PROGRAM

International Interdisciplinary Congress on Space Debris

7-9 May 2009
McGill University, Montreal, Canada

Organised by:
The McGill University Institute of Air and Space Law,
Montreal, Canada

Co-organised by:
The Cologne University Institute of Air and Space Law,
Cologne, Germany

The International Association for the Advancement of Space Safety,
Katwijk, the Netherlands

Sponsored by:
Erin J. C. Arsenault Trust

Co-sponsored by:
United Nations Office for Outer Space Affairs, Vienna, Austria

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On 10th February 2009, an unpredicted accident occurred in space when an inactive Cosmos-2251 satellite and an active commercial Iridium-33 satellite collided in low-Earth orbit at an altitude of about 800 kilometers above Siberia. Consequently, a large cloud of space debris was created which could remain in orbit possibly for decades and continue threatening other active satellites. The loss of Iridium-33 disrupted telecommunication service to a section of Iridium customers

The growing awareness of the impact of space debris upon the safety of space operations and space-based assets has encouraged some space actors to take steps to mitigate the production of new debris through the development and implementation of national and international debris mitigation measures. In 2007, the United Nations Committee on Peaceful Uses of Outer Space (COPUS) adopted Space Debris Mitigation Guidelines, which were subsequently endorsed by the UN General Assembly (hereinafter referred to as UN COPUOS Guidelines). For the text of the Guidelines and detailed background of the Congress, please see the document entitled: Space Debris Congress - Background.

CONGRESS OBJECTIVE

- **To assess the value of the UN COPUOS Guidelines**
- **To assess current efforts to implement the UN COPUOS Guidelines**
- **To examine further legal, organizational and technical foundations and endeavours for possible national, regional, and international implementation and to assess whether they could be complementary to the UN COPUOS Guidelines**
- **To put forward specific and viable policy and regulatory steps (mechanisms) that may be considered by states and other stake holders to monitor and reduce the space debris risks**

PROGRAM

DAY ONE: Thursday 7th May 2009

	TOPICS and DESCRIPTIONS
08:00 – 09:00	**Registration and Coffee**
09:00 – 09:15	**Opening Remarks** • Nicolas Kasirer (Faculty of Law, McGill University) • Paul Dempsey (Institute of Air & Space Law, McGill University) • Ray Williamson (Secure World Foundation, US)
0915 - 0945	**Keynote Speech**

	• Gerard Brachet (MFA, France)
09:45 – 10:45	<u>**Session 1 – Space Debris Capstone**</u> **Provide summary of current knowledge on the space debris problem from both a technical and legal perspective. This up-to-date snapshot will provide the foundation for the rest of the discussion and the policy recommendations to follow.** <u>Chair</u>: Lubos Perek (CAS, Czech Republic) <u>Reporter</u>: Brian Weeden (Secure World Foundation, US) <u>Invited Papers by</u>: (3) • Fernand Alby (CNES, France) • Rudi Jehn (ESA, Germany) • Darius Nikanpour (CSA, Canada) • Stephan Hobe and Jan Mey (IASL, Germany)
10:45 – 11:00	**Refreshment Break**
11:00 – 12:30	<u>**Session 2 – Analysis of the UN COPUOS Debris Mitigation Guidelines**</u> **Provide a technical and legal analysis of the guidelines, the intent behind their creation and the key considerations and compromises. Discussion will also focus on their projected long-term effectiveness, and any areas where the guidelines could be improved.** <u>Chair</u>: Richard Tremayne-Smith (OoS, UK) <u>Reporter</u>: Yaw Nyampong (IASL, McGill, Canada) <u>Invited Papers by</u>: (3) 1. Stephan Hobe (IASL, Germany) 2. Niklas Hedman (UN OOSA, Austria) 3. David Wright (UCS, US)
12:30 – 13:30	**Lunch**
13:30 – 15:30	<u>**Session 3 – Current Coordination and Implementation**</u> **Examination of the need to enlarge the international technical coordination to more nations and other actors. Examination of actors who are implementing the guidelines to date and in what capacity. Also discussion of which actors should have concrete plans for implementation.** <u>Chair</u>: Jeffrey Foust (Futron, US) <u>Reporter</u>: Catherine Doldirina (IASL, McGill, Canada) <u>Invited Papers by</u>: (6) 1. Michael Taylor (USAF, US)

	2. Laura Montgomery (FAA, US) 3. Carsten Wiedemann (TUB, Germany) 4. Indian Space Research Organization: K.R. Sridhara Murthi (ISRO, India) 5. Feng Jiehan (WU, PRC) 6. Michael Yakovlev (CRIMB, Russia) 7. CSA: Hugues Gilbert (CSA, Canada) 8. Takashi Nakajima, (JAXA, Japan) (TBC) 9. David A. Turner. (DoS, US) (TBC)
15.30-15.45	**Refreshment Break**
15.45-17.45	**Session 3 continues**
18:00-20:00	**Reception**

DAY TWO: Friday 8th May 2009

09:00 - 10:45	**Session 4 – Discussion of Implementation Strategies** **Discuss various technical, organizational and legal strategies for UN COPUOS Guidelines implementation at the national, regional, and international level. Objective is to put forward implementation options for guidance and framework for any space actor in a variety of capacities.** Chair: K. Kasturirangan (NIAS, India) Reporter: Michael Mineiro (IASL, McGill, Canada) Invited Papers by: (6) 1. Developing Countries Perspective: Peter Martinez (SAAO, South Africa) 2. Emerging Space Powers: Wade Huntly (UBC, Canada) 3. Various Regulatory Mechanisms: Ram Jakhu (IASL, McGill, Canada) 4. Private sector perspective: Richard DalBello (INTELSAT, US) 5. NGO-Professional Organization: Tommaso Sgobba (IAASS, the Netherlands) 6. ISO Standards Work: Dave Finkleman (CSSI, US) 7. European policy mechanisms: Xavier Pasco (FRS, France) 8. Satellite re-orbiting: Rudi Jehn (ESA, Germany)
10:45 - 11:00	**Refreshment Break**
11:00 - 12:30	**Session 4 continues**
12:30 - 14:00	**Lunch**
14:00 - 16:00	**Session 5 – Complementary Initiatives** **Evaluate other initiatives which could be complementary to the UN COPUOS Guidelines to enhance space sustainability (SSA, STM, debris removal, etc)** Chair: Claudio Portelli (ASI, Italy)

	Reporter: Catherine Doldirina (IASL, McGill, Canada) Invited Papers by: (4) 1. International Civil SSA: Brian Weeden (Secure World Foundation, US) 2. Luca del Monte (ESA, France) 3. Maria Buzdugan (Milbank, US) 4. William Ailor (Aerospace Corporation, US)
19:00 - 22:00	**Gala Dinner**

DAY THREE: Saturday 9th May 2009

09:15 - 10:45	**Session 6 – The Way Forward** **Condense sessions 1-4 into a concise summary which will be input for the Bonn-Cologne Leg of the Congress. Generate action items of research to fill remaining gaps in knowledge of space debris and of development of complementary strategies.** Chair: Paul Dempsey (IASL, McGill, Canada) Reporter: Yaw Nyampong (IASL, McGill, Canada) 1. Ciro Arevalo (Chairman of COPUOS) 2. Lubos Perek (CAS, Czech Republic) 3. Richard Tremayne-Smith (OoS, UK) 4. Jeffrey Foust (Futron, US) 5. K. Kasturirangan (NIAS, India) 6. Claudio Portelli (ASI, Italy)
10:45 - 11:00	**Refreshment Break**
11:15 - 12:15	**Session 6 continues & Congress Wrap-up**
12:30 - 14:30	**Lunch**

INTERNATIONAL INTERDISCIPLINARY ROUNDTABLE

A day prior of the Space Debris Congress, the Institute of Air and Space Law (IASL) is organizing a high level International Interdisciplinary Roundtable on the study of space, its governance and its peaceful use. This event will be held on 6th May 2009 from 2.00 PM to 6.00 PM in the Moot Room, Faculty of Law, 3644 Peel Street, Montreal and it will be followed by a reception. If you wish to attend this event, free of any charge, please register on the same form for the Space Debris Congress.

SPACE SECURITY INDEX WORKSHOP

In addition, we are organizing our annual Space Security Index Workshop (i.e. on 5 and 6 May). At this meeting several invited experts in the space field from around the world review and comment on the research papers produced by our research assistants. For more information, please contact Ms. Jessica West at: jwest@ploughshares.ca or visit: http://spacesecurity.org/

BACKGROUNDER

1. BACKGROUND

Current debris situation

In 2007, the world celebrated the 50th anniversary of the dawn of the space age. Although the space age has brought about many technological, societal, and economic benefits for all humankind, these benefits have not come without negative consequences. As a result of past activities in space and the rapidly increasing rate of usage of space, the space-faring nations are creating environmental damages that could have long-term effects. The most immediate of these is space debris, the non-functional satellites, launch vehicles and related objects that orbit the Earth uncontrolled.

The United States Space Surveillance Network, the single best resource in this regard, is currently tracking over 17,000 human-made objects larger than four inches (ten centimetres) in diameter orbiting the Earth. It is estimated that there are additional 300,000 objects in Earth orbit measuring between 1 and 10 cm in diameter and many millions smaller than 1 cm. Most of the objects greater than 10 cm that can be identified with a specific space launch are placed in the Satellite Catalogue, maintained by the U.S. government, which as of June 2008 contains just over 13,000 objects. Of these, only six to seven percent are operational satellites; meaning that, at best, over 90% of space objects in Earth orbit are uncontrolled. As these objects orbit at speeds between 3 km/sec and 7.7 km/sec (6,700 and 17,000 mph) an impact from a collision with one of any size can have serious consequences. Although they are spread out over a vast area, most of this space debris is generated by human activities and as such is concentrated in the areas that provide the greatest utility and benefit.

Sources of space debris

The primary source of space debris, approximately 40% of the catalogued objects, is from break-ups or fragmentations of spacecraft and rocket bodies. Often this results from leftover fuel or other reactive chemicals. Trapped within confined space, pressure can build up resulting in violent explosions. An additional source of fragmentation debris are collisions between large objects, usually spacecraft or rocket bodes, and other pieces of space debris. The most well-known of the handful of events in this category was the disintegration of the French government micro-satellite CERISE on 24 July 1996 by a French rocket body from a previous launch.

Another significant source of space debris is the act of placing satellites in orbit. Explosive bolts, fuel tanks and payload shrouds can all separate from the satellite and end up in orbit. This mission-related debris and the rocket bodies which remain

on orbit account for 25% of the total catalogued debris. Inoperable satellites account for another 25%.

There have also been cases of deliberate destruction of satellites which have contributed significantly to the space debris population.

Impact of space debris

Space debris poses a risk in two major ways. First, it is a navigation hazard to operational satellites of all space-faring nations. A collision between a piece of debris and a satellite risks damage to or even loss of the satellite. Satellite owner-operators are faced with a tough choice – do they invest resources into the ability to detect and determine whether or not their satellite will conjunct with another object? Or do they simply let it be and hope that they are not the unlikely collision. And even if they do have the resources to determine that there will be a close approach, satellite owner-operators must weigh the fuel and opportunity costs of any avoidance manoeuvre against the risk of collision and possibly losing the entire satellite.

While the United States government and NASA have been doing conjunction assessment for their critical satellites over the last several years, only recently have close approaches been widely reported. On 22 June 2007 NASA reported manoeuvring the US $1.3 billion Terra satellite to avoid a piece of Fengyung-1C debris. On 4 July 2007 NASA reported a manoeuvre of its US $217 million CloudSat to avoid an Iranian satellite, the Sinah-1. The European Space Agency [ESA] also monitors some of its higher-value satellites and works with the U.S. satellite owner-operators to provide conjunction assessment.

The second major risk from space debris is to humans on the surface of the Earth. All but the highest altitude pieces of space debris will eventually re-enter the Earth's atmosphere. On average, one catalogued space object (greater than 10 cm in size) re-enters the Earth's atmosphere every day. And on average a piece greater than 1 meter in size re-enters the atmosphere each week. Many of these objects survive their trip through the atmosphere in some form and impact the surface of the Earth. While so far there have not been any confirmed reports of human fatalities due to this, the possibility still exists.

In late December 2007, the United States determined that there was enough of a risk to human life from the re-entry of a failed satellite that it destroyed the satellite just before re-entry with a missile in February 2008. This assessed risk was due to the large amount of hydrazine, an extremely toxic rocket fuel, which was left on board the satellite after it malfunctioned shortly after launch. Similar concerns were voiced over the re-entry of the Russian Mir and American Skylab, both large space stations, and great effort was put into managing their re-entry so as to avoid any human causalities or property damage.

There is also the risk of re-entering space objects creating environmental pollution, as was the case of the Soviet satellite COSMOS 954 which disintegrated in 1978 and scattered radioactive debris over a large area of Northern Canada. Additional risk from re-entering orbital debris could be faced by aircraft, although there have been no reported cases of actual collisions.

Current progress and solutions

The growing awareness of the impact of space debris upon the safety of space operations and space-based assets has encouraged some space actors to take steps to mitigate the production of new debris through the development and implementation of national and international debris mitigation measures. Several space-faring nations support the mitigation of space debris production, though there are some differences between their respective debris mitigation efforts. In 2002, the European Space Agency issued the European Space Debris Safety and Mitigation Standard, and in 2003, it announced new debris mitigation guidelines. The 2006, US National Space Policy reiterated the American policy to "seek to minimize the creation of space debris." In 2006, China released a white paper entitled "China's Space Activities in 2006," in which it reported actively participating in debris mitigation mechanisms and policy efforts at an international level. Such initiatives are useful in the short term, but the effectiveness of national and even multilateral regulatory initiatives could be limited since a single major accident could create hazards for the space activities of all States.At the international level, the Scientific and Technical Subcommittee of the United Nations Committee on the Peaceful Uses of Outer Space (COPUOS) has dealt with the issue of space debris since 1994, first by adopting in 1999 a technical report on space debris, and then in 2007 by adopting space debris mitigation guidelines. These guidelines were endorsed by COPUOS, at its fiftieth session in 2007, as Space Debris Mitigation Guidelines of the Committee on the Peaceful Uses of Outer Space. The COPUOS Guidelines were subsequently endorsed by the General Assembly in its resolution 62/217 of 21 December 2007 (hereinafter referred to as UN COPUOS Guidelines, attached herewith as Annex). They are voluntary and based on and consistent with the Inter-Agency Space Debris Coordination Committee (IADC) guidelines, and present general recommendations in the form of seven guidelines to be implemented through national legislation. COPUOS, in 2007, agreed that its approval of the voluntary guidelines for the mitigation of space debris 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.

2. OBJECTIVE

Long Term Goal:

To effectively mitigate the global risks posed by space debris through international and/or national monitoring, technical cooperation and harmonized rules for the purpose of increasing the long term sustainability of space and ensure access to and usability by all actors, current and future.

Congress Objectives:

- **To assess the value of the UN COPUOS Guidelines**
- **To assess current efforts to implement the UN COPUOS Guidelines**
- **To examine further legal, organizational and technical foundations and endeavours for possible national, regional, and international implementation and to assess whether they could be complementary to the UN COPUOS Guidelines**
- **To put forward specific and viable policy and regulatory steps (mechanisms) that may be considered by states and other stake holders to monitor and reduce the space debris risks**

3. ORGANISATION

The Congress will be organized in two sessions; the first session will be held in Montreal on 7-9 May 2009 and the second one in Bonn-Cologne, Germany, in May-June 2010. The first session will concentrate on comprehensive analysis and assessment of the causes, trends and implications of space debris in order to fully and precisely understand the seriousness of the problem; i.e. essentially covering the first four objectives mentioned above. The Bonn-Cologne session, in the form of a smaller but intensive workshop, by following the Chatham House rule will thoroughly and critically analyze the in-house prepared documents (consisting of the options/solutions collected and suggested at Montreal session) in order to put forward viable and concrete policy and regulatory options (including draft policies and/or treaty), both at international and national levels.

The Congress's organizers aim to publish and promote research that is outcome-oriented and that will promote institutional development and impact policy and law making in space matters. The publication to be released is expected undoubtedly to generate transferable results that will provide a forum of ideas, discussion and policy assessment for leading decision makers. The findings and recommendations of the Congress will further be presented at other fora in order to stimulate and contribute

to international debate on the challenges posed by increasing space debris and viable solutions that could be implemented both at national and international levels.

<u>Organising Committee:</u>

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Tommaso Sgobba (President, IAASS, the Netherlands)
Ray Williamson (Executive Director, Secure World Foundation, US)

ANNEX

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,[a] 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.

[*] *Official Records of the General Assembly, Sixty-second Session, Supplement No. 20* (A/62/20), paras. 117 and 118 and annex. The UN General Assembly in its Resolution endorsed the Space Debris Mitigation Guidelines of the Committee on the Peaceful Uses of Outer Space in 2007. See: United Nations General Assembly, Sixty-second session, Agenda item 31, Document A/RES/62/217 (10 January 2008), paragraph 26. The General Assembly adopted this Resolution as a whole without a vote.

[a] United Nations publication, Sales No. E.99.I.17.

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 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).