

This is a preview of "ISO/TR 18146:2020". [Click here to purchase the full version from the ANSI store.](#)

Second edition
2020-10

Space systems — Space debris mitigation design and operation manual for spacecraft

Systèmes spatiaux — Conception de réduction des débris spatiaux et manuel d'utilisation pour les engins spatiaux



Reference number
ISO/TR 18146:2020(E)

© ISO 2020

This is a preview of "ISO/TR 18146:2020". [Click here to purchase the full version from the ANSI store.](#)



COPYRIGHT PROTECTED DOCUMENT

© ISO 2020

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

This is a preview of "ISO/TR 18146:2020". [Click here to purchase the full version from the ANSI store.](#)

Contents

	Page
Foreword	v
Introduction	vi
1 Scope	1
2 Normative reference	1
3 Terms and definitions	1
4 Symbols and abbreviated terms	1
5 System-level activities	2
5.1 General.....	2
5.2 Design for limiting the release of objects.....	3
5.2.1 Intents of requirements in ISO 24113:2019 ^[1]	3
5.2.2 Work breakdown.....	3
5.2.3 Identification of released objects and design measures.....	4
5.2.4 Design measures.....	5
5.2.5 Monitoring during operation.....	5
5.2.6 Preventing failure.....	5
5.3 Prevention of break-up.....	5
5.3.1 General.....	5
5.3.2 Break-up caused by intentional behaviour, or stored energy.....	6
5.3.3 Break-up caused by a collision with catalogued objects.....	7
5.3.4 Break-up caused by the impact of debris or meteoroid.....	11
5.4 Disposal after the end of mission to minimize interference with the protected regions ...	14
5.4.1 Intents of requirements in ISO 24113:2019 ^[1]	14
5.4.2 Work breakdown.....	15
5.4.3 Procedure for determination of mission extension or termination.....	17
5.4.4 Disposal plan.....	19
5.4.5 Estimation of the orbital lifetime.....	20
5.4.6 Design of the function to remove spacecraft from the protected regions.....	20
5.4.7 Assurance of resources for disposal manoeuvre.....	21
5.4.8 Reliability of disposal function up to the design life.....	21
5.4.9 Useful life limited items.....	22
5.4.10 Health assessment procedure and contingency planning.....	22
5.4.11 Design the monitoring system to monitor the critical parameters.....	23
5.4.12 Assessment of the risk of debris impact.....	24
5.4.13 Operational remediations.....	24
5.4.14 Decision-making to extend or terminate the mission.....	25
5.4.15 Disposal.....	25
5.4.16 Registration of objects launched into outer space complying with the UN treaty.....	25
5.4.17 Specific subjects for GEO mission.....	26
5.4.18 Specific subjects for LEO mission.....	26
5.4.19 High elliptical orbit mission.....	26
5.5 Ground safety from re-entering objects.....	26
5.5.1 Intents of requirements in ISO 24113:2019 ^[1]	26
5.5.2 Work breakdown.....	26
5.5.3 Identification of requirements.....	27
5.5.4 Hazards analysis.....	27
5.5.5 Design measures.....	28
5.5.6 Specific design for controlled re-entry in subsystem level.....	29
5.5.7 Notification.....	29
5.5.8 Conduct controlled re-entry and monitoring.....	29
5.6 Quality and reliability assurance.....	29
6 Debris-related work in the development cycle	30

This is a preview of "ISO/TR 18146:2020". [Click here to purchase the full version from the ANSI store.](#)

6.1	General.....	30
6.2	Concept of debris-related work in phased planning.....	30
6.3	Mission analysis phase (phase 0 or pre-phase A).....	34
6.3.1	General.....	34
6.3.2	Debris-related work.....	34
6.4	Feasibility phase (phase A).....	35
6.5	Definition phase (phase B).....	35
6.5.1	Work in phase B.....	35
6.5.2	Work procedure.....	35
6.6	Development phase (phase C).....	36
6.6.1	Work in phase C.....	36
6.6.2	Conditions.....	37
6.7	Production phase (phase D).....	38
6.7.1	Work in phase D.....	38
6.7.2	Qualification review.....	38
6.8	Utilization phase (phase E).....	38
6.8.1	Launch preparation.....	38
6.8.2	Lift-off time.....	39
6.8.3	Initial operation.....	39
6.8.4	Normal operation.....	39
6.8.5	Decision to terminate or extension of operations.....	40
6.9	Disposal phase (phase F).....	40
7	System-level information.....	41
7.1	Mission design.....	41
7.2	Mass allocation.....	41
7.3	Propellant allocation.....	42
7.4	Power allocation.....	42
8	Subsystem/component design and operation.....	42
8.1	General.....	42
8.2	Debris-mitigation measures and subsystem-level actions for realizing them.....	42
8.3	Propulsion subsystem.....	44
8.3.1	General.....	44
8.3.2	Debris-related design.....	44
8.3.3	Information of propulsion subsystems.....	44
8.3.4	Information in component design.....	46
8.4	Attitude and orbit control subsystem.....	48
8.4.1	Debris-related designs.....	48
8.4.2	Information of AOCS.....	48
8.4.3	Information of component design.....	49
8.5	Power-supply subsystem.....	49
8.5.1	Debris-related designs.....	49
8.5.2	Information of power-supply subsystems.....	50
8.5.3	Information of component design.....	51
8.6	TT&C subsystem.....	52
8.6.1	Debris-related designs.....	52
8.6.2	Information of TT&C subsystems.....	52
8.6.3	Information of component design.....	53
8.7	Structural subsystem.....	53
8.7.1	Debris-related design.....	53
8.7.2	Information of structural subsystems.....	53
8.8	Thermal-control subsystem.....	54
8.8.1	Debris-related design.....	54
8.8.2	Information of thermal-control subsystem.....	54
	Bibliography.....	55

This is a preview of "ISO/TR 18146:2020". [Click here to purchase the full version from the ANSI store.](#)

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*.

This second edition cancels and replaces the second edition (ISO/TR 18146:2015), which has been technically revised.

The main changes compared to the previous edition are as follows:

- text has been updated to be aligned with ISO 24113:2019^[1];
- information has been added that the ejection of slag debris from solid rocket motors is limited newly in low Earth orbit in addition to GEO previously;
- information relating to collision avoidance against catalogued space objects has been improved;
- information of the intention of the new requirement avoiding fragmentation caused by impact of space debris and meteoroid, and typical assessment procedure in the world space agencies has been added;
- corresponding to the new requirement limiting the total probability of successful disposal to be at least 0,9, the state of the art to confirm the compliance with that taken in the world space industries and national agencies has been added;
- other information relating to the changes in ISO 24113 has been added.

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

Coping with debris is essential to preventing the deterioration of the orbital environment and ensuring the sustainability of space activities. Effective actions are also taken to ensure the safety of those on the ground from re-entering objects that were disposed of from low-Earth orbit.

Recently, the orbital environment has become so deteriorated by debris that action is taken to prevent damage due to the impact. Collision avoidance manoeuvres are taken to avoid large debris (larger than 10 cm, for example), which can be observed from the ground. Spacecraft design protects against micro-debris (even smaller than 1 mm) that can cause critical damage to vulnerable components.

ISO 24113:2019^[1] and other ISO documents, introduced in Bibliography, were developed to encourage debris mitigation activities.

In [Clause 5](#), the major space debris mitigation requirements are informed.

In [Clause 6](#), the information of life-cycle implementation of space debris mitigation related activities is provided.

In [Clause 7](#), the system level aspects stemming from the space debris mitigation requirements are highlighted; while in [Clause 8](#), the impacts at subsystem and component levels are detailed.

This document provides comprehensive information on what ISO requires to do for the design and operation of the launch vehicles, and where such requirements and recommendations are registered in a set of ISO documents.