



Space sustainability

Adoption Notice of ISO 24113: Space systems - Space debris mitigation requirements

**ECSS Secretariat
ESA-ESTEC
Requirements & Standards Section
Noordwijk, The Netherlands**

Foreword

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. 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.

This Adoption Notice has been prepared by the ECSS Space Debris Working Group, reviewed by the ECSS Executive Secretariat and approved by the ECSS Technical Authority.

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Change log

ECSS-U-AS-10A	Never issued
ECSS-U-AS-11-00A	Never issued
ECSS-U-AS-10C 10 February 2012	First issue Adoption Notice of ISO 24113:2011 (Second edition 2011-05)
ECSS-U-AS-10C Rev.1 3 December 2019	First issue Revision 1 Adoption Notice of ISO 24113:2019 (Third edition 2019-07)
ECSS-U-AS-10C Rev.2 9 February 2024	First issue Revision 2 Adoption Notice of ISO 24113:2023 (Fourth edition 2023-05)

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1 Scope

This document identifies the clauses and requirements (including notes and clarifications) modified or added with respect to the standard ISO 24113, Space systems – Space debris mitigation requirements, [fourth edition 2023-05](#) (referred to as ISO 24113:2023) for application in ECSS.

Context information

The standard ISO 24113, Space systems — Space debris mitigation requirements has been developed by ISO TC20/SC14. The key space debris mitigation requirements have been thoroughly discussed at international level, agreed by the ISO members and published as standard ISO 24113.

Aiming at the development of worldwide implementation standards dealing with space debris mitigation, ECSS has proactively contributed to the preparation of ISO 24113.

ECSS decided to adopt and apply ISO 24133 with a few modifications, identified in the present document, to account for the needs of the ECSS members.

In 2012, ECSS adopted ISO 24113:2011 with a minimum set of modifications (as per ECSS-U-AS-10C), which were mostly incorporated in ISO 24113:2019. ISO 24113:2019 represented a significant improvement with respect to the previous ISO 24113:2011, therefore, in 2019 ECSS decided to adopt ISO 24113:2019 as it was, with only a few clarifications.

In May 2023, ISO 24113:2023 was issued with an improved, clearer text, but with limited delta requirements with respect to ISO 24113:2019. ECSS decided to adopt ISO 24113:2023 with a few modifications and delta requirements to account for the needs of the ECSS members.

A few major modifications are addressed in the present document to:

- reduce the number and the orbit lifetime of launch vehicle orbital stages and space debris left in Earth orbit, and to
- reduce the risk of break-up of spacecraft due to an on-board source of energy or to a collision.

Moreover, the present document provides notes and clarifications with respect to ISO 24113:2023 and references to relevant ECSS standards and handbooks.

3 Application

ECSS-U-AS-10_1300001

- a. ISO 24113:2023, Space systems - Space debris mitigation requirements, fourth edition 2023-05 shall apply with the modifications and clarifications listed in Table 3-1.

ECSS-U-AS-10_1300002

Table 3-1: Applicability table for ISO 24113:2023

Clause or requirement number	Applicability	Applicable text (the new/added text is underlined)	Comments	Text as in the original document (deleted text with strikethrough)
3.13 launch vehicle orbital stage	Modified	launch vehicle orbital stage complete element of a <i>launch vehicle</i> (3.12) that is designed to deliver a defined thrust during a dedicated phase of the launch vehicle's <u>normal</u> operations and achieve orbit	Minor editorial modifications to improve consistency in the terminology.	launch vehicle orbital stage complete element of a <i>launch vehicle</i> (3.12) that is designed to deliver a defined thrust during a dedicated phase of the launch vehicle's operation and achieve orbit
3.20 probability of successful disposal	Added	<u>Note 4 to entry: The calculation of this probability can be based on reliability analyses performed according to "ECSS-Q-ST-30 - Space product assurance – Dependability", "ECSS-Q-HB-30-08 - Space</u>	Note added to clarify and add information on the methods to evaluate the probability of successful disposal (already	

Clause or requirement number	Applicability	Applicable text (the new/added text is underlined)	Comments	Text as in the original document (deleted text with strikethrough)
		<u>product assurance - Components reliability data sources and their use”, or any other methods set by the approving agent.</u>	added in ECSS-U-AS-10C Rev.1).	
7.1.1.3	Modified / Added	<p>Space debris left in Earth orbit by a launch vehicle after normal operations, other than space debris from pyrotechnics and solid rocket motors, shall satisfy the following conditions:</p> <p>a) remain outside the GEO protected region for at least 100 years;</p> <p>b) have an orbit lifetime of less than 25 years if released into an orbit that lies within or crosses the LEO protected region within 100 years;</p> <p><u>c) have a cumulative collision probability until re-entry with space objects larger than 1 cm, less than 10⁻³ if released into an orbit that lies within or crosses the LEO protected region within 100 years.</u></p> <p>NOTE For condition b) the aim is to achieve an orbit lifetime of much less than 25 years.</p>	<ul style="list-style-type: none"> - To better specify the applicability of the clauses, and - To add clause c) to reduce the orbit lifetime of space debris (below 25 years) for densely populated orbital regions with high collision probability. 	<p>Space debris left in Earth orbit by a launch vehicle after normal operations, other than space debris from pyrotechnics and solid rocket motors, shall satisfy the following conditions:</p> <p>a) remain outside the GEO protected region for at least 100 years;</p> <p>b) have an orbit lifetime of less than 25 years if released into an orbit that lies within or crosses the LEO protected region within 100 years.</p> <p>NOTE For condition b) the aim is to achieve an orbit lifetime of much less than 25 years.</p>
7.1.2.2	Modified	<p>Solid rocket motors shall be designed and operated so as not to release space debris larger than 1 mm in their largest dimension into <u>Earth orbit.</u></p> <p>NOTE The main aim of this requirement is to limit the generation of slag debris ejected</p>	<ul style="list-style-type: none"> - To avoid release of space debris larger than 1 mm (originated from solid rocket motors) in the Earth orbit and not only in LEO and GEO protected regions, and 	<p>Solid rocket motors shall be designed and operated so as not to release space debris larger than 1 mm in their largest dimension into the LEO and GEO protected regions.</p> <p>NOTE The main aim of this requirement is to limit the generation of slag debris ejected</p>

Clause or requirement number	Applicability	Applicable text (the new/added text is underlined)	Comments	Text as in the original document (deleted text with strikethrough)
		into Earth orbit during the final phase of combustion. Slag debris is potentially hazardous to current and future space operations due to its size, number and orbit lifetime. This is particularly the case when slag debris is ejected into <u>long-lifetime orbits</u> where it can pose a <u>prolonged</u> impact risk.	<ul style="list-style-type: none"> - To improve consistency in the terminology. 	into Earth orbit during the final phase of combustion. Slag debris is potentially hazardous to current and future space operations due to its size, number and orbital lifetime. This is particularly the case when slag debris is ejected into a high orbital region where it can pose an impact risk for a long period of time .
7.2.1	Added	In Earth orbit, intentional break-up of a spacecraft or launch vehicle orbital stage shall be avoided. <u>NOTE Design for demise measures leading to a fragmentation during atmospheric re-entry are acceptable provided it is demonstrated that they result in a reduced casualty risk and they do not generate additional collision risk in orbit.</u>	<ul style="list-style-type: none"> - Note added to explain that design for demise measures are acceptable (and may have positive effects) under the stated conditions. 	In Earth orbit, intentional break-up of a spacecraft or launch vehicle orbital stage shall be avoided.
7.2.2.6	Modified	If for any reason a <u>spacecraft or</u> launch vehicle orbital stage cannot perform a controlled re-entry as planned, then it shall be passivated, provided that this can be done in a safe, timely and controlled manner.	To extend the application of the clause (passivation) to spacecraft (it was limited to launch vehicle orbital stages).	If for any reason a launch vehicle orbital stage cannot perform a controlled re-entry as planned, then it shall be passivated, provided that this can be done in a safe, timely and controlled manner.
7.2.3.1	Modified / Added	A spacecraft shall have a recurrent manoeuvre capability <u>if it satisfies at least one of the following conditions:</u> <u>a) its normal operations occur within or whilst crossing the GEO protected region;</u>	To extend the clause (of having a recurrent manoeuvre capability) to spacecraft in LEO and in densely populated orbital regions with high collision	A spacecraft that operates in the GEO protected region shall have a recurrent manoeuvre capability.

Clause or requirement number	Applicability	Applicable text (the new/added text is underlined)	Comments	Text as in the original document (deleted text with strikethrough)
		<p><u>b) the spacecraft operates continuously or periodically in the LEO protected region and its orbit lifetime after injection into LEO is longer than 25 years assuming that the evolution of its orbit is subject solely to natural perturbations;</u></p> <p><u>c) its cumulative collision probability with space objects larger than 10 cm is above 10^{-3} through to its end of life.</u></p>	<p>probability (under specified conditions).</p>	
7.2.3.5	Added	<p><u>The risk of collision between a launch vehicle, including the released objects, and inhabitable systems shall be assessed in accordance with the following criteria:</u></p> <p><u>a) the assessment considers the dispersion of the trajectories;</u></p> <p><u>b) the assessment is performed over a time period of 3 days from launch assuming that the orbital evolution of the trajectories is subject solely to natural perturbations.</u></p>	<p>To require an assessment of the risk posed by a launch vehicle to inhabitable systems.</p>	
7.2.3.6	Added	<p><u>If the collision risk between a launch vehicle, including the released objects, and inhabitable systems is assessed to be above the threshold set by an approving agent, then the launch vehicle normal operations shall be adjusted to reduce the risk of collision below the threshold.</u></p>	<p>To require that the risk posed by a launch vehicle to inhabitable systems is lower than a threshold set by an approving agent.</p>	

Clause or requirement number	Applicability	Applicable text (the new/added text is underlined)	Comments	Text as in the original document (deleted text with strikethrough)
7.3.1.2	Modified	<p>During the design of a spacecraft, the probability that a space debris or meteoroid impact prevents the successful disposal of the spacecraft <u>shall be assessed and included in the assessment of the probability of successful disposal.</u></p> <p><u>NOTE: Examples of the calculation of this probability and relevant input models can be found, for instance, in: ECSS-E-ST-10-04 Space Engineering-Space Environment, IADC-04-03 IADC Protection Manual, ISO 16126 Survivability of unmanned spacecraft against space debris and meteoroid impacts for the purpose of space debris mitigation, MIT-COL-MAN-00309-OPS-SD:2021 Small Debris and Meteoroid Risk Requirements Verification Guidelines based on DRAMA/MIDAS.</u></p>	To require that the probability that a space debris or meteoroid impact preventing the successful disposal is included in the computation of the probability of successful disposal (the inclusion was not mandatory).	<p>During the design of a spacecraft, an assessment shall be made of the probability that a space debris or meteoroid impact prevents the successful disposal of the spacecraft.</p> <p>NOTE The result of this assessment can be included in the assessment of the probability of successful disposal, but this is not mandatory.</p>
7.3.2.3	Modified/Added	<p>A spacecraft operating in the GEO protected region with a periodic presence shall be disposed of in such a way that <u>it satisfies at least one of the following conditions:</u></p> <p>a) long-term perturbation forces do not cause it to enter the GEO protected region within 100 years after its end of life;</p> <p>b) <u>after end of life its orbit lifetime is limited to 100 years and the cumulative collision</u></p>	To add a disposal option for specific classes of missions with a periodic presence in the GEO protected region.	A spacecraft operating in the GEO protected region with a periodic presence shall be disposed of in such a way that long-term perturbation forces do not cause it to enter the GEO protected region within 100 years after its end of life.

Clause or requirement number	Applicability	Applicable text (the new/added text is underlined)	Comments	Text as in the original document (deleted text with strikethrough)
		<p><u>probability with space objects larger than 1 cm is less than 10⁻³.</u></p> <p><u>NOTE Option b) is a potential disposal alternative for missions in Highly Eccentric Earth Orbits or Inclined Geosynchronous Orbits.</u></p>		
7.3.3.2	Modified/Added	<p>NOTE 1 Augmenting the orbital decay by means of such a device can increase the collision probability with other space objects. The implied acceptable risk threshold is generally provided by the approving agent.</p> <p><u>NOTE 2 In case the remaining orbit lifetime limit can be satisfied by various orbital trajectories, the preferred trajectory evolution is the one with the least cumulative collision probability after the disposal.</u></p>	To add a note encouraging the disposal action to be performed targeting a lower cumulative collision probability	NOTE Augmenting the orbital decay by means of such a device can increase the collision probability with other space objects. The implied acceptable risk threshold is generally provided by the approving agent.
7.3.3.3	Added	<p><u>A launch vehicle orbital stage released into an orbit that lies within or crosses the LEO protected region within 100 years after normal operations, shall have a probability of collision less than 10⁻³ with space objects larger than 1 cm until re-entry.</u></p>	To add a clause to reduce the orbit lifetime of launch vehicle orbital stages in densely populated, low Earth orbit regions with high collision probability	
8.2.2	Modified/Added	<p>As a minimum, the SDMP shall contain the following:</p> <p>a) the applicable space debris mitigation requirements;</p>	To add a clause asking for the justification for the disposal option selection	<p>As a minimum, the SDMP shall contain the following:</p> <p>a) the applicable space debris mitigation requirements;</p>

Clause or requirement number	Applicability	Applicable text (the new/added text is underlined)	Comments	Text as in the original document (deleted text with strikethrough)
		<p>b) plans for addressing the applicable space debris mitigation requirements;</p> <p>c) the verification and validation means to assess compliance with the applicable space debris mitigation requirements;</p> <p>d) a compliance matrix;</p> <p>e) justifications for non-compliance, including risk trade-offs for each non-compliance;</p> <p><u>f) a justification for the selection of the disposal option.</u></p> <p>NOTE The listed contents of the SDMP include specific requirements, methods, tools and guidelines for which either detailed verification and validation means are not specified, or a risk assessment is required but a threshold is not specified. These are set by the approving agent dealing with requirements in the SDMP.</p>		<p>b) plans for addressing the applicable space debris mitigation requirements;</p> <p>c) the verification and validation means to assess compliance with the applicable space debris mitigation requirements;</p> <p>d) a compliance matrix;</p> <p>e) justifications for non-compliance, including risk trade-offs for each non-compliance.</p> <p>NOTE The listed contents of the SDMP include specific requirements, methods, tools and guidelines for which either detailed verification and validation means are not specified, or a risk assessment is required but a threshold is not specified. These are set by the approving agent dealing with requirements in the SDMP.</p>