

**UNITED NATIONS
OFFICE FOR OUTER SPACE AFFAIRS**

**Space Debris Mitigation Guidelines of the Committee
on the Peaceful Uses of Outer Space**



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Cover illustration: European Space Agency.

This image is an artistic impression. The sizes of the objects in relation to the Earth have been exaggerated for illustrative purposes.

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Preface

The Space Debris Mitigation Guidelines of the Committee on the Peaceful Uses of Outer Space are the result of many years of work by the Committee and its Scientific and Technical Subcommittee.

At its thirty-first session, in 1994, the Subcommittee considered for the first time, on a priority basis, matters associated with space debris under a new item of its agenda (A/AC.105/571, paras. 63-74). In accordance with the agreement of the Committee, the Subcommittee considered under that item scientific research relating to space debris, including relevant studies, mathematical modelling and other analytical work on the characterization of the space debris environment (A/48/20, para. 87).

In addressing the problem of space debris in its work, the Subcommittee at its thirty-second session, in 1995, agreed to focus on understanding aspects of research related to space debris, including debris measurement techniques; mathematical modelling of the debris environment; characterizing of the space debris environment; and measures to mitigate the risks of space debris, including spacecraft design measures to protect against space debris. Accordingly, the Subcommittee adopted a multi-year workplan for specific topics to be covered from 1996 to 1998. The Subcommittee agreed that at each session it should review the current operational debris mitigation practices and consider future mitigation methods with regard to cost efficiency (A/AC.105/605, para. 83).

At its thirty-third session, in 1996, the Subcommittee agreed to prepare a technical report on space debris that would be structured according to the specific topics addressed by the workplan during the period 1996-1998 and that the report would be carried forward and updated each year, leading to an accumulation of advice and guidance, in order to establish a common understanding that could serve as the basis for further deliberations of the Committee on that important matter (A/AC.105/637 and Corr. 1, para. 96).

At its thirty-sixth session, in 1999, the Subcommittee adopted the technical report on space debris (A/AC.105/720) and agreed to have it widely distributed, including by making it available to the Third United Nations Conference on the Exploration and Peaceful Uses of Outer Space (UNISPACE III), the Legal Subcommittee at its thirty-ninth session, in 2000, international organizations and other scientific meetings (A/AC.105/736, para. 39).

At its thirty-eighth session, in 2001, the Subcommittee agreed to establish a workplan for the period from 2002 to 2005 (A/AC.105/761, para. 130) with the goal of expediting international adoption of voluntary debris mitigation measures. In addition to the plan to address debris mitigation measures, it was envisaged that member States and international organizations would continue to report on research and other relevant aspects of space debris.

In accordance with that workplan, at the fortieth session of the Subcommittee, in 2003, the Inter-Agency Space Debris Coordination Committee (IADC) presented its proposals on debris mitigation, based on consensus among the IADC members. At the same

session, the Subcommittee began its review of the proposals and discussed means of endorsing their utilization.

At its forty-first session, in 2004, the Subcommittee established a working group to consider comments from member States on the above-mentioned proposals of IADC on debris mitigation. The Working Group recommended that interested member States, observers to the Subcommittee and members of IADC become involved in updating the IADC proposals on space debris mitigation for the Working Group's consideration at the next session of the Subcommittee.

During the forty-second session of the Subcommittee, in 2005, the Working Group agreed on a set of considerations for space debris mitigation guidelines and prepared a new workplan for the period from 2005 to 2007, which was subsequently adopted by the Subcommittee. The Working Group also agreed on the text of the revised draft space debris mitigation guidelines (A/AC.105/848, annex II, paras. 5-6), submitted the text to the Subcommittee for its consideration and recommended that the revised draft space debris mitigation guidelines be circulated at the national level to secure consent for adoption of the guidelines by the Subcommittee at its forty-fourth session, in 2007.

At its forty-fourth session, in 2007, the Subcommittee adopted the space debris mitigation guidelines (A/AC.105/890, para. 99).

At its fiftieth session, in 2007, the Committee endorsed the space debris mitigation guidelines and agreed that its approval of those voluntary guidelines would increase mutual understanding on acceptable activities in space and thus enhance stability in space-related matters and decrease the likelihood of friction and conflict (A/62/20, paras. 118-119).

In its resolution 62/217 of 22 December 2007, the General Assembly endorsed the Space Debris Mitigation Guidelines of the Committee on the Peaceful Uses of Outer Space and agreed that the voluntary guidelines for the mitigation of space debris reflected the existing practices as developed by a number of national and international organizations, and invited Member States to implement those guidelines through relevant national mechanisms.

Space Debris Mitigation Guidelines of the Committee on the Peaceful Uses of Outer Space

1. Background

Since the Committee on the Peaceful Uses of Outer Space published its Technical Report on Space Debris in 1999,¹ it has been a common understanding that the current space debris environment poses a risk to spacecraft in Earth orbit. For the purpose of this document, space debris is defined as all man-made objects, including fragments and elements thereof, in Earth orbit or re-entering the atmosphere, that are non-functional. As the population of debris continues to grow, the probability of collisions that could lead to potential damage will consequently increase. In addition, there is also the risk of damage on the ground, if debris survives Earth's atmospheric re-entry. The prompt implementation of appropriate debris mitigation measures is therefore considered a prudent and necessary step towards preserving the outer space environment for future generations.

Historically, the primary sources of space debris in Earth orbits have been (a) accidental and intentional break-ups which produce long-lived debris and (b) debris released intentionally during the operation of launch vehicle orbital stages and spacecraft. In the future, fragments generated by collisions are expected to be a significant source of space debris.

Space debris mitigation measures can be divided into two broad categories: those that curtail the generation of potentially harmful space debris in the near term and those that limit their generation over the longer term. The former involves the curtailment of the production of mission-related space debris and the avoidance of break-ups. The latter concerns end-of-life procedures that remove decommissioned spacecraft and launch vehicle orbital stages from regions populated by operational spacecraft.

2. Rationale

The implementation of space debris mitigation measures is recommended since some space debris has the potential to damage spacecraft, leading to loss of mission, or loss of life in the case of manned spacecraft. For manned flight orbits, space debris mitigation measures are highly relevant due to crew safety implications.

A set of mitigation guidelines has been developed by the Inter-Agency Space Debris Coordination Committee (IADC), reflecting the fundamental mitigation elements of a series of existing practices, standards, codes and handbooks developed by a number of national and international organizations. The Committee on the Peaceful Uses of Outer

¹United Nations publication, Sales No. E.99.I.17.

Space acknowledges the benefit of a set of high-level qualitative guidelines, having wider acceptance among the global space community. The Working Group on Space Debris was therefore established (by the Scientific and Technical Subcommittee of the Committee) to develop a set of recommended guidelines based on the technical content and the basic definitions of the IADC space debris mitigation guidelines, and taking into consideration the United Nations treaties and principles on outer space.

3. Application

Member States and international organizations should voluntarily take measures, through national mechanisms or through their own applicable mechanisms, to ensure that these guidelines are implemented, to the greatest extent feasible, through space debris mitigation practices and procedures.

These guidelines are applicable to mission planning and the operation of newly designed spacecraft and orbital stages and, if possible, to existing ones. They are not legally binding under international law.

It is also recognized that exceptions to the implementation of individual guidelines or elements thereof may be justified, for example, by the provisions of the United Nations treaties and principles on outer space.

4. Space debris mitigation guidelines

The following guidelines should be considered for the mission planning, design, manufacture and operational (launch, mission and disposal) phases of spacecraft and launch vehicle orbital stages:

Guideline 1: Limit debris released during normal operations

Space systems should be designed not to release debris during normal operations. If this is not feasible, the effect of any release of debris on the outer space environment should be minimized.

During the early decades of the space age, launch vehicle and spacecraft designers permitted the intentional release of numerous mission-related objects into Earth orbit, including, among other things, sensor covers, separation mechanisms and deployment articles. Dedicated design efforts, prompted by the recognition of the threat posed by such objects, have proved effective in reducing this source of space debris.

Guideline 2: Minimize the potential for break-ups during operational phases

Spacecraft and launch vehicle orbital stages should be designed to avoid failure modes which may lead to accidental break-ups. In cases where a condition leading to such a failure is detected, disposal and passivation measures should be planned and executed to avoid break-ups.

Historically, some break-ups have been caused by space system malfunctions, such as catastrophic failures of propulsion and power systems. By incorporating potential break-up scenarios in failure mode analysis, the probability of these catastrophic events can be reduced.

Guideline 3: Limit the probability of accidental collision in orbit

In developing the design and mission profile of spacecraft and launch vehicle stages, the probability of accidental collision with known objects during the system's launch phase and orbital lifetime should be estimated and limited. If available orbital data indicate a potential collision, adjustment of the launch time or an on-orbit avoidance manoeuvre should be considered.

Some accidental collisions have already been identified. Numerous studies indicate that, as the number and mass of space debris increase, the primary source of new space debris is likely to be from collisions. Collision avoidance procedures have already been adopted by some member States and international organizations.

Guideline 4: Avoid intentional destruction and other harmful activities

Recognizing that an increased risk of collision could pose a threat to space operations, the intentional destruction of any on-orbit spacecraft and launch vehicle orbital stages or other harmful activities that generate long-lived debris should be avoided. When intentional break-ups are necessary, they should be conducted at sufficiently low altitudes to limit the orbital lifetime of resulting fragments.

Guideline 5: Minimize potential for post-mission break-ups resulting from stored energy

In order to limit the risk to other spacecraft and launch vehicle orbital stages from accidental break-ups, all on-board sources of stored energy should be depleted or made safe when they are no longer required for mission operations or post-mission disposal.

By far the largest percentage of the catalogued space debris population originated from the fragmentation of spacecraft and launch vehicle orbital stages. The majority of those break-ups were unintentional, many arising from the abandonment of spacecraft and launch vehicle orbital stages with significant amounts of stored energy. The most effective mitigation measures have been the passivation of spacecraft and launch vehicle orbital stages at the end of their mission. Passivation requires the removal of all forms of stored energy, including residual propellants and compressed fluids and the discharge of electrical storage devices.

Guideline 6: Limit the long-term presence of spacecraft and launch vehicle orbital stages in the low-Earth orbit (LEO) region after the end of their mission

Spacecraft and launch vehicle orbital stages that have terminated their operational phases in orbits that pass through the LEO region should be removed from orbit in a controlled fashion. If this is not possible, they should be disposed of in orbits that avoid their long-term presence in the LEO region.

When making determinations regarding potential solutions for removing objects from LEO, due consideration should be given to ensuring that debris that survives to reach the surface of the Earth does not pose an undue risk to people or property, including through environmental pollution caused by hazardous substances.

Guideline 7: Limit the long-term interference of spacecraft and launch vehicle orbital stages with the geosynchronous Earth orbit (GEO) region after the end of their mission

Spacecraft and launch vehicle orbital stages that have terminated their operational phases in orbits that pass through the GEO region should be left in orbits that avoid their long-term interference with the GEO region.

For space objects in or near the GEO region, the potential for future collisions can be reduced by leaving objects at the end of their mission in an orbit above the GEO region such that they will not interfere with, or return to, the GEO region.

5. Updates

Research by Member States and international organizations in the area of space debris should continue in a spirit of international cooperation to maximize the benefits of space debris mitigation initiatives. This document will be reviewed and may be revised, as warranted, in the light of new findings.

6. Reference

The reference version of the IADC space debris mitigation guidelines at the time of the publication of this document is contained in the annex to document A/AC.105/C.1/L.260.

For more in-depth descriptions and recommendations pertaining to space debris mitigation measures, Member States and international organizations may refer to the latest version of the IADC space debris mitigation guidelines and other supporting documents, which can be found on the IADC website (www.iadc-online.org).

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the peaceful uses of outer space and assisting developing
countries in using space science and technology.*

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