NUCLEAR POWER SOURCES IN OUTER SPACE+

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The total number of objects which have been or are as of now in Earth orbit since Sputnik I was first launched October 4, 1957, is 10,791.[1] Of this number there are still 4,601 objects orbiting the Earth, the remaining 6,190 objects having decayed and reentered the Earth's atmosphere. Excluded from this number are objects in lunar, planetary or solar orbits, or objects on a deep space trajectory.[2]

Of 4,546 U.S. objects that were or are now in Earth orbit, 2,997 are still in orbit and 1,549 have decayed. For the Soviet Union, of 6,019 objects that were or are now in orbit, 1,447 objects still are in orbit and 4,572 objects that were in orbit have decayed. Percentage wise, 33 ⅓% of the U.S. space objects have reentered the atmosphere as opposed to 75% of USSR space objects having decayed and reentered the atmosphere. Others having objects in orbit are France with 53 of which 27 have decayed; Intelsat 23 of which all are still in orbit (this is most likely due to the fact they are in geostationary orbit at an altitude of 25,000 miles, and the orbit decays at a very slow rate, centuries rather than years); Japan with 31, none of which has decayed (probably due to their comparatively recent entry into space activities). The balance of space objects that now are in orbit is scattered among Australia (1), Canada (8), European Space Agency (5), FRG/France (2), FRG (9), India (1), Indonesia (2), Italy (1), NATO (4), PRC (5), Spain (1), and UK (11).[3]

Of the space objects which were or are now in orbit, 2,186 are payloads rather than debris; and of this number 953 are still in orbit and 1,233 have decayed. The size of a space object listed in the box score would range from a Skylab payload to a fragment of a Delta launch vehicle which is approximately 127 centimeters in diameter. The large majority of objects burn up on reentry into the Earth's atmosphere or impact in an ocean area (ocean areas represent approximately 70% of the Earth's surface). Of the 6,190

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[1]The statistical data included in this article is based on information acquired by the author from NASA's Goddard Space Flight Center and upon information furnished by Air Defense Command (NORAD).

[2]The term "object" is used because the number is a mixture of payloads and debris, and the term "debris" describes non-functional parts put into orbit in connection with payloads (*e.g.*, spent stages, shroud coverings, pieces resulting from in-space disintegration of objects, etc.).

[3]See *supra* n. 1.

decayed objects (payloads and debris), an extremely small number (less than 100) have produced fragments that have survived reentry to land on the Earth's surface and been found.[4]

The likelihood or probability of injury or damage to person and property is very small. Dr. Frosch, the Administrator of NASA, when asked recently what are the chances being struck by a falling piece of satellite said: "We can't compute the hazard exactly but we can compare it to similar hazards. And we think that the possibility of being hit by a piece of Skylab is smaller than the probability of being hit by a meteor." Dr. Frosch indicated there are but two confirmed cases in the last 200 years of anyone being struck by a meteor.[5] Notwithstanding the small probability of injury or damage, NASA started taking steps, prior to the Cosmos 954 incident and not as a result of it, to extend the orbital life of the Skylab to provide sufficient time to either reboost the Skylab or deorbit it into planned ocean reentry.

Sputnik I was launched on October 4, 1957. One year later on December 13,1958, the United Nations by UN General Assembly established the Ad Hoc Committee on the Peaceful Uses of Outer Space.[6] The following year, the General Assembly established a standing Committee on the Peaceful Uses of Outer Space which was requested, *inter alia,* to "study the nature of legal problems which may arise from the exploration of outer space."[7] The membership of the Committee has more than doubled in size from an initial membership of 18 countries on the Ad Hoc Committee to its current membership of 47. The member nations on the Committee are fairly representative of UN membership as a whole having African, Asian, Latin American, Western European, Mid East, First World and Third World countries, and countries in every stage of development from the US and USSR to Benin and the United Republic of Cameroon.

The Committee established two subcommittees—a Scientific and Technical Subcommittee and a Legal Subcommittee—the membership of the Subcommittees being the same as on the full committee. All three bodies operate on the principle of consensus. There is no voting, and any one member under this consensus procedure can prevent any matter being reported out of a subcommittee to the committee or from the committee to the UN General Assembly.

The Legal Subcommittee has compiled an outstanding record of achievement. It has produced four treaties and may be close to agreement on a fifth. In 1967 agreement was reached on the Treaty on Principles Governing the Activities of States in the

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[4] *Ibid.*

[5] Communications received by the author from the indicated source.

[6] G.A. Res. 1348 (XIII) (1958).

[7] G.A. Res. 1472 (XIV) (1959).

Exploration and Use of Outer Space, Including the Moon and other Celestial Bodies.[8] More than 70 countries are now Parties to this Treaty. It is universally and justly regarded as the "Mother Treaty" of all of the law of outer space that has been developed to date. The three other multilateral treaties are the Agreement on the Rescue and Return of Astronauts, the Return of Astronauts and the Return of Objects Launched into Outer Space, which entered into force in 1968,[9] the Convention on International Liability for Damage Caused by Space Objects, which entered into force in 1973;[10] and the Convention on Registration of Objects Launched into Outer Space, which entered into force in 1976.[11]

The Cosmos 954 incident occurred shortly before the Scientific and Technical Subcommittee of the Committee on the Peaceful Uses of Outer Space was to meet at the United Nations in New York, and the matter received a great deal of attention in that Subcommittee.[12]

The U.S. Delegation presented to the Subcommittee a complete illustrated description of U.S. use of nuclear power sources in space. The U.S. Delegation explained the technical differences and different safety implications of nuclear reactors, on the one hand, and radioisotope thermoelectric generators and other scientific use of such smaller amounts of nuclear material in spacecraft, on the other hand. It also explained the differing reasons for and implications of the placement of nuclear sources in low Earth versus higher Earth orbit and distant space trajectory.[13] These technical distinctions involve important safety implications, and the U.S. supported a study by competent technical experts on the question of nuclear power sources in space.[14] The radioisotope power systems for U.S. spacecraft (the U.S. does not use nuclear reactors)

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[8]The Treaty on Principles Governing the Activities of States in the Exploration and Use of Outer Space, Including the Moon and Other Celestial Bodies (hereinafter referred to as the Outer Space Treaty) was signed on January 27, 1967 and entered into force October 10, 1967, 18 U.S.T. 2410, T.I.A.S. No. 6347, 610 U.N.T.S. 205.

[9]Agreement on the Rescue of Astronauts, the Return of Astronauts, and the Return of Objects Launched into Outer Space, April 22, 1968, [1968] 19 U.S.T. 7570, T.I.A.S. No. 6599, 672 U.N.T.S. 119 (hereinafter cited as Rescue and Return Agreement or Rescue Agreement).

[10]Convention on International Liability for Damage Caused by Space Objects, March 29, 1972, [1973] 24 U.S.T. 2389, T.I.A.S. No. 7762 (hereinafter cited as Liability Convention).

[11]The Convention on Registration of Objects Launched into Outer Space (hereinafter referred to as Registration Convention) was opened for signature on Jan. 14, 1975 and entered into force on Sept. 15, 1976; T.I.A.S. No. 8480.

[12]U.N. Doc. A/AC. 105/216 (1978).

[13]U.N. Doc. A/AC. 105/C.1/SR. 202, para. 9-10, 12-13 (1978).

[14]U.N. Doc. A/AC. 105/C.1/SR. 191, para. 36-39 (1978).

are designed to release no radioactivity under normal conditions and only inconsequential amounts under the most severe accident conditions. Our radioisotope power sources systems are launched only after a detailed and thorough national multi-agency safety and environment review, and such reviews are made public. Every nuclear power system must be personally approved by the President prior to launch.

Canada and most of the other delegations, including the United States, wanted to establish a working group of the Subcommittee to do the fact-finding to support a competent international study of the use of nuclear power sources in space. Following completion of the fact-finding inquiry, discussion and negotiation of a binding multilateral regime could proceed. The U.S. Delegation to the Scientific and Technical Subcommittee identified three principal elements of such a regime:

> "First—Establishment of safety requirements, including the publication of a safety analysis statement by the launching state and the opportunity for other states to comment on that statement. Also setting of standards for nuclear power sources in space, including exposure standards on the basis of risks determined throughout the entire mission.
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> "Second—The establishment of requirements for notification. Possible aspects of this proposal could include (a) notice of a launching state to the UN of the launch of a nuclear power source, (b) provision of private notice by the launching state to affected countries of the re-entry of a nuclear power source, and (c) notice by any states with relevant information to the affected states of the fact of impact of a nuclear power source upon the territory of the affected states.
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> "Third—Providing assistance in locating debris, its cleanup and emergency treatment of affected persons, including: (a) a requirement, in addition to existing obligations, that launching states have the capability to provide assistance, and do so upon request by an affected state; (b) the use of suitable existing international organizations to coordinate assistance efforts if requested by an affected state; and (c) the appropriate handling of costs of search and cleanup."[15]

Because of the lack of a consensus in the Scientific and Technical Subcommittee, the proposal to establish a fact-finding working group was not adopted.

The subject of nuclear power sources in space was also debated in the meeting of the Legal Subcommittee which ended on April 7, 1978. However, procedural objections limited the topic to statements in the general debate, a reference to the subject in the final report of the Legal Subcommittee, and the introduction of a working paper co-sponsored by Australia, Belgium, Chile, Colombia, Egypt, Iran, Italy, Japan, Kenya, Mexico, Sierra Leone, Sweden, and the United Kingdom.[16] Basically, it proposed that the Legal Subcommittee begin a substantive discussion on the legal aspects of the use of nuclear power sources in outer space, in particular on those issues of notification, and

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[15] *Ibid.*

[16] Doc. A/AC. 105/218 (April 13, 1978), Annex IV.

emergency assistance, which do not require special scientific and technical study.[17] It also suggested that the subject of safety measures be examined with appropriate follow-up action and that nuclear power sources in space be placed on the agenda of the Legal Subcommittee.[18]

At the time of this paper, the parent Committee on the Peaceful Uses of Outer Space had not considered this subject. It meets June 26 to July 7 in New York. The subject of nuclear power sources in space will certainly be raised again in the Committee, and it is this writer's personal view it will be added to the agenda of both Subcommittees.

[17] *Id.*, p. 2.

[18] *Id.*, p. 1.