

Space product assurance — Flammability testing for the screening of space materials

The European Standard EN 14090:2002 has the status of a
British Standard

ICS 49.025.01; 49.140

National foreword

This British Standard is the official English language version of EN 14090:2002.

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.

A list of organizations represented on this committee can be obtained on request to its secretary.

Cross-references

The British Standards which implement international or European publications referred to in this document may be found in the BSI Standards Catalogue under the section entitled “International Standards Correspondence Index”, or by using the “Find” facility of the BSI Standards Electronic Catalogue.

A British Standard does not purport to include all the necessary provisions of a contract. Users of British Standards are responsible for their correct application.

Compliance with a British Standard does not of itself confer immunity from legal obligations.

This British Standard, having been prepared under the direction of the Engineering Sector Policy and Strategy Committee, was published under the authority of the Standards Policy and Strategy Committee on 18 March 2002

Summary of pages

This document comprises a front cover, an inside front cover, the EN title page, pages 2 to 36, an inside back cover and a back cover.

The BSI copyright date displayed in this document indicates when the document was last issued.

Amendments issued since publication

Amd. No.	Date	Comments

© BSI 18 March 2002

ISBN 0 580 39286 4

English version

Space product assurance - Flammability testing for the screening of space materials

Assurance produit des projets spatiaux - Essai de flammabilité pour la sélection des matériaux d'un projet spatial

Raumfahrtproduktsicherung - Brennverhaltenstest für die Auswahl von Raumfahrtmaterialien

This European Standard was approved by CEN on 26 December 2001.

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

CEN members are the national standards bodies of Austria, Belgium, Czech Republic, Denmark, Finland, France, Germany, Greece, Iceland, Ireland, Italy, Luxembourg, Malta, Netherlands, Norway, Portugal, Spain, Sweden, Switzerland and United Kingdom.



EUROPEAN COMMITTEE FOR STANDARDIZATION
COMITÉ EUROPÉEN DE NORMALISATION
EUROPÄISCHES KOMITEE FÜR NORMUNG

Management Centre: rue de Stassart, 36 B-1050 Brussels

Contents

	page
Foreword.....	5
Introduction	6
1 Scope.....	7
2 Normative references	7
3 Terms, definitions and abbreviated terms	7
3.1 Terms and definitions.....	7
3.2 Abbreviated terms	7
4 Test procedure	8
4.1 Preparatory conditions	8
4.1.1 Hazards, health and safety precautions	8
4.1.2 Preparation of samples	8
4.1.3 Facilities	8
4.1.4 Equipment.....	9
4.2 Test methods	9
4.2.1 Categories.....	9
4.2.2 Screening tests	10
4.2.3 Test 4: Configuration test method.....	27
5 Quality assurance.....	28
5.1 General.....	28
5.2 Data.....	28
5.3 Nonconformance	28
5.4 Calibration	28
5.5 Traceability.....	28
Annex A (informative) Preparation and qualification of chemical igniters	29
A.1 General.....	29
A.2 Safety requirements	29
A.3 Materials and equipment.....	29
A.3.1 Hexamethylenetetramine (HMT).....	29
A.3.2 Anhydrous sodium metasilicate	29
A.3.3 Gum arabic (acacia).....	29
A.3.4 Hammer mill	29

A.3.5	Glove box with a temperature/humidity meter	29
A.3.6	Bags	29
A.3.7	040 mesh screen.....	29
A.3.8	Fume hood.....	30
A.3.9	Respirator with organic canisters.....	30
A.3.10	Deionized water	30
A.3.11	250 ml burette.....	30
A.3.12	Heavy duty electric mixer.....	30
A.3.13	Spatula.....	30
A.3.14	Plastic trays.....	30
A.3.15	Conveyor belt.....	30
A.3.16	Extruder	30
A.3.17	Cutting tools	30
A.3.18	Drying racks	30
A.3.19	Desiccator and desiccant.....	30
A.3.20	Scale	30
A.3.21	Plastic corrugated holder	30
A.3.22	Certified breathing air.....	31
A.3.23	Voltage source	31
A.3.24	90 mm, bare nickel chromium wire	31
A.3.25	Calibrated ruler	31
A.3.26	Test chamber	31
A.3.27	Calibrated stop watch	31
A.3.28	Soft bristled brush.....	31
A.3.29	Plastic container (box)	31
A.3.30	Foam corrugated wrap.....	31
A.4	Grinding the igniter mix	31
A.5	Weighing the igniter mix.....	32
A.6	Adding water	32
A.7	Extruding the igniters.....	32
A.8	Curing, cutting and weighing the igniters	33
A.9	Certifying the igniters.....	33
A.10	Waste disposal	34
A.11	Packaging and storing igniters	34
	Bibliography	36
Figures		
Figure 1	— Diagram of the equipment used to determine the oxygen concentration limit.....	15
Figure 2	— Frame used to fix the sample	16
Figure 3	— Sample holder.....	17
Figure 4	— Sample holder.....	18
Figure 5	— Samples from thermoplastic polymer materials.....	19
Figure 6	— Test set up for flammability of electric wires under heated wire conditions at 25 % by volume oxygen	21

Figure 7 — General arrangement of modified burner and flame dimensions 24

Figure 8 — General arrangement of apparatus for flammability test 25

Tables

Table 1 — Description of test equipment (as per Figure 6)..... 22

Foreword

This document EN 14090:2002 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.

Annex A is informative.

This standard includes a Bibliography.

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-70-21

Introduction

All non-metallic materials are inherently flammable, the degree to which this is true is dependant on the chemical nature of the material itself and the environment to which the material is exposed. In the closed environment of a manned spacecraft this can lead to a potentially dangerous situation and close control is therefore required.

1 Scope

This European Standard specifies a multi-test procedure for the determination of the flammability characteristics of non-metallic materials under a set of closely controlled conditions. The test procedure covers both individual materials and materials used in configuration. This standard describes a series of tests to provide data for aid in the evaluation of the suitability of materials for use in a space vehicle crew compartment. The data obtained are in respect to the ease of ignition and the flame propagation characteristics of materials.

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*.

DIN 50050-1, *Testing of materials; burning behaviour of materials; small burning cabinet*.

ISO 6941:1984, *Textile fabrics — Burning behaviour — Measurement of flame spread properties of vertically oriented specimens*.

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, ECSS-Q-70 and the following apply.

3.1.1

C_{lim}

minimum volumetric concentration of oxygen contained in an oxygen-nitrogen mixture, in the presence of which a material can still combust after ignition from the bottom

3.1.2

flammability

measure of the ease with which a material is set on fire

3.2 Abbreviated terms

The following abbreviated term is defined and used within this standard.

Abbreviation	Meaning
r.m.s.	root-mean-square

4 Test procedure

4.1 Preparatory conditions

4.1.1 Hazards, health and safety precautions

Particular attention shall be given to health and safety precautions. A safety checklist is produced below.

- a. Hazards to personnel, equipment and materials shall be controlled and reduced to a minimum.
- b. Hazardous substances, items and operations shall be isolated from other activities.
- c. Items and controls shall be so located that personnel are not exposed to hazards such as chemical burns, electric shock, cutting edges, sharp points or toxic atmospheres.
- d. Suitable warning and caution notes shall be provided in operations, storage, transport, testing, assembly, maintenance and repair instructions and distinctive markings placed on hazardous items, equipment or facilities for personnel protection.

4.1.2 Preparation of samples

4.1.2.1 Configuration of samples

Sufficient specimens of the material in their minimum thickness of intended use shall be submitted for testing (for actual numbers see the individual test methods).

4.1.2.2 Cleaning

The cleaning and other treatment of the samples shall be the same as that to which the sample is submitted before incorporation into the spacecraft. Further cleaning or treatment shall not be carried out by the test house.

4.1.2.3 Handling and storage

Contamination of the sample during handling shall be avoided by the use of, for instance, suitable protective gloves. In addition, samples shall be stored in a cleanliness-controlled area with an ambient temperature of $(22 \pm 3) ^\circ\text{C}$ and relative humidity of $(55 \pm 10) \%$. Coated surfaces shall be shielded from contact by using polyethylene or polypropylene bags or sheets. Mechanical damage shall be avoided in the standard way by packing the polyethylene- or polypropylene-wrapped test pieces in clean, dust- and lint-free material.

Limited-life material shall be labelled with its relative shelf-life and date of manufacture, or date of delivery if date of manufacture is not known.

4.1.2.4 Identification

Materials submitted for testing shall be accompanied by a clear description of, for instance, the name and nature of the material or processing.

4.1.3 Facilities

4.1.3.1 Cleanliness

The work area shall be clean and free of dust. Air used for ventilation shall be filtered to prevent contamination of the workpieces by moisture, oil or dust.

4.1.3.2 Environmental conditions

- a. **Test process.** Preferably the same as for conditioning (see below) unless otherwise stated.
- b. **Conditioning temperature.** See 4.1.2.3 above. This can be achieved either in a conditioning room, or by the use of desiccators filled with silica gel or a saturated salt solution.

NOTE A saturated salt solution of calcium nitrate gives approximately 51 % humidity at the testing temperature.

4.1.3.3 Special utilities

Oxygen and nitrogen supplies (minimum purity 99,9 %).

4.1.4 Equipment

4.1.4.1 Test equipment

Suitable test equipment fulfilling the monitoring requirements detailed in the applicable test method shall be available.

4.1.4.2 Special apparatus

As detailed in the applicable test method.

4.2 Test methods

4.2.1 Categories

Four test methods are included within this Standard. They can be divided into two different categories as indicated below:

- **Screening tests.** These are the prime tests to be performed on a material to assess its basic acceptability or otherwise with respect to flammability. They are designed to test the material under worst case test conditions, with respect to, for instance, environment, use, or thickness. Two tests form the basis for acceptance or otherwise of most non-metallic materials (tests 1 and 2) but are very different in the data generated. The choice of which test method should be used is dependant on the project concerned and shall be specified within the business agreement. Test 3 is related specifically to wire insulation materials. Materials which meet the requirements of these tests may be considered for general application, within the constraints of the test conditions used.
- **Configuration test.** Materials failing to meet the requirements of the applicable screening test shall be subject to testing in configuration. Materials which are shown to be acceptable in this manner may be accepted for restricted application, within the constraints of the test conditions used. Materials which fail this test shall be subject to a deviation request. Examples are:
 - flammable adhesives where the use is to bond two non-flammable substrates together, or
 - flammable conformal coatings applied thinly to a non-flammable printed circuit board.
- **Additional tests.** These tests may be proposed related to the determination of such properties as flash and fire point, or heat of combustion. These shall, however, be decided on a case-by-case basis.

4.2.2 Screening tests

4.2.2.1 Test 1: Upward propagation test²⁾

a. Scope

The purpose of this test is to determine the flammability characteristics of candidate materials supplied to a standard format when exposed to an ignition source applied at the bottom edge. This test in general is applicable to NASA payloads (e.g. Space Station, STS). If the materials are unavailable in the standard format then the test described in subclause 4.2.3 shall be followed.

b. Preparation of specimen

After visual inspection to verify that no cuts, abrasions or other flaws exist, the material samples shall be prepared as follows:

1. films, fabrics, sheets and composites shall be tested in the “as received” condition. Samples shall be cut in the form of rectangles 300 mm × 64 mm minimum. Foams and high-bulk materials shall be tested in the “as applied” thickness and have the same minimum dimensions as specified above;
2. primers, coating materials, paints and pressure-sensitive tapes shall be applied on the substrate materials intended for use, if known. The coatings shall be applied in a thickness equivalent to normal use and post-cured in accordance with prescribed manufacturing processes. If the spacecraft substrate is not available, the coatings shall be applied to 300 mm × 60 mm × 0,075 mm aluminium panels;
3. the test specimens shall be conditioned at $(22 \pm 3) ^\circ\text{C}$ and $(55 \pm 10) \%$ relative humidity for 24 h before testing.

c. Test conditions: pressures and atmosphere

The test pressure and atmosphere shall be specified to represent the most hazardous atmosphere anticipated in the spacecraft.

d. Test equipment and apparatus

- **Chamber.** The test chamber shall have a volume sufficient to ensure complete combustion of the sample under test. It shall have therefore a minimum volume of 250 l and be suitably constructed to ensure safe operation. A window or viewing port for visual observation and recording shall be included. Internal lighting should be installed. Suitable feed-throughs shall be available for gas inlets, evacuation, venting to air, and electricity for ignition. Organic materials used in the construction of the chamber shall be of a type that contribute little or no outgassing to the chamber.
- **Pressure gauge.** Apparatus shall include a pressure gauge capable of measuring pressures to an accuracy of 10 hPa.

²⁾ Based on NASA STD 6001 Test 1.