INTERNATIONAL STANDARD

# ISO 23020

First edition
2021-09

# Space systems — Determination of test methods to characterize material or component properties required for break-up models used for Earth re-entry

*Systèmes spatiaux — Détermination des méthodes d'essai pour caractériser les matériaux ou les éléments de structure nécessaires pour les modèles de calcul de « désintégration » utilisés pour la rentrée terrestre*

This document is a preview generated by EVS

Reference number
ISO 23020:2021(E)

© ISO 2021

This document is a preview generated by EVS

**COPYRIGHT PROTECTED DOCUMENT**

© ISO 2021

All rights reserved. Unless otherwise specified, or required in the context of its implementation, no part of this publication may be reproduced or utilized otherwise in any form or by any means, electronic or mechanical, including photocopying, or posting on the internet or an intranet, without prior written permission. Permission can be requested from either ISO at the address below or ISO's member body in the country of the requester.

ISO copyright office
CP 401 • Ch. de Blandonnet 8
CH-1214 Vernier, Geneva
Phone: +41 22 749 01 11
Email: copyright@iso.org
Website: www.iso.org

Published in Switzerland

# Contents

Page

**Foreword** ... **iv**
**Introduction** ... **v**
**1 Scope** ... **1**
**2 Normative references** ... **1**
**3 Terms, definitions and abbreviated terms** ... **1**
3.1 Terms and definitions ... 1
3.2 Abbreviated terms ... 5
**4 Methodology of material characterization** ... **5**
4.1 General ... 5
4.2 Temperature range ... 5
4.3 Type of tests ... 6
4.4 Test conditions ... 6
4.5 Mechanisms of degradation ... 7
**5 Definition of the elementary tests** ... **7**
5.1 General ... 7
5.2 List of the elementary tests ... 8
5.3 Composite materials specifications ... 9
**6 Metallic and metallic composite materials** ... **10**
6.1 Test conditions ... 10
6.2 List of the recommended standards ... 10
**7 Organic and organic composite materials** ... **11**
7.1 Organic materials ... 11
7.1.1 General ... 11
7.1.2 Test conditions ... 11
7.2 Organic composite materials ... 11
7.2.1 General ... 11
7.2.2 Test conditions in virgin state ... 11
7.2.3 Test conditions in charred state ... 12
7.3 List of the recommended standards ... 12
**8 Ceramic and associated composite materials** ... **12**
8.1 Test conditions ... 12
8.2 List of the recommended standards ... 13
8.2.1 Ceramic ... 13
8.2.2 Ceramic composite ... 13
**Bibliography** ... **14**

This document is a preview generated by EVS

# 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.

The procedures used to develop this document and those intended for its further maintenance are described in the ISO/IEC Directives, Part 1. In particular, the different approval criteria needed for the different types of ISO documents should be noted. This document was drafted in accordance with the editorial rules of the ISO/IEC Directives, Part 2 (see www.iso.org/directives).

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. ISO shall not be held responsible for identifying any or all such patent rights. Details of any patent rights identified during the development of the document will be in the Introduction and/or on the ISO list of patent declarations received (see www.iso.org/patents).

Any trade name used in this document is information given for the convenience of users and does not constitute an endorsement.

For an explanation of the voluntary nature of standards, the meaning of ISO specific terms and expressions related to conformity assessment, as well as information about ISO's adherence to the World Trade Organization (WTO) principles in the Technical Barriers to Trade (TBT), see www.iso.org/iso/foreword.html.

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

Any feedback or questions on this document should be directed to the user's national standards body. A complete listing of these bodies can be found at www.iso.org/members.html.

This document is a preview generated by EVS


© ISO 2021 – All rights reserved

# Introduction

New regulations require unmanned spacecraft and launch vehicle orbital stages, called space bodies in this document, to be designed and manufactured in such way that fragments generated during Earth re-entry cannot cause casualties, damage to property or environmental pollution on the ground (see ISO 24113).

Space bodies are submitted to high aero-thermodynamic fluxes, pressures and shear stresses that lead to their disintegration into fragments that can potentially reach ground after a re-entry. These fragments are generated by the effect of aero-thermal loads seen by components that constitute a space body. The assessment of the fragmentation and subsequent survivability of the fragments in terms of size and trajectory is based on simulation.

The methodology to determine the size of the debris is based on an idealized two-step process, called fragmentation and survivability.

— Fragmentation

  Based on the knowledge of the orbital (ballistic) trajectory of the space body and the knowledge of its design, the computation of temperature and stresses determine the most probable failure locations that will generate sub components. The breakup fragments prior to re-entry are termed debris.

— Survivability

  The objective is then to determine if debris can survive (no completely burned), and then if the final size and energy when touching down the Earth are in accordance with the international regulation.

  The computation of the final size and energy of the debris is based on generic geometry definition, homogenized properties and on the knowledge of their trajectories.

For both fragmentation and survivability, suitable thermal response models require a range of material properties for a full characterization of the material response.

Thermal tests used to determine material properties need to be well defined and shared between spacecraft manufacturers and regulation authorities.

There are a range of relevant spacecraft materials, from metals, organic and ceramics to composite materials.

As a result, the material or component properties used in break-up models is an essential model input.

Objects that separate during the ascent phase and impact the ground are addressed in ISO 14620-2.

Assessment, mitigating and control of potential risks created by the re-enter of objects from the orbit are addressed in ISO 27875.

This document is a preview generated by EVS

© ISO 2021 – All rights reserved 

This document is a preview generated by EVS

# Space systems — Determination of test methods to characterize material or component properties required for break-up models used for Earth re-entry

This document is a preview generated by EVS

## 1 Scope

This document defines the elementary thermal tests to obtain thermal properties of materials and composite materials used to manufacture space body to support the fragmentation and survivability analysis.

This document does not apply to spacecraft containing nuclear power sources[1].

## 2 Normative references

There are no normative references in this document.

## 3 Terms, definitions and abbreviated terms

### 3.1 Terms and definitions

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

ISO and IEC maintain terminology databases for use in standardization at the following addresses:

— ISO Online browsing platform: available at https://www.iso.org/obp

— IEC Electropedia: available at https://www.electropedia.org/

**3.1.1**
**ablation**
chemical change and removal of surface *material* (3.1.12) due to the action of external high temperature heating

Note 1 to entry: Ablation can be a chemical process, addressing chemical reaction (gas-solid or gas-liquid).

Note 2 to entry: Ablation can be a physical process addressing vaporization, melting, fusion.

Note 3 to entry: Ablation can be a mechanical process addressing phenomena of erosive process (applied to solid or liquid surface) linked to pressure effect and wall shear stress due to high-speed motion.

[SOURCE: EN 16603-31:2014, 3.2.4.2, modified — Notes 1, 2 and 3 to entry have been added.]

**3.1.2**
**break-up**
event that completely or partially destroys an object and generates *space debris* (3.1.18)

Note 1 to entry: Debris generated during earth *re-entry* (3.1.16) can survive and fall to the ground.

[SOURCE: ISO 24113:2019, 3.2, modified — Note 1 to entry has been added.]

© ISO 2021 – All rights reserved