Space Debris Mitigation Guidelines

Nicholas L. Johnson
NASA Chief Scientist for Orbital Debris

Symposium on Small Satellite Programmes for Sustainable Development
“Implementing Small Satellite Programmes: Technical, Managerial, Regulatory and Legal Issues

Graz, Austria

13-16 September 2011
The purpose of national and international space debris mitigation guidelines is to promote the preservation of near-Earth space for applications and exploration missions far into the future.

- To accomplish this objective, the accumulation of objects, particularly in long-lived orbits, must be eliminated or curtailed.

Number of Cataloged Objects in Low Earth Orbit
National and International Space Debris Mitigation Guidelines


- Europe’s five leading space agencies established a Code of Conduct for Space Debris Mitigation in 2006.
  - ESA and the national space agencies from France, Germany, Italy, and the UK

- The first international set of space debris mitigation guidelines was created by the then 11 members of the Inter-Agency Space Debris Coordination Committee in 2002.
  - Find at http://www.iadc-online.org/index.cgi?item=docs_pub

- The United Nations, through the Committee on the Peaceful Uses of Outer Space and its Scientific and Technical Subcommittee, approved a set of space debris mitigation guidelines in 2007.
  - Find at http://orbitaldebris.jsc.nasa.gov/library/Space%20Debris%20Mitigation%20Guidelines_-_COPUOS.pdf
The scope of the United Nations Space Debris Mitigation Guidelines is representative of other national and international space debris mitigation guidelines.

- 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
  - Includes the mitigation of reentry risks to people and property on Earth
- Guideline 7: Limit the long-term interference of spacecraft and launch vehicle orbital stages with geosynchronous Earth orbit (GEO) region after the end of their mission
Application of Space Debris Mitigation Guidelines

- National and international space debris mitigation guidelines are applicable to all spacecraft and launch vehicle orbital stages, regardless of mission, size, or power source.

  Space debris mitigation guidelines apply to all small satellites.

- Typically, satellites with a mass of less than 100 kg easily meet guidelines covering the intentional release of debris, accidental breakups, post-mission passivation, and reentry risks.
Small Satellites and the LEO and GEO Protected Regions

• To date, the most frequent violation of space debris mitigation guidelines by small satellites is persistence in the low Earth orbit region following mission termination, i.e., residual lifetimes in excess of 25 years.

  – Potential solutions include
    • post-mission orbit changes (via propulsion or drag augmentation) or
    • limiting operational orbits to below ~700 km, depending upon ballistic coefficient.

  – The relatively short operational lifetimes and increasing number of small satellite make compliance with this guideline especially important.

• The deployment of small satellites in the geosynchronous region should be avoided. If high altitude orbits are necessary, orbital regimes above or below the GEO protected region (GEO +/- 200 km) are recommended.

  – If small satellites are deployed within the GEO region, they are subject to standard GEO spacecraft disposal guidelines, i.e., removal from the GEO protected region after end of mission.
Trackability of Small Satellites

• To limit the probability of accidental collisions (UN Space Debris Mitigation Guideline 3), small satellites should be trackable by established space surveillance systems.

• Small satellites with at least one dimension of 10 cm or larger are normally trackable in LEO by ground-based radar networks.

• Small satellites with at least one dimension of 80 cm or larger are normally trackable in GEO by ground-based radar or optical networks.

• In many cases trackability can be enhanced with simple passive devices which can boost optical or radar signatures.
  – Corner reflectors
  – Dipoles
Small Satellite Constellations

- Space debris mitigation guidelines do not explicitly limit the number of operational satellites in a constellation.

- However, concepts to deploy very large numbers (100’s or 1000’s) of small satellites should be carefully examined for negative environmental consequences.

- Large numbers of non-maneuverable small satellites in narrow orbital regimes would increase collision probabilities not only among themselves, but also with other resident space objects, both functional and non-functional.

- The addition of large numbers of new satellites would also further stress existing conjunction assessment processes.
Summary

• During the past two decades, great strides have been made in the international community regarding orbital debris mitigation for the purpose of preserving near-Earth space for future generations.

• The majority of space-faring nations have reached a consensus on an initial set of orbital debris mitigation measures.

• Implementation of and compliance with the IADC and UN space debris mitigation guidelines should be a high priority for all spacecraft and launch vehicle designers and operators.

• These space debris mitigation guidelines apply to spacecraft of all sizes.