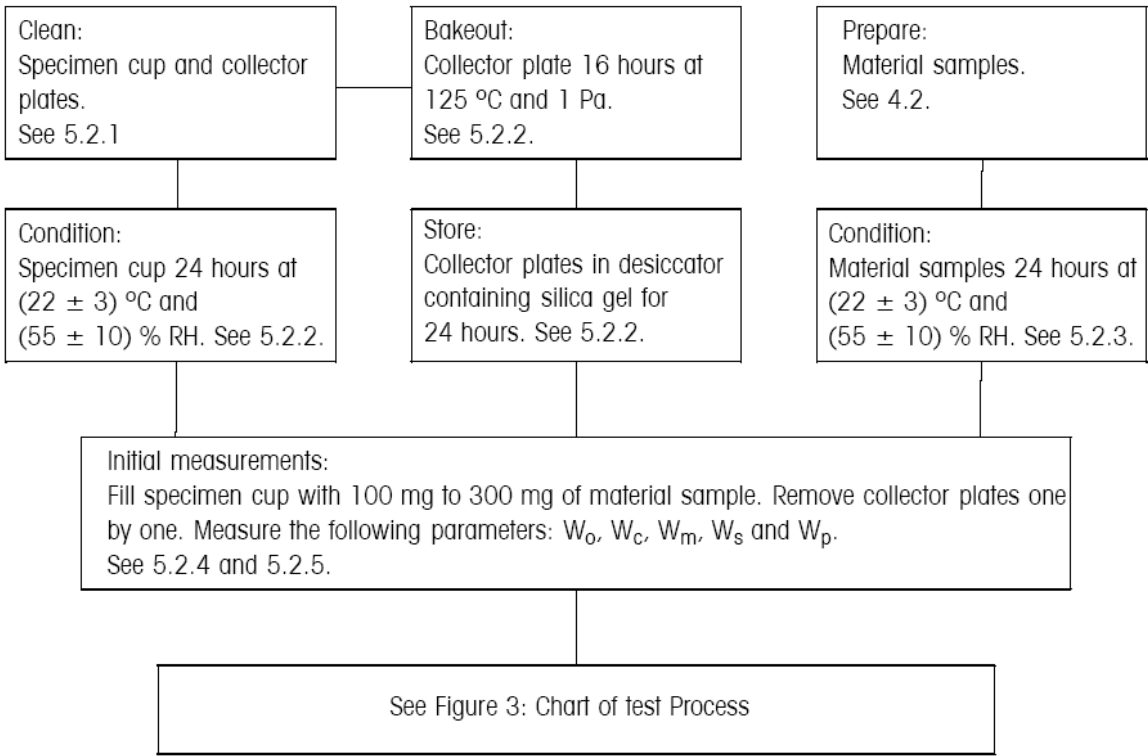


Figure 4-1: Flow chart of preparation and initial measurements