SCIENTIFIC AND LEGAL ASPECTS OF SPACE DEBRIS

by

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Historical Note

Although there had been a general awareness for many years of the dangers resulting from the presence of man-made debris in outer space it was not until the 11th Scientific-Legal Roundtable of the International Academy of Astronautics/International Institute of Space Law that the subject was considered by the Committee.[1] The subject of space debris generated much interest and in 1987 the IISL considered at length the topic of "Legal Aspects of Outer Space Environmental Problems."[2]

This was followed in 1990 at the 13th Scientific-Legal Roundtable with a panel first entitled "Legal Aspects of the Control of Space Debris,"[3] and later changed to "Scientific/Legal Aspects of Management of Space Debris."[4] The members of the committee considered the subject to be of sufficient importance to schedule a workshop to be held in 1991. The focus of the workshop was on means designed to advance further action on the issue of space debris.

At the 1991 meeting Dr. V. Kopal, Co-Chairman of the committee, distributed a two-page memorandum entitled "Issues Concerning Space Debris." In addition to the identification of critical substantive issues he asked whether a position paper might not be prepared by the IAF/IAA/IISL so that the attention of the world community might be alerted to the dangers of space debris. The committee also received a two-page memorandum dated September 9, 1991 authored by Dr. L. Perek entitled "Follow-Up on Space Debris."

The committee was made aware of a study being finalized by the Committee on Safety, Rescue, and Quality of the IAA. It was distributed on August 27, 1992.[5]

At the 1991 meeting of the Scientific-Legal Committee Dr. V. Kopal provided the members with a questionnaire dealing with space debris. At the meeting of the committee on August 30, 1992 he made available a summary of replies compiled by him.[6] At the 1992 meeting of the IISL the subject of "Managing Environmental Issues Including Space Debris" was one of the topics on which papers were prepared. [7]

In 1992 it was decided to pursue the issue further with the subject for the 1993 meeting of the committee to be "Scientific and Legal Aspects of Space Debris." The present paper was invited by the Co-Chairman of the Committee, Dr. V. Kopal, to assist in arriving at conclusions on the subject. This paper relies extensively on the contributions of committee members whose views have appeared in many learned publications. [8] It must be noted that very important views have been expressed by other experts in a variety of publications. The author has relied on all relevant sources.

Abstract

If success is to mark future space activities measures must be formalized to mitigate, and if possible to eliminate the real and potential dangers occasioned by the presence of man-made debris in outer space. If there is to be a legal regime for space debris it will be necessary to assign a legal meaning to that term. What can be done in the immediate future to address the dangers and to formulate relevant legal principles, standards, and rules?

Moreover, it will be necessary to create procedures for managing the problem. What kind of institution should be contemplated and what powers should be accorded to such an entity? Who will be the mid-wife? What impact will it have on assuring the peaceful and safe uses of outer space, per se, the Moon, and other celestial bodies?

Definitional Problems

What is space debris? At present there is no treaty definition of "space debris" or "space object."[9]

In seeking a definition of man-made space debris a number of criteria offer themselves for consideration. These criteria are the product of mankind's experience in space.

To be taken into account are the places where the debris is located, "the circumstances under which it came to be situated there, the intent of the . . . [launching entity] which placed the unitary space object initially into orbit, the physical characteristics of the debris, the adversity resulting to functioning space objects and to the community at large from the presence of debris, and the range of responses available to the . . . [launching entity] and to other concerned international legal persons, including other States and international intergovernmental organizations, both universal and regional as well as consortia of States which anticipate detriment as a result of the existence of the debris."[10]

Highlighting these practical perspectives of the nature of man-made space debris, and adding to the drive for a suitable definition of such debris, have been valid concerns. Non-functional objects in space, both large and small, are perceived as imposing limitations on the peaceful uses of the space environment. Fears, both real and anticipated, exist that ever-increasing amounts of debris can produce very substantial harms in outer space, in air space, and on the ground to persons and property as well as to the natural environment, per se. The use of nuclear power sources enlarges such concerns.

One practical approach to the identification of debris is to list those observable materials which are deemed harmful to the success of outer space

activities. Such debris, also frequently referred to as "junk," "refuse," or "derelict hardware" includes, by way of example, used rocket states, separation devices, shrouds, clamps, microparticulate matter, paint flakes, and component parts. This list become more impressive when the term "fragments" is added to it. To these illustrations the Ad hoc Expert Group has added "spent rocket bodies," "material released during planned space operations," and "aluminum oxide of solid motor propellant." [11] But, even this does not complete the inventory. To be added is something wholly unlike fragments, namely the space object itself in its original unitary condition except that it has become non-functional, e.g., a "non-operational spacecraft." [12]

It is important to identify those materials deemed to be either dangerous or potentially dangerous. Following their identification it becomes easier and more practical to fashion a definition taking the indicated items into account.

Another approach to the identification of debris focuses on the intent of launchers including the consequences of such activities. Thus, the Space Committee of the International Law Association is now suggesting that man-made debris results from routine space operations, orbital explosions and satellite break-ups, collisions, solid rocket fuel, and the act of abandonment. [13] Examples of debris produced by the foregoing causes are the spent stages of rockets, released hardware, the product of explosions and break-ups, the product of collisions, particles created from the exhaust of solid fuels, and abandoned satellites. [14]

The ILA reference to abandoned satellites as debris needs clarification. There has not been complete agreement in the past that a unitary non-functional space object, e.g., a spent or abandoned satellite, falls into the category of debris. The present author has taken the position, because of the vast damage resulting from the collision of a unitary non-functional space object with another satellite, whether in a geostationary orbital position or elsewhere, that the non-functional object logically should fall into the category of debris. [15]

Support for this position is found in the writings of H.A. Baker, who lists as examples of space debris "inactive payloads," "operational debris," "fragmentation debris," and "micro-particulate matter," [16] and of He Qizhi. Professor He has stated "In terms of space law, the word 'debris' may be safely assumed to cover spent space objects." [17]

Unsurprisingly, support for including abandoned satellites as debris comes from the government of China. Within the category of space debris it included "especially a satellite that is no longer in use." [18]

The views of the astronomer, Dr. L. Perek, offer guidance in determining what constitutes man-made space debris. Writing in 1982 he expressed concern over prospects of collisions between space objects. He put forward the timeless advice that "prevention is better than cure." [19] In briefly addressing the subject of debris he observed that "There are about 3500 debris orbiting in outer space which are large enough to be tracked by radar and an unknown number of smaller pieces and fragments." [20] In early 1992 some 7,200 trackable artificial objects were in orbit of which 95% consisted of space

debris.[21] According to Perek the presence of 3500 debris would "incapacitate an active satellite and in fact this is what may have happened to some satellites which developed a sudden malfunction."[22] These brief comments suggest that his focus was on fragments as debris and that the large volume of fragments posed a threat to active satellites. Implicit in his analysis was that the debris-fragments served no useful purpose. He did not reach the conclusion that space objects in their original unitary condition, but which had become non-operational, and hence were not serving any useful purpose, also might be classified as debris. This early focus on fragments continues to influence efforts to achieve a suitable legal definition of debris.

Also writing in 1982 Professor I.H. Ph. Diederiks-Verschoor in examining the debris problem offered a distinction between a common and a legal meaning. In her view the former is "generally taken to mean 'scattered fragments' or 'wreckage.'"[23] But, in a legal sense she concluded that the expression "may be safely assumed to cover (fragments of) space objects which are spent or no longer functional."[24] Her reasoning was based on the proposition that when something is broken up, as in the case of a fragment, the original or unitary, and now damaged entity could not serve its purpose anymore.

In 1990 Perek, after referring to "fragments," wrote that "Space debris is generally understood to mean parts of space objects generated by break-ups of spacecraft, rockets, etc. Its characteristic attribute is being inactive and not serving any purpose anymore. In this respect there is no sharp limit between debris and non-functional space objects, the latter conveying the impression of large objects, while the former may refer also to small objects down to a fraction of a millimetre."[25]

In the same vein is his response to the 1992 committee questionnaire where he observed that "originally the term 'space debris' suggested the meaning of 'fragments,' but later, all inactive objects from burnt out rocket stages down to submillimeter particles were included under 'space debris.'"[26] Presumably the expression "all inactive objects" would include the unitary non-functional space objects previously identified. Perek in his response referred to the definition of space debris appearing in the 1992 Ad hoc Expert Group's report. It reads:

> Orbital debris is herein defined as any man-made Earth-orbiting object which is non-functional with no reasonable expectation of assuming or resuming its intended function or any other function for which it can be expected to be authorized, including fragments and parts thereof. Orbital debris includes non-operational spacecraft, spent rocket bodies, material released during planned space operations, and fragments generated by satellite and upper stage breakup due to explosions and collisions.[27]

Since Perek was a member of the Ad hoc Expert Group it may be surmised that the foregoing proposed definition met with his approval. This conclusion is supported by his short memorandum of September 9, 1991 in which he noted that "the scientific and technical

communities understand by space debris all uncontrolled objects in space, irrespective of their size and irrespective of the fact whether they are fragments of some larger body or not."[28]

In a more recent writing Perek has referred to "non-functional objects or pieces of debris . . ."[29] Such objects are "collectively called space debris."[30] This appears to signify that he now considers unitary and intact but non-functional space objects to constitute debris.

To be compared with the Ad hoc Expert Group's definition of debris is that of the ILA's Space Law Committee. Its definition, which is undergoing study, means "objects in outer space, other than active satellites, in the vicinity of the Earth environment, implying a risk of collision with active spacecraft or other undesirable interference with activity in outer space."[31]

Although there is no official definition of man-made space debris it is submitted that "space debris" has a fairly precise meaning. In all events it consists of something which possesses tangible, physical characteristics of the kind that can be seen, touched, weighed, processed in factors, or analyzed in laboratories. This perception of the characteristics of space debris is the product of the practical conclusions arrived at by informed students of space activities. Support for this conclusion is reflected in the foregoing illustrations.

In real terms the prospects for the collision of two man-made active unitary space objects are quite remote. Harms produced by fragments either following a collision or following the intentional or accidental break up of a space object are statistically more likely. However, a satisfactory new international agreement should take into account the harms produced by either a functioning or non-functioning unitary space object and all other man-made debris, including fragments of an original whole space object.

Among the commentators there is unanimous support for the view that fragments of man-made space objects, including their functional equivalents in the sense of things capable of producing harm, as well as comparable component parts of space objects, constitute debris. Early views which would not have included unitary non-functional space objects as debris appear to have been modified. In an analytical sense both fragments and their equivalents as well as non-functioning unitary space objects should be identified as debris. Neither serves a meaningful space function. Their common denominator is danger.

If the true quality of "debris" is to depend on the non-functional and non-utilitarian nature of such "debris," then the factor of size becomes irrelevant. Both fragments and large non-functional and non-utilitarian unitary entities will fall within the definition.

Remaining doubts, if any, will have to be resolved through the negotiational and drafting process, but the answer seems clear. The adoption of a definition of man-made space debris is fundamental to the maximization of space activities. Such a definition should be the leading article in a formal international agreement.

Non-Definitional Problems: Fundamental Issues

Aside from the foregoing

definitional problem a satisfactory regime to cope with debris will have to deal with those measures designed to prevent the "generation" of space debris.[32] Such measures would also mitigate the potential harms of man-made debris. They could be both active and passive.

Among the active measures foreseen by Kopal are "changes in design and operation of space objects," "removal of non-functional space objects into the atmosphere, into a disposal orbit, out of the Earth's influence," and "return to Earth by means of reusable space vehicles."[33] It has also been indicated that through active measures it would be possible to capture an inactive or abandoned space object at different altitudes. In 1992 the U.S. space shuttle recovered *Intelsat VI*. A two and one-half foot long robot arm on the shuttle *Columbus* succeeded in clamping onto a floating aluminum die not quite an inch in size in 1993.[34] These are costly procedures.

Without making physical contact it is possible through remote action to force such a satellite to lower altitudes with resultant disintegration.[35] Passive measures would include shielding, improving the dissemination of information, and evasive maneuvers.[36] A recent study has concluded that "there are some technologically mature and economically feasible measures that can be readily applied in minimizing debris."[37]

In addition to the availability of practical active and passive measures for reducing the threat of harmful space debris account must also be taken of legal approaches to the problem. These include issues of jurisdiction and control, liability for damages, identification, and international responsibility.[38] Under the heading of damages there will be a need to determine the legal premise upon which monetary reparations will be based. This will require an analysis of the concepts of liability based on fault, with its antecedents in negligence, and liability without fault, also known as absolute liability.

Under the heading of measures it will be necessary to determine if the entity that captures the non-functional space object has a duty to return it to the owner. The respective roles of a capturing State and a capturing international intergovernmental organization will have to be clarified.

In addition to the foregoing problem areas there is the fundamental issue of determining whether the new legal regime, either with a focus exclusively on the issue of debris or on more far ranging space issues, should adopt a prohibitory or a regulatory posture. In each instance it will be necessary to determine what measures or procedures should be established in order to secure the implementation of the accepted legal norms. Encompassed in the foregoing would be provisions dealing with registration of space objects and identification of debris. The circumstances within which notice would be provided and assistance rendered would be a part of the project, as would be the factor of consultation. Consideration should be given to the matter of insurance[39] and dispute resolution.[40] If the scope of the formal international agreement were to extend beyond harms to persons and property, namely, to the protection of the environmental balance of the biosphere, then the dispute resolving procedures

would be quite complex.[41] At issue are those space activities "which may disrupt the balance of the environment of outer space, the Moon, and other celestial bodies or adversely change their environment. . . ."[42]

As worthy for consideration as is the environmental balance of the biosphere perhaps the more immediate approach should be to focus on harms to persons and property in outer space, in the airspace, and on the Earth's surface. The nature of harms is a very complicated problem. Encompassed are such concepts as "direct damages," "indirect damages," "moral damage," and "nominal and punitive damages.[43] Perhaps the wisest course is to obtain experience in the application of such concepts to harms experienced by persons and property before asserting claims resulting from adverse changes in the environment.

The prospect that harms produced by debris will open the door to claims for damages requires an assessment of the formal international institution best designed to deal with the totality of debris-related problems. First, a decision is required concerning the best institution for establishing a formal legal regime. Second, what institution is best suited to provide the infrastructure needed for successful long-term management and control?

Many international intergovernmental organizations, States, and private professional bodies have already demonstrated an interest. A part of the problem, as has been noted by many informed commentators, has been to mobilize the required political commitment to support the generalized awareness of the prospective harms of space debris.

That there are substantial and varied needs to bring the debris problem under regulation is attested to by the number of institutions which have examined the subject. Leading the list is the United Nations where the General Assembly has adopted resolutions on the subject.[44] As early as 1982 the UNISPACE 82 Conference took note of the importance of the problem.[45]

Although COPUOS has considered the matter, as have the two sub-committees, the topic has as yet not been placed on the agenda of either of them. This is despite the fact that COPUOS regularly receives extended reports on "National Research on the Question of Space Research" from major users of outer space.[46] Other information on debris is contained in the periodic reports dealing with "Activities of Member States."[47]

Further, within the major countries there is firm national support for controlling space debris. For example, the United States in 1988 announced as official policy that "all space sectors will seek to minimize the creation of space debris. Design and operation of space tests, experiments and systems will strive to minimize or reduce accumulation of space debris consistent with mission requirements and cost effectiveness."[48] This policy was restated in 1993 with the addendum that "The United States Government will encourage other spacefaring nations to adopt policies and practices aimed at debris minimization."[49]

Under the aegis of the European Space Agency the "First European Conference on Space Debris" was held

in the Spring of 1993. Co-sponsored by the national space agencies of France, Germany, Italy, and the United Kingdom the meeting drew experts from non-ESA countries. Under the heading of space debris mitigation and policy issues the authors of the 1992 IAA "Position Paper on Orbital Debris," W. Flury and D.S. McKnight, reported on their findings.

The International Telecommunication Union has addressed the dangers created by the presence of inactive satellites in geostationary orbital positions. Collisions obviously would jeopardize entire communications systems. The dangers of debris continue to receive the attention of the ITU. It has been suggested by Professor Jakhu that this body "is the most appropriate international organization for the resolution of the problem of space debris in the GSO."[50] He added that the ITU's "jurisdiction in this regard has been implicitly confirmed by all the States that participated in the 1985 WARC . . . as well as several CCIR [Consultative Committee on International Radio] meetings."[51]

If, as has been generally assumed, the United Nations were to assume the lead policy and legal roles in this area,[52] it is evident that the foregoing international intergovernmental groups will occupy highly important supporting positions. Additionally, such institutions as the Committee on Space Research (COSPAIR),[53] the International Astronautical Federation, the International Academy of Astronautics, the International Institute of Space Law, and the International Law Association will provide leadership based on major concerns so that at long last important decisions can and will be taken. Reference must also be made to private national organizations such as the American Institute of Aeronautics and Astronautics which has published a report entitled "Orbital Debris Mitigation Techniques: Technical, Economic and Legal Aspects."[54] In order to generate multinational cooperation at the grass-roots level a citizen-based Orbital Debris Action Committee has been proposed.[55]

Before the foregoing matters can be dealt with it will be necessary to arrive at the policy to be pursued respecting the dangers presented by space debris. There is wide-ranging support for measures to eliminate if possible, or at least to mitigate the presence of debris as it constitutes dangers to space activities. The goal must be the mitigation and control of space debris augmented by a relevant legal regime and institutional support. There is not support for prohibitory policies. Positive efforts to prevent debris from accumulating in outer space are preferred to clean-up activities.

The regulatory approach must be refined. This must be accomplished through the identification of specific steps which will mitigate the harms posed by debris. Logically, such steps must include design and construction of space objects, pre-launch planning launch procedures, control during the orbiting phase of space objects, elevation of non-utilitarian objects in orbit to "parking" areas, acquisition of orbiting space objects, deorbiting, the return of debris to Earth, and disposal after return to Earth. Particular care will be required when the non-functional material is radioactive.

In analyzing the nature of a regulatory regime two approaches must

be taken into account. First, the purpose must be identified. These are frequently stated in fairly general terms. Such terms, because of their importance, must be selected only after very careful consideration. Second, specific acceptable procedures and practices must be identified. The nature of the latter will emanate from and be consistent with the previously identified purposes.

The efforts of several countries to identify goals or purposes are instructive. In assessing the considerations leading to the 1988 United States policy Baker has noted that goal was "to minimize the damage which could be caused by space refuse [debris], in order to protect US assets in space and on Earth, and to avoid claims for liability by foreign States. [Additionally there was the goal of] minimization or reduction of space refuse [debris]."[56]

As an alternative to the goal of minimizing or reducing space debris, it has been suggested that a broader, and possibly preferred policy, would be to favor "elimination" of the undesirable object or its bits and pieces.[57] In support of a policy of "elimination" it was urged that this would allow for reducing and minimizing space refuse [debris] . . . more quickly, with benefits accruing not only to persons and property in space and on Earth, but also to the environments of Earth, airspace and outer space."[58] Further, it was suggested that such a policy would provide a strong indication to the space-resource States that the United States was committed to resolving the space debris problem.

China has announced in favor of the mitigation of the presence of space debris. Through cooperative efforts countries will be able "to promote actively the exchange of information and technology, search together for effective ways to reduce the generation of space debris and make genuine efforts to preserve the space environment."[59] Control over the "generation" of space debris is a central part of the Chinese policy.[60]

The Russian Federation after taking note of the increasing amount of dangerous debris, particularly in low-Earth orbits, has urged that measures be taken to "reduce the growth rate of such debris."[61] Although the United States policy refers to "minimization or reduction," the Chinese policy uses "reduce the generation," and the Russian Federation would "reduce" the growth rate, the commonality of outlook is clearly evident. At the present there is substantial support for the policy of prevention of debris and the mitigation of potential harms.

The question then arises as to the means to be used to achieve the common goal. Here again there is a basic understanding of what is required. Technical measures are considered as the answer to the problem.

This being the case the question arises as to the specific technical measures that would be most efficient and cost effective. Here again, taking into account the importance of modeling of procedures before they are practically implemented, there is a considerable amount of agreement. Implicit is the view that present and future research will provide guidance as to the sufficiency of practical measures.

Among such methods the United

States has suggested laboratory research with radar frequencies, shielding research, and on-going observational activities.[62] China has identified tethering, design changes in satellite-rocket separation devices, fixing lower perigees for transfer orbits, shortening of the orbital lifetime of the final stage of the separation of the satellite from the launch rocket, and methods for the prompt release of residual propellants and high-pressure gasses remaining in the final-stage rockets, thereby preventing explosions while they are in orbit.[63]

The Russian Federation has also provided a long list of technical measures which would reduce the growth rate of debris. These include the reduction of launches and the use of space objects having long life-orbital lifetimes, prohibition of deliberate destruction, reduction of the number of rocket stages and elements of space vehicles which separate in orbit, use of fuels which do not produce solid particulates, shielding, deorbiting and graveyard orbit procedures, avoidance of placing launch equipment into orbit, and greater use of man-operated shuttles.[64] Other methods might also be listed. The foregoing instances clearly indicate that the presence of debris in outer space can be suitably mitigated through the use of present and future technical means.

As is often the case of examining policy issues attention initially is directed to practical considerations which in their own way are conditioned by the scientific and technological developments of the times. The foregoing identification of practical measures for the mitigation of space debris through reduction and minimization, however, are only some of the considerations to be weighed.

Policy First - Law Second: Variations on the Theme

As noted in the 1988 United States directive on space policy, and taken into account by commentators in the field, attention must also be given to the factor of "cost effectiveness,"[65] as well as to agreement by the space-resource States on basic principles and practices.[66] Another way to address this aspect of policy is to ask when do the prospective harms resulting from space debris rise to the point where at least the expenditure of an equivalent sum or sums for mitigating purposes is required. This then leads to the further question of how much should be expended for the several problems designed to deal with the different aspects of the "debris problem." Since all debris, depending on size, location, toxicity, etc. does not constitute the same hazard, presumably it would be the best course of action to concentrate only on the most dangerous situation. For example, it may be possible to agree that shielding mechanisms are better suited to certain altitudes than for others or that equipment allowing for ascent from geostationary orbital positions to higher parking graveyards would be mandated whereas the same requirement would not be established for objects at lower altitudes.

The Role of Law

Any future legal regime relating to man-made space debris will be inadequate if it does not set forth measures designed to protect against potential harms. Such measures can be passive or active. They can be preventive or corrective.

Earlier reference was made to passive measures. In their preventive

mode they range from skillful launches of carefully designed space objects, and similar practices and procedures to the acceptance of such legal norms as those calling for negotiation in good faith, to the general obligation to consult and to cooperate, and to accord due regard to the corresponding interests of States pursuant to Article 9 of the 1967 Principles Treaty.

When prevention fails then there will be a need for active measures designed to eliminate, if possible, and if that is not possible at least to mitigate and reduce debris-based harms. Both active preventive and active corrective measures theoretically can be carried out by a State threatened with harm or by a collectivity or States. The latter could be assembled hastily if and when a threat is imminent, or, the action-taking body could be permanently established in an appropriate constitutive document.

The fundamental norms of general international law can serve as the basis for national or cooperative protective measures. States in the absence of international legal prohibitions are free to act, particularly where confronted with a serious challenge to territorial security and sovereign integrity.[67]

Since States do exercise jurisdiction and control over their space objects, and since abandonment of non-functional unitary satellites would not relieve the State possessing jurisdiction and control from liability, undoubtedly a threatened State would be cautious in invoking the right to engage in unilateral protective action. But, in making a decision respecting preventive action a threatened State would wish to consider the absence of formal international law dealing with man-made space debris.

After a careful review of debris in space the conclusion was reached by Baker that "There are neither prohibitions against against its creation nor specific regulations for its avoidance, prevention or removal."[68] With regard to the issue of removal there is support in international law's general principles for States to engage in reasonable and proportional protective measures. The law is not novel. Only the application of this traditional law to space debris would be new.

New international space law for man-made debris is required because of the tension existing between the general principle of sovereign self-protection and the treaty-based principle of national jurisdiction and control over national space objects. It is this challenge which must be dealt with by those who wish to draft a specific treaty law dealing with debris.

When all the bargains have been struck, and after all of the accommodations have been identified as serving common interests, there comes a moment when the understandings must be reduced to writing. It is here that the artistry of the lawyer will be called upon to select the words, while taking into account competing policy perspectives, which sufficiently capture the sense of the negotiations.

The present generation of space lawyers and policy formulators would be well advised to study with some care the lessons learned in the negotiations which took place leading to the five UN-based international space agreements. This approach would require an understanding of what these agreements

contain and what they do not contain.

The UN-sponsored agreements do take into account satellite failure. The agreements without exception deal with a space object as a whole or unitary entity. Nonetheless, implicit in the treaties is the expectation that mishaps may occur with the result being that the original satellite would disintegrate into what has popularly been known as debris or fragments. Neither of these two terms are mentioned, least of all defined, in the agreements.

Yet the agreements do contemplate the prospect of debris. If this were not the case what would have been the purpose of the provision in Article 8 of the Principles Treaty according to a State of registry jurisdiction and control over the object? Further, along the same line, why, if debris were not considered to be a prospect, would Article 7 of the Principles Treaty have dealt with liability for damages? If debris were not considered to be within the scope of the obligations contained in the Rescue and Return, Liability for Damages, or Registration agreements what would have been the basis for Canada's claim against the Soviet Union as a result of the *Cosmos-954* re-entry?

Yet, in an opposite vein and because of the absence of "debris" in the foregoing agreements, it could be urged that they do not have application to harms produced by debris. It is this absence of specificity respecting "debris" that has served to stimulate calls for a new agreement dealing with it. These circumstances have led the government of China to observe: "In view of the inadequacy of the provisions concerning space debris in existing treaties, agreements or customary law, new international agreements must be adopted on the basis of in-depth studies and through consultations in order to settle certain questions relating to space debris."[69]

In any event, and most significantly, there are now in place a bundle of highly important and relevant treaty-based principles which have a bearing on man-made debris in outer space. Nonetheless, they must be given a higher and more specific focus.

Moreover, the UN agreements have employed fairly consistent terminology and over time quite specific meanings have been attached to them. This patina should not be casually put aside by those who draft new space-related agreement. To the extent that a new agreement is required to use terminology that already exists in space treaties the same language and the same meaning should be assigned in the new agreement as has been employed in the older ones.

But, times have changed. With respect to space debris there is a need for new highly specific prescriptions. The new treaty law for debris will have to provide its own relevant definitions. It will have to formulate its own substantive provisions designed to mitigate the dangers resulting from the existence of space debris.

In short, since the existing international law of outer space does not sufficiently deal with the subject of space debris, there is a need for an early, fresh, and definitive approach. Such new efforts should eventuate in a new formal international agreement. Other devices or strategies for dealing with the

problem in a less authoritative way should be rejected.

A formal agreement is to be preferred to a resolution or declaration of a body such as the General Assembly of the United Nations, although the substance of such decisions, especially when unanimous, carry with them significant legal consequences. The formal agreement, especially when ratified by all of the space-resource States and others, is more authoritative than less traditional formulations. There need be no disagreement with a Resolution or a Declaration of the General Assembly if it is seen as a preliminary step to the entry into force of a formal international agreement.

Conclusion

Mankind's concerns for the general well-being of the environment have been alerted by the presence of man-made debris in outer space. More specifically, the warnings have made it evident that its presence can inhibit substantially the peaceful uses of outer space.

The problem is to know how to deal with the admitted danger. Since the danger is international it must be approached by international intergovernmental institutions with the final determination of policy and law to be made by the United Nations. For this to be accomplished the factor of "political will" must be mobilized. This is a primary function of the members of the world-wide professional community of lawyers and scientists who best understand the nature of the problem and who can lead in eliciting the support of governments. At this moment the mobilization of political will is more important than further scientific and technological findings. The fact of the danger is now self-evident. Governmental decision makers must be made to share the concerns of the professional space community.

For the political decision makers to be able to respond they must understand what they are to be asked to do. They will be asked to support an international legal regime having as its principal purpose the minimization of the presence of man-made space debris in outer space. They will also be asked to assist in the formation of procedures and processes allowing for the implementation of measures designed to minimize dangerous space debris. Support for the new legal regime and an accompanying institutional infrastructure is based on accepting the fact that existing policy, law, and institutions are inadequate. The challenges are substantial but not unresolvable.

The minimization of space debris requires policies of prevention and correction. In order to mitigate, if not eliminate, the presence of debris these policies will have to be implemented by both active and passive measures. They must include the previously identified procedures and are to be legal obligations.

Such measures should be carried out by any sufficiently threatened State and by a collectivity of States operating either on an ad hoc or on a permanent basis. The latter requires the formation of a suitable international organization which would also be accorded supervisory responsibilities, including the monitoring of debris and the provision of information respecting it.

To achieve success it will be necessary to add a number of specific requirements to the existing international space law as reflected in the five UN-based space agreements. The first item to consider must be a definition of man-made "space debris." It must include both fragments and non-functional unitary space objects.

The agreement would provide that a "launching State" has the first and principal responsibility for preventing the presence of debris in outer space and for correcting the condition created by it. In this connection very careful attention will have to be given to the definition of the "launching State," since important uncertainties exist concerning the legal status of "procuring States" in their relationship to "launching States."

The agreement would make provision for the monetary liability of the launching State for measurable harms resulting from its space activities. The legal standard to be applied to the responsibility of the launching State should be absolute liability, also referred to as liability without fault. The standard of negligence should not be adopted. Liability for reparations should be applicable to harms occurring to persons, and to property, wherever located. This means that the provision contained in Article 3 of the 1972 Liability for Damages Convention would not be adopted.

If the United Nations were perceived as the best institution to secure the maximum peaceful uses of outer space then steps must be taken to place man-made debris on the agendas of both of the sub-committees of COPUOS. Following close cooperation between the two, aided by the advice of a body of experts if deemed advisable, a body of principles should be adopted, approved by COPUOS, and referred to the General Assembly for approval by way of a Resolution or Declaration. The next step would be to refer its terms to UN members as a treaty. To secure its acceptance and ratification by the largest possible number of States full and dynamic support must be manifested by all persons and institutions composing the outer space community.

NOTES

1. M.G. Wolfe, "Orbital Debris -- Current Issues as They Impact on an Expanded Manned Presence in Space," *Proceedings of the 28th Colloquium on the Law of Outer Space 260* (1986). The roundtable's theme was "Legal and Technical Implications of Space Stations."

2. *Proceedings of the 30th Colloquium on the Law of Outer Space* 121-190 (1988).

3. *Proceedings of the 32nd Colloquium on the Law of Outer Space* 461 (1990).

4. *Proceedings of the 33rd Colloquium on the Law of Outer Space* 399-428 (1991). In keeping with the name of the committee individuals trained in law and in science and technology made presentations.

5. "Position Paper on Orbital Debris" compiled by an ad hoc Expert Group of the IAA, Committee on Safety, Rescue and Quality. Pp. 22. May 12, 1992. Hereafter cited as *Ad hoc Expert Group Position Paper.*

Membership included several members of the IAA/IISL Scientific-Legal Committee. See pp. 15-16 for a review of past scientific studies going back to the mid-1970s.

6. V. Kopal, "Summary on Replies to the Questionnaire which Included Issues Concerning Space Debris," August 30, 1992.

7. *Proceedings of the 35th Colloquium on the Law of Outer Space* 259-324 1993).

8. The following were active members of the committee on April 1, 1992: M. Lachs, Chairman, F.X. Kane and V. Kopal, Co-Chairmen, and Bozidar Bakotic, K-H. Böckstiegel, Michel G. Bourély, F.G. Casal, Carl Q. Christol, Aldo A. Cocca, I.H. Diederiks-Verschoor, Jean-Jacques Dordain, Stephen E. Doyle, Ernst Fasan, Manuel A. Ferrer Jr., Edward R. Finch Jr., Gyula Gal, Eilene M. Galloway, Stephen Gorove, Antonio Guell, Petrus P. Haanappel, He Qizhi, Gloria W. Heath, Nandasiri Jasentuliyana, Gabriel Lafferranderie, Andre Lebeau, Roger Malina, Miguel Orrico Alarcon, Lubos Perek, Boris V. Rauschenbach, J.P. Valentin, Vladlen S. Vereshchetin, Malcolm G. Wolfe, Gennady P. Zhukov, and Youri V. Zonov.

9. The closest to a definition of a space object are the descriptions contained in the 1972 Liability for Damages Convention in Article 1 stating that "The term 'space object' includes component parts of the space object as well as its launch vehicle and parts thereof." The same language appears in Article 1 of the 1975 Registration Convention. It has been suggested that a space object should be defined as including debris. C. Fishman, "Space Salvage: A Proposed Treaty Amendment to the Agreement on the Rescue of Astronauts, the Return of Astronauts and the Return of Objects Launched into Outer Space," 26 *Va. J. Int'l L.* 988 (1986).

10. C.Q. Christol, "Suggestions for Legal Measures and Instruments for Dealing with Debris," in K.H. Böckstiegel, ed., *Environmental Activities in Outer Space, State of the Law and Measures of Protection*, 9 *Studies in Air and Space Law* 258 (1990). Footnotes omitted.

11. *Ad hoc Expert Group Position Paper*, *supra*, note 5, at 1-2.

12. *Id*. at 1.

13. *Final Text, First Reading*, "International Instrument Concerning the Protection of the Environment from Damage Caused by Space Debris," Professor Sylvia Maureen Williams, Rapporteur, 5, 17 Oct. 1992.

14. Ibid. This proposal in Article 9 contemplates dispute settlement procedures.

15. *Supra*, note 10 at 266-7.

16. H.A. Baker, *SPACE DEBRIS: LEGAL AND POLICY IMPLICATIONS* 155 (1989).

17. He Qizhi, "Space and the Environment," in N. Jasentuliyana, ed., *SPACE LAW: DEVELOPMENT AND SCOPE*, 173, fn. 16 (1992).

18. U.N. Doc. A/AC.105/510/Add. 1, p. 8, 21 Feb. 1992.

19. L. Perek, "Traffic Rules for Outer Space," *Proceedings of the 25th Colloquium on the Law of Outer Space* 37 (1983).

20. *Id*. at 39.

21. Yu. A. Mozjourin and S.V. Chekalin, "Orbital Debris: The View from Russia," 30 *Aerospace America*, No. 3 15, March 1992. It has been estimated that by 2010 there will be between 12,000 plus items of debris calculated on a linear progression and 18,000 minus calculated on a five percent growth pattern. Ad hoc Expert Group Position Paper, *supra*, note 5, at 6.

22. *Supra*, note 19, at 39.

23. I.H. Ph. Diederiks-Verschoor, "Harm Producing Events Caused by Fragments of Space Objects (Debris)," *Proceedings of the 25th Colloquium on the Law of Outer Space* 1 (1983).

24. *Ibid*.

25. L. Perek, "Technical Aspects of the Control of Space Debris," in *Proceedings of the 33rd Colloquium on the Law of Outer Space* 400 (1991). This paper was presented at a meeting of the 13th Scientific Legal Roundtable of the International Institute of Space Law and the International Academy of Astronautics.

26. *Supra*, note 6, at 6.

27. *Supra*, note 5, at 1.

28. L. Perek, "Follow Up on Space Debris," 2, 9 Sept. 1991.

29. L. Perek, "The Scientific and Technological Basis of space Law," in N. Jasentuliyana, ed., *supra*, note 17, at 188.

30. *Ibid*.

31. *Supra*, note 13, at 5. The present author as a member of the Committee has suggested that the word "active" should be replaced by "operating/functioning," that "implying" be replaced by "posing" or "presenting," and that a more specific term be found for "environment."

32. V. Kopal, "Issues Concerning Space Debris," 1, 1991 Committee paper.

33. *Ibid*.

34. *Los Angeles Times*, A 13, May 3, 1993.

35. L. Perek, "Technical Aspects of the Control of Space Debris," *supra*, note 25, at 404.

36. *Id*. at 405-406.

37. "Orbital Debris Mitigation Techniques: Technical, Economic, and Legal Aspects," AIAA Special Project Report 5 (1992).

38. Baker, *supra*, note 16, at 155.

39. The topic "Assessing the Space Insurance Field" was brought to the attention of the Legal Sub-Committee in April 1991 by the

IISL. *Proceedings of the 34th Colloquium on the Law of Outer Space* 386 (1992).

40. Procedures for Resolving Disputes are identified in the International Law Association's present formulation of an international instrument on debris. *Report of the Sixty-Fourth Conference* 9 (1991). It is also considering a "Draft Convention on the Settlement of Space Law Disputes."

41. G. Jaenicke, "Suggestions for Legal Measures and Instruments," in Böckstiegel, ed., *supra*, note 10, at 255-256.

42. *Id*. at 253.

43. C.Q. Christol, "International Liability for Damage Caused by Space Objects," 74 *Am. J. Int'l L.* 346 (1980), reprinted in C.Q. Christol, *SPACE LAW, PAST, PRESENT, AND FUTURE* 205 (1991).

44. General Assembly Resolution 44/46, par. 23, 8 Dec. 1989; General Assembly Resolution 45/72, par. 23, 11 Dec. 1990.

45. U.N. Doc. A/CONF. 101/10, 31 Aug. 1982. The United Nations has served as a forum for discussions on disposal orbits since 1977 and space debris since 1979. For a listing of the presentations between 1977 and 1990 see L. Perek, "Technical Aspects of the Control of Space Debris," *supra*, note 25, at 406-407 (1991).

46. See for example the report submitted by China, U.N. Doc. A/AC.105/510/Add.1, 3, 21 Feb. 1992 and that of the Russian Federation, U.N. Doc. A/AC.105/510/Add.3, 2, 26 Feb. 1992.

47. See for example that of the United States, U.N. Doc. A/AC.105/505/Add.2, 12, 2 April 1992. This report identified cooperative working relations on the subject with Germany, Japan, and ESA.

48. *Fact Sheet Presidential Directive on National Space Policy*, 11 Feb. 1988.

49. The National Space Council, *Final Report to the President of the U.S. Space Program* III-6 (1993).

50. R.S. Jakhu, "Space Debris in the Geostationary Orbit: A Major Challenge for Space Law," 17-1 *Annals of Air & Space L.* 322 (1992).

51. *Ibid*.

52. L. Perek has suggested that COPUOS should proceed without delay to act on the matter. "Space Debris and the World Community," 7 *Space Policy* 12 (February 1991).

53. COSPAR Symposium on Space Debris, The Hague, 1990, U.N. Doc. A/AC.105/502, 61, 23 January 1992).

54. AIAA Special Study (1991).

55. D.S. McKnight, "Track Two Diplomacy," 7 *Space Policy* 13 (February 1991).

56. H.A. Baker, *supra*, note 16, at 119.

57. *Ibid*.

58. *Ibid*.

59. U.N. Doc. A/AC.105/510/Add. 1, 5, 21 Feb. 1992.

60. U.N. Doc. A/AC.105/510/Add. 3, 2, 26 Feb. 1992.

61. U.N. Doc. A/AC.105/510/Add. 3, 2, 26 Feb. 1992.

62. *Supra*, note 47, at 12.

63. *Supra*, note 59, at 6.

64. *Supra*, note 61, at 2-3.

65. *Supra*, note 48.

66. *Supra*, note 49, at III-6.

67. C.Q. Christol, *supra*, note 10, at 276-284 dealing with unilateral and collective measures. Compare H. DeSaussure, "The International Right to Reorbit Earth Threatening Satellites," 3 *Annals of Air & Space L.* 383 (1978).

68. H.A. Baker, *supra*, note 16, at 102.

69. *Supra*, note 46, at 8.