

Space sustainability

**ECSS Secretariat**

**ESA-ESTEC**

**Requirements & Standards Section**

**Noordwijk, The Netherlands**

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

This document is distributed to the ECSS Community for Public Review.

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**End of Public Review: 15 September 2023**

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**Foreword**

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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

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| --- | --- |
| Previous steps |  |
| ECSS-U-AS-10CRev2(10July2023)sent3  (10 July 2023) | Draft for Review received from WG convenor (R. Destefanis, TAS) on 10 July 2023. |
| Current step |  |
| ECSS-U-AS-10C Rev.2 DIR1  10 July 2023 | Draft distributed for Public Review.  14 July – 15 September 2023 |
| Next steps |  |
| DIR + impl. DRRs | Draft with implemented DRRs |
| DIR + impl. DRRs | DRR Feedback |
| DIA | TA Vote for publication |
| DIA | Preparation of document for publication (including DOORS transfer for Standards) |
|  | Publication |
|  | **Change log for published Standard (to be updated by ES before publication)** |

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| --- | --- |
| 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.1  3 December 2019 | First issue Revision 2  Adoption Notice of ISO 24113:2023 (Fourth edition 2023-05) |

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# 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/or 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 clarifications with respect to ISO 24113:2023 and references to relevant ECSS standards and handbooks.

# Application

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.

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 *launch vehicle* (3.12) that is designed to deliver a defined thrust during a dedicated phase of the launch vehicle’s normal operations and achieve orbit | Minor editorial modifications to improve consistency in the terminology. | | launch vehicle orbital stage  complete element of a *launch vehicle* (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 | | 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 product assurance - Components reliability data sources and their use”, or any other methods set by the approving agent. | Note added to clarify and add information on the methods to evaluate the probability of successful disposal (already added in ECSS-U-AS-10C Rev.1). | |  |
| 7.1.1.3 | Modified / Added | | 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:  a) remain outside the GEO protected region for at least 100 years;  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;  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.  NOTE For condition b) the aim is to achieve an orbit lifetime of much less than 25 years. | * 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. | | 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:  a) remain outside the GEO protected region for at least 100 years;  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.  NOTE For condition b) the aim is to achieve an orbit lifetime of much less than 25 years. |
| 7.1.2.2 | Modified | | Solid rocket motors shall be designed and operated so as not to release space debris larger than 1 mm in their largest dimension into Earth orbit.  NOTE The main aim of this requirement is to limit the generation of slag debris ejected 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 long-lifetime orbits where it can pose a prolonged impact risk. | * 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 * To improve consistency in the terminology. | | 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~~.  NOTE The main aim of this requirement is to limit the generation of slag debris ejected 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~~al~~ 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.  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. | * 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 spacecraft or 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 if it satisfies at least one of the following conditions:  a) its normal operations occur within or whilst crossing the GEO protected region;  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;  c) its cumulative collision probability with space objects larger than 10 cm is above 10−3 through to its end of life. | To extend the clause (of having a recurrent manoeuvre capability) to spacecraft in LEO and in densely populated orbital regions with high collision probability (under specified conditions). | | A spacecraft ~~that operates in the GEO protected region~~ shall have a recurrent manoeuvre capability. |
| 7.2.3.5 | Added | | The risk of collision between a launch vehicle, including the released objects, and inhabitable systems shall be assessed in accordance with the following criteria:  a) The assessment considers the dispersion of the trajectories.  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**.** | To require an assessment of the risk posed by a launch vehicle to inhabitable systems. | |  |
| 7.2.3.6 | Added | | 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. | To require that the risk posed by a launch vehicle to inhabitable systems is lower than a threshold set by an approving agent. | |  |
| 7.3.1.2 | Modified | | During the design of a spacecraft, the probability that a space debris or meteoroid impact prevents the successful disposal of the spacecraft shall be assessed and included in the assessment of the probability of successful disposal. | 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). | | 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.  ~~NOTE The result of this assessment can be included in the assessment of the probability of successful disposal, but this is not mandatory.~~ |
| 7.3.2.3 | Modified/Added | | A spacecraft operating in the GEO protected region with a periodic presence shall be disposed of in such a way that it satisfies at least one of the following conditions:  a) long-term perturbation forces do not cause it to enter the GEO protected region within 100 years after its end of life;  b) after end of life its orbit lifetime is limited to 100 years and the cumulative collision probability with space objects larger than 1 cm is less than 10−3.  NOTE Option b) is a potential disposal alternative for missions in Highly Eccentric Earth Orbits or Inclined Geosynchronous Orbits. | 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. |
| 7.3.3.2 | Modified/Added | | 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.  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. | 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 | | 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. | 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 | | As a minimum, the SDMP shall contain the following:  a) the applicable space debris mitigation requirements;  b) plans for addressing the applicable space debris mitigation requirements;  c) the verification and validation means to assess compliance with the applicable space debris mitigation requirements;  d) a compliance matrix;  e) justifications for non-compliance, including risk trade-offs for each non-compliance;  f) a justification for the selection of the disposal option.  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. | To add a clause asking for the justification for the disposal option selection | | As a minimum, the SDMP shall contain the following:  a) the applicable space debris mitigation requirements;  b) plans for addressing the applicable space debris mitigation requirements;  c) the verification and validation means to assess compliance with the applicable space debris mitigation requirements;  d) a compliance matrix;  e) justifications for non-compliance, including risk trade-offs for each non-compliance.  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. |