International Standard

ISO 27875

Space systems — Re-entry risk management for uncrewed spacecraft and launch vehicle orbital stages

Systèmes spatiaux — Gestion du risque de la rentrée atmosphérique pour les engins spatiaux sans équipage et les étages orbitaux de lanceurs

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Foreword

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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).

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

This third edition cancels and replaces the second edition (ISO 27875:2019), which has been technically revised. It also incorporates the Amendment ISO 27875:2019/Amd 1:2020.

The main changes are as follows:

— a description explaining the entire analysis process has been added (6.3.2.1);

— a description for the selection of the Earth model and the atmospheric model has been added corresponding to the difference of controlled or uncontrolled re-entry (6.3.2.2);

— adding to the expected number of casualties, the following risk factors have been newly added (6.6 and 7.1) and design measures to reduce each risk have been described (7.4):

  — radioactive substances;

  — floating objects;

  — pressurized or explosive objects;

  — hazardous chemical substances;

— in Annex B, for a more detailed description, Table B.1 has been revised;

— in Annex C, an explanation for the “Expected number of casualties per unit casualty area as an example” has been added with a chart (Figure C.4);

— a design for demise during re-entry has been added as Annex D;

— an “Example of report of the re-entry risk assessment for design review” has been added as Annex E.

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

Under international space treaties, the “launching state” is liable for damage or injuries caused by uncrewed spacecraft and launch vehicle orbital stages that re-enter the Earth's atmosphere. In addition, commercial operators are subject to the national safety regulations or laws of the launching country that relate to the re-entry of spacecraft and launch vehicle orbital stages. To minimize damages and injuries caused by re-entering spacecraft and launch vehicle orbital stages, all parties (i.e. developers, manufacturers, space service providers, satellite operators and launch service providers) should take preventive measures during design and operations.

NOTE Useful background information for this document is available in ISO 24113[2].

Space systems — Re-entry risk management for uncrewed spacecraft and launch vehicle orbital stages

1 Scope

This document provides a framework to assess, reduce and control the potential risks that spacecraft and launch vehicle orbital stages (referred to hereinafter as “space vehicles”) pose to people and the environment when those space vehicles re-enter the Earth's atmosphere and impact the Earth’s surface. It applies to the planning, design and review of space vehicle missions for which controlled or uncontrolled re-entry is inevitable.

This document applies to the following objects when assessing their risk to the ground:

a) objects re-entering from orbit;

b) launch vehicles (including payloads, other objects separated during the ascent phase, etc.) that are mentioned in flight safety activities under ISO 14620-2:2019[1], 6.2;

c) interplanetary spacecraft returning to Earth.

This document does not apply to systems with wings and control functions intended for targeted landing.

This document assumes that the main specifications and operational procedures for ensuring safety on the ground against the re-entry of spacecraft containing radioactive material have already been determined in the mission requirements definition stage, system definition stage, operational concept definition stage, etc. Therefore, apart from matters related to re-entry safety, the main parts of the mission design and operational concept of spacecraft containing radioactive material are outside the scope of this standard.

2 Normative references

The following documents are referred to in the text in such a way that some or all 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 14620-1[1)], *Space systems — Safety requirements — Part 1: System safety*

ISO 17666:2025, *Space systems — Programme management — Risk management*

3 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:

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

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

1) Under preparation. Stage at the time of publication: ISO/FDIS 14620-1:2026.

3.1
controlled re-entry
type of re-entry where the time of re-entry is sufficiently controlled so that the impact of any surviving debris on the surface of the Earth is confined to a designated area

Note 1 to entry: The designated area is usually an uninhabited region, such as an ocean.

3.2
expected number of casualties
number of people who are predicted to be killed or seriously injured by the re-entry, per project or programme

Note 1 to entry: The calculation of the expected *number of casualties* (3.2) is complex. Organizations use different processes to estimate it based on methods deemed applicable by the organizations (see 6.5.1 and Annex C).

Note 2 to entry: The medical profession has defined several different injury-scoring systems to distinguish the *severity* (3.8) of an injury. Broadly, a serious injury is one of such *severity* (3.8) that hospitalization is required.

Note 3 to entry: Typically, the assessment of the expected *number of casualties* (3.2) is conducted at every re-entry event. However, in the case of a system disintegrated into multiple sub-systems that would independently cause re-entry, the approving agent authority requires assessing the total expected *number of casualties* (3.2) of all re-entering objects.

3.3
footprint
envelope of predicted impact points of surviving objects

3.4
likelihood
classification of probability of occurrence of severe events caused by re-entry, classified as “maximum”, “high”, “medium”, “low” and “minimum”, as examples

Note 1 to entry: This term is used in the classification of the probability of occurrence of severe events from the re-entry event.

Note 2 to entry: The definition of this term has been derived from ISO 17666: 2025, 5.2.2 e), Table 2.

3.5
lumped mass approach
one of the typical methods for the survivability analysis to attain the better cost performance effect that assumes the simplified structural and thermal property for simple trajectory, aerodynamic, aerothermodynamic and thermal analyses

Note 1 to entry: This term is used in the re-entry survivability analysis.

Note 2 to entry: The objects are treated as simple solid objects, or combination of multiple layered solid objects. For details, see 6.3.2.2 a).

3.6
risk index
index for scoring schemes for the risk assessment, defined from a combination of the *severity* (3.8) of the consequences and the *likelihood* (3.4) of the occurrence to denote the *risk magnitude* (3.7) of the various risk scenarios

Note 1 to entry: The definition of this term has been derived from ISO 17666: 2025, 5.2.1.2 e) and f).

3.7
risk magnitude
criteria to determine the actions to be taken regarding risks and the decision level related to the associated risk in the project structure based on the risk index and classified with “very high level”, “high risk”, “medium risk”, “low risk” and “very low risk”

Note 1 to entry: The definition of this term has been derived from ISO 17666: 2025, 5.2.1.2 g) and Figure 3.

3.8
severity
classification of the negative consequences caused by re-entry in terms of cost impacts, human safety, etc., when the risk occurs and is categorised as “catastrophic”, “critical”, “major”, “significant” and “negligible”

Note 1 to entry: This term is used in the classification of the negative consequences of the re-entry events.

Note 2 to entry: The definition of this term has been derived from ISO 17666: 2025, 5.2.1.2 e), Table 1.

4 Symbols and abbreviated terms

4.1 Symbols

E_c expected number of casualties (see 6.3.2)

P_i probability of impact

A_c casualty area

A_d projected area of fallen objects

r_d radius of projected area of fallen objects

r_h radius of a standing individual

A_h cross-sectional area of a standing individual

4.2 Abbreviated terms

AIP	aeronautical information package
ATCM	Antarctic Treaty Consultative Meeting
CFRP	carbon fibre reinforced plastics
CIESIN	Centre for International Earth Science Information Network
DTM	Deutsche Tourenwagen Masters
G7	Group of Seven
GGP	gridded global population distribution of the world
GPW	gridded population of the world
GRAM	global reference atmospheric model
ICAO	International Civil Aviation Organization
NAVAREA	navigational area
NOTAM	notice to airmen
NOTMAR	notice to mariners
RRAMP	re-entry risk assessment and mitigation plan
TCBMs	transparency and confidence-building measures
UNESCO	United Nations Educational, Scientific and Cultural Organization

5 Re-entry risk management

5.1 General

Re-entry risk management shall be conducted according to ISO 17666, which is briefly explained in Annex B. This document mainly focuses on the estimation of the risk of casualty and, partly, on ground pollution. This also presents requirements for when controlled re-entry would be conducted to reduce risk.

5.2 Re-entry safety programme

In addition to the safety activities required by ISO 14620-1:—,4.4, a re-entry safety programme shall be established to ensure:

a) minimization of damage and injuries caused by re-entering spacecraft or launch vehicle orbital stages;

b) suggestions for corrective actions regarding risks assessed as exceeding safety requirements.

5.3 Re-entry safety oversight and management

In accordance with ISO 14620-1:— 4.3, safety representatives shall be appointed. Safety representatives shall be responsible for safety activities, have the right to access related data and be authorised to reject any project document, stop any project activities, or interrupt hazardous operations. In accordance with ISO 14620-1:—, 4.4, at each design or operation phase, a safety representative shall review the result of the safety assessment, review the plan for the next phase and endorse the decision to proceed to the following phase. If there are requirements that cannot be met, a request for deviation or a waiver is generated and reviewed, and the space vehicle shall be disposed of in accordance with ISO 14620-1:—, 4.10.6.

5.4 Re-entry risk assessment and mitigation plan (RRAMP)

5.4.1 Preparation of the plan

A RRAMP shall be prepared and updated throughout the project life cycle as part of the safety data package specified in ISO 14620-1:—,4.10.5.

The RRAMP defines the work plan corresponding to each requirement in this document and detailed schedules for critical activities (design, analysis and testing reviews) throughout the life of the project. Typical contents of the RRAMP are given in Annex A.

5.4.2 Authorization of the plan

The RRAMP shall be approved by the safety representative, the head of project management and the customers. The RRAMP is changed and evolved as the project progresses.

5.5 Re-entry risk management concept

The scoring schemes for the severity of consequence of re-entry hazards are defined by the national authority. Risk is assessed by the risk magnitude expressed as the combination of its severity and likelihood (see Annex B and ISO 17666:2025).

The scoring is typically related to the casualty area (see 6.5.1.2) in the case of casualty risk, damage of properties in the case of social risk, or pollution on the ground in the case of environmental risk (see Table B.1 or ISO 17666:2025, Table 1). Generally, a risk index is defined as a combination of severity and likelihood, and a risk magnitude is defined for each risk index.

For assessing re-entry risk:

a) In the case of uncontrolled re-entry, the expected number of casualties is calculated as a function of the casualty area, orbital inclination and population density. Since falling to the ground is unavoidable, likelihood, as one factor of the risk index, is fixed at 1,0, and the risk index is equivalent to the rest of