

DEFINITION OF SPACE DEBRIS *

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ABSTRACT

The definition of space debris has to reflect the fact that space debris are non-functional objects and that in principle only the launching State can make an authoritative statement on the functional or non-functional status of the object. To avoid the necessity of individual statements for very large numbers of small objects, the relevant legal instrument should contain general rules for declaring as space debris certain classes of objects, such as fragments.

The instrument should contain selected safety and mitigation standards, such as those concerning the re-orbiting of geostationary satellites into disposal orbits at the end of their active lives. Further it should state that the liability for space objects applies to space debris. The instrument should contain the principle that specified obligations, related to the end of functional life of a space object, are binding for its eventual new owner.

INTRODUCTION

The five instruments of space law know terms such as space object, object

launched into outer space or component of a space object, but there is no mention of space debris. Yet, 95% of trackable objects and 100% of the smaller, non-trackable objects in outer space are space debris.

In spite of measures restricting the generation of new debris, the total number of debris is growing. The total mass of all space objects in orbit up to about 2000 km is between 2000 and 3000 tons. Approximately one quarter of that amount is in active spacecraft, three quarters in space debris. It is rather probable that the amount of space debris will have to be reduced in the future to make space activities sufficiently safe. In fact, among the reasons why no effort at systematic removal of either small or large space debris has been made up to now, is not only the prohibitively high cost of adequate methods, but also the obstacles posed by space law to any interference with foreign space objects. There is little doubt that technology will develop and that it will become possible to de-orbit a significant fraction of unwanted debris. As regards space law, the protection of space objects by the Outer Space Treaty should not be as general as it is today. It should apply to active or otherwise important space objects. The

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extension of the protection to space debris is counterproductive.

Space debris are objects, which have terminated their functions, do not have any useful purpose, and are of no value to their owner. Moreover, they pose a risk to active satellites, which, on the contrary, are very valuable and profitable investments. Active satellites and space debris are two different kinds of objects. It is necessary to distinguish between these two kinds and the distinction, in order to be useful, has to be recognized by space law.

A technical definition of space debris has been adopted in the Position Paper on Orbital Debris¹. In order to have a common understanding of the term space debris, the Scientific and Technical Subcommittee of the UN Committee on the Peaceful Uses of Outer Space proposed a very similar definition of the term that it modified at its subsequent sessions to read as follows:

Space debris are all man-made objects, including their fragments and parts, whether their owners can be identified or not, in Earth orbit or re-entering the dense layers of the atmosphere that are non-functional with no reasonable expectation of their being able to assume or resume their intended functions or any other functions for which they are or can be authorized.

That wording was published in the Technical Report on Space Debris². There is, however, still no consensus in the UN on that matter.

The above definition is technically correct. The question is how to determine that a particular objects is, indeed, non-functional. The answer to that question depends on the character of the object, whether it is a **fragment, a part or component part, a rocket body or stage, or a payload.**

PAYLOADS

Payloads can be recognized in the Online Index of Objects Launched into Outer

Space³ either by the description in the column Function of Space Object or by the letter A in the COSPAR International Designator in a single launch, or by the letters A, B, C, ... in a multiple launch. Payloads are among the largest and most massive objects in space even after they have terminated their functions. According to a list of 200 most massive payloads⁴ the total mass of those 200 objects (not counting the Mir complex which decayed on 23 March 2001) is about 600 tons, or 20-30% of the total mass of all objects in space. Their estimated lifetimes are mostly below 400 years. Only 39 objects are likely to survive for more than 1000 years.

The status of payloads, when they become non-functional, cannot be directly recognized. Not even the absence of radio telecommunication signals, established by extended observations, would be sufficient. The plans of activities of some satellites may not have called for any telecommunication in the interval of time under consideration. That could be the case of spare communication satellites, which would be put into service at a later time. Also scientific satellites, such as those used for investigating the field of gravity, may not send any radio signals, their only function being to reveal their position by reflecting light.

Launching State may keep being interested in the fate of a space object even after it became non-functional. That may happen when the object contains industrial or military classified information. The term function of a space object could be understood to cover also the keeping of classified information.

In general, the functional or non-functional status of a satellite cannot be reliably determined without information from the owner. Let us just recall two recent examples. The Compton Gamma Ray Observatory or the Mir Station were functional objects as long as their respective launching States considered them functional and useful. It was only after a decision of the

launching State that the object became officially non-functional.

It may be concluded that a space object cannot be designated as space debris without an explicit statement of the owner, i.e. from the launching State. Such statements are sometimes — but by no means always — published by the launching State or agency in specialized periodicals or in official publications. In some cases they also appear in the governmental announcements made to the Secretary General of the UN in compliance with the provisions of the Registration Convention⁵. This practice, if followed by all launching countries, would become a most important source of information on the fact that a payload ceased being active and became a piece of space debris. It would be sufficient if launching States and agencies agreed, formally or informally, on a suitable phrase denoting the fact that a space object became non-functional and that its owner is not interested anymore in keeping it under the protection of the Outer Space Treaty⁶.

There is, indeed, a need to know which objects, in particular the large ones, are **officially** space debris and which are not. How can scientist and technicians study space debris without this basic knowledge?

ROCKET BODIES AND STAGES

In the COSPAR International Designator, rocket bodies and stages are assigned letters following those of payloads. In single launches it is the letter B and following. The list of 200 most massive rockets (see note 4) shows that their total mass is about 500 tons, or 20-25% of the total mass of all space objects, and that the distribution of their lifetimes is not much different from that of payloads. Taken together, large bodies contain between one third and half of all the mass of space objects up to a couple of thousand kilometers. That is a significant fraction. It would be worthwhile

to consider methods for de-orbiting at least some of the large bodies before they break up into very large number of small debris.

Rockets usually terminate their function after they have transported the payload into orbit. They are passivated by removing remaining fuel and all other chemicals posing a danger of explosion. From a certain moment on, they are, for all practical purposes space debris.

It is up to the international community to discuss if all these objects can be summarily declared space debris or if individual announcements should be required in some cases. It has to be born in mind that individual announcements require more effort and are more costly than the implementation of a general rule.

PARTS AND COMPONENT PARTS

These two terms appear in instruments of space law, but are seldom used in connection with orbiting objects. It could be understood that these objects, which separated from the parent body either by intention or by accident, do not show fractures or deformations. Since it is highly difficult and costly, if not outright impossible, to recover such objects or to put them to a useful function, they should be declared as space debris.

FRAGMENTS

Fragments are products of break-ups or explosions. They are of no value because the cost of recovery, if possible at all, would exceed the value of the material. If they are smaller than about 10 cm in Low Earth Orbit - or smaller than about 1 m in GEO - they cannot be systematically tracked and individual orbits remain unknown. For this reason and because of their large numbers they cannot be listed in a catalogue. The number of fragments of 1 cm and larger,

which can already severely damage or destroy a satellite, exceeds 100.000.

Fragments larger than the above limits are tracked and listed in catalogues, but the fact that they are fragments, is seldom established and listed.

Fragments should be declared by the international community to be space debris. Objects with individually determined orbital elements should be published in national registers of space objects. National registers should be made accessible on the Internet.

LEGAL INSTRUMENT ON SPACE DEBRIS

The first proposal for a legal instrument on space debris, entitled International Instrument on the Protection of the Environment from Damages Caused by Space Debris, was elaborated by the Space Law Committee of the International Law Association⁷. It contains a definition of space debris, which is a concise — and more readable — version of the definition published in the Technical Report (see note 2):

Space Debris means man-made objects in outer space, other than active or otherwise useful satellites, when no change can reasonably be expected in these conditions in the foreseeable future.

The ILA Instrument reflects the situation in 1994, the year when space debris became an agenda item in the UN Scientific and Technical Subcommittee. It was in the following years when the true extent of the problem, in particular the large and growing number of space debris, became apparent, and when some standard practices were developed and recommended. Also the UN Index (see note 3), which became available in 2001, changed the role which the Registration Convention could play in providing authoritative information on the functional or non-functional status of a space object.

The ILA Instrument deals with the obligations to cooperate, to prevent, inform, consult, and negotiate in good faith.

International consultations and negotiations are, of course, important means of solving disputes and should be preserved in any future proposal of a legal instrument dealing with space debris. They are, however, costly and time consuming. Some general rules would simplify the procedure. Only complicated and extraordinary cases should require international consultations and negotiations.

Among the rules to be incorporated into a legal instrument on space debris would be provisions for statements of launching States on the status of large objects as well as general rules for declaring classes of non-functional objects as space debris. Also selected safety and mitigation standards, whether they are recommended or obligatory, should be incorporated. Among these could be the limits on the numbers and lifetimes of objects separating from the parent body during launch and operation. Of paramount importance in this context are practices for re-orbiting satellites from the geostationary and other high orbits into disposal orbits.

Numerical parameters involved in implementation of these practices may change with the progress of technology, as well as with the actual situation in the geostationary and other orbits. Therefore, a mechanism will have to be included for changing these parameters. There could be some analogy with the Radio Regulations of the ITU, which are periodically reviewed and appear in updated editions.

The instrument should also include a statement that the liability for damage caused by space objects is not affected if an object becomes space debris as was done in article 8 of the ILA Instrument.

As a consequence of advancing commercialization of space activities,

satellites may change their owners or operators. It is necessary to agree which of the obligations related to advanced or terminal stages of active lives of space objects will have to be fulfilled by the launching State and which by the new owner or operator.

CONCLUSION

In most matters dealing with outer space, the scientific and technical aspects are closely interrelated with political and legal aspects. Space debris are no exception. It is not possible to study the technical and scientific aspects of space debris without having in mind, tacitly or explicitly, a political and legal definition of space debris, as well as ways of determining or finding out the true status of a space object. Consequently, it is not premature to discuss the legal definition of space debris, including all the aspects stated in this paper and including standards for mitigation and prevention of the increase of space debris in the future.

On the other hand, it would be premature to regulate the removal of existing space debris from outer space at a time when relevant methods have not yet been developed and tested. The present task is to remove legal obstacles to possible future introduction of measures for de-orbiting of space debris.

The basic difference between functional space objects of considerable value on one hand and abandoned or relinquished space objects of no value and use whatsoever on the other hand, has to be formally recognized by space law. Consequences of the difference have to be drawn.

NOTES

¹ Position Paper on Orbital Debris, International Academy of Astronautics, Editions of 1995 and 2001, p.2

² Technical Report on Space Debris, UN Document A/AC.105/720, paragraph 6, 1999.

³ Online Index of Objects Launched into Outer Space is an index of governmental announcements submitted by launching States to the Secretary General of the UN in compliance with the Registration Convention. Prepared by the UN office of Outer Space Affairs. It can be accessed at <http://registry.oosa.unvienna.org/oosa/index/index.stm>.

⁴ Based on the DISCOS data system of ESA. Provided by the courtesy of Dr. H. Klinkrad and Dr. C. Hernandez de la Torre of ESA/ESOC. The data refer to the beginning of 2001.

⁵ E.g., Sweden Announced the termination of activities of Freja, 1992-064A, in the UN Document ST/SG/SER.E/318, of Tele-X, 1989-027A, in E/335, and of Astrid 2, 1998-072B, in E/364.

⁶ The Online Index (see note 3) facilitates the access to information contained in the series ST/SG/SER.E.

⁷ Final text submitted to the 66th conference of the International Law Association, Buenos Aires, August 1994.