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INTERNATIONAL LAW AND PEACEFUL USE OF NUCLEAR POWER SOURCES IN OUTER SPACE

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Abstract

Peaceful use of nuclear power sources - and all the promise they entail for humanity - are often perceived as a nuclear deterrent in juxtaposition with the prospects of nuclear weapons proliferation and nuclear war. The mixed perception is understandable: the materials, knowledge, and expertise required to produce nuclear weapons are often indistinguishable from those needed to generate nuclear power and conduct peaceful nuclear researches. As a result, the focus of the international community attention has always been to ensure that nuclear energy is used peacefully - including in Outer Space. Regulation of peaceful use of nuclear energy in space activity, because of potential transboundary impacts, demands from the international community to guarantee the uniformity of national standards of nuclear safety or acceptance of the international norms providing association of national efforts of the states for development of uniform approaches in this area on the basis of a combination of the international and national legal measures.

INTERNATIONAL LAW AND PEACEFUL USE OF NUCLEAR POWER SOURCES IN OUTER SPACE

The receipt of nuclear energy and output in Outer Space was the most important achievements of humanity in the last century. The intensive progress of science and technique stipulated the objective necessity of combination of these two directions of activity of man and resulted in a volume that on the side of space vehicles began to use nuclear energy sources (NUS). NUS got the name because they create traction due to the use of nuclear energy that is energies which is selected as a result of nuclear reactions. In common sense under these reactions there are any changes of the power state of atomic nucleus, and also transformation of one nucleus in other, related to alteration of structure of nucleus' or change of quantity of elementary particles – nucleons that are contained in them. Thus nuclear reactions, as known, can take place either spontaneously (that is involuntarily), or to be caused artificially, for example, at bombardment of one nucleus other (or elementary particles).

Correction of orbit of satellites, their orientation in Outer Space, work of scientific apparatus, information transfer on Earth – all it needs a reliable, compact and enough mighty energy source which would

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function regardless of sun radiation[1]. Nuclear power installations own such qualities in a complete measure.

The use of NUS on the side of space objects – appropriate result of development of scientific and technical progress and it is caused by the urgent tasks of the subsequent mastering of space. The use of NUS in Outer Space in many case is scientifically soundly, technically expedient and economic advantageous. Expedience of application of NUS for space flights is explained by a compactness and protracted term of functioning of similar sources. For their help the feed of apparatus of space object is carried out, Especially effective of NUS for providing of the protracted space flights, that is flights in so called «distant space», and also for realization of operations in space, that it is needed a plenty of energy.

International-legal adjusting of questions, that arise up in connection with the use of nuclear energy sources in space related to that:

- An applied in them nuclear fuel is dangerous characteristics, requires the special measures of safety
- Its use fraught by failures, that have the special, often unforeseeable character and consequences, including, and potential influencing of nuclear contamination and contamination by the hazardous substances of earthly environment and space
- A space object with a nuclear energy source or his radio-active parts can land on territory of the foreign state, that is the start in space of object with a nuclear energy source on a side can touch interests of other states, and not only those, that start.

To one of the most important in sphere of regulation of space nuclear energy sources became on adoption by the U.N.G.A. on December 14, 1992 "Principles Relating to the Use of Nuclear Power Sources in Outer Space." Because the NPS Resolution deals with the politically sensitive subject of nuclear power, its adoption is significant; this is particularly so given the specificity of its terms. To the extent that State practice consistent with the Resolution creates customary international law, the framework set forth could significantly affect space warfare-at least as to those nuclear power sources used in space warfare fitting within the scope of the Resolution.

The NPS Resolution provides in the Preamble that its terms apply to "nuclear power sources in outer space devoted to the generation of electric power on board space objects for non-propulsive purposes."[2] Thus, any application to space weaponry that the Resolution may have relates only to those means of warfare using a nuclear power source to sustain electrical systems for the object. Following this initial qualification, the Resolution's eleven Principles contain guidelines and criteria for safe use (Principle 3), safety assessments (Principle 4), and notification of re-entry (Principle 5). The Resolution also makes reference to the Outer Space Treaty in its assertions regarding State responsibility (Principle 8), and to the Liability Convention regarding State liability and compensation (Principle 9).

The heart of the Resolution is to be found in Principle 3. In establishing conditions for the safe use of nuclear power in space, it exhorts States to use an NPS only for missions "which cannot be operated by non-nuclear energy sources in a reasonable way."[3] Thus, without defining "reasonable," the Resolution attempts to limit State use of an NPS while recognizing that for certain missions, such power sources are appropriate. Indeed the Resolution continues by establishing the three cases in which nuclear reactors may be used:

(1) on interplanetary missions;
(2) in "sufficiently high orbits";
(3) in low-earth orbits if they are stored in sufficiently high orbits after the operational part of their mission.[4]

Further, Principle 3 specifies that nuclear reactors for space missions must only use enriched uranium 235 as fuel,[5] and that design and construction of the nuclear

[1] A/AC.105/220 Add.1

[2] NPS Resolution, supra note 504 (from the Preamble).
[3] NPS Resolution, supra note 504, at princ. 3.
[4] Id. at princ. 3(2)(a).
[5] Id. at princ. 3(2)(c).

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reactor "shall ensure that it cannot become critical before reaching the operating orbit during all possible events."[6]

Significantly, Principle 5 states what may well be a rule of customary international law: "Any State launching a space object with nuclear power sources on board shall in a timely fashion inform States concerned in the event this space object is malfunctioning with a risk of re-entry of radioactive materials to the earth."[7] This general statement would certainly affect space combat as to cases in which malfunctioning weapons, containing nuclear power sources, appear likely to reenter earth's atmosphere and impact on foreign soil. The existence of an ongoing state of hostilities would render the duty to warn less certain as between the belligerents, though it would probably apply to dangerous, radioactive space objects likely to impact neutral States, even if pursuant to accidents occurring in military operations.

According to an unofficial report, States appear to be following the recommendations contained in the NPS Resolution.[8]As an example, the Russian report to the U.N. Secretary General of its anticipated launch of the Mars 96 satellite powered by plutonium-238 is cited. When the satellite malfunctioned and reentered the atmosphere, the Russians made notification of that event as well, in accord with Principle 5. Similarly, the U.S. notified the Secretary General of its launch of the Cassini space probe, containing about 35 kg of plutonium-238 dioxide.[9] These instances of "compliance" are important. To the extent that spacefaring States behave in accord with the U.N. Resolution as though doing so represents a legal norm, the behavior will slowly come to be a legal norm in the form of customary international law-if it isn't already.

There are a number of high-level international instruments of a general nature that, while not necessarily citing nuclear power sources within their text, still may be relevant to activities involving space nuclear power sources. They include the following:
(a) The Treaty on Principles Governing the Activities of States in the Exploration and Use of Outer Space, including the Moon and Other Celestial Bodies;
(b) The Convention on International Liability for Damage Caused by Space Objects;
(c) The Convention on Registration of Objects Launched into Outer Space;
(d) The Agreement on the Rescue of Astronauts, the Return of Astronauts and the Return of Objects Launched into Outer Space.

The latter Agreement may regulate the transfer of space nuclear power sources or parts thereof from the country that has been affected by re-entry of the nuclear power sources back to the originating country.

In 1978 for consideration of problems which are connected to use of nuclear energy sources onboard of space objects, in the UN Scientific and Technical Subcommittee on the Peaceful Uses of Outer Space has been created Working Group on the Use of Nuclear Power Sources in Outer Space.

The Working Group decided to focus on those international instruments of a less general nature and more specific to nuclear power sources. It also focused its attention on the technical aspects of relevant conventions and procedures. With that in mind, the Group identified the following conventions that might be relevant to the safety of nuclear power sources in outer space:
(a) The Convention on Early Notification of a Nuclear Accident;
(b) The Convention on Assistance in the Case of a Nuclear Accident or Radiological Emergency;
(c) The Convention on Nuclear Safety;
(d) The Convention on the Physical Protection of Nuclear Material.

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[6]Id. at princ. 3(2)(e).
[7] Id. at princ. 5(1)
[8] A.D. Terekhov U.N.G.A. Resolutions and Outer Space Law, in proceedings of the 14 Colloquium on the Law of Oiter Space 97, 102 (1998)
[9] Is Cassini Risky? Look to Facts, Not Emotion, 147:13 AV. WK. & SPACE TECH., Sept. 29, 1997, at 66

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This Convention was also examined, although its potential relevance relates to protecting or safeguarding nuclear material in international transport either prior to launch or subsequent to accidental re-entry (rather than being related to launch nuclear safety per se).

The four above-mentioned international conventions are inherently high-level documents, the first two of which are generic in nature, the third being developed specifically for civil land-based nuclear power plants, and the fourth being developed to address international transport of nuclear material between States.

The Convention on Early Notification of a Nuclear Accident (the Early Notification Convention) entered into force in October 1986. The facilities and activities to which the Convention relates include, inter alia, "any nuclear reactor wherever located" and "the use of radioisotopes for power generation in space objects" (article 1). The Convention applies in the event of any accident involving any such facility or activity under the jurisdiction or control of a State party "from which a release of radioactive material occurs or is likely to occur and which has resulted or may result in an international transboundary release
that could be of radiological significance for another State" (article 1). In the event of such an accident, the relevant State party shall "forthwith notify ... those States which are or may be physically affected ... of the nuclear accident, its nature, the time of its occurrence and its exact location where appropriate; and promptly provide [those] States ... with such available information relevant to minimizing the radiological consequences in those States, as specified in Article 5" (article 2).

Each State party is also required by the Convention to make known to the other States parties "its competent authorities and point of contact [responsible] for issuing and receiving the notification and information" (article 7). In each case, States parties may provide notification and information directly or through IAEA.

The main procedure vitally important for addressing the emergency return to Earth of a space object with nuclear power sources on board is the earliest possible exchange of information related to trajectory parameters, the forecast related to space object entry in the upper layers and the possible geographical location of fallen nuclear power sources and space object. This procedure of cooperation among Member States of the United Nations and IAEA member States that have relevant means of outer space control and space object tracking in near-Earth orbits will ensure the receipt of objective information related to a possible re-entry of nuclear power sources and the timely preparation for it, using all available ways and means to spot the location, and retrieve the nuclear power sources and/or some of their parts from the territory of a country that has been affected by the fall.

The procedure that exists for sharing information related to safety of nuclear power sources even before launch is a much more simple procedure, with States providing the Secretary-General of the United Nations with information on the results of the safety assessment prior to launch of a spacecraft with nuclear power sources.

The Convention on Assistance in the Case of a Nuclear Accident or Radiological Emergency (the Assistance Convention) entered into force in February 1987. The Convention requires the States parties to "cooperate between themselves and with the International Atomic Energy Agency ... to facilitate prompt assistance in the event of a nuclear accident or radiological emergency to minimize its consequences and to protect life, property and the environment from the effects of radioactive releases" (article 1). Although many of the specific obligations concern the provision of assistance by States parties to other States parties, the Convention requires IAEA to "respond, in accordance with its Statute and as provided for in this Convention, to a requesting State Party's or a Member State's request for assistance in the event of a nuclear accident or radiological emergency" (article 2).

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In addition to the reactive functions set out in the Assistance Convention under article 5, States parties or Member States may request IAEA:

(a) To collect and disseminate information concerning experts, equipment and materials that could be made available in the event of an emergency and on relevant methodologies, techniques and research findings;

(b) To assist States on request in preparing emergency plans and appropriate legislation and in developing training or radiation monitoring programmes.

The Convention on Nuclear Safety entered into force in October 1996. It is somewhat different in nature from the Early Notification Convention and the Assistance Convention, in that its main focus is on encouraging parties to pursue agreed nuclear safety objectives by fulfilling specific safety obligations at the national level. The international dimension takes the form of peer review: each contracting party is required to report periodically on the steps that it has taken with regard to the specific obligations set out in the Convention, and those reports are reviewed by the other contracting parties.

The scope of the Convention on Nuclear Safety is explicitly restricted to land-based civil nuclear power plants and associated on-site handling, treatment and storage facilities. The Convention does not, therefore, apply to nuclear power sources in outer space, and contains no provision for reporting on or reviewing safety measures taken in relation to such sources. Nevertheless, the articles under the "General Safety Considerations" section of the Convention covering such areas as quality assurance, radiation protection and emergency preparedness, have potential relevance to space nuclear power sources with the possible exception of article 12 addressing human factors.

The Convention on the Physical Protection of Nuclear Material entered into force on 8 February 1987. The Convention applies to nuclear material used for peaceful purposes while in international transport from one State to another. The Convention contains provisions on the physical protection of the material from theft, robbery or any other unlawful taking, as well as legal provisions related to the prosecution of offenders.

As this Convention was developed for international transport between States, it was not intended to apply to the launch of space nuclear power sources. Space nuclear power sources have historically used uranium-235 (for nuclear reactors) or plutonium-238 (for radioisotope power systems). The Convention does not apply to most radioisotopes, including plutonium-238 of the purity typically used in space radioisotope power systems. The Convention would apply, however, to international shipments of uranium-235 that may be used in space fission reactor power systems.

An interesting case concerns the applicability of this Convention as it relates to re-entry of a space nuclear reactor with uranium-235 fuel. Obviously, the Convention cannot practically be applied in the event of aerodynamic destruction of the nuclear fuel and the fallout in the atmosphere of small, dispersed fuel particles. However, in the event of the return to Earth of an undamaged or partly damaged reactor, the Convention may be applicable, beginning with the moment of tracing the reactor location and its seizure from the impact area.

Nuclear power sources have been used on a variety of different missions to date, either in the form of radioisotope thermal or electrical generators or nuclear reactors. Below is a summary discussion of a conceivable range of technologies and applications that may be studied or developed in the future. The feasibility, justification and timing of any particular technology development activities and potential applications have yet to be determined and are subject to decision-making at the national level.

Nuclear power sources on board space objects can be used as a source of heat for direct use, for electricity generation and/or propulsion. For conversion of thermal energy to electric power, those systems may

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use direct (for example, thermoelectric or thermionic) or dynamic (for example, Rankine, Brayton or Stirling) conversion technology.

Radioisotope sources can be employed to generate electricity with a power generally in the range of milliwatts to about one kilowatt. They may be also used as thermal units with a thermal power of approximately 1-1,000 W to provide heat for spacecraft equipment.

Radioisotope systems were initially used on navigational, meteorological and communication satellites in Earth orbit. Subsequently, they were used for sensing seismic activity and on missions conducting science experiments on the Moon and Mars. Presently, they are being used in support of deep space missions exploring other celestial bodies. Some missions are still sending signals back to Earth on their way out of the solar system over 20 years after launch. Small radioisotope heaters have also been used to provide the thermal energy needed to keep spacecraft equipment operating in the cold environments of space.
81. Future developments for radioisotope systems may include the development of advanced systems with improved performance for powering spacecraft in collecting information on other celestial bodies. Advanced systems may also, for example, be developed for use in powering surface vehicles for extended scientific study and may possibly even be used to energize small submersibles searching for life in oceans existing beneath the frozen surface of certain celestial bodies.

To date, nuclear reactors have been used on board spacecraft carrying out experimental and observational missions. Bimodal (used for both propulsion and electrical power generation) nuclear electric propulsion systems may be used to provide electricity for spacecraft systems, including thrusters or engines for orbital correction and transfer from the reference near-Earth orbit to a higher operational orbit and as far as geostationary orbit. In the future, advanced systems with higher power capability on the order of tens to hundreds of kilowatt electric are possible. Such nuclear reactors could provide the electricity needed for thrusters on nuclear electric propulsion vehicles to reach various destinations within our solar system and to enable orbital missions of the outer planets, supplying abundant power on arrival for data gathering and transmittal. Nuclear reactors could be used to provide a power-rich environment for advanced robotic missions on planetary bodies in which deep drilling operations, in situ propellant generation and other power-intensive activities are performed. Those reactors, capable of higher power levels, could be used to sustain life for human exploration missions on the surface of the Moon and Mars.

Nuclear reactor power could also be used to provide direct thermal heating of propellant, making it possible to create a propulsion engine with about twice the specific impulse of chemical engines, and with higher thrust than electrical propulsion engines. Such systems could provide the capability for more rapid travel of cargo and perhaps eventually piloted missions to planetary destinations, reducing cosmic radiation exposure to astronauts en route. Alternatively, very high power nuclear electric propulsion systems could be developed for interplanetary transport. Intensive development of space activity, growths of its scientific and technical potential certainly will be tying up with all more wide application of the NUS. And that the existent international-legal adjusting does not answer the necessities of the present.

At consideration of question about perfection of the international legal adjusting of the use of nuclear energy sources in space it follows to spare the special attention to development of the proper rules of safety, the observance of which would decrease the risk of offensive of possible negative consequences.

In some industries of still human activity, where nuclear energy sources are used, the special international technical norms of safety a long ago are already developed and accepted. So, in a naval law there are rules and standards of safe appeal of radio-active matters and application of

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nuclear energy in communication with marine activity of the states. These positions touch both the problems of defense of marine environment from radio-active contamination, and exploitation of ships with nuclear power installation.[10] The proper international standards of safety in relation to air ships are contained in Addition 8 to Convention on International Civil Aviation 1944.[11]

Similar rules of safety in relation to the use of nuclear energy sources in space must include the scientifically grounded, most rational and economic methods of prevention or reduction of negative side results of such activity. The criteria of choice of these methods are found outside legal science and are determined by the proper branch of the applied science that sets a technical rule which makes maintenance of legal norm.[112]

Principles in 1992 are an act, so called, «soft law», that is fastened in them positions carries not obligatory for the states, and recommendation character. The necessary special international-legal regulation of application of NUS on the side of space objects. Within the framework of such regulation it follows to foresee both rules, that will be called to decrease the danger of offensive of negative consequences, and positions by means which the states would settle correlation in different emergency situations that are related to the indicated activity.

A basic role in the question of perfection of the existent international-legal use of nuclear energy sources must be taken by the space states and IAEA, how a sole on a present tense organ which produces norms and standards in industry of the use of nuclear energy is. Must develop IAEA procedures, technical requirements, limits of safety to nuclear installations that are used in space.

In the Legal committee of the UN already a question in relation to development and acceptance Universal Convention on Peaceful Uses of Outer Space is considered enough a long ago. In our opinion, the questions related to used of NUS on the side of spaces to this Convention of separate block of question, that will be dedication to the use of nuclear energy sources in Outer Space. That is inclusion of afore-mentioned questions in the document of obligatory character. An international concord already accumulated enough experience for formulation of obligatory norms of the relatively given type of space activity. However, swift development of science and techniques in the region of cosmonautics requires a large carefulness at formulation of international-legal norms, with that they adequately answered nascent necessities and did not become the brake of scientific and technical progress.

To advantages of acceptance by General Assembly of the UN of the proper Convention it follows, obviously, to take and that the offered document must have an obligatory character for its participants. Therefore on the given stage appears to expedient to develop and adopt Universal Convention on Peaceful Uses of Outer Space.

International cooperation in the region of nuclear safety and radiation defense at the use of nuclear energy sources in space must engulf the wide range of problems: from concordance of national principles and standards of nuclear safety and radiation defense, developments of codes of safe building of NUS for their exploitation in Outer Space, the concerted measures on the personnel training, and to co-ordination of efforts of the states on the grant of mutual help in the case of origin of the nuclear or radiation failure caused falling on the earthly surface of space object with NUS on board .

The vast field for international cooperation must present the union of activity of the states on providing of

[10] Иойрыш А.И. Атомная энергия: Правовые проблемы. М.: Наука, 1975. С. 23

[11] Современное международное морское право. М.: Наука, 1978. С.64-72.

[12] Иойрыш А.И. Атомная энергия: Правовые проблемы. М.: Наука, 1975. С. 21-22

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radiation defense at the use of sources of ionizing radiations.

We will select only the most important directions of collaboration some, in our view, and which require international-legal regulation in the indicated industry, namely:

- regulating functions of international organizations in industry of nuclear safety and radiation defense in the process of space activity;
- international cooperation on providing of safe exploitation of NUS and grant of mutual help in the case of extraordinary event (nuclear failure);
- international cooperation in industry of exchange by information about the refusals and disrepairs of nuclear-power equipment on space objects and conducting of researches and developments in industry of nuclear safety;
- estimation of influence on an environment in the transboundary context of objects with NUS, their fragments and constituents;
- making of international norms of radiation safety, which would limit influencing of radiation to the factor on cosmonauts, personnel of ground infrastructure, environment of Earth, near-earth orbit;
- creation of the system of supervision after the observance of norms of radiation safety in the process of exploitation of space objects with NUS.

International-legal regulation of application of nuclear energy-plant on the side of space objects would be instrumental in strengthening of law and order in a «sixth ocean», to development and deepening of collaboration of the states on business of its mastering.