Conversations For The Future : Space Garbage, Recycling, & Sustainability
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Legal Aspects of Space Debris

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A Useful Logical Framework for Analysis & Discussion

An activity, behaviour, action is not simply either legal or illegal

In fact, action may be regulated in the following manners:

Obligatory	Legally required / mandated / compulsory.
Permissory	Permitted… with or without conditions… a.k.a. “freedom”.
Legally Neutral	Gaps (*lacunae*) in the law, where law is unintentionally or intentionally lacking in specificity or unclear (*non liquet*), as well as other “no law” areas.
Licensory	Generally prohibited, but permitted when specifically licensed.
Prohibited	Legally proscribed / outlawed.

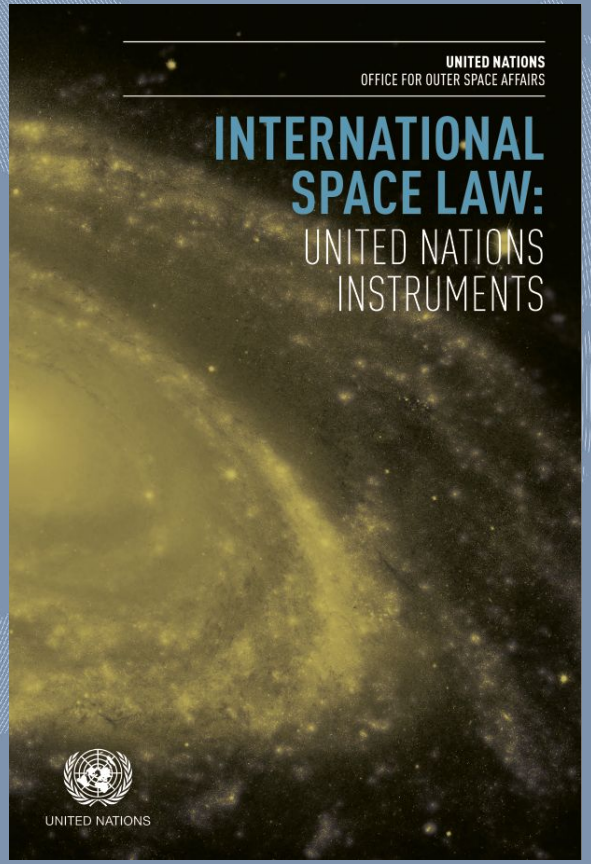
For more, *see* Ilmar Tammelo, *On the Logical Openness of Legal Orders, A Modal Analysis of Law with Special Reference to the Logical Status on Non Liquet in International Law*, 8 American Journal of International Law 187 (1959) https://doi.org/10.2307/837458 *and* Helen Quane, Silence in International Law, *British Yearbook of International Law*, Volume 84, Issue 1, 2014, Pages 240–270, https://doi.org/10.1093/bybil/bru021

1967 Outer Space Treaty

Treaty on the Principles Governing the Activities of States in the Exploration and Use of Outer Space, including the Moon and Other Celestial Bodies

As of September 2021

- 111 States Parties
- 23 additional States have signed by not yet ratified



UN Treaty Booklet at:

https://www.unoosa.org/oosa/oosadoc/data/documents/2017/stspace/stspace61rev.2_0.html

1967 Outer Space Treaty Article 1

Freedom of exploration and use

The exploration and use of outer space, including the Moon and other celestial bodies, **shall be carried out** for the benefit and in the interests of all countries, irrespective of their degree of economic or scientific development, **and shall be the province of all mankind**.

Outer space, including the Moon and other celestial bodies, **shall be free for exploration and use** by all States without discrimination of any kind, on a basis of equality and in accordance with international law, and there **shall be free access** to all areas of celestial bodies.

1967 Outer Space Treaty Article 1

Freedom of exploration and use

There **shall be freedom of scientific investigation** in outer space, including the Moon and other celestial bodies, and States shall facilitate and encourage international cooperation in such investigation.

1967 Outer Space Treaty Article 6

International responsibility for national activities

States Parties to the Treaty **shall bear international responsibility for national activities** in outer space, including the Moon and other celestial bodies, **whether such activities are carried on by governmental agencies or by non-governmental entities**, and **for assuring that national activities are carried out** in conformity with the provisions set forth in the present Treaty.

The activities of non-governmental entities in outer space, including the Moon and other celestial bodies, **shall require authorization and continuing supervision** by the appropriate State Party to the Treaty.

1967 Outer Space Treaty Article 7

International liability for damage

Each State Party to the Treaty **that launches or procures the launching** of an object into outer space, including the Moon and other celestial bodies, and each State Party from whose territory or facility an object is launched, **is internationally liable for damage** to another State Party to the Treaty or to its natural or juridical persons by such object or its component parts on the Earth, in air space or in outer space, including the Moon and other celestial bodies.

1967 Outer Space Treaty Article 8

State jurisdiction and control over registered space objects

A State Party to the Treaty on whose registry an object launched into outer space is carried **shall retain jurisdiction and control over such object, and over any personnel thereof**, while in outer space or on a celestial body.

Ownership of objects launched into outer space, including objects landed or constructed on a celestial body, and of their component parts, **is not affected** by their presence in outer space or on a celestial body or by their return to the Earth.

Such objects or component parts found beyond the limits of the State Party to the Treaty on whose registry they are carried shall be returned to that State Party, which shall, upon request, furnish identifying data prior to their return.

1967 Outer Space Treaty Article 9, Sentence 1

Principles of cooperation and mutual assistance, and of due regard

In the exploration and use of outer space, including the Moon and other celestial bodies, States Parties to the Treaty shall be guided by **the principle of cooperation and mutual assistance** and shall conduct all their activities in outer space, including the Moon and other celestial bodies, with **due regard to the corresponding interests of all other States Parties to the Treaty**.

1967 Outer Space Treaty
Article 9, Sentence 2

Harmful contamination

States Parties to the Treaty shall pursue studies of outer space, including the Moon and other celestial bodies, and **conduct exploration of them so as to avoid their harmful contamination** and also adverse changes in the environment of the Earth resulting from the introduction of extraterrestrial matter and, where necessary, shall adopt appropriate measures for this purpose.

1967 Outer Space Treaty
Article 9, Sentences 3 & 4

International consultations

If a State Party to the Treaty **has reason to believe that an activity or experiment planned by it or its nationals** in outer space, including the Moon and other celestial bodies, would cause potentially harmful interference with activities of other States Parties in the peaceful exploration and use of outer space, including the Moon and other celestial bodies, **it shall undertake appropriate international consultations** before proceeding with any such activity or experiment.

A State Party to the Treaty which has reason to believe that an activity or experiment planned **by another State** Party in outer space, including the Moon and other celestial bodies, would cause potentially harmful interference with activities in the peaceful exploration and use of outer space, including the Moon and other celestial bodies, **may request consultation** concerning the activity or experiment.

Some relevant subsequent law & policies

1. 1972 Liability Convention
2. Space Debris Mitigation Guidelines
    a. IADC Space Debris Guidelines
    b. COPUOS Space Debris Guidelines
3. Long-term Sustainability Guidelines (“LTS Guidelines”)
4. US Space Policy Directive 3
    a. US regulatory documents

1972 Liability Convention Article 1

Definitions of damage, launching state, and space object

(a) The **term "damage" means** loss of life, personal injury or other impairment of health; **or loss of or damage to property** of States or of persons, natural or juridical, or property of international intergovernmental organizations;

(c) The **term "launching State" means**:

i. A State which **launches or procures** the launching of a space object;

ii. A State from whose **territory or facility** a space object is launched;

(d) The **term "space object" includes** component parts of a space object as well as its launch vehicle and parts thereof.

1972 Liability Convention Article 3

Fault based liability regime in space

In the event of damage being caused elsewhere than on the surface of the Earth **to a space object** of one launching State or to persons or property on board such a space object **by a space object** of another launching State, **the latter shall be liable only if the damage is due to its fault** or the fault of persons for whom it is responsible.

1972 Liability Convention Article 4

Joint and several liability

Whenever two or more States jointly launch a space object, they shall be **jointly and severally liable** for any damage caused.

IADC Space Debris Mitigation Guidelines (revised 2020)

The Inter-Agency Space Debris Coordination Committee (IADC) is **an international forum of space agencies**, authorized governmental or inter-governmental entities for the coordination of activities related to the issues of human-made and natural debris in space.

Members of the IADC are the Italian Space Agency (ASI), Centre National d'Etudes Spatiales (CNES), China National Space Administration (CNSA), Canadian Space Agency (CSA), German Aerospace Center (DLR), European Space Agency (ESA), Indian Space Research Organisation (ISRO), Japan Aerospace Exploration Agency (JAXA), Korea Aerospace Research Institute (KARI), National Aeronautics and Space Administration (NASA), State Space Corporation (ROSCOSMOS), State Space Agency of Ukraine (SSAU), and United Kingdom Space Agency (UKSA).

IADC Space Debris Mitigation Guidelines (revised 2020)

5 Mitigation Measures

5.1 Limit Debris Released during Normal Operations

In all operational orbit regimes, spacecraft and orbital stages **should be designed not to** release debris during normal operations. Where this is not feasible any release of debris should be minimised in number, area and orbital lifetime.

5.2 Minimise the Potential for On-Orbit Break-ups On-orbit

5.2.1 Minimise the potential for **post mission break-ups** resulting from stored energy

5.2.2 Minimise the potential for **break-ups during operational phases**

5.2.3 Avoidance of **intentional destruction** and other harmful activities

IADC Space Debris Mitigation Guidelines (revised 2020)

5.3 Post Mission Disposal

5.3.1 Geosynchronous Region Spacecraft

Spacecraft that have terminated their mission should be manoeuvred far enough away from GEO so as not to cause interference with spacecraft or orbital stage still in geostationary orbit. The manoeuvre should place the spacecraft in an orbit that remains above the GEO protected region.

The IADC and other studies have found that fulfilling the two following conditions at the end of the disposal phase would give an orbit that remains above the GEO protected region:

(1) A minimum increase in perigee altitude of:

$$235\ \text{km} + (1000 \cdot C_R \cdot A/m)$$

where

C_R	is the solar radiation pressure coefficient
A/m	is the aspect area to dry mass ratio (m^2kg^{-1})
235 km	is the sum of the upper altitude of the GEO protected region (200 km) and the maximum descent of a re-orbited spacecraft due to luni-solar & geopotential perturbations (35 km).

(2) An eccentricity less than or equal to 0.003.

IADC Space Debris Mitigation Guidelines (revised 2020)

5.3.3 Other Orbits

Spacecraft or orbital stages that are terminating their operational phases in other orbital regions should be manoeuvred to reduce their orbital lifetime, commensurate with LEO lifetime limitations, or relocated if they cause interference with highly utilised orbit regions.

5.4 Prevention of On-Orbit Collisions

In developing the design and mission profile of a spacecraft or orbital stage, a program or project **should estimate and limit the probability** of accidental collision with known objects during the spacecraft or orbital stage's orbital lifetime. If reliable orbital data is available, avoidance manoeuvres for spacecraft and co-ordination of launch windows **may be considered** if the collision risk is not considered negligible.

Spacecraft design should limit the probability of collision with small debris which could cause a loss of control, thus preventing post-mission disposal.

IADC Space Debris Mitigation Guidelines (revised 2020)

2 Application

The IADC Space Debris Mitigation Guidelines are applicable to mission planning and the design and operation of spacecraft and orbital stages that will be injected into Earth orbit.

Organisations **are encouraged to use** these Guidelines in identifying the standards that they will apply when establishing the mission requirements for planned spacecraft and orbital stages.

Operators of existing spacecraft and orbital stages **are encouraged to apply** these guidelines to the greatest extent possible.

IADC Space Debris Mitigation Guidelines

Are they effective??

- **53.3% of the payloads** and **60.3% of the payload mass** reaching End-of-Life in LEO between 2006-2015 are compliant. In terms of mass, this share is constantly sloping downward;
- **71.6%** of the rocked bodies reaching End-of-Life in LEO between 2007-2016 are compliant, **a fraction virtually unchanged** for 8 years in a row despite an increased EOL manoeuvre activity;
- **66.1%** of the payloads reaching EOL in GEO between 2007-2016 are compliant, tendency rising but possibly saturating;

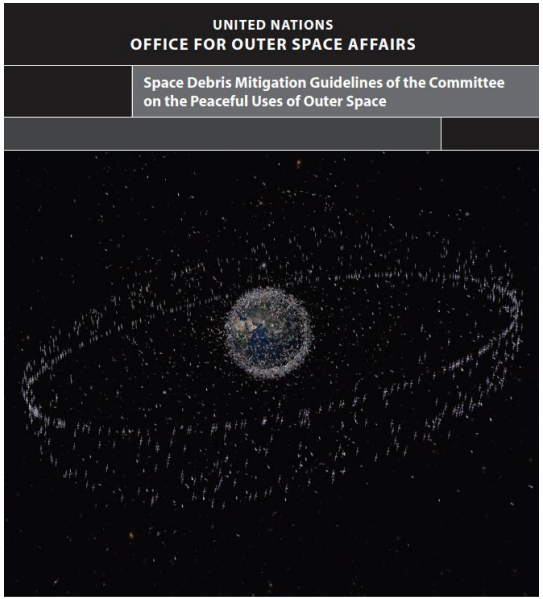
The level of adherence 15 years after the introduction of the mitigation guidelines is sobering, the only exception being the clearance of payloads in GEO.

The environment around Earth, **especially in LEO is continuing to get more hostile almost every year.**

The goal of the mitigation guidelines - to preserve the Earth environment for future generations - is still beyond reach.

- Frey & Lemmens, *Status of the Space Environment: Current Level of Adherence to the Space Debris Mitigation Policy*, 2017.

2007 COPUOS Space Debris Mitigation Guidelines



UNITED NATIONS

Guideline 1: Limit debris released during normal operations

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

Guideline 3: Limit the probability of accidental collision in orbit

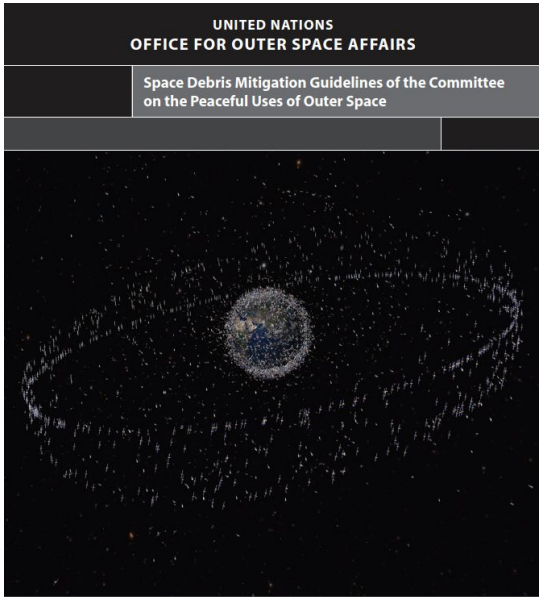
Guideline 4: Avoid intentional destruction and other harmful activities

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

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

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

2007 COPUOS Space Debris Mitigation Guidelines



UNITED NATIONS

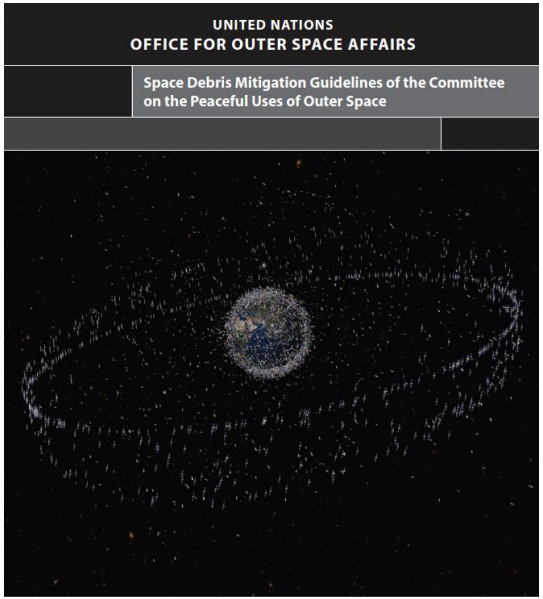
Guideline 6: Limit the long-term presence of spacecraft and launch vehicle orbital stages in the low-Earth orbit (LEO) region after the end of their mission

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.

2007 COPUOS Space Debris Mitigation Guidelines



UNITED NATIONS

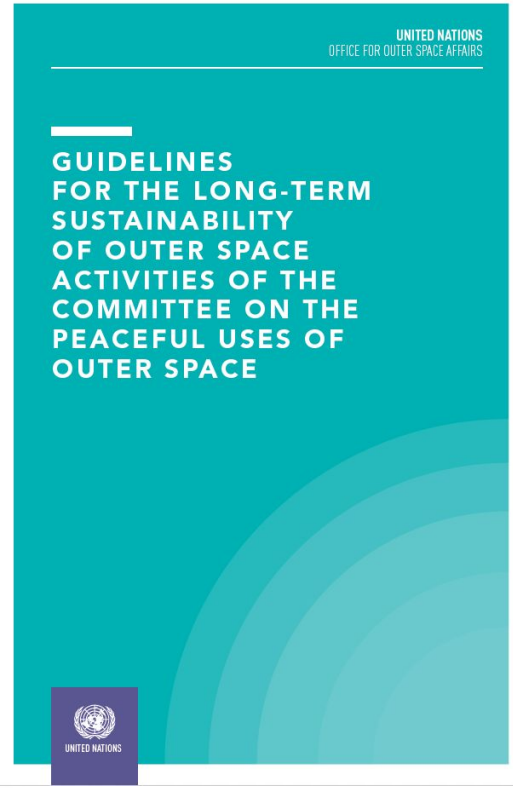
3 Application

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.

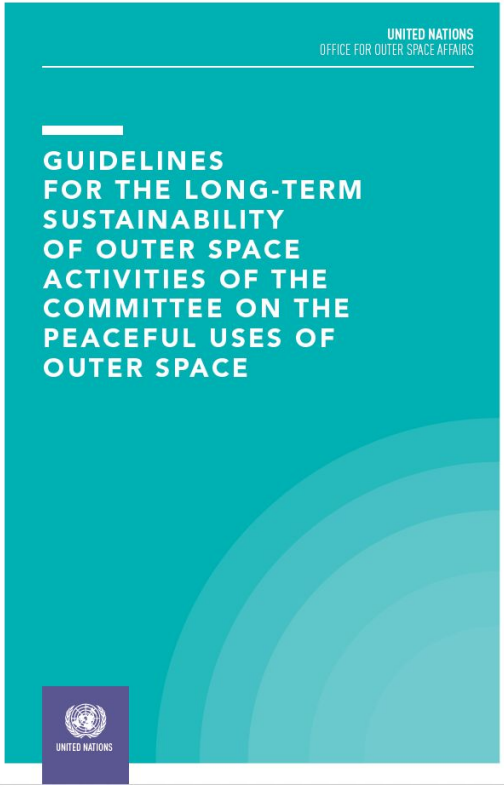
COPUOS LTS Guidelines



Guideline B.4
Perform conjunction assessment during all orbital phases of controlled flight

Guideline B.9
Take measures to address risks associated with the uncontrolled re-entry of space objects

COPUOS LTS Guidelines



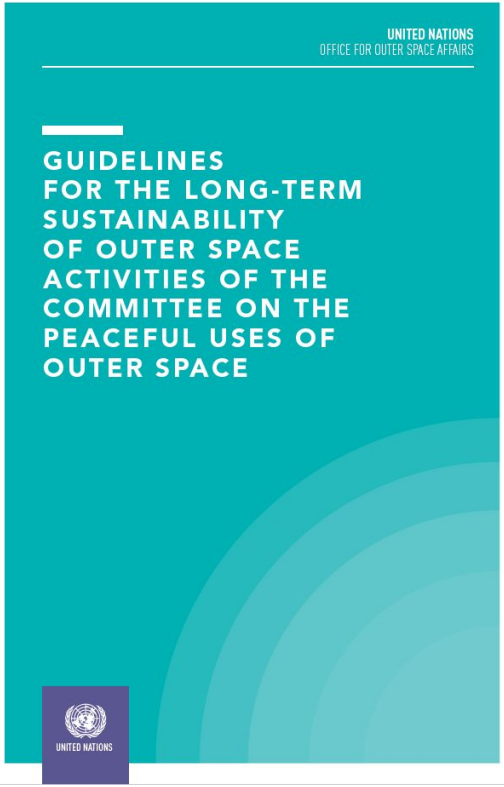
Guideline D.2

Investigate and consider new measures to manage the space debris population in the long term.

1. States and international intergovernmental organizations should investigate the necessity and feasibility of possible new measures, including technological solutions, and consider implementation thereof, in order to address the evolution of and manage the space debris population in the long term. These new measures, together with existing ones, should be envisaged so as not to impose undue costs on the space programmes of emerging spacefaring nations.

2. States and international intergovernmental organizations should take measures at the national and international levels, including international cooperation and capacity-building, to increase compliance with the Space Debris Mitigation Guidelines of the Committee on the Peaceful Uses of Outer Space

COPUOS LTS Guidelines

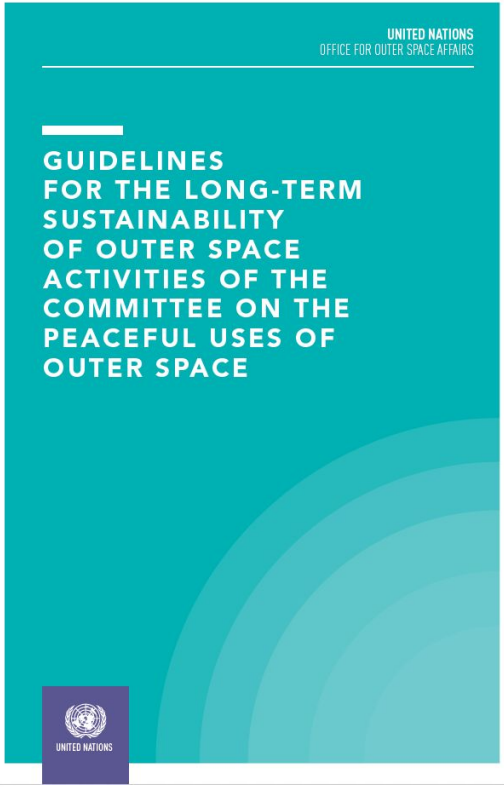


Guideline D.2

Investigate and consider new measures to manage the space debris population in the long term.

3. Investigation of new measures could include, inter alia, methods for the extension of operational lifetime, novel techniques to prevent collision with and among debris and objects with no means of changing their trajectory, advanced measures for spacecraft passivation and post-mission disposal and designs to enhance the disintegration of space systems during uncontrolled atmospheric re-entry.

COPUOS LTS Guidelines



Status of the Guidelines

The existing United Nations treaties and principles on outer space provide the fundamental legal framework for the guidelines.

The guidelines are **voluntary and not legally binding under international law**, but any action taken towards their implementation should be consistent with the applicable principles and norms of international law.

The guidelines are formulated in the spirit of enhancing the practice of States and international organizations in applying the relevant principles and norms of international law.

Nothing in the guidelines should constitute a revision, qualification or reinterpretation of those principles and norms.

Nothing in the guidelines should be interpreted as giving rise to any new legal obligation for States.

Any international treaties referred to in the guidelines apply only to the States parties to those treaties.

At the national level
Space Policy Directive 3

Calls for updating the U.S. Government Orbital Debris Mitigation Standard Practices (ODMSP)


PRESIDENTIAL MEMORANDA

Space Policy Directive-3, National Space Traffic Management Policy

INFRASTRUCTURE & TECHNOLOGY | Issued on: June 18, 2018

Section 4. Goals

(b) Mitigate the effect of orbital debris on space activities. The volume and location of orbital debris are growing threats to space activities. It is in the interest of all to minimize new debris and mitigate effects of existing debris. This fact, along with increasing numbers of active satellites, highlights **the need to update existing orbital debris mitigation guidelines and practices** to enable more efficient and effective compliance, and establish standards that can be adopted internationally. These trends also highlight the need to establish satellite safety design guidelines and best practices.

At the national level

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PRESIDENTIAL MEMORANDA

Space Policy Directive-3, National Space Traffic Management Policy

INFRASTRUCTURE & TECHNOLOGY | Issued on: June 18, 2018

Mitigating Orbital Debris

It is in the interest of all space operators to minimize the creation of new orbital debris. Rapid international expansion of space operations and greater diversity of missions have rendered the current **U.S. Government Orbital Debris Mitigation Standard Practices (ODMSP) inadequate** to control the growth of orbital debris. These standard practices should be **updated** to address current and future space operating environments.

The United States should **develop a new protocol of standard practices** to set broader expectations of safe space operations in the 21st century. This protocol should begin with updated ODMSP, but also incorporate sections to address operating practices for **large constellations, rendezvous and proximity operations, small satellites, and other classes** of space operations. These overarching practices will provide an avenue to promote efficient and effective space safety practices with U.S. industry and internationally.

The United States should pursue **active debris removal** as a necessary long-term approach to ensure the safety of flight operations in key orbital regimes. This effort should not detract from continuing to advance international protocols for debris mitigation associated with current programs.

At the national level

Space Policy Directive 3

Calls for updating the U.S. Government Orbital Debris Mitigation Standard Practices (ODMSP)


PRESIDENTIAL MEMORANDA

Space Policy Directive-3, National Space Traffic Management Policy

INFRASTRUCTURE & TECHNOLOGY | Issued on: June 18, 2018

Global Engagement

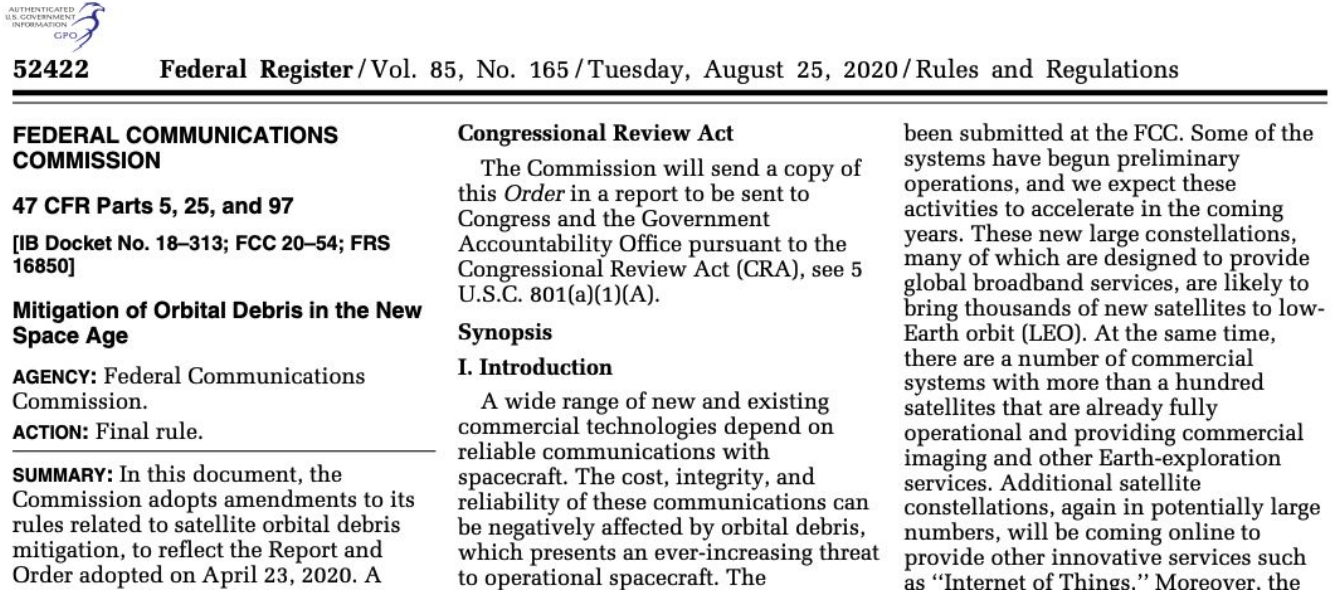
In its role as a major spacefaring nation, the United States should continue to develop and promote a range of norms of behavior, best practices, and standards for safe operations in space to minimize the space debris environment and promote data sharing and coordination of space activities.

It is essential that other spacefaring nations also adopt best practices for the common good of all spacefaring states.

The United States should **encourage the adoption of new norms of behavior and best practices** for space operations by the international community through bilateral and multilateral discussions with other spacefaring nations, and through U.S. participation in various organizations such as the Inter-Agency Space Debris Coordination Committee, International Standards Organization, Consultative Committee for Space Data Systems, and UN Committee on the Peaceful Uses of Outer Space.

At the national level

- Update to the Orbital Debris Mitigation Standard Practices, November 2019
- The FAA (for launch vehicles and intact re-entry) and NOAA (for commercial remote sensing satellites) both have orbital debris-related regulations which apply to non-government (in most cases commercial) operators licensed by those agencies.



52422 **Federal Register** / Vol. 85, No. 165 / Tuesday, August 25, 2020 / Rules and Regulations

FEDERAL COMMUNICATIONS COMMISSION

47 CFR Parts 5, 25, and 97

[IB Docket No. 18–313; FCC 20–54; FRS 16850]

Mitigation of Orbital Debris in the New Space Age

AGENCY: Federal Communications Commission.

ACTION: Final rule.

SUMMARY: In this document, the Commission adopts amendments to its rules related to satellite orbital debris mitigation, to reflect the Report and Order adopted on April 23, 2020. A

Congressional Review Act

The Commission will send a copy of this *Order* in a report to be sent to Congress and the Government Accountability Office pursuant to the Congressional Review Act (CRA), see 5 U.S.C. 801(a)(1)(A).

Synopsis

I. Introduction

A wide range of new and existing commercial technologies depend on reliable communications with spacecraft. The cost, integrity, and reliability of these communications can be negatively affected by orbital debris, which presents an ever-increasing threat to operational spacecraft. The

been submitted at the FCC. Some of the systems have begun preliminary operations, and we expect these activities to accelerate in the coming years. These new large constellations, many of which are designed to provide global broadband services, are likely to bring thousands of new satellites to low-Earth orbit (LEO). At the same time, there are a number of commercial systems with more than a hundred satellites that are already fully operational and providing commercial imaging and other Earth-exploration services. Additional satellite constellations, again in potentially large numbers, will be coming online to provide other innovative services such as "Internet of Things." Moreover, the

Categories of Norms on Space Debris

Creation of new debris

Prohibitions on the creation of new debris?
(Alternatively, positive obligations *to not* create debris?)

- intentional (kinetic ASATs, etc.,)
- or unintentional/negligent creation

Your existing debris

Norms on remediation, removal, re-entry @ End-of-Life & after?

Other's existing debris

Is it permissible to remove space debris?

- where owner/Launching State can be identified (large pieces)
- where owner/Launching State cannot be identified (small debris)

Do we have salvage rights? + geopolitical issues

D-ORBIT SIGNS €2,2 MILLION SPACE DEBRIS REMOVAL CONTRACT WITH ESA

Edinburgh, 9 September 2021. – The UK branch of D-Orbit signed a € 2,197 million contract with ESA for phase 1 of the development and in-orbit validation of a "Deorbit Kit", D-Orbit said.

Image: D-Orbit

The agreement is part of ESA's Space Safety Programme.

The decommissioning kit is a self-contained suite of equipment that can be used with space vehicles of any size. The bespoke kit enables spacecraft to perform a propulsive decommissioning manoeuvre when their mission is over. It can also be used in case of spacecraft failure, even if it has become unresponsive. The kit and the know-how developed will be used in the future for in-orbit installation on satellites already in space, D-Orbit said.

The company will lead a consortium including Airbus Defence and Space, ArianeGroup, GMV Innovating Solutions, and Optimal Structural Solutions to develop the multi-purpose kit. The Deorbit Kit will initially be installed on VESPA (Vega Secondary Payload Adapter), a Vega Rocket payload adapter. It will be expected to perform a propulsive direct re-entry manoeuvre after the rocket has deployed its payload.

The first phase of development for the device is the designing of VESPA´s upper part. This apparatus might become the launch adaptor for ESA's ClearSpace-1 mission scheduled for 2025.

The business cases seem to exist for large, known spacecraft.

What about the small stuff, where we don't know the owner / Launching State?

Thank you!

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