

SPACE DEBRIS - LEGAL PROBLEMS TO BE SOLVED WITHIN THE UNITED NATIONS

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ABSTRACT

As an issue of great concern to all space faring nations, space debris should be globally dealt with by the United Nations Committee for the Peaceful Uses of Outer Space (UNCOPUOS). As to the technical problems relating to space debris such a discussion has already begun. National studies on space debris have been submitted to the UNCO-PUOS "Scientific and Technical Subcommittee" for a number of years already. As to the legal aspects of this subject it is necessary to start the debate in the Legal Subcommittee. As a preparation for such a discussion, this paper deals with the identification of the main legal problems in this matter and suggests solutions which could be proposed in such a legal debate. The following legal problems can be dealt with immediately with respect to space debris: As a first step the definition of space debris and its incorporation into the already existing definition of space object in international space law. The term space debris could be referred to as a space object regardless whether it still exists as a whole or whether it is fragmented to any size, in the event that such an object is non-functional and there is no reasonable expectation of it assuming or resuming its function. Such definition shows that the difference between space debris and a functioning space object has not to be seen primarily in the fragmentation of a space object but in the decisive criterion whether a space object (as a whole or fragmented to any size) is functional or not. In this connection the term "space object" refers to the definition as contained in Article I (d) of the Convention on Liability for Damage Caused by Space Objects as well as to all mission related objects including refuse generated during space missions and space objects assembled in outer space. As a second question state liability has to be dealt with in case of damage caused by unidentified space debris reentering the earth's atmosphere. Of course, the risk of such an event is absolutely minimal: If micro-particular matter or small debris reenter the Earth atmosphere there will usually be no damage since such debris burns up upon reentry. In case that big structures survive reentry, like e.g. parts of a space station, the identification of the object is possible. Then there might be smaller debris which survive reentry that cannot be identified. In that particular case however, the norms of international space law relating to state liability for logical reasons cannot be applied since the "culprit", namely the launching state of the space object whose debris has caused the damage cannot be found out. This, of course, is a situation which is not compatible with justice and equity. Therefore it is suggested that in analogy to Article V of the Liability Convention all states who might have generated the unidentified space debris in question shall be jointly and severally held liable for the damage caused so that the victims can claim full compensation from any of these states. The state who has paid compensation for damage has of course the right to claim indemnification from the others. Indemnification shall be effected in

accordance with international law and principles of justice and equity which means that in the case of indemnification from developing countries possibly the individual share of this country in the participation in international space flight has to be taken into account. As to questions relating to measures to be taken to avoid the generation of space debris as well as measures of protection against damage caused by debris these problems have to be studied by the UNCO-PUOS Scientific and Technical Subcommittee first. Only then the results of such studies can be translated into legal terms by the Legal Subcommittee.

1. INTRODUCTION

As an issue of great concern to all nations, space debris should be globally dealt with by the United Nations Committee for the Peaceful Uses of Outer Space (UNCOPUOS). As to the technical problems relating to space debris such a discussion has already begun. National studies on space debris have been submitted to the UNCO-PUOS "Scientific and Technical Subcommittee" for a number of years already. As to the legal aspects of this subject it is necessary to start a debate in the Legal Subcommittee. As a preparation for such a discussion the main legal problems in this matter have to be identified and suggestions for solutions have to be proposed as early as possible since, as we learned from technical publications dealing with this subject, the problems relating to space debris are urgent mainly for two reasons: (1.) to avoid a space debris belt in low earth orbits which might severely impede access to outer space in the future and (2.) to avoid damage caused by space debris reentering the earth's atmosphere. Therefore it would be desirable that, at least as a preliminary legal step, a set of legal principles would be elaborated within UNCO-PUOS and that this work could be finished faster than usual. (As a general rule the Legal Subcommittee needs 10 to 13 years for the elaboration of legal principles. Naturally this is also due to the fact that the Legal Subcommittee meets only once a year during three weeks only which means that just a couple of days per year are left to every single item on its agenda). Therefore, delegations have to be well prepared if in the case of space debris results should be achieved quicker.

The following legal problems can be identified with respect to space debris and should be tackled immediately by the Legal Subcommittee:

1. The definition of space debris and its incorporation in the already existing definition of "space object" as contained in the Convention on Liability for Damage Caused by Space Objects and the Treaty on Principles Governing the Activities of States in the Exploration and Use of Outer Space (see Annex II).

2. Questions relating to state responsibility as well as to liability in case of damage caused by space debris and especially in the case that such damage has been caused by an unidentified space debris reentering the earth's atmosphere. From the legal as well as the procedural point of view a working paper on space debris should be elaborated in a "conservative" manner that is it should be drafted along the lines of well established precedences in the UNCOPUOS: Such a suitable precedence for a set of principles relating to space debris are the principles on the use of nuclear power sources in outer space, which were unanimously adopted on 14 December 1992 by the United Nations' General Assembly (see Annex I). They deal with an environmental subject as well and could even be regarded as dealing with one particular aspect of the space debris problem namely with nuclear debris. This set of principles is also a practical example of legal and technical experts working together on an international instrument. This type of cooperation could be continued as an established practice in the UNCOPUOS.

As to questions relating to measures to be taken to avoid the generation of space debris as well as measures of protection against damage caused by debris these problems have to be studied by the UNCOPUOS Scientific and Technical Subcommittee first. Only then the results of such studies can be translated into legal terms by the Legal Subcommittee.

2. DEFINITION "SPACE DEBRIS"

From the technical point of view it appears that it is not the **definition** of the term space debris which gives a headache to the experts but rather the solution of the technical problems as such. (Therefore, the Scientific and Technical Subcommittee does not have to study the definition question first before the Legal Subcommittee can work on it.) As we take it from technical publications and especially from the position paper on orbital debris compiled by an ad hoc expert group of the International Academy of Astronautics of August 27, 1992 (Ref.1), space debris are considered to be every man-made object in outer space whether it still exists as a whole or whether it is fragmented to any size in the event that such object is non-functional and there is no reasonable expectation of it assuming or resuming its function. Therefore, from the practical point of view, the term space debris does not seem to be problematic. In international space law, however, this definition cannot be simply adopted since space law already contains the term "space object". This term plays a key role in the liability regime of outer space. According to Article I (d) of the Liability Convention it includes component parts of a space object as well as its launch vehicle and parts thereof. Therefore the term "space object" already includes at least some types of space debris, although it is of course not "tailored" to this problem (Ref.2).

Other types of space debris however are possibly not included namely debris of mission related objects and space refuse generated during space missions (Ref.3). Therefore, in order to avoid discussions of this nature a legal principle, which has to be elaborated by the Subcommittee, has to give a technically correct and unambiguous interpretation of the term "space object" **including** any types of space debris as well as space refuse since the terms "space debris" and "space object" cannot and should not be separated in international space law. The reason for this is that all provisions relating to state liability refer to space objects as described in Article I of the Liability Convention as well as to space debris (even if debris is insufficiently defined). Therefore, the second term should be extended with respect to any type of

space debris including any man-made object in outer space so that it is ensured that the Liability Convention is applicable for any damage caused whether by a functional space object or a non-functional one or by any kind of disintegrated space object or refuse and that at least theoretically any possibility is excluded that damage caused by space debris might not be covered by the liability regime of the Convention.

With regard to these problems the terms "space debris" and "space object" could be defined as follows:

Use of Terms

For the purpose of these Principles:

1. The term "space debris" means a space object regardless, whether it still exists as a whole or whether it is fragmented to any size, in the event that such an object is non-functional and there is no reasonable expectation of it assuming or resuming its function. (E.g. deactivated satellites, spent rocket stages, fragments of rockets and satellites, engine exhaust particles, refuse, paint flakes).

2. The term "space object" refers to the definition as contained in Article I (d) of the Convention on Liability for Damage Caused by Space Objects as well as to all mission related objects including refuse generated during space missions and space objects assembled in outer space.

Thereby it would be ensured that the term "space object" covers all sorts of man-made debris. The difference between space debris and a functional space object has not to be regarded primarily in the fragmentation of a space object but in the decisive criterion whether a space object (as a whole or fragmented to any size) is functional or not. (An absolutely undamaged satellite is space debris in case it is not functional.)

3. STATE RESPONSIBILITY AND LIABILITY

As to the aspects of State responsibility and liability the Legal Subcommittee could elaborate two more principles along the line of the principles relating to these subjects with regard to the use of nuclear power sources in outer space which could be taken again as a precedence.

As to State responsibility Principle 8 of the NPS Principles could be adapted almost without any changes. Such a principle would restate State responsibility for space activities according to Article VI of the Outer Space Treaty including activities in outer space which lead to the generation of space debris. This principle could be worded as follows :

Responsibility

In accordance with Article VI of the Treaty on Principles Governing the Activities of States in the Exploration and Use of Outer Space, including the Moon and Other Celestial Bodies, States shall bear international responsibility for national activities in outer space involving the generation of space debris, whether such activities are carried on by governmental agencies or by nongovernmental entities, and for assuring that such national activities are carried out in conformity

with that Treaty and the recommendations contained in these Principles. When activities in outer space involving the generation of space debris are carried on by an international organization, responsibility for compliance with the aforesaid Treaty and the recommendations contained in these Principles shall be borne both by the international organization and by the States participating in it.

As to state liability with respect to damage caused by space debris it should be stated in a separate principle similar to Principle 9 of the NPS Principles that each state which launches or procures the launching of a space object and each state from whose territory or facility a space object is launched shall be internationally liable for damage caused by such a space object and its debris in accordance with Article VII of the Outer Space Treaty and the provisions of the Liability Convention. In this connection however, we have to distinguish between two different types of damage: 1. damage caused in outer space which implies that the victim of such a damage is always a nation which is participating in international space flight and 2. damage on the surface of the Earth or to aircraft in flight possibly victimizing states which are not space nations and persons who are definitely not involved in space flight (Ref.4).

In the first case, the Liability Convention follows a conservative solution which means that states are liable for damage in case of **fault**. Unfortunately, this solution is not very helpful in case of an accident caused by space debris since the problems between the states concerned often start already with the identification of the State who is responsible for the generation of a particular space debris. Such identification might be - at least at the present state of the art - impossible in case of damage caused by space dust or micro particles such as paint flakes. In addition to this, the term "fault" which is already difficult to be determined for terrestrial activities is very often useless with respect to space activities where we can lead an endless discussion about the meaning of fault, e.g. in case of collision between spacecraft out of operational control.

Therefore, damage caused in outer space by space debris will, for practical reasons, in most of the cases not be reimbursable. Theoretically of course, the Legal Subcommittee could start its legal work in this field. However, we think that neither legal reasoning in this field can change the facts nor that indemnification for damages can solve the space debris problem among space nations at least for the time being. The solution has rather to be seen in the **prevention** of damage. Otherwise, the use of outer space could be severely restricted or even made impossible within the next 20 years for **all** space nations. In this respect, the conclusions of the ESA Space Debris Working Group have to be taken into account which were adopted already in 1988. They read as follows (Ref.5):

"Preventive Measures. Recognizing that space debris constitutes an unacceptable (man-made) risk to man and material in space and also on ground the objective for the future must be to minimize the consequences of the existence of space debris and to minimize the creation of additional space debris. This requires the adoption of preventive measures that on the one hand will enable space flights to continue and humans to live in a space debris environment (observation and analysis of the space debris population, collision avoidance, minimization of collision effects)

and on the other hand aim at a minimization of space debris in the future (minimization of the number of pieces of space debris and of the mass of space debris)."

Therefore, in our opinion, the Legal Subcommittee should not waste time at least for the moment to look for new solutions relating to liability in case of damage caused in outer space. It should rather, as a first step, state that this liability regime as a whole is applicable to damage caused by space debris.

As to the second type of damage described above, namely damage on the surface of the Earth or to aircraft in flight, the liability situation is different. In this case, the launching state or launching states are absolutely liable to pay compensation for the damage, which means that the launching state has to pay full compensation to the victims while no proof of fault is required. This demonstrates that the Convention gives priority to the protection of those victims who are not involved in space flight and who have nevertheless to suffer damage from events they cannot prevent or control.

Anyhow, it seems to be difficult to obtain full compensation in case of damage on the surface of the Earth and to aircraft in flight should damage be caused by unidentified space debris. The risk of such an event is absolutely minimal: If microparticulate matter or small debris reenter the Earth atmosphere there will usually be no damage since such debris burns up upon reentry. In case that big structures survive reentry, like e.g. parts of a space station, the identification of the object is possible. There might also be smaller debris which survive reentry that can nevertheless not be identified. In that particular case, the Liability Convention for logical reasons cannot be applied since the "culprit", namely the launching state of the space object whose debris has caused the damage cannot be found out. This is a situation which is not compatible with the aims of the Convention which are laid down in its Preamble saying *inter alia*:

Recognizing the need...to ensure in particular the prompt payment under the terms of this Convention of the full and equitable measure of compensation to victims of such damage.

Also, it would be a shame for international space flight and space nations dealing with hightech if victims who are in no way involved in space activities had to suffer damage from international space flight without compensation according to the norms of international space law for the only reason that the particular launching state (who is definitely one among the few involved in space flight) is unable or even **unwilling** to identify its own space object or parts of it.

In legal literature an interesting solution to this problem is suggested: an international fund should be established for such cases (Ref.6) (e.g. like the Fund for Compensation for Oil Pollution Damage) so that victims could be indemnified with the money that has to be contributed by all nations involved in international space flight - possibly in relation to their participation in international space launching.

We do not think however, that this solution is a practicable one since the probability of accidents making such a fund necessary is extremely small and it will be a matter of endless disputes to determine how much money has to be paid into that fund: One probable position would be that the estimated damage in such cases is relatively small since those space debris which survive reentry into the Earth atmosphere and which cannot be identified cannot be very big

structures so that damage caused by these objects would not be tremendous. On the other hand, a pessimist could argue that even such a small space object could cause enormous damage by hitting for example an unshielded nuclear reactor on the Earth... Furthermore, it would be very difficult to persuade developing countries for example to make an initial payment to such a fund since these countries will argue absolutely reasonably by pointing out that space debris which have been generated until now and the quantity of which has made the situation so dangerous that even the big space nations are willing to discuss this matter openly within the United Nations have been generated almost completely by the "big" space nations, namely Soviet Union, the United States and ESA. Therefore, it would be a heavy load of persuasion in order to receive an initial payment from developing countries or to get their agreement for a regular contribution to an international fund even if these countries are expected to possibly generate most of the future space debris. Then, even if such a fund could be established it would always run the problem that it would either contain too much money, in case no accident occurs or there would possibly not be enough money in case that a major accident happens.

Therefore, it is more reasonable to search for a solution within the Liability Convention and to aim at the applicability of its Article V which reads as follows;

"1. Whenever two or more States jointly launch a space object they shall be jointly and severally liable for any damage caused.

2. A launching State which has paid compensation for damage shall have the right to present a claim for indemnification to other participants in the joint launching. The participants in a joint launching may conclude agreements regarding the apportioning among themselves of the financial obligation in respect of which they are jointly and severally liable. Such agreements shall be without prejudice to the right of a State sustaining damage to seek the entire compensation due under this Convention from any or all of the launching States which are jointly and severally liable.

3. A State from whose territory or facility a space object is launched shall be regarded as a participant in a joint launching."

In general terms, Article V stipulates that those states who have jointly launched a space object and who thereby have jointly created a particular risk are jointly and severally liable for the damage caused (Ref.7). The similarity of this case with the event that damage is caused by an unidentified space debris is evident: Since it is beyond any doubt that the space debris has been generated by one of the few states involved in international space flight - it is only problematic which particular state can be singled out as the "culprit". Therefore, all states who might have generated the space debris in question shall be jointly and severally held liable for the damage caused according to Articles V and II of the Liability Convention so that the victims can claim full compensation from any of these states. The state who has paid compensation for damage has of course the right to claim indemnification from the others. Of course, indemnification shall be effected in accordance with international law and principles of justice and equity which means that in the case of indemnification from developing countries possibly the individual share of this country in the participation in international space flight has to be taken into account. Thereby it

could be ensured that the states are not heavily burdened by a risk to which they have not (yet) contributed significantly.

The advantages of such a solution are evident: It is legally guaranteed that a full and equitable measure of compensation will be paid to victims of damage caused by an unidentified space debris on the Earth or to an aircraft in flight according to the Liability Convention and the state or states liable in this case can be identified immediately. Thereby all potential victims who might be affected by unidentified space debris are protected in the same way as those who suffer damage from any other space object. This solution has also its positive aspects for States involved in international space flight since they do not have to spend any money on the indemnification of potential victims already now and hopefully never will if an accident as already described does not happen.

A principle relating to liability and compensation could be worded as follows: .

Liability and Compensation

1. In accordance with Article VII of the Treaty on Principles Governing the Activities of States in the Exploration and Use of Outer Space, including the Moon and Other Celestial Bodies, and the provisions of the Convention on International Liability for Damage Caused by Space Objects, each State which launches or procures the launching of a space object and each State from whose territory or facility a space object is launched shall be internationally liable for damage caused by such space objects or the debris of that space object as defined in Principle 1. Whenever two or more States jointly launch such a space object, they shall be jointly and severally liable for any damage caused by such a space object or its debris, in accordance with Article V of the above mentioned Convention.

2. In the event that space debris have caused damage to the surface of the Earth or to aircraft in flight and the launching State with respect to this particular space debris cannot be identified, nevertheless a full and equitable amount of compensation shall be ensured to the victims according to the provisions of the afore mentioned Convention. To this end all States who might have generated this particular space debris by their space objects shall be jointly and severally liable for the damage caused in accordance with Articles V and II of the abovementioned Convention.

3. A State which has paid compensation for damage shall have the right to present a claim for indemnification to the other States liable in this case.

Indemnification shall be effected in accordance with international law and principles of justice and equity taking into account the individual share of participation in international spaceflight of the State to whom the claim of indemnification is presented. However this shall be without prejudice to the right of a State sustaining damage to seek the entire compensation from any or all of the States which are jointly and severally liable in accordance with the abovementioned Convention.

4. STRUCTURING OF A POSSIBLE SET OF PRINCIPLES

Following the precedence given by the adoption of the Principles on the Use of Nuclear Power Sources in Outer Space, the principles relating to space debris could be structured as follows :

Principle 1. Use of Terms

Principle 2. Applicability of International Law

Principle 3. Guidelines and Criteria for the Avoidance of the Generation of Space Debris and Measures of Protection Against Existing Space Debris

Principle 4. Exchange of Data

Principle 5. Notification of Reentry

Principle 6. Consultations

Principle 7. Assistance to States

Principle 8. Responsibility

Principle 9. Liability and Compensation

Principle 10. Settlement of Disputes

Principle 11. Review and Revision

Principles 1 and 9 will probably be the main work of the Legal Subcommittee. As to Principle 2 it could be adopted from the NPS Principles almost unchanged. The same is true for Principle 6, 7, 10, and 11. The work of the Scientific and Technical Subcommittee with relation to guidelines and criteria for the control, limitation and minimization of space debris might be incorporated in Principle 3 as well as Principle 4 about the exchange of data and international cooperation.

5. CONCLUSION

The problems relating to space debris should be globally dealt with on an international level within UNCOPUOS. As a precedence for the elaboration of legal principles in this field UN Resolution 47/68 of 14 December 1992, containing legal principles relating to the use of nuclear power sources in outer space should be taken. The reason for this is that these principles were adopted by consensus and deal i.a. with one particular environmental space debris problem namely with cases of malfunctioning nuclear power sources reentering the earth's atmosphere. As to legal questions which could be studied immediately by UNCOPUOS without any preparations by its Scientific and Technical Subcommittee two problems can be identified, namely 1. the definition of space debris and the incorporation of this term into the already existing definition of space object as contained in international space law and 2. questions relating to state responsibility as well as to liability in case of damage caused by space debris. Here especially the case has to be considered that such damage was caused by an unidentified space debris reentering the earth's atmosphere.

6. REFERENCES

* The present article reflects exclusively the opinion of the authors and not that of the institutions they are connected with.

1. International Academy of Astronautics, Committee on Safety, Rescue and Quality, August 27, 1992 and Report of the ESA Space Debris Working Group of November 1988, ESA Document *ESA SP-1109* In this connection see also *UN Doc. A/AC 105/420, Annex of 15 December 1988 Environmental Effect of Space Activities*. A Report prepared by COSPAR and IAF for the United Nations Scientific and Technical Subcommittee of the Committee of the Peaceful Uses of Outer Space. Submitted to the UN in November 1988, p. 5. See also: U.S. Congress, Office of Technology Assessment (OTA), *Orbiting Debris: A Space Environmental Problem - Background Paper, OTA- BP-ISC-72* (Washington, DC: U.S. Government Printing Office, September 1990).

2. With regard to the definition of space objects as well as legal problems relating to space debris see especially: Baker, Howard A., *Space Debris: Legal and Policy Implications*, (Utrecht Studies in Air and Space Law, Vol. 6), Dordrecht, Martinus Nijhoff Publishers, 1989; Frantzen, Bernd, 'Umweltbelastungen durch Weltraumaktivitäten', in: Böckstiegel, K.-H. (Hrsg.), *Handbuch des Weltraumrechts*. Köln/Berlin/Bonn/München, Carl Heymanns Verlag, 1991, p. 597; International Institute of Space Law of the International Astronautical Federation:

- *Proceedings of the 14th Session*, Brussels, September 20-25, 1971. See especially part 4 on the protection of the earth environment, p. 52.

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- *Proceedings of the 30th Session*, Brighton (UK), October 10- 17, 1987. See especially chapter on legal aspects of outer space environmental problems, p. 121.

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3. Among the latest publications in this matter see especially Baker op. cit. Ref. 2, p. 61 ff.

4. As to policy considerations and the debates in the UNCOPUOS Legal Subcommittee preceding the adoption of the Convention on Liability for Damage Caused by Space Objects see especially Christol, Carl Q., *The Modern International Law of Outer Space*, New York, 1982 p. 59 ff. and Hurwitz, Bruce A., *State Liability for Outer Space Activities in Accordance with 1972 Convention on International Liability for Damage Caused by Space Objects*, (Utrecht Studies in Air and Space Law, Vol.11), Dordrecht, Martinus Nijhoff Publishers, 1992, p.9.

5. op. cit. ESA Ref. 1, p. 69.

6. One among the first authors who recognized this problem and suggested such a fund was Manfred A. Dausen in Wolf,

D. / Hoose, H. / Dauses, M., *Gefahr aus dem Weltraum: Politische, militärische und rechtliche Aspekte der Weltraumnutzung*, Neuwied 1979, p. 155; more recently see for example: Reijnen op. cit. Ref. 2, p. 65 f.

7. Christol, Carl Q. op cit. Ref. 4, p. 61 ff and p. 81 and Hurwitz, Bruce A. op. cit. Ref. 4, p. 38.

Annex I

UN Resolution 47/68 of 14 December 1992

PRINCIPLES RELEVANT TO THE USE OF NUCLEAR POWER SOURCES IN OUTER SPACE

Preamble

The General Assembly,

Recognizing that for some missions in outer space nuclear power sources are particularly suited or even essential due to their compactness, long life and other attributes,

Recognizing that the use of nuclear power sources in outer space should focus on those applications which take advantage of the particular properties of nuclear power sources,

Recognizing that the use of nuclear power sources in outer space should be based on a thorough safety assessment, including probabilistic risk analysis, with particular emphasis on reducing the risk of accidental exposure of the public to harmful radiation or radioactive material,

Recognizing the need, in this respect, for a set of principles containing goals and guidelines to ensure safe use of nuclear power sources in outer space,

Affirming that this set of Principles applies to nuclear power sources in outer space devoted to the generation of electric power on board space objects for non-propulsive purposes, which have the characteristics generally comparable to those of systems used and missions performed at the time of the adoption of the Principles,

Recognizing that this set of Principles will require future revision in view of emerging nuclear power applications and of evolving international recommendations on radiological protection,

Adopts the Principles Relevant to the Use of Nuclear Power Sources in Outer Space as set forth below.

Principle 1. Applicability of international law

Activities involving the use of nuclear power sources in outer space shall be carried out in accordance with international law, including in particular the Charter of the United Nations and the Treaty on Principles Governing the Activities of States in the Exploration and Use of Outer Space, including the Moon and other Celestial Bodies.

Principle 2. Use of terms

1. For the purpose of these Principles, the terms "launching State" and "State launching" mean the State which exercises jurisdiction and control over a space object at a given point in time relevant to the principle concerned.

2. For the purpose of principle 9, the definition of the term "launching state" as contained in that principle is applicable.

3. For the purpose of principle 3, the terms "foreseeable" and "all possible" describe a class of events or circumstances whose overall probability of occurrence is such that it is considered to encompass only credible possibilities for purposes of safety analysis. The term "general concept of defence-in-depth" when applied to nuclear power sources in outer space considers the use of design features and mission operations in place of or in addition to active systems, to prevent or mitigate the consequences of system malfunctions. Redundant safety systems are not necessarily required for each individual component to achieve this purpose. Given the special requirements of space use and of varied missions, no particular set of systems or features can be specified as essential to achieve this objective. For the purposes of paragraph 2.4 of principle 3, the term "made critical" does not include actions such as zero-power testing which are fundamental to ensuring system safety.

Principle 3. Guidelines and criteria for safe use

In order to minimize the quantity of radioactive material in space and the risks involved, the use of nuclear power sources in outer space shall be restricted to those space missions which cannot be operated by non-nuclear energy sources in a reasonable way.

1. General goals for radiation protection and nuclear safety

1.1. States launching space objects with nuclear power sources on board shall endeavour to protect individuals, populations and the biosphere against radiological hazards. The design and use of space objects with nuclear power sources on board shall ensure, with a high degree of confidence, that the hazards, in foreseeable operational or accidental circumstances, are kept below acceptable levels as defined in paragraphs 1.2 and 1.3 .

Such design and use shall also ensure with high reliability that radioactive material does not cause a significant contamination of outer space.

1.2 During the normal operation of space objects with nuclear power sources on board, including re-entry from the sufficiently high orbit as defined in paragraph 2.2, the appropriate radiation protection objective for the public recommended by the International Commission on Radiological Protection shall be observed. During such normal operation there shall be no significant radiation exposure.

1.3. To limit exposure in accidents, the design and construction of the nuclear power source systems shall take into account relevant and generally accepted international radiological protection guidelines.

Except in cases of low-probability accidents with potentially serious radiological consequences, the design for the nuclear power source systems shall, with a high degree of confidence, restrict radiation exposure to a limited geographical

region and to individuals to the principal limit of 1 mSv in a year. It is permissible to use a subsidiary dose limit of 5 mSv in a year for some years, provided that the average annual effective dose equivalent over a lifetime does not exceed the principal limit of 1 mSv in a year.

The probability of accidents with potentially serious radiological consequences referred to above shall be kept extremely small by virtue of the design of the system.

Future modifications of the guidelines referred to in this paragraph shall be applied as soon as practicable.

1.4 Systems important for safety shall be designed, constructed and operated in accordance with the general concept of defence-in-depth. Pursuant to this concept, foreseeable safety-related failures or malfunctions must be capable of being corrected or counteracted by an action or a procedure, possibly automatic.

The reliability of systems important for safety shall be ensured, *inter alia*, by redundancy, physical separation, functional isolation and adequate independence of their components.

Other measures shall also be taken to raise the level of safety.

2. Nuclear reactors

2.1 Nuclear reactors may be operated:

- (i) On interplanetary missions;
- (ii) In sufficiently high orbits as defined in paragraph 2.2;
- (iii) In low-Earth orbits if they are stored in sufficiently high orbits after the operational part of their mission.

2.2 The sufficiently high orbit is one in which the orbital lifetime is long enough to allow for a sufficient decay of the fission products to approximately the activity of the actinides. The sufficiently high orbit must be such that the risks to existing and future outer space missions and collision with other space objects are kept to a minimum. The necessity for the parts of a destroyed reactor also to attain the required decay time before re-entering the Earth's atmosphere shall be considered in determining the sufficiently high orbit altitude.

2.3 Nuclear reactors shall use only highly enriched uranium 235 as fuel. The design shall take into account the radioactive decay of the fission and activation products.

2.4. Nuclear reactors shall not be made critical before they have reached their operating orbit or interplanetary trajectory.

2.5. The design and construction of the nuclear reactor shall ensure that it cannot become critical before reaching the operating orbit during all possible events, including rocket explosion, re-entry, impact on ground or water, submersion in water or water intruding into the core.

2.6 In order to reduce significantly the possibility of failures in satellites with nuclear reactors on board during operations in an orbit with a lifetime less than in the sufficiently high

orbit (including operations for transfer into the sufficiently high orbit), there shall be a highly reliable operational system to ensure an effective and controlled disposal of the reactor.

3. Radioisotope generators

3.1. Radioisotope generators may be used for interplanetary missions and other missions leaving the gravity field of the Earth. They may also be used in Earth orbit if, after conclusion of the operational part of their mission, they are stored in a high orbit. In any case ultimate disposal is necessary.

3.2 Radioisotope generators shall be protected by a containment system that is designed and constructed to withstand the heat and aerodynamic forces of re-entry in the upper atmosphere under foreseeable orbital conditions, including highly elliptical or hyperbolic orbits where relevant. Upon impact, the containment system and the physical form of the isotope shall ensure that no radioactive material is scattered into the environment so that the impact area can be completely cleared of radioactivity by a recovery operation.

Principle 4. Safety assessment

1. A launching State as defined in principle 2, paragraph 1, at the time of launch shall, prior to the launch, through cooperative arrangements, where relevant, with those which have designed, constructed, or manufactured the nuclear power source, or will operate the space object, or from whose territory or facility such an object will be launched, ensure that a thorough and comprehensive safety assessment is conducted. This assessment shall cover as well all relevant phases of the mission and shall deal with all systems involved, including the means of launching, the space platform, the nuclear power source and its equipment and the means of control and communication between ground and space.

2. This assessment shall respect the guidelines and criteria for safe use contained in principle 3.

3. Pursuant to article XI of the Treaty on Principles Governing the Activities of States in the Exploration and Use of Outer Space, including the Moon and Other Celestial Bodies, the results of this safety assessment, together with, to the extent feasible, an indication of the approximate intended time frame of the launch, shall be made publicly available prior to each launch, and the Secretary-General of the United Nations shall be informed on how States may obtain such results of the safety assessment as soon as possible prior to each launch.

Principle 5. Notification of re-entry

1. Any State launching a space object with nuclear power sources on board shall timely inform States concerned in the event this space object is malfunctioning with risk of re-entry of radioactive materials to the Earth. This information shall be in accordance with the following format:

A. System parameters

A.1 Name of launching State or States including the address of the authority which may be contacted for additional information or assistance in case of accident

A.2 International designation

A.3 Date and territory or location of launch

A.4 Information required for best prediction of orbit lifetime, trajectory and impact region

A.5 General function of spacecraft

B. Information on the radiological risk of nuclear power source(s)

B.1 Type of nuclear power source: radioisotopic/reactor

B.2 The probable physical form, amount and general radiological characteristics of the fuel and contaminated and/or activated components likely to reach the ground. The term "fuel" refers to the nuclear material used as the source of heat or power.

This information shall be transmitted to the Secretary-General of the United Nations.

2. The information, in accordance with the format above, shall be provided by the launching State as soon as the malfunction has become known. It shall be updated as frequently as practicable and the frequency of dissemination of the updated information shall increase as the anticipated time of re-entry into the dense layers of the Earth's atmosphere approaches so that the international community will be informed of the situation and will have sufficient time to plan for any national response activities deemed necessary.

3. The updated information shall also be transmitted to the Secretary-General of the United Nations with the same frequency.

Principle 6. Consultations

States providing information in accordance with principle 5 shall, as far as reasonably practicable, respond promptly to requests for further information or consultations sought by other States.

Principle 7. Assistance to States

1. Upon notification of an expected re-entry into the Earth's atmosphere of a space object containing a nuclear power source on board and its components, all States possessing space monitoring and tracking facilities, in the spirit of international cooperation, shall communicate the relevant information that they may have available on the malfunctioning space object with a nuclear power source on board to the Secretary-General of the United Nations and the State concerned as promptly as possible to allow States that might be affected to assess the situation and take any precautionary measures deemed necessary.

2. After re-entry into the Earth's atmosphere of a space object containing a nuclear power source on board and its components:

(a) The launching State shall promptly offer, and if requested by the affected State, provide the necessary assistance to eliminate actual and possible harmful effects, including assistance to identify the location of the area of impact of the

nuclear power source on the Earth's surface, to detect the re-entered material and to carry out retrieval or clean-up operations;

b) All States, other than the launching State, with relevant technical capabilities and international organizations with such technical capabilities shall, to the extent possible, provide necessary assistance upon request by an affected State.

In providing the assistance in accordance with subparagraphs (a) and (b) above, the special needs of developing countries shall be taken into account.

Principle 8. Responsibility

In accordance with article VI of the Treaty on Principles Governing the Activities of States in the Exploration and Use of Outer Space, including the Moon and Other Celestial Bodies, States shall bear international responsibility for national activities involving the use of nuclear power sources in outer space, whether such activities are carried on by governmental agencies or by non-governmental entities, and for assuring that such national activities are carried out in conformity with that Treaty and the recommendations contained in these Principles. When activities in outer space involving the use of nuclear power sources are carried on by an international organization, responsibility for compliance with the aforesaid Treaty and the recommendations contained in these Principles shall be borne both by the international organization and by the States participating in it.

Principle 9. Liability and compensation

1. In accordance with article VII of the Treaty on Principles Governing the Activities of States in the Exploration and Use of Outer Space, including the Moon and Other Celestial Bodies, and the provisions of the Convention on International Liability for Damage Caused by Space Objects, each State which launches or procures the launching of a space object and each State from whose territory or facility a space object is launched shall be internationally liable for damage caused by such space objects or their component parts. This fully applies to the case of such a space object carrying a nuclear power source on board. Whenever two or more States jointly launch such a space object, they shall be jointly and severally liable for any damage caused, in accordance with article V of the above-mentioned Convention.

2. The compensation that such States shall be liable to pay under the aforesaid Convention for damage shall be determined in accordance with international law and the principles of justice and equity, in order to provide such reparation in respect of the damage as will restore the person, natural or juridical, State or international organisation on whose behalf a claim is presented to the condition which would have existed if the damage had not occurred.

3. For the purposes of this principle, compensation shall include reimbursement of the duly substantiated expenses for search, recovery and clean-up operations, including expenses for assistance received from third parties.

Principle 10. Settlement of disputes

Any dispute resulting from the application of these Principles shall be resolved through negotiations or other established

procedures for the peaceful settlement of disputes, in accordance with the Charter of the United Nations.

Principle 11. Review and revision

These Principles shall be reopened for revision by the Committee on the Peaceful Uses of Outer Space no later than two years after their adoption.

Annex II

TREATY OF PRINCIPLES GOVERNING THE ACTIVITIES OF STATES IN THE EXPLORATION AND USE OF OUTER SPACE, INCLUDING THE MOON AND OTHER CELESTIAL BODIES.

DONE ON JANUARY 27, 1967 (EXCERPTS)

Article VI

States Parties to the Treaty shall bear international responsibility for national activities in outer space, including the moon and other celestial bodies, whether such activities are carried on by governmental agencies or by non-governmental entities, and for assuring that national activities are carried out in conformity with the provisions set forth in the present Treaty. The activities of non-governmental entities in outer space, including the moon and other celestial bodies, shall require authorization and continuing supervision by the appropriate State Party to the Treaty. When activities are carried on in outer space, including the moon and other celestial bodies, by an international organization, responsibility for compliance with this Treaty shall be borne both by the international organization and by the States Parties to the Treaty participating in such organization.

Article VII

Each State Party to the Treaty that launches or procures the launching of an object into outer space, including the moon and other celestial bodies, and each State from whose territory or facility an object is launched, is internationally liable for damage to another State Party to the Treaty or to its natural or juridical persons by such object or its component parts on the earth, in air or in outer space, including the moon and other celestial bodies.

Article VIII

A State Party to the Treaty on whose registry an object launched into outer space is carried shall retain jurisdiction and control over such object, and over any personnel thereof, while in outer space or on a celestial body. Ownership of objects launched into outer space, including objects landed or constructed on a celestial body, and of their component parts, is not affected by their presence in outer space or on a celestial body or by their return to the earth. Such objects or component parts found beyond the limits of the State Party to the Treaty on whose registry they are carried shall be returned to that State Party, which shall, upon request, furnish identifying data prior to their return.

CONVENTION ON INTERNATIONAL LIABILITY FOR DAMAGE CAUSED BY SPACE OBJECTS. DONE ON MARCH 29, 1972 (EXCERPTS)

Article I

For the purpose of this Convention:

...

c) The term "launching State" means:

- (i) A State which launches or procures the launching of a space object;
- (ii) A State from whose territory or facility a space object is launched;

(d) The term "space object" includes component parts of a space object as well as its launch vehicle and part thereof.

Article II

A launching State shall be absolutely liable to pay compensation for damage caused by its space object on the surface of the earth or to aircraft in flight.

Article III

In the event of damage being caused elsewhere than on the surface of the earth to a space object of one launching State or to persons or property on board such a space object by a space object of another launching State, the latter shall be liable only if the damage is due to its fault or the fault of persons for whom it is responsible.

Article IV

1. In the event of damage being caused elsewhere than on the surface of the earth, to a space object of one launching State or to persons or property on board such a space object by a space object of another launching State, and of damage thereby being caused to a third State or to its natural or juridical persons, the first two States shall be jointly and severally liable to the third State, to the extent indicated by the following:

- (a) If the damage has been caused to the third State on the surface of the earth or to aircraft in flight, their liability to the third State shall be absolute;
- (b) If the damage has been caused to a space object of the third State or to persons or property on board that space object elsewhere than on the surface of the earth, their liability to the third State shall be based on the fault of either of the first two States or on the fault of persons for whom either is responsible.

2. In all cases of joint and several liability referred to in paragraph 1 of this article, the burden of compensation for the damage shall be apportioned between the first two States in accordance with the extent to which they were at fault; if the extent of the fault of each of these States cannot be established, the burden of compensation shall be apportioned equally between them. Such apportionment shall be without prejudice to the right of the third State to seek the entire compensation due under this Convention from any or all of the launching States which are jointly and severally liable.

Article V

1. Whenever two or more States jointly launch a space object, they shall be jointly and severally liable for damage caused.

2. A launching State which has paid compensation for damage shall have the right to present a claim for indemnification to other participants in the joint launching. The participants in a joint launching may conclude agreements regarding the apportioning among themselves of the financial obligation in respect of which they are jointly and severally liable. Such agreements shall be without prejudice to the right of a State sustaining damage to seek the entire compensation due under this Convention from any or all of the launching States which are jointly and severally liable.

3. A State from whose territory or facility a space object is launched shall be regarded as a participant in a joint launching.