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Study on the Legal Regime for Space Debris Mitigation — Taking the Inter-Agency Space Debris Coordination Committee Space Debris Mitigation Guidelines as an Example

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Abstract

As human space activities continue, the problem of space debris which is regarded as the "killer of satellites, spacecraft, and space shuttles", remains unresolved. 2021 saw the release of the latest version of the IADC Space Debris Mitigation Guidelines (hereinafter referred to as the IADC Guidelines), the only remediation program to date that has had a significant positive impact on addressing the accumulation of space debris. The IADC Guidelines complement the body of outer space law in the area of space debris and provide a good model for addressing the issue of space debris mitigation. The present paper proposes a path for the future development of the IADC Guidelines to contribute to the improvement of the legal regime for space debris mitigation.

Keywords: outer space law, space debris, international soft law

1. Introduction

The IADC Guidelines define space debris as non-functional man-made objects, including their fragments and parts, located in Earth's orbit or the atmosphere. This definition has been adopted by the United Nations Committee on the Peaceful Uses of Outer Space (hereinafter referred to as COPUOS), and although it is not legally binding, it is of legal significance as a recognized state practice. (Larsen, P. B, 2018)

The problem of space debris is an unsolved challenge. Space debris can have serious consequences for human space activities and the space environment. On the one hand, there is the threat posed by collisions of space debris with functional space objects. Space debris in the course of space activities, may collide with satellites and spacecraft in orbit. On the other hand, the threat to the space environment posed by space debris refers mainly to the presence of a large amount of space debris in an orbit, which leads to changes in the composition of that orbit and affects its normal utilization.

Currently, the problem of space debris is being addressed in two ways: from the perspective of

prevention, by proposing mitigation measures to curb the accumulation of space debris, and from the perspective of remediation, by proposing methods for the active removal of space debris. Considering the irreversible damage to the environment caused by space debris, the present paper highlights space debris mitigation measures, analyzes the development history and content updates of the IADC Guidelines, and proposes a path for the future development of the Guidelines to contribute to solving the space debris problem.

2. The Basis for Space Debris Mitigation Obligations in Outer Space Law

The main body of current outer space law consists of five international treaties promulgated by COPUOS and sets of principles adopted by the General Assembly. One of these, the Treaty on Principles Governing the Activities of States in the Exploration and Use of Outer Space, including the Moon and Other Celestial Bodies (hereinafter referred to as the Outer Space Treaty), is the Magna Carta of outer space activities and sets out the general legal principles applicable to space activities, which are further deepened in the four subsequent multilateral treaties. These activities mainly include non-appropriation of outer space by one State; the freedom of use and exploration of outer space; liability regimes applicable to damage caused by space objects; safety and rescue of space objects and astronauts; notification and registration of space activities with the United Nations; the scientific investigation and exploitation of the natural resources of outer space; and the settlement of disputes arising out of outer space activities. (Bohlmann UM & Petrovici G, 2019)

On the issue of space debris, the international treaties promulgated by COPUOS do not contain specific provisions on space debris, but they provide a broad legal framework applying to space debris. First, from the perspective of liability, Article VII of the Outer Space Treaty provides that launching States, as well as contributing States, are internationally liable for "damage" caused by entities launched into outer space by them. However, both that article and the Convention on International Liability for Damage Caused by Space Objects (hereinafter referred to as the Liability Convention) limit the concept of "damage" to damage to States parties or private persons and do not directly include damage to the environment. However, in consideration of the irreversibility of the damage caused by space debris to the space environment, the priority in addressing the issue of space debris is to prevent the fragile space environment from damage, not to compensate the individuals or States that have suffered damage. Therefore, it makes more sense to follow the path of space debris prevention, focusing on the link between the duty of prevention and liability, rather than discussing damage caused by space debris. (Diego Zannoni, 2022)

Closely related to the duty of prevention in the treaty regime is Article IX of the Outer Space Treaty. That article provides that each State party shall conduct its activities in outer space in such a manner as to avoid the harmful contamination of outer space and that each State party shall take appropriate measures to that end (also known as the principle of protection of the space environment). This provision can be seen as the source and basis for the obligation of States to take appropriate measures to mitigate space debris. From this point of view, current outer space law provides general legal principles for dealing with the issue of space debris but does not provide specific rules for its implementation, and is unable to provide a good response to the complex issue of space debris.

The IADC Guidelines provide specific guidance on ways and means for States to mitigate space debris and make recommendations on appropriate measures for States to take to mitigate space debris and meet their prevention obligations, making the application of outer space law more operational.

3. Analysis of the IADC Guide System

3.1 History of the Development of the IADC Guide

In 2002, at the initiative of the United Nations, the Inter-Agency Space Debris Coordination Committee (IADC) drafted the IADC Guidelines, which provide remediation options for the creation and accumulation of space debris and have had a wide range of positive effects. (UNOOSA, 2002) The IADC Guidelines, which aim to advance the space debris mitigation process by identifying publicly available methods for mitigating space debris, is now a fundamental requirement for international organizations as well as States to mitigate space debris. In June 2021, the Guidelines were upgraded for the third time. The Inter-Agency Space Debris Coordination Committee (IADC) is

the only international intergovernmental platform in the field of space debris, comprising the space agencies of thirteen countries and regions, including China, the United States, the United Kingdom, France, Italy, Canada, and the European Space Agency.

Based on the IADC Guidelines, the United Nations General Assembly adopted 2007 the Space Debris Mitigation Guidelines, which largely follow the recommendations of the IADC Guidelines, and Member States, as well as international organizations, have taken measures, voluntarily, to implement the space debris mitigation procedures described in the Guidelines. (ZHAO Yaodong, 2022)

In the March 2022 compilation of the UNISPACE Update, a total of 42 countries have submitted notifications of their implementation of space debris mitigation standards, and 15 countries have adopted domestic legislation to incorporate the IADC Guidelines and the COPUOS Space Debris Mitigation Guidelines into their domestic space debris mitigation mechanisms, including space-faring nations such as the United States, Canada, Russia, France, Germany, the United Kingdom, and Japan. (Gao Guozhu, 2019) Most of the countries that have not established their space debris mitigation mechanisms are in favor of the space debris mitigation process. China, as an important member of IADC, has formulated the Administrative Measures for Space Debris Mitigation and Protection by the standards and recommendations of the IADC Guidelines.

3.2 The Content of the IADC Guidelines

The IADC Guidelines list the requirements for space debris mitigation in three points: prevention of on-orbit break-ups; removal of spacecraft that have reached the end of their flight life from dense orbital regions; and limitation of the release of objects during normal operations. The specific elements include: limiting the amount of operational debris released in the course of normal launch activities; minimizing the potential risk of on-orbit break-ups; rule-based disposal principles for spacecraft at the end of their useful life; and preventing on-orbit collisions. A series of standards are proposed for spacecraft and carriers entering Earth orbit from the project planning stage and the design stage to the operational stage in orbit, reflecting the standards and norms currently being developed by the international community in the area of space debris mitigation, while incorporating the latest research and practical experience through three revisions.

In the 2021 edition of the IADC Guidelines, it was specifically revised that at the end of a mission, launch vehicle orbital stages and spacecraft in circular orbits located entirely in the GEO protection zone should leave GEO immediately and remain above the GEO protection zone for at least 100 years. Meanwhile, the IADC Guidelines, based on its latest research, suggest two elements required to meet this standard, firstly, an increase in the near-Earth altitude point, and secondly, an eccentricity of less than or equal to 0.003.[7] The Guidelines for the Support of Space Debris Mitigation in IADC describe other options and ways to meet this standard. From this point of view, the Space Debris Mitigation Guidelines, while establishing the standards and requirements for space debris mitigation, also provide specific technical support for countries to meet the standards, and are highly practical and flexible. Compared with the seven broad guidelines set out by COPUOS in its Space Debris Mitigation Guidelines, the newly revised version of the IADC Guidelines is more effective in its application.

3.3 Advantages of the IADC Guidelines

The IADC Guidelines are the only remediation program to date that has had a significant positive impact on the problem of space debris accumulation. Its developer, IADC, is recognized as the technical and scientific authority in the field of space debris issues. (U.N. Office for Outer Space Affairs, n.d.) By transforming the IADC Guidelines program into the UNCOPUOS Space Debris mitigation Guidelines, the IADC Guidelines have now gained general acceptance in countries and regions other than those of its member organizations. (Lyall, F., & Larsen, P.B., 2018)

The IADC space debris mitigation mechanism is more acceptable and less sensitive than the EU model. The EU has sought to establish a code of conduct to regulate space activities, however, it ultimately failed due to its implications in the area of defense and security. In contrast, IADC Guidelines pay attention to the technical aspect, causing countries to have less resistance to voluntarily implementing the standard.

Meanwhile compared with the space debris mitigation model of COPUOS, the decision-making mechanism of IADC is more

flexible. Space debris mitigation is closely related to the current development of advanced technology. However, the COPUOS is unable to adapt to the speed of development of technology for its lengthy resolution mechanism. While the IADC Guidelines have been updated to the third version and are supplemented and supported by the Guidelines for Supporting Space Debris Mitigation of the IADC, which are more flexible in adapting to the development of technology.

However, special attention should be paid to the limitations of the IADC Guidelines in addressing the space debris problem, despite their unique advantages due to their technical nature and flexibility. The main reasons for this are that, on the one hand, the Guidelines are not an international treaty to address the issue of space debris, so there are deficiencies in their binding force; on the other hand, the IADC Guidelines themselves rely mainly on voluntary compliance by subjects conducting space activities and do not have enforcement power and lack an implementing organization. Therefore, the next part of this paper will consider how to better utilize the IADC Guidelines in the field of space debris mitigation.

3.4 Limitations of IADC Guidelines

Of particular concern, however, are the limitations of the IADC Guidelines in addressing the space debris problem. The main reason for this is that the IADC Guidelines themselves, as "soft law", rely mainly on voluntary compliance by subjects conducting space activities and are not binding.

Article 38 of the Statute of the International Court of Justice provides for the scope of international treaties, international customs, and general principles of law as traditional sources of international law. As a non-traditional source of international law, international soft law, in contrast to the binding "hard law" represented by binding treaties, customs, and general principles of law, consists of a series of non-legally binding normative international documents such as guidelines, guides, declarations of principles and so on, adopted by consensus by the relevant international organizations. International soft law is not legally binding in the strict sense, but it has certain legal effects, and it prepares the way for the formulation of treaties and the formation of international customs.

The IADC Guidelines, prepared jointly by Working Group IV of the Inter-Agency Space Debris Coordination Committee and adopted by consensus, are the first international technical document on space debris and represent the standards for space debris mitigation measures adopted by the major spacefaring nations. It lays the foundation for the formation of international law in the field of space debris mitigation and provides strong support for the existing United Nations treaties on outer space, and belongs to the category of international soft law. (Huang Yun, 2017)

Therefore, the next part of this paper considers how the IADC Guidelines can be better utilized in the field of space debris mitigation.

4. The Development Pathway of IADC Guidelines

4.1 Incorporating the IADC Guidelines into the Legal Regime on Outer Space Through the Treaty Interpretation Approach

According to Article 31 of the Vienna Convention on the Law of Treaties, a treaty shall be interpreted taking into account the subsequent practice of the parties in addition to the context. The outer space law system just provide the state parties with a framework applying to space debris problems, therefore it is necessary to take IADC guidelines as a reference for the subsequent practice of the Outer Space Treaty.

An examination of subsequent State practice shows that Article IX of the Outer Space Treaty stipulates that state parties shall take appropriate measures for the protection of the space environment. The article establishes the obligation of States parties to take precautionary measures in carrying out activities for the exploration of outer space, as well as the responsibility for consultations if the obligation of precaution is not properly fulfilled.

However, the standard for meeting the prevention obligation is not mentioned in any of the international treaties promulgated by COPUOS. Specifically in the area of space debris mitigation, about the prevention obligation, the IADC Guidelines provide a series of criteria for spacecraft and launch vehicles entering Earth orbit, from the project planning stage, through the design stage, to the in-orbit operation stage, which can be used to judge whether States

parties are fulfilling their prevention obligation. The IADC Guidelines provide States with detailed technical guidance that includes specialized technical recommendations and code provisions that have practical value as references, while the IADC Guidelines have a broad and consistent national practice among the State's parties and have become the subsequent practice of the Outer Space Treaty.

The IADC Guidelines were developed by the Inter-Agency Space Debris Coordination Committee (IADC), whose membership includes all of the world's major spacefaring nations, and there is an extensive national practice based on the Space Debris Mitigation Guidelines. First, as a founding member of IADC, the United States has fully practiced the IADC Guidelines from the legislative level to the judicial level. (FENG Guodong, 2014) The U.S. is at the forefront of space legislation and, as a founding member of IADC, has provided a wealth of advice for the development of the IADC Guidelines. Second, at the practical level of space debris management, the IADC Guidelines have become the operational standard for U.S. federal agencies to implement early warning and control mechanisms. The United States Space Debris Warning and Control Mechanism (SDWCM) is a system of explicit control or warning requirements for the launch or in-orbit operation of launch vehicles or aircraft to minimize the creation of space debris.

Secondly, as a long-established spacefaring nation, Russia is also a member of IADC, and following the adoption of the IADC Guidelines. Russia formulated the General Requirements for the Mitigation of Man-made Near-Earth Inter-Space Contamination of Space Systems, which include mitigation of man-made near-Earth space contamination during normal operation; prevention of the break-up of a space system; prevention of the break-up of a space system at the end of its effective operation; and prevention of collision of a space system with a space object. Its content and purpose are broadly similar to the IADC Guidelines and reflect the efforts and explorations of the Russian space sector to establish a national mechanism for space debris mitigation and control in compliance with IADC requirements. (Li Bin, 2008)

Once again, China, as one of the world's leading spacefaring nations, has actively participated in the preparation of international documents such as the IADC Guidelines and has also responded positively to the requirements of the IADC Guidelines by initiating the construction of a national mechanism for space debris mitigation. (Li Shouping, 2008) In the construction of national mechanisms for space debris mitigation, China has initiated the construction of space debris mitigation-related laws and management systems and formulated the Space Debris Action Plan (2006-2010).

At the same time, after the adoption of the UNCOPUOS Space Debris Mitigation Guidelines, which were developed based on the IADC Guidelines, most countries in the world have expressed their adherence to them. Thus, adherence to the IADC Guidelines has become the practice of most countries in the world in fulfilling their preventive obligations under Article IX of the Outer Space Treaty.

Therefore, through the method of treaty interpretation and in conjunction with the subsequent practice of States, the IADC Guidelines can provide standards and references for States in fulfilling their preventive obligations under the Outer Space Treaty, thereby expanding the current outer space legal system and giving full play to the regulatory role of the current outer space system in the field of space debris mitigation.

4.2 Building International Consensus, Enhancing Implementation, and Providing the Ground for the Formation of International Treaties as Well as Customary Law

As a representative document of international soft law in the field of space debris regulation, the IADC Guidelines, although deficient in terms of their enforceability and binding force, demonstrate the basic understanding of space debris mitigation by all countries, and have both political and moral implications. (WANG Haifeng, 2007) From the perspective of its general nature as international soft law, for the IADC Guidelines to be more effectively followed, the rationality of their content should be improved, their formulation procedures should be standardized, the participation of international governance actors should be promoted and the consensus of the international community should be consolidated.

After three revisions, the newly revised version in 2021 incorporates the latest research and practical experience and emphasizes the requirements for the de-orbiting and disposal of

aircraft at the end of a mission. However, it is still insufficient in following up on the latest challenges of the space debris problem. Therefore, it is necessary to improve and develop the content of the IADC Guidelines by focusing on the new challenges of the current space debris problem, to enhance the rationality of the content of the IADC Guidelines, and to increase the motivation for the voluntary and proactive fulfillment of the Guidelines by the main parties involved in space activities. Specifically, the current IADC Guidelines system is divided into two main aspects: First, the access mechanism. The general policy of the IADC Guidelines proposes that when planning and operating a space system, an organization should adopt systematic activities from the mission requirement analysis and definition phases, and that every project should establish a feasible Space Debris Mitigation Plan. The IADC Guidelines provide detailed space debris mitigation measures, which include inter alia, releasing all stored energy from a space system to minimize the chance of disintegration, artificially re-entering a space system into the Earth's atmosphere, and placing an end-of-life space system into a desired orbit. As far as the two existing aspects are concerned, the IADC Guidelines are ambiguous in terms of the access mechanism, and it can be recommended that member entities take Space Debris Mitigation Plan as an indicator for assessing the feasibility of projects for launching a space system and clarify the status of Space Debris Mitigation Plan at the access stage. Secondly, in the preventive mechanism, consideration should be given to the emergence of special spacecraft as a result of technological development. Special criteria should be set for spacecraft with nuclear power sources, as well as for microsatellites, such as nano and micron satellites, to minimize the possibility of the generation of space debris during the launch and operational phases.

Secondly, the IADC Guidelines are flexible enough to adapt to the current pace of technological development in the field of space debris mitigation, but this does not mean that they can be formulated arbitrarily. Improvements in their formulation procedures can better reflect their formal rationality, ensure effective compliance by the international community, and give full play to their role in the governance of space debris. Specifically, the current IADC consists of a steering group and four working groups, the steering group is not only responsible for guiding the meeting and listening to the working group report but also studying and discussing the revision of the charter and international cooperation matters. The IADC General Assembly is currently held once a year, which is organized by the member countries of the IADC on a rotating basis, and regularly reports to the COPUOS on its work. (The State Administation of Science, Technology and Industry for National Defence, 2009) In the published Terms of Reference of the Inter-Agency Space Debris Coordination Committee (IADC), the terms of reference and objectives of the Steering Group and the Working Groups are set out, and the membership of IADC is introduced, but the rules of procedure of the General Assembly and the procedure for revising the designation of the IADC Guidelines have not been publicized. To improve the rationality of the IADC Guidelines, the procedure for its formulation should follow the principles of openness, transparency, and democracy. Therefore, in the direction of future development, IADC should make efforts to promote the standardization of the procedure for the formulation of the IADC Guidelines, drawing on the formulation procedure of some hard laws while retaining its flexibility, to gain the respect and observance of the international community through its rationality of form.

Finally, in terms of the soft law attributes of the IADC Guidelines, since they do not have the binding force like treaties, customary law, and general principles of law, compliance with the Guidelines by national entities does not only stem from international political and public opinion pressure; at the same time, when considering whether to comply with international soft law, they are guided by the interests of their own countries and whether the soft law is in line with their current and long-term interests. Therefore, to fully utilize the role of the IADC Guidelines in the field of space debris mitigation, the international community should reach a consensus and find common interests of all countries, which on the one hand can increase the effective compliance of all countries with the IADC Guidelines, and on the other hand, can provide support for the formation of new rules of international law. Specifically, the IADC Guidelines should include more national space agencies as members, making them more universal and representative

and providing the ground for the formation of an international treaty to regulate debris mitigation in space. For example, the principle of non-appropriation of outer space, which prohibits States from claiming sovereignty over outer space and celestial bodies, was first mentioned in the 1961 United Nations General Assembly resolution and subsequently became the basis for the establishment of Article II of the Outer Space Treaty. At the same time, the IADC Guidelines advocated for State practice in space debris mitigation, providing evidence of general State practice and motivation for the formation of customary law.

5. Conclusion

This paper briefly describes the international legal basis for space debris mitigation obligations, analyzes the IADC Guidelines, pays attention to their lack of binding force and enforceability, and makes recommendations on their future development to help the international community better address the space debris problem. On the one hand, by applying the general aspects of treaty interpretation and combining them with the subsequent practice of States, the IADC Guidelines provide a reference for the regulation of States' compliance with their space debris mitigation obligations, thus contributing to the formation and improvement of the current system of space debris legal regulation.

On the other hand, from the perspective of its nature as international soft law, it is suggested that the rationality of the content and form of the IADC Guidelines be upgraded and that more countries be involved in the process of formulating the Guidelines. By forging an international consensus to promote effective compliance with the Guidelines by countries, the formation of international treaties and customary law could be accelerated.

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