TOWARDS A NEW LEGAL REGIME FOR THE USE OF NUCLEAR POWER SOURCES IN OUTER SPACE

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In January 1978 a malfunctioning Soviet nuclear powered satellite, COSMOS-954, re-entered the earth's atmosphere and disintegrated, scattering radioactive debris over a wide area of the Canadian Northwest Territory. In January 1983/February 1984, another Soviet Satellite, COSMOS-1402, which had a nuclear reactor on board, irregularly re-entered the atmosphere and broke into three parts. Although these three parts, including the compact part carrying the core of the nuclear reactor, were burned up in the dense atmosphere, the incident raised world-wide concern justified by the risk of hazards it involved. Since 1978, the issue of the safe use of nuclear power sources (NPS) in outer space has been placed on the agenda of the Committee on Peaceful Uses of Outer Space (COPUOS) and its two subordinate bodies, the Scientific and Technical Sub-Committee and the Legal Sub-Committee, with a view toward elaborating legal principles on the use of NPS in space. It has been a new subject in the progressive development of international space law.

I. *The Necessity and Potential Hazards of the Use of NPS in Outer Space*

The use of NPS in outer space is a sophisticated technology aimed at providing electric power for spacecraft sub-systems such as attitude control, communications and command, as well as operations of various equipment on board. At present, solar cells, chemical batteries, and other fuel cells have generally been used for most satellite missions, solar cells proving to be the most valuable and economic choice among them. These non-nuclear sources of power, however, present certain disadvantages such as relatively short lifetimes, low generating capacities, and inability to provide energy while not in the sun.[1] In these circumstances, there is a general trend in favor of the use of

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1. In the case of solar cells, there is speculation that significant amounts of power could be supplied from massive space arrays of solar cells beaming gigawatts to earth by microwaves. Yet, on the basis of present knowledge, solar cells in conjunction with electrical storage devices appear capable of producing power of about 50 kw. Large solar panels may produce unacceptable drag in low-orbit missions and involve complex unfolding mechanisms to convert from launch to operational configuration. Therefore, at higher outputs the solar panels begin to lose their power to weight advantage. *See* Ques-

NPS for space missions, particularly long duration missions and deep space missions.

There are two types of NPS currently used in outer space. The first is the isotopic source in which energy is derived from the decay of a radioactive isotope. The second is the nuclear reactor which derives its thermal energy from controlled fission process. For both types, a converter is needed to produce electricity from the nuclear heat sources. The former is simpler and its output lower than the latter. For higher outputs and longer duration, a nuclear reactor would be the logical choice.

The first nuclear powered satellite carrying an isotopic source was launched by the United States. It had a generating capacity of 2.7 electrical watts.[2] The chosen isotope was plutonium-238, which has been generally used in the United States program. The electrical power provided by an isotopic generator is estimated to be from 2.7 to 500 watts, with the maximum output limited to 1 kw.[3] Nuclear fuels are contained in a capsule which will remain sealed and not break up when it penetrates the atmosphere and impacts on land and which will withstand corrosion in water.[4]

The Soviet Union, besides carrying on research and development work on isotope-type electricity generators,[5] has given greater efforts to the development of a nuclear reactor. In 1964, a "Romaska" type was produced. It contained a total of 49 kilograms of uranium-235, with an electrical output of 500 watts and 1,500 hours lifetime. In the 1970's, as a result of improvement, a "Topaz" type reactor was produced and a safe life of 5,000 hours and an electrical output of 5-10 kilowatts could be achieved. These reactors have been used by the COSMOS series in either low or high orbits and in deep space.[6]

The possibility of malfunctioning nuclear powered satellites entering the earth is not rare. The first re-entry occurred in April, 1964, when the United States Transit/SNAP-9A deflected from its normal flight route and vaporized over the Indian Ocean, dispersing 17,000 curies of plutonium-238 at high altitude. In May, 1968, the Nimbus/SNAP-19 system re-entered and the fuel was recovered from the sea off the California coast. In April, 1970, the Apollo 13/

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tions Relating to the Use of Nuclear Power Sources in Outer Space, U.N. Doc. A/AC.105/220, at 12-13 (1978).

2. Use of Radioactive Materials by the U.S. for Space Power Generation, U.N. Doc. A/AC.105/102, at 1 (1978).

3. U.N. Doc. A/AC.105/L.102 (1978); A/AC.105/220 (1978).

4. *Id.*

5. The first isotope generator "Orion-1", using polonium-210, came into being in 1965 in the Soviet Union and was tested on board COSMOS-84 and COSMOS-90, with an electrical output of 22 watts at the beginning and 8 watts at the end of its 3,000-hour lifetime. *See* U.N. Doc. A/AC.105/220/Add.1, at 19 (1978).

6. U.N. Doc. A/AC.105/220/Add.1, at 16-19 (1978).

SNAP-27 unit survived re-entry and sank in the deep South Pacific Ocean.[7]

The two incidents of aborted nuclear powered satellites announced by the Soviet Union were mentioned at the beginning of this paper. COSMOS-954, with a nuclear reactor of the "Romashka" type on board, was launched on September 17, 1977 in a low orbit on a mission of marine observation. According to design, it would be abandoned by being lifted to a higher orbit after completing its mission; but, it failed and disintegrated scattering debris in Canadian territory. In operation "Morning-light," carried out by Canada with assistance from the United States, a significant amount of debris and particles, some of them highly radioactive, was recovered.[8] COSMOS-1402, launched on August 30, 1982, was also for marine observation. It carried 45 kg of highly enriched uranium-235, and was to be boosted to a high orbit of 900 km after completing its mission. However, it also failed and broke into three parts which were burned up after re-entry. The incident raised concerns among states and forced emergency planning agencies in many countries to upgrade their operations in forestalling the threat.[9]

From the foregoing review, it can be seen that although the incidents occurred, so far uncontrolled re-entry of nuclear powered satellites has not caused major disastrous effects. It must be recognized that the use of NPS in space involves an inherent risk that can not be wholly eliminated due to the large amount of radioactive material contained in such sources. Nuclear powered satellites dispatched beyond earth orbit for interplanetary exploration and those re-boosted to higher orbits after their missions have been completed will bring no harm to the earth. But, as to malfunctioning nuclear powered satellites re-entering the atmosphere, it will be impossible to exclude radiological hazards resulting from the dispersal of their radioactive material in the biosphere. The hazards to man will primarily be radiological, arising from radiation exposure through both direct external radiation and internal radiation from inhalation or ingestion.[10] In view of such possible dangers, the issue of elaborating legal principles on the use of NPS in outer space for protecting human life and environment from harmful effects caused by radiological material of malfunctioning nuclear powered satellites has become an important subject of international concern, and has been a main item on the agenda of COPUOS and its two subordinate bodies, the Scientific and Technical Sub-Committee and the Legal Sub-Committee.

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7. U.N. Doc. A/AC.105/L.105, Attachment 5 (1978).

8. Legault and Farand, Canada's Claim for Damage Caused by the Soviet COSMOS-954 satellite, reference paper submitted at the Symposium on Conditions Essential for Maintaining Outer Space for Peaceful Uses, organized jointly by the International Institute of Space Law and the United Nations University (1984).

9. Facts on File, at 16G3, 58A2, 88D3 (1983).

10. U.N. Doc. A/AC.105/220, at 13-14 (1978).

II. *The Course of Deliberation*

An elaboration of legal principles on the use of NPS in outer space should be founded on a full understanding of the development of relevant space science and technology. Thus, the deliberation on this issue in COPUOS and its two subordinate bodies has been mainly carried on in the following two fields.

A. *The Scientific and Technical Aspects of the Use of NPS in Outer Space*

The issue was first raised by Canada in the Scientific and Technical Sub-Committee convened on February 13, 1978.[11] In the discussion, Canada, joined by eight other countries, submitted a proposal[12] calling for the establishment of a Working Group to consider "Questions Relating to the Use of Nuclear Power Sources in Outer Space." The efforts of this Committee should be paralleled by studies of legal implications in the Legal Sub-Committee.

The subjects suggested for preliminary study included: alternative power sources for satellites and their advantages and disadvantages; restrictions on the use of NPS; precautions respecting radioactive contamination at launch, during the mission, or during or after re-entry; technical feasibility of providing early notification of re-entry, associated risks, and probable time and place of impact; the possibility of providing emergency assistance for search, recovery and clean-up operations, etc. The purpose of such study was to provide a technical base for a multilateral regime of strict and effective standards, safeguards, and limitations pertaining to the use of NPS in outer space. This proposal, having received the approval of the Scientific and Technical Sub-Committee and of COPUOS, was adopted by the General Assembly on November 10, 1978.[13]

Accordingly, the Working Group was set up in February 1979. After deliberation in its first session the Working Group arrived at the conclusion that NPS can safely be used in outer space, provided certain safety considerations are met in full. The safety requirements listed by the Working Group were:

1) that appropriate measures for radiation protection during all phases of an orbital mission of a spacecraft with NPS, *viz.*, launch, parking orbit, operational orbit, or re-entry, should be derived principally from the existing internationally accepted basic standards recommended by the International Commission on Radiological Protection (ICRP), in particular, ICRP document No. 26.

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11. Canada raised this problem after the COSMOS-954 incident occured above its territory and elimination work was still in progress. *See* U.N. Doc. A/AC.105/C.1/SR.188, at 6 (1978).

12. U.N. Doc. A/AC.105/C.1/L.103 (1978). The eight other countries were: Australia, Colombia, Ecuador, Egypt, Italy, Japan, Nigeria and Sweden.

13. U.N. Doc. GA/Res.33/16 (1978).

2) that the safety of radio-isotope systems would be assured by designing them to contain the radio-isotope for all normal and abnormal conditions. The design should ensure minimal leakage of the radioactive contents and must at least meet the limits recommended by ICRP in all circumstances including launch accidents, re-entry into the atmosphere, impact, and prolonged water immersion.

3) that the safety of reactor systems do no present any difficulty when they are started and operated in orbits sufficiently high to give time for radioactive materials to decay to a safe level in space after the end of the mission. In this way, the dose equivalents at the time of re-entry could be guaranteed in all circumstances to be within the limits recommended by ICRP for non-accident conditions. For those reactors that are intended for use in low orbits where the radioactive materials do not have sufficient time to decay to an acceptable level, safety depends on the start of the operation in orbit and the success of boosting NPS to a higher orbit after the operation is completed. In the event of an unsuccessful boost into higher orbit, the system must in all circumstances be capable of dispersing the radioactive material so that when the material reaches the earth, the radiological hazards conform to the recommendations of ICRP.[14]

The second important element reached by the Working Group was the essential need for early notification of an unprogrammed re-entry of a NPS.[15] The Working Group stressed that existing standards and practices do not provide any specific guidelines for notification concerning NPS used by space objects, except as proposed in a resolution by the General Assembly (GA/Res. 33/16). This resolution requests that the launching state inform the states concerned in the event that a space object with NPS on board is malfunctioning with a risk of re-entry of radioactive materials to earth.[16]

However, such early notification of unprogrammed re-entry is not easy and remains one of the most difficult and intractable problems of orbital mechanics, due to various elusive factors.[17] Therefore, the Working Group decided that there was a need for further studies in certain fields, including the evaluation of orbital mechanics for a more accurate prediction of the

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14. U.N. Doc. A/AC.105/238, Annex II, paras. 13-15 (1979).

15. *Id.* at para. 18.

16. *Id.* at para. 17.

17. In this connection, for most of those satellites which do not perform any maneuvers in the last phases of their lives, decay days can be predicted with an error of about 10 per cent of their remaining lifetime. Thus, a prediction of 10 days before decay would be likely to be in error by one day, and a prediction of 10 hours before decay might be in error by about one hour during which time a satellite travels more than half way around the world. Therefore, although a track over the earth on the final orbit can be specified about a day in advance, the predicted re-entry point along this track may still be in error by thousands of kilometers. *Id.* at para. 20.

phenomena.[18]

The third important element in the report of the Working Group dealt with search and recovery operations. The Working Group expressed the hope that in the event that a state affected requests assistance for search and recovery from other states, such other states will respond promptly to provide the necessary assistance.[19]

In the second session held in February, 1980, the Working Group, besides reaffirming the conclusions reached in its first session and making a general review of related technical questions, was particularly concerned with the formulation of radiation standards which would serve to protect the population and the environment during launch, parking orbit, operational orbit, and reentry. In this connection, guidelines were provided in para. 12 of ICRP publication 26.[20]

In the third session held in February 1981, the Working Group made special efforts to deal with the issue of notification. As a result, a format was agreed upon for notification of re-entering space vehicles containing NPS which may give rise to radiological hazards. The format, as a supplement to the general provision of GA/Res.33/16, consisted of two parts: system parameters and information on the radiological risk of nuclear power sources.[21]

B. *The Legal Implications of the Use of NPS in Outer Space*

Following the session of the Scientific and Technical Sub-Committee in February, 1978, a working paper sponsored by 15 countries at the instance of Canada was submitted to the Legal Sub-Committee in April, 1978.[22] It called for a review of relevant international legal instruments with a view of adopting supplementary legal measures, including possibly a further convention or legal documents for protecting the integrity of human life and environment. The working paper was not discussed and was reintroduced in 1979, but a consensus was not reached because some delegations insisted that it was inadvisable to initiate legal studies on this issue before some conclusions had been reached in the Scientific and Technical Sub-Committee. However, at its session in June, 1979, the parent committee, after receiving the report of the Scientific and Technical Sub-Committee,[23] recommended by consensus that the Legal

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18. *Id.* at para. 40.

19. *Id.* at para. 26.

20. *See infra* text *Safety Measures* under the heading *Main Issues of Deliberation.*

21. *See infra* text *Notification* under the heading *Main Issues of Deliberation.*

22. U.N. Doc. A/AC.105/C.2/L.115 (1978). The fifteen countries were: Australia, Belgium, Canada, Chile, Colombia, Egypt, Federal Republic of Germany, Iran, Italy, Japan, Kenya, Mexico, Sierra Leone, Sweden and the United Kingdom.

23. *See supra*, note 14.

Sub-Committee include in its agenda, at the next session in 1980, an item entitled "Review of Existing International Law Relevant to Outer Space Activities With a View to Determining the Appropriateness of Supplementing Such Law With Provisions Relating to the Uses of Nuclear Power Sources in Outer Space,"[24] which was approved by the General Assembly on December 5, 1979.[25]

When the Legal Sub-Committee met in 1980, it opened debate on the above item. Canada submitted a new working paper[26] covering issues respecting safety, notification, and assistance on the use of NPS in outer space. Many developing and western countries expressed the view that provisions in the existing five multilateral treaties on outer space are inadequate to deal with the NPS problem, and held that the Committee should initiate deliberations along the lines set out in the Canadian working paper, with a view to elaborating new supplementary rules.

Countries of the Soviet bloc held opposing views, stressing that the use of NPS in outer space is not only legal, but desirable, and the provisions of the existing treaties can effectively remove the harmful effects and consequences which might arise from the use of NPS. Moreover, they argued that specific problems resulting from certain circumstances can be dealt with separately, and there is no ground for elaborating new legal instruments.

No decision was made in the parent Committee in 1980, but the General Assembly adopted a resolution[27] to change the title of this item to "Consideration of the Possibility of Supplementing the Norms of International Law Relevant to the Use of Nuclear Power Sources in Outer Space," and requested that the Legal Sub-Committee review this item in its next session by a Working Group.

Since 1981, the Legal Sub-Committee has established a Working Group for consideration of this item, but no progress was made in 1981-1982 due to basic differences existing among the countries concerned. In 1983, Canada submitted a consolidated working paper[28] which coordinated the views expressed in the course of past deliberation and which included the format of notification on re-entry provided in the report of the second session of the Working Group of the Scientific and Technical Sub-Committee. The Working Group of the Legal Sub-Committee focused its discussion in 1983 on the issue of notification on re-entry, and as a result, accepted the above mentioned format as a basis for reaching consensus in the near future. In 1984, in an effort to achieve further progress on the existing achievement, Canada, China, Sweden and later the Netherlands, submitted two working papers[29] in succession. The main pur-

24. U.N. Doc. GA/34/20 (1980).

25. U.N. Doc. GA/34/66 (1980).

26. U.N. Doc. A/AC.105/271, Annex III (1980).

27. U.N. Doc. GA/34/34 (1980).

28. U.N. Doc. A/AC.105/C.2/L.137 (1983).

29. U.N. Doc. WG/NPS (1984)/WP.2 (1984); U.N. Doc. WG/NPS (1984)/W.P.4

pose was to substantiate safety measures in line with those already agreed to by the Working Group of the Scientific and Technical Sub-Committee in its second session. They failed to reach agreement; however, by 1985 the Working Group of the Legal Sub-Committee, after repeated informal consultation, arrived at a preliminary agreement on the draft text of assistance, and succeeded in adding a new supplementary paragraph to the agreed upon provisions on the format and procedure of notification on re-entry. These measures were finalized in the 1986 session. They constituted a notable achievement in the deliberation of this item by the Legal Sub-Committee.

III. *Main Issues of Deliberation*

Elaboration of legal principles for the use of NPS in outer space is a new subject of space law. After many years of exploration and discussion in COPUOS and its two Sub-Committees, the main issues can be summed up under the following headings, on some of which agreement has been reached, while others require further consultation for coordinating different views in order to formulate common rules.

A. *Notification*

Since the problem of the use of NPS in outer space was first under discussion in 1978, a number of working papers on this question have been submitted. The proposals contained therein can be grouped into two categories. The first concerns notification by the launching state before launch of a space object with NPS on board. The second concerns notification by the launching state in case of re-entry of a malfunctioning space object with NPS on board.

Existing standards and practices do not provide any specific guidelines for notification of the use of NPS in outer space except those provided in General Assembly resolution 33/16. The resolution requests that the launching state inform states concerned in the event a space object with NPS on board is malfunctioning with a risk of re-entry of radioactive materials.[30] During the discussion in the Legal Sub-Committee, Canada and many other countries expressed the necessity of notification by the launching state before the launch. However, the Soviet Union and other Eastern European countries insisted that such notification was unnecessary since a space object with NPS on board operating normally was in no way different from, and no more dangerous than,

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(1984).

30. *See supra* note 16. However, Art. 7§2 of the 1980 Moon Agreement requires launching states to notify the Secretary-General of the United Nations in advance of all placements by them of radioactive materials on the moon and other celestial bodies as well as the trajectories to, from and around their orbits and of the purposes of such placements. But, this clause only refers to lunar launchings. Existing space law does not obligate the prior notification of the launch of any space object, including a space object with NPS on board.

other space objects with non-nuclear power sources. They further held that a notification in advance might cause unjustified anxiety and fear in the general public. In view of the strong reluctancy on the part of the main space powers to give notification in advance of the launch of a space object with NPS on board, it would be very difficult to reach agreement by requiring them to accept such a condition.

With regard to notification of re-entry of a malfunctioning space object with NPS on board, the first session of the Working Group of the Scientific and Technical Sub-Committee has already arrived at the conclusion that the earliest possible notification of such an occurrence is essential.[31] The third session of the Working Group further agreed by consensus on the format of such notification.[32] On this basis, the Working Group of the Legal Sub-Committee, following discussion and a number of informal consultations, agreed upon the following provisions in 1983:

> Any state launching a space object with nuclear power sources on board should timely inform states concerned in the event this space object is malfunctioning with a risk of re-entry of radioactive materials to the earth. The information should be in accordance with the following format:
> 1. System parameters
> 1.1 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
> 1.2 International designation
> 1.3 Date and territory or location of launch
> 1.4 Information required for best prediction of orbit lifetime, trajectory and impact region
> 1.5 General function of spacecraft
> 2. Information on the radiological risk of nuclear power source(s)
> 2.1 Type of NPS: radio-isotopic/reactor
> 2.2 The probable physical form, amount and general radiological characteristics of the fuel and contaminated and/or activitated components likely to reach the ground. The term 'fuel' refers to the nuclear material used as the source of heat or power.
> This information should also be transmitted to the Secretary General of the United Nations.[33]

In the above provisions, the first and last paragraphs refer to the procedure of notification. In accordance with the above agreed upon formulation, notification should be given whenever a "space object is malfunctioning with a

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31. *See supra* note 15.

32. *See supra* note 21. The agreed format reached in the third session of the Working Group of the Scientific and Technical Sub-Committee was contained in U.N. Doc. A/AC.105/287, Annex II, at 4 (1981).

33. U.N. Doc. A/AC.105/320, Annex II, at 22-23 (1983).

risk of re-entry of radioactive materials to the earth." If the operation is normal or the re-entry to earth takes place as planned, then it is not necessary to give notification. The second important element is that notification should be given "timely" to "states concerned". The word "timely" means that notification should be given no later than when the malfunction is discovered. The addressee should in the first place be "states concerned," which include states on whose territory radiological materials could land and also states possessing tracking facilities who are in need of the information provided in the format for monitoring purposes. The last paragraph provides that the notification should also be given to the Secretary-General of the United Nations; that means to all countries. This is justified as the orbit lifetime and place of re-entry cannot be accurately predicted and could be in error by thousands of kilometers.[34] Therefore, it is expedient to inform the Secretary-General of the United Nations and through him the international community of the incident in light of imperfections of forecast of the re-entry.

With regard to the format of notification, it is quite logical for lawyers to adopt the text already agreed upon by the technical experts which is contained in the report of the third session of the Working Group of the Scientific and Technical Sub-Committee.[35] In analyzing the format, it should be noted that in the section of "System parameters", all provisions, except 1.4 are borrowed from the appropriate provisions of the format of notification in the 1975 Registration Convention.[36] The new paragraph 1.4 is of particular significance since the information provided therein is helpful in answering the important question—where and when the re-entry of a malfunctioning space object with NPS on board will be taking place.[37]

The information in section 2 of the format is for answering another important question—What are the exact kind and amount of radioactive materials which could reach the earth due to the re-entry of a malfunctioning space object with NPS on board. Such information is specially needed for organizing and carrying out the search, clean-up and recovery operations, and will be very useful for enabling the affected state to work out a more appropriate emergency plan for providing the necessary technical means and personnel to deal with the radiological risks of the incident which has occurred in its territory.

In 1983, the Federal Republic of Germany submitted a working paper[38] to

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34. *See supra* note 17.

35. *See* supra notes 21, 32.

36. Art. IV of the Convention on Registration of Objects Launched into Outer Space (1975). For the text of the Convention, *see* U.N. Doc. A/Res. 3235, Annex IXXX (1974).

37. In a strict sense, 1.4 was worded in general terms, since accurate prediction of orbit lifetime and place of re-entry remains one of the most difficult and intractable problems of orbital mechanics. *See supra* notes 17, 34.

38. U.N. Doc. A/AC.105/C.2/L.138 (1983); U.N. Doc. A/AC.105/320, Annex III, at 29-34 (1983).

the Legal Sub-Committee illustrating the experience of the unprogrammed re-entry of COSMOS-1402. On the basis of this experience, the paper suggested that the launching state should provide "timely and comprehensive information". In 1984, FGR again raised this issue in a working paper[39] that would require the launching state to provide repeated and updated information as re-entry approaches. Following consultation and discussion in 1984-1986, the Working Group has finally succeeded in agreeing by consensus to add the following two paragraphs to the above-mentioned format on notification:

> The information, in accordance with the format above, should be provided by the launching state as soon as the malfunction has become known. It should be updated as frequently as practicable and the frequency of dissemination of the updated information should increase as the anticipated time of re-entry into the dense layers of the Earth's atmosphere approaches so that the international community would be informed of the situation and would have sufficient time to plan for any national response activities deemed necessary.
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> The updated information should also be transmitted to the Secretary-General of the United Nations with the same frequency.[40]

As a whole, the above draft text on notification reached by consensus in the Legal Sub-Committee appears to be rather comprehensive and suits the needs of the various parties concerned. These provisions on notification will constitute an integral part of the new legal regime for the use of nuclear power sources in outer space.

B. *Assistance*

As most countries lack the tracking facilities and necessary technology, equipment, men and financial resources to cope with incidents of re-entry of space objects with NPS on board, the problem of providing emergency assistance is of great concern to a majority of countries, particularly the developing countries. An important point at issue is to whom the victim state or states should direct its or their petition for assistance, i.e., to the launching state only or also to other states. The existing treaty provisions in this respect are of little assistance. Article 5.4 of the 1968 Rescue Agreement provides:

> A contracting party which has reason to believe that a space object or its component parts discovered in territory under its jurisdiction, or recovered by it elsewhere, is of a hazardous or deleterious nature may so notify the launching authority, which shall immediately take effective steps, under the direction and control of the said Contracting

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39. U.N. Doc. A/AC. 105/C.2/L.146 (1984); U.N. Doc. A/AC.105/337, Annex IV, at 36-37 (1984).

40. U.N. Doc. A/AC.105/370, Annex II, at 17 (1986).

> Party, to eliminate possible danger of harm.[41]

Article XXI of the 1972 Liability Convention provides:

> If the damage caused by a space object presents a large-scale danger to human life or seriously interfers with the living conditions of the population of the functioning of vital centers, the state parties, and in particular the launching state, shall examine the possibility of rendering appropriate and rapid assistance to the state which has suffered the damage, when it so requests. . . .[42]

From the above quoted two clauses, it is clear that although the victim states may request the launching state to provide assistance, the provisions do not prohibit the victim state from requesting assistance from states other than the launching state. The latter clause further broadens the scope of states to provide assistance to include all States Parties to the Convention.

During discussion both in the Working Group and the plenary session of the Legal Sub-Committee, the Soviet Union insisted that the launching state had a priority right to provide assistance to the victim state. The Soviet Union based its assertion on 5.4 of the Rescue Agreement and stressed that only the experts of the launching state had specific knowledge of the space object with NPS, and therefore, only the launching state could render effective and economical assistance; moreover, unnecessary costs might be incurred without the participation of the launching state, and the launching state has no obligation to bear the unnecessary expenses due to its non-participation. However, other countries held the view that it is a sovereign right of the victim state to decide from which state it will seek assistance, be it the launching state or not. In any case, the launching state should be responsible for all costs of the search, clean-up and recovery operations. This issue of compensation would be better dealt with in the section on liability.

After discussions and repeated informal consultations in the 1985 and 1986 sessions, the Working Group of the Legal Sub-Committee arrived at an agreement by consensus on the theme of assistance as follows:

> Upon the 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

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41. For the text of the Agreement on the Rescue of Astronauts, the Return of the Astronauts and the Return of Objects Launched into Outer Space (1968), *see* U.N. Doc. A/Res.2345, Annex XXII (1967).

42. For the text of the Convention on International Liability for Damage Caused by Space Objects (1972), *see* U.N. Doc. A/Res.2777, Annex XXVI (1971).

as promptly as possible to allow states that might be affected to assess the situation and take any precautionary measures deemed necessary.

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 promptly the necessary assistance to eliminate actual and possible harmful effects;

(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 should be taken into account.

(*The question of the definition of the term "affected state" is to be considered later).[43]

The above agreed upon draft text on assistance has cleared up some uncertain points in the existing legal instruments. Due to inherent risks involved in the re-entry of space objects with NPS on board, it would be necessary to strengthen the tracking and monitoring network. The above-mentioned draft provision requires all states possessing monitoring and tracking facilities to cooperate with one another in this field. Such an arrangement is fully consistent with Article IX of the 1967 Outer Space Treaty,[44] which provides that in the exploration and use of outer space, "States Parties to the Treaty shall be guided by the principle of cooperation and mutual assistance." The said text permits the affected state in whose territory the accident takes place to resort either to the launching state or to other states or international organizations for assistance. With such a flexible provision, it would be able to meet the various demands of the affected state.

C. *Liability*

On the question of liability, the 1967 Outer Space Treaty contains a general provision that States Parties to the Treaty shall bear international responsibility for their activities in outer space, whether such activities are carried on by governmental or non-governmental agencies (Article VI). The Treaty also provides that each State Party to the Treaty is internationally liable for damage caused by its space objects to other States Parties or their natural or juridical persons on the earth, in air, or in outer space. (Article VII).[45]

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43. U.N. Doc. A/AC.105/370, Annex II, paras. 5.4-5.5, at 17-18 (1986).

44. For text 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 (1967), *see* U.N. Doc. A/Res.2222, Annex XXI (1966).

45. *Id.*

The 1972 Liability Convention further provides that "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 II), and the compensation "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 organization on whose behalf the claim is presented to the condition which would have existed if the damage had not occurred". (Article XII).[46]

On the other hand, according to Article V of the 1968 Rescue Agreement, the launching state seems to be liable to pay for such expenses only if it requests the return of the material that has re-entered from another state which recovers such material.[47] Moreover, the "damage" as defined by the Liability Convention must cause loss of life, personal injury or damage to property (Article I),[48] but no mention is made of damage to the environment. As large amounts of expense will be incurred from search and clean-up of radioactive materials to restore the condition that existed before the incident occurred, such damage to the environment should also be included and be compensated for by the launching State. All of these issues need further clarification.

In the Working Group of the Legal Sub-Committee, the Soviet Union and some Eastern European countries held that the existing treaties, particularly the Liability Convention, are adequate and sufficient to deal with issues which arise due to accidents involving malfunctioning space objects with NPS. In the discussion, they tended to be occupied with the issue of liability along with the problem of assistance. But, most countries insisted that the issues of assistance and liability, though having linkages, are two different questions which should be dealt with separately. Assistance could be provided by all countries with such capabilities, including the launching state; while compensation should only be paid by the launching state.

The Canadian working paper submitted in 1981, did not refer to liability.[49] After accommodating the views of a number of countries, the Canadian working paper of 1983 added another section on liability as an independent principle.[50] In dealing with the incident involving COSMOS-954, Canada based its demands to the Soviet Union mainly on provisions of the Liability Convention.[51] After three years of negotiation, the two countries signed a Protocol on

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46. *See supra* note 42.

47. *See supra* note 41.

48. *See supra* note 42.

49. U.N. Doc. A/AC.105/320, Annex IV, at 4-6 (1981).

50. U.N. Doc. A/AC.105/320 Annex III, at 25-28 (1983).

51. One of the crucial assertion in Canada's "Statement of Claim" was based on the definition of damage provided in the Liability Convention, and read as follows: "The deposit of hazardous radioactive debris from the satellite throughout a large area of Canadian territory, and the presence of that debris in the environment rendering

April 21, 1981, by which Canada accepted the payment of 3 million Canadian dollars "in full and final settlement of all matters connected with the disintegration of the Soviet satellite COSMOS-954 in January 1978."[52] The above sum was about half of the amount of the 6 million Canadian dollars which Canada originally claimed from the Soviet Union. A characteristic of the Protocol is that Canada obtained compensation while the Soviet Union made the payment without accepting liability. This case, having settled the dispute arising from the COSMOS-954 incident by providing a temporary adjustment of interest, lacks a legal component that is essential to the creation of international law. It remains uncertain whether this case will set a precedent establishing a rule of international space law on state responsibility and liability. Therefore, in developing a comprehensive regime governing the use of nuclear power sources in outer space, it is still necessary to formulate a definite and separate article and provisions on the issue of liability.

D. *Safety Measures*

The 1967 Outer Space Treaty contains a general provision which provides that in the exploration and use of outer space, States Parties to the Treaty shall avoid harmful contamination (Article IX).[53] With regard to specific measures on radiological protection, the Working Group of the Scientific and Technical Sub-Committee, in its first session held in 1979, agreed that such measures for adequate radiation protection during all phases of an orbital mission of a space object with NPS should be derived principally from the existing and internationally recognized basic standards recommended by ICRP, in particular ICRP publication 26.[54] In the second session, the Working Group, besides reaffirming those recommendations agreed upon in the first session, took particular note of the ICRP recommendations contained in paragraph 12 of its publication 26 as follows:

> (a) No practice shall be adopted unless its introduction produces a positive net benefit:
> (b) All exposures shall be kept as low as reasonably achievable, economic and social factors being taken into account; and
> (c) The dose equivalent to individuals shall not exceed the limits recommended for the appropriate circumstances by the commission.[55]

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part of Canada's territory unfit for use, constituted damage to property within the meaning of the Convention." *See* International Legal Materials at 905 (1979).

52. Department of External Affairs of Canada, communique No.27 (1981).

53. *See supra* note 44.

54. U.N. Doc. A/AC.105/238, Annex II, at 2 (1979).

55. *See supra* note 20. *See also* U.N. Doc. A/AC.105/267, Annex II, ¶ 11, at 2 (1980).

It was recognized that a careful analysis of these issues should be undertaken by the launching states prior to the use of NPS in space; and, the result of such an analysis should be communicated to other states to the extent feasible. Concerning dose limits, the Working Group agreed that in each case, prior to launch, an assessment of the collective and individual dose equivalent commitments must be carried out for all planned phases of a space mission with NPS. The Working Group further noted that ICRP publication 26 recommends an annual dose equivalent limit for workers of 50 mSv (5 rem) whole body dose (or equivalent doses to parts of the body), and an annual dose equivalent limit for the most highly exposed members of the public (the critical group) of 5 mSv from all man-made sources. The Working Group recommended that these limits not be exceeded during the normal phase of an NPS mission.[56]

In an effort to make progress in the field of safety measures, Canada, China, and Sweden, later joined by the Netherlands, submitted two working papers[57] to the Legal Sub-Committee. The main contents therein were based on what had been achieved by consensus in the Working Group of the Scientific and Technical Sub-Committee as mentioned above. When deliberation on the issue of safety measures is restarted in the Working Group of the Legal Sub-Committee, the Working Group will likely proceed further and make decisions on the basis of the results already achieved by the technical experts.

IV. *Perspective of a New Regime*

Developments in space technology point to the trend that nuclear power sources seem to be a preferred technical choice for certain important space missions due to their advantages, such as long life, compactness and ability to operate independently of solar radiation. In these circumstances, the establishment of a new legal regime to deal with the unique questions arising from the use of NPS in outer space is an important problem which must be satisfactorily solved in order to ensure its safe use for space missions. Despite great discrepancies in views with respect to the issues involved and the slow pace in moving forward, the general trend thus far has appeared to be a steady and constructive one toward the evolvement of a new regime for the use of NPS in outer space.

In 1985, the Legal Sub-Committee agreed by consensus that the title of this item in the agenda be changed to "The Elaboration of Draft Principles Relevant to the Use of Nuclear Power Sources in Outer Space."[58] This is indeed noteworthy since the change of title signifies that substantive progress has been made in the deliberation of this item. It may be recalled that when this item was first placed on the agenda, it was under the title "Review of

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56. *Id.* ¶ 11, 12, at 3.

57. *See supra* note 29.

58. U.N. Doc. A/AC.105/352, Annex II, at 29 (1985).

Existing International Law Relevant to Outer Space Activities With a View to Determining the Appropriateness of Supplementing Such Law With Provisions Relating to the Use of Nuclear Power Sources in Outer Space."[59] In 1981, as the discussion progressed, it was renamed as "Consideration of the Possibility of Supplementing the Norms of International Law Relevant to the Use of Nuclear Power Sources in Outer Space."[60] For the purpose of facilitating the work of deliberation, the Chinese Delegation as early as 1982, at the twenty-fourth session of COPUOS, urged that the title of this item should be adequately changed[61], and afterwards, together with the Canadian and other delegations, proposed in the Legal Sub-Committee in 1983 and 1984 to change the title of this agenda item to "Consideration of Supplementing the Norms of International Law Relevant to the Use of Nuclear Power Sources in Outer Space Through Its Working Group". But, such proposals to make necessary changes in the agenda items only succeeded after reaching consensus in 1985. This change more correctly reflected and corresponded to the actual process of deliberation in the Working Group in that consideration of this item had far surpassed the procedural process and entered substantive discussion. This new title will undoubtedly be helpful to the deliberation work for achieving better results.

So far, the efforts of COPUOS and its two Sub-Committees have been directed toward the assessment of the four main issues mentioned in the previous part of this paper. These issues are notification, including procedure and information to be transmitted before an unprogrammed re-entry; emergency assistance; liability for damages; and safety measures. Since agreements by consensus mainly have been reached on notification and assistance, and since the issue of legal liability of the launching state for harm caused by NPS seems to be clear and uncontroverted, the future concern of COPUOS and its two Sub-Committees on the use of NPS in outer space will be concentrated on the issue of new safety standards. While the relevance of basic criteria contained in document No. 26 of the ICRP was suggested by the technical experts,[62] these standards are merely recommendations. Therefore, after analysis by the Legal Sub-Committee as to the completeness of such standards in the legal sense, it would be desirable to formulate and agree upon new specific principles and rules on the basis of such recommendations. These principles and rules constitute an integral part of a new international agreement under COPUOS sponsorship.

Another important question is, are there any other issues which should be

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59. *See supra* note 24.

60. *See supra* note 27.

61. U.N. Doc. A/AC.105/PV.237, at 7 (1982). The proposed title was "Consideration of the Questions Supplementing the Norms of International Law Relevant to the Use of Nuclear Power Sources in Outer Space."

62. *See supra* notes 54, 55.

included in the legal framework for the use of NPS in outer space. In 1985, the Working Group of the Legal Sub-Committee, at the instance of some delegations, suggested that the theme of protection of space objects with NPS on board should be discussed in addition to the four main issues enumerated above. But, some delegations were of the view that the protection of space objects with NPS on board must not be considered except with reference to the protection vis-a-vis fortuitous external events, and that protection vis-a-vis international agreement is a matter which is beyond any mandate given to COPUOS and its Sub-Committees.[63] The recent Canadian working paper, submitted in 1986 to the Legal Sub-Committee,[64] contained five principles of which four correspond to those that have already been agreed upon. Only the fifth principle, concerning safety assessments and notification, remains to be agreed upon and thrashed out through consultation.

As evidenced by the developments, analyzed above, the evolution of a new legal regime for the use of NPS in outer space has been a growing trend and has gained momentum in recent years. Although a long and difficult process has to be gone through and many thorny problems still have to be tackled, adequate results can nevertheless be expected and achieved step by step with a spirit of compromise and through untiring efforts.

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63. U.N. Doc. A/AC.105/352, Annex II, at 27 (1985).

64. U.N. Doc. A/AC.105/370, Annex IV, at 28-30 (1986).