TECHNICAL SPECIFICATION

ISO/TS 20991

First edition
2018-07

Space systems — Requirements for small spacecraft

Systèmes spatiaux — Exigences relatives aux petits engins spatiaux

Reference number
ISO/TS 20991:2018(E)

ISO copyright office
CP 401 • Ch. de Blandonnet 8
CH-1214 Vernier, Geneva
Phone: +41 22 749 01 11
Fax: +41 22 749 09 47
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 and definitions **1**
4 Symbols and abbreviated terms **2**
5 Requirements **2**
5.1 Launch interface 2
5.2 Safety 2
5.3 Main payload, adjacent payload(s), and launcher harmlessness 3
5.3.1 Separation 3
5.3.2 Outgassing 3
5.3.3 Dummy specimen 3
5.3.4 Power state, radio transmission and deployable mechanism 3
5.3.5 Radio Frequency Compatibility 3
5.4 Debris mitigation 3
5.5 Use of radio frequencies 3
5.6 UN registration 4
5.7 Verification for design and manufacturing 4
5.8 CubeSat 4
5.9 Release from ISS 4
6 Verification **4**
Bibliography **6**

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.

Introduction

Since 2013, the number of small spacecraft built and launched has shown explosive growth. These small spacecraft are often built by universities, or by newcomers to the space sector, employing untraditional development philosophy.

One particularity of small spacecraft is their need to be launched either with a main payload or in a grapple, which implies specific requirements.

Besides requirements regarding mission success or other goals, which are beyond the scope of this document, there are minimum requirements every small spacecraft complies with regardless of its size, mission, value, capability or any other nature. The purpose of this document is to clearly state those minimum requirements.

This document provides references to existing standards and documents that elaborate on those requirements, especially for the benefit of those who are entering the space sector through small spacecraft development and utilization.

The document was originally proposed as an International Standard. Although the committee draft for voting obtained enough support from P-member countries to proceed to the draft international standard stage, a unanimous agreement was not obtained about the need of publishing the document that referenced the existing standards and documents as an International Standard. Considering the need of having a normative document describing the requirements for small spacecraft, however, the document was resubmitted as a Technical Specification. By the time of review in three years from now, other small spacecraft related standards may be proposed and definition of small spacecraft may advance further. Depending on the situation surrounding small spacecraft then, the decision will be made on whether the document will be upgraded to an International Standard or not.

Space systems — Requirements for small spacecraft

1 Scope

This document describes minimum requirements for small spacecraft.

Small spacecraft may employ untraditional spacecraft development and management philosophy. These spacecraft projects are usually budget-limited or mass-limited, which makes a single (exclusive) launch unaffordable.

The scope of this document encompasses different categories of small spacecraft — so-called mini-, micro-, nano-, pico- and femto-, as well as CubeSat, spacecraft. Therefore, for the sake of convenience, the term "small spacecraft" is used throughout this document as a generic term.

Regardless of the development philosophy, there are minimum requirements every spacecraft complies with. This document explicitly states those requirements and also refers to existing applicable standards. In that sense, this document serves as the top document to cover the minimum requirements for various stages of small spacecraft system life-cycle — with emphasis on design, launch, deployment, operation, and disposal phases. In this way, (1) safety, (2) harmlessness to co-passengers and launcher, and (3) debris mitigation, are all assured.

This document is addressed to small spacecraft developers, as well as dispenser providers and/or the launch operators.

2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements 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 17770, *Space systems — Cube satellites (CubeSats)*

ISO 19683, *Design qualification and acceptance tests of small spacecraft and units*

ISO 24113, *Space systems — Space debris mitigation requirements*

ISO 14620-1, *Space systems — Safety requirements — Part 1: System safety*

3 Terms and definitions

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

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

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

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

3.1
cubeSat
picosatellite measuring 100 mm cubic and weighing 1,33 kg or less

Note 1 to entry: Variations on the basic form factor are also considered CubeSats.

[SOURCE: ISO 17770:2017]

3.2
deployer
encloses CubeSats within a confined volume with a lid at one side that closes the ejection port during the launch phase

Note 1 to entry: It is capable of carrying one or multiple standard CubeSats and serves as the interface between the CubeSats and launch vehicle.

[SOURCE: ISO 17770:2017]

3.3
launch operator
private or institutional entity in charge of launching spacecraft

Note 1 to entry: This entity is in charge of the corresponding ICD with the launcher, and operates or delegates the launch in accordance with the contract.

3.4
untraditional spacecraft development and management philosophy
philosophy that manages risks in cost and time effective manner to achieve low-cost and fast-delivery

Note 1 to entry: See Reference [1]

4 Symbols and abbreviated terms

COTS	Commercial-Off-The-Shelf
ICD	Interface Control Document
ISS	International Space Station
UN	United Nations
EMC	Electromagnetic Compatibility
MCI	Mass Centering and Inertia

5 Requirements

5.1 Launch interface

Once a launcher ICD is agreed as a part of launch contract, small spacecraft shall comply with the ICD. If small spacecraft is launched as an auxiliary payload, i.e. piggy-back payload, ISO 26869 provides basic rules for writing an ICD and a general format for the document.

5.2 Safety

Every small spacecraft, regardless of its size, mission, value, capability or any other nature, shall comply with safety requirements as indicated in ISO 14620-1.

Specific safety requirements depending on the launcher and mission are commonly stated in the launcher ICD.

Every small spacecraft shall also comply with the given safety launch site regulation (hazards related to pressure, pyrotechnics, EMC, contamination, chemical and others).

5.3 Main payload, adjacent payload(s), and launcher harmlessness

5.3.1 Separation

Capability of separation and jettisoning from launcher, with respect to given parameters (such as speed, cone angle separation or others), in order to avoid any collision during separation, shall be demonstrated.

An aborted separation in case multiple point attachments are not fully released shall not create a situation which might induce damage to adjacent payload(s) or to the launcher.

5.3.2 Outgassing

If small spacecraft is launched as an auxiliary payload, i.e. auxiliary (or piggy-back) payload, or shares the launch vehicle with others, it shall satisfy maximum out-gassing criteria specified in the launcher ICD.

NOTE If not specified in the launcher ICD, the outgassing criterion of ISO 17770:2017, 5.1.5 is used.

5.3.3 Dummy specimen

If small spacecraft is launched as an auxiliary payload, i.e. piggy-back payload, or shares the launch vehicle with others, a dummy spacecraft representative for MCI shall be prepared according to the launch contract.

NOTE In case the foreseen small spacecraft, as auxiliary spacecraft, would not be in time, or would finally not be accepted to be launched together with the main paying passenger, and in order to avoid some last minute dynamic coupled analysis, this dummy can be mounted on the launcher (but not separated from the launcher).

5.3.4 Power state, radio transmission and deployable mechanism

If small spacecraft is launched as an auxiliary payload, i.e. piggy-back payload, or shares the launch vehicle with others, it shall comply with requirements on the state of satellite power during launch phase, the start of radio emission and the activation of deployable mechanism specified in the launcher ICD.

NOTE 1 Typically, small spacecraft are required to turn off the power with multiple inhibits during its launch phase. They are also required to start the radio transmission and activate the deployable mechanism only after certain moments specified in the launcher ICD from the launch vehicle separation or the release into space.

NOTE 2 “Turn off” means no current flows in the circuit.

5.3.5 Radio Frequency Compatibility

The radio frequency compatibility with launcher, the main payload(s) and/or other small spacecraft(s) shall be assured as required in the ICD under launch operator management.

5.4 Debris mitigation

Every small spacecraft, regardless of its size, mission, value, capability or any other nature, shall comply with the debris mitigation requirement provided in ISO 24113.

NOTE See Reference [2] as an informative reference to mitigation design and operation guidelines.

5.5 Use of radio frequencies

The use of radio frequencies is covered by international and domestic regulations. These apply for every small spacecraft, regardless of its size, mission, value, capability or any other nature.

International and domestic regulations on the usage of radio frequencies also applies for ground station operations.

International frequency coordination is done through the International Telecommunication Union before a spacecraft is launched.

NOTE See Reference [3] for details.

5.6 UN registration

The United Nations requires that every small spacecraft, regardless of its size, mission, value, capability or any other nature, be registered after launch.

NOTE The registration is typically done through a government body of the country that owns the spacecraft. See Reference [3].

General Assembly resolution 62/101 is also taken into consideration to share the information of important changes of the status of spacecraft, in particular when they have become non-functional. See Reference [4].

5.7 Verification for design and manufacturing

Testing is a part of verification. Small spacecraft try to minimize the testing cost while managing risks. ISO 19683 describes minimum test requirements to qualify the design and manufacturing methods of small spacecraft and units, and to accept the final products.

ISO 19683 puts emphasis on achieving reliability against infant mortality after launch to orbit while maintaining low-cost and fast-delivery.

A unit based on COTS parts and technology shall be qualified against the test level and duration described in ISO 19683 to provide the minimum assurance that it has a certain level of tolerance against the launch environment and the space environment after launch vehicle separation.

Integrity under launcher static and dynamic loads and reliability of the separation demonstration device (transducer or other) if any shall be demonstrated before flight.

5.8 CubeSat

If small spacecraft is to be launched as a CubeSat, the satellite and its Deployer shall comply with the requirements described in ISO 17770. In the event of any conflict regarding requirements between ISO 17770 and this document, the requirements in this document supersede those of ISO 17770.

5.9 Release from ISS

If small spacecraft is to be released from ISS, the satellite shall also comply with the requirements specific to the ISS release.

6 Verification

Verification of compliance with requirements listed below shall be documented with sufficient precision and quality to allow review and approval by the appropriate authority.

a) safety (5.2);

b) main payload, adjacent payload(s), and launcher harmlessness (5.3);

c) debris mitigation (5.4);

d) use of radio frequencies (5.5);

e) testing related to safety, debris mitigation, and harmlessness to co-passengers and launcher (5.7); and

f) CubeSat (5.8).

The documentation regarding these verifications may be required by the launch operator to guaranty harmlessness to the main passenger or the co-passengers of the flight.