IISL-ECSL Symposium on Space Debris: Issues of Policy & Law
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Space Debris: Discussion in the Scientific and Technical Subcommittee in February 1996

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Election of the Chairman

The thirty-third session of the Scientific and Technical Subcommittee was held in Vienna from 11 to 23 February 1996. After the retirement of Professor Carver last year, the Subcommittee elected as its new Chairman, Professor Dietrich Rex of the Federal Republic of Germany. In his professional life, Professor Rex is heading the Institute for Spaceflight Technology and Nuclear Reactor Technology at the Technical University of Braunschweig, Germany. He serves as Chairman of the European Space Agency Space Debris Advisory Group and is a member of the US National Research Council's Committee on Space Debris. He and his colleagues are authors of many highly important scientific papers on space debris. At a time when Space Debris is a priority item, the Subcommittee has a chairman who is an eminent expert in the field.

Views of Delegations

About twenty delegations participated in the discussion on Space Debris. Only a few contributions can be mentioned here:

The Russian Federation proposed to establish an international centre for providing information and advance warning on explosions in space, on fragmentation of space objects and on possible collisions of space objects with space debris. Also an exchange of data on space debris was advocated with a view to make the catalogues of space debris more reliable, consistent, and complete.

Indonesia supported the opinion expressed at the thirty-second session of the Subcommittee (A/AC.105/605, para 95) and considered important to adopt an

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explanation of the term "space debris". The view was expressed that designating an object as "space debris" should not depend on the identification of the owner. The following wording was proposed:

> "Space debris are all man-made objects, including their fragments and parts, whether their owners can be identified or not, in Earth orbit or re-entering the dense layers of the atmosphere, that are non-functional with no reasonable expectation of their being able to assume or resume their intended functions or any other functions for which they are or can be authorized".

Some delegations stressed the importance of reorbiting geostationary satellites into disposal orbits after the termination of their useful lifetimes. India proposed to reorbit to more than 300 km while Japan recommended a higher altitude of at least 500 km beyond the geostationary orbit. The latter is a somewhat higher and safer altitude than that proposed in the IAA Position Paper on Orbital Debris (300 km) but requires more fuel. It should be noted in this context that space debris in the geostationary orbit were discussed under the item on Space Debris and not under the item on the Geostationary Orbit. The proposal to do so was put before the COPUOS in 1995 (see Report of the COPUOS A/50/20, para 80).

The US reported in detail about results obtained with the Haystack Debris Radar which is so powerful that it can detect a pea (0.65 cm) at 650 km distance. Because of the increased accuracy, some of the debris can be assigned to individual breakup events, or previously unrecognized debris sources can be discovered. NASA completed the development of the Liquid Metal Mirror Telescope for observing orbital debris. It will be possible to observe objects of 2.5 cm at 900 km altitude and of 10 cm in the geostationary orbit. In February 1995, the second mission of the Orbital Debris Radar Calibration Spheres was launched. Three spheres and three dipoles of different sizes were deployed from the Shuttle. They were observed by ground based radars and optical telescopes and the observations were used for calibrating the scales and consequently for improving the interpreting capabilities of the radars and telescopes.

The Czech delegation stressed the importance of preventive measures but pointed out that a large number of inactive objects is already in orbit. Their highest density occurs at about 800 to 1500 km where the average lifetime is very long, of several hundred years at least. During that time secondary collisions can increase the amount of debris. Methods for removing those objects from orbit have been already studied but further research is needed. The scientific community should be encouraged to study these methods with an emphasis on efficiency and cost effectiveness.

Some delegation supported the view that the Legal Subcommittee should be informed of the discussions in the Scientific and Technical Subcommittee and that a set of international rules should be adopted in order to reduce the risk posed by orbital debris and to support a rational use of outer space. That view was, however, not shared by all delegations. Some considered it premature at present and insisted on a thorough discussion of all important technical aspects of the problem by the Scientific and Technical

Subcommittee before deciding on any possible further steps.

Technical Presentations

Several technical presentations supplemented the information provided by delegations:

Prof. Dr. Walter Flury, speaking for the European space Agency, gave an overview of the chapter of the work plan on measurements of space debris and effects of the environment on space systems. He treated in detail ground-based measurements, in particular those made by radar and by optical telescopes, space-based measurements by radar, by optical means, by infrared sensors and by particle detectors, and those derived from spacecraft returned from space. He concluded with an analysis of possible damage to space systems. While large debris can destroy a spacecraft, the impacts by debris of 1 cm size can seriously damage it.

Dr. Dieter Mehrholz of the Research Institute for High Frequency Physics in Germany, reported on research activities of the Research Establishment for Applied Science, in particular on the Tracking and Imaging Radar system. It uses a 34 m antenna for tracking objects down to 5 cm at 2500 km distance and to 1 m objects in the geosynchronous orbit. The imaging data can be used for checking the functionality of the spacecraft and for identification purposes.

Dr. S. Banerjee and A.S. Ganeshan of the ISRO Satellite Center in Bangalore, India, reported on a Hybrid Model to find Spatial Distribution of Debris from a Breakup. Small debris are not listed in catalogues and have to be studied statistically. The paper lays down the background for the development of a new analytical method for studying small debris.

Dr. Andrew Potter of the Johnson Space Center, NASA, presented a Summary of the United States Space Debris Measurements Programme. The programme uses radars for low earth orbits, optical telescopes for deep space, and surfaces returned from space for identifying man-made particles in impact pits. Many results have been already arrived at: There are over 100.000 debris in LEO down to 1 cm size. An unsuspected source of debris was discovered near 900 km altitude, possibly from Rorsat nuclear reactors. A study of surfaces returned from space yields evidence for swarms of microdebris and some microdebris in highly elliptical orbits. Damage on Shuttle windows shows that the microdebris population is underestimated and that it is growing. An additional capability for studies of debris at geosynchronous altitudes is needed. Very little is known about debris population in Molniya and geotransfer orbits, although one geotransfer breakup has been accidentally detected.

Dr. Fernand Alby of the Centre Spatial de Toulouse, CNES, France, spoke on Modelization of Space Debris and Comparison with Observations. The analysis consists in searching for impact craters on exposed surfaces and in identifying impact particles. The observed flux of particles in space is compared with theoretical models. At the same time, detectors of debris are studied with a view to mount them on all satellites to obtain information on the debris population, in particular in the geostationary orbit.

Dr. Richard Crowther of the Defence Research Agency, United Kingdom, reported on The Unique Hazards Associated With Satellite Constellations. A constellation is a collection of satellites performing a common function, such as global positioning, earth observation, hand held personal communications etc. Several constellations are planned for launch in the near future, requiring tens or hundreds of satellites with lifetimes of 5-8 years. Each system would require frequent launchings of new satellites and frequent deorbiting of satellites approaching the end of their useful lifetimes. Unless the system has a built-in mechanism for restricting the number of debris, the collision risk would increase in a substantial way. The paper gives estimates of collision probabilities. New constellations will add a new dimension of complexity in managing the space debris environment but operational practices can reduce the hazard.

Mr. George Levin, NASA Headquarters, gave a Summary of the United States National Research Council Report on Space Debris 1995[2]. The Report presents the most recent and detailed information. It puts its authority behind previously recommended measures, in general confirming the conclusions of the IAA Position Paper on Orbital Debris. It makes several recommendations for improving knowledge of the debris environment, for improving spacecraft protection against the impact of debris, and for reducing the future debris hazard. In the last area, it advocates:

* Reduction of debris on a multilateral basis in order not to penalize those engaging in mitigation measures,
* Prevention of explosions,
* Minimizing of mission-related debris,
* Minimizing the unintentional release of surface materials, such as paint,
* Avoiding intentional breakups, in particular those producing debris with long lifetimes,
* Reorbiting of spacecraft and rocket bodies in Low Earth Orbit after their functional lifetime and achieving an international consensus on the magnitude of such manoeuvres, and,
* Until a verifiably superior strategy is produced, reorbiting spacecraft and rocket bodies in the geostationary orbits at least 300 km beyond that orbit.

Other Documents

Several documents on space debris, some of them in connection with nuclear power sources, were before the Subcommittee:

[2]Orbital Debris: A Technical Assessment. National Research Council, National Academy Press, Washington, D.C., 1995, ISBN 0-309-05125-8, 224 p.

A/AC.105/619 of 21 November 1995 and Add. 1 of 1 February 1996, National Research on Space Debris, Safety of Nuclear-Powered Satellites, Problems on Collisions of Nuclear-Powered Sources with Space Debris. Contains replies from Canada, Chile, Germany, Japan and the United Kingdom.

A/AC.105/C.1/L.203 of 9 February 1996, Interpretation and Development of the Safety Principles for Nuclear Power Sources in Space, working paper by the UK.

A/AC.105/C.1/L.204 of 13 February 1996, on collisions between nuclear power sources and space debris, working paper by the Russian Federation.

A/AC.105/C.1/L.205 of 13 February 1996, Brief Review of the Work Done by Russian Scientists on the Problem of the Technogenic Pollution of Near Space, working paper by the Russian Federation.

Space Agencies

The implementation of concrete steps for reducing the amount on space debris in future missions is in the hands of those space agencies which do the launching. They can influence the design , launching and operation of spacecraft. These may be the reasons why many delegations expressed their appreciation of the document A/AC.105/620 on Steps Taken by Space Agencies for Reducing the Growth or Damage Potential of Space Debris. It reports on preventive measures adopted by space agencies on a voluntary basis, without awaiting the outcome of the discussions in the United Nations. This is regarded as an important event because space agencies have shown that they are approaching the problem of space debris with a high degree of responsibility and that they have not only the power but also the will to preserve outer space in a state fit for future space activities. Accordingly, several delegations supported the view, already expressed at the thirty-eight session of COPUOS (A/50/20, para 78), that space agencies should be brought into a closer contact with the Subcommittee. The Subcommittee decided to invite a representative of the Inter-Agency Space Debris Coordination Committee to give a presentation at the next session of the Subcommittee.

Technical Report

The most important part of the work of the Subcommittee consisted in preparing a structured Technical Report in agreement with last year's decision to follow the Work Plan. Accordingly, the Technical Report deals briefly with previous history and explains why it has to be structured. It contains also an explanation of the term "space debris". As recently as last year, a proposal to explain what is the common understanding of the term failed to find a wide support in the Subcommittee. This year, the Report states:

"It is understood that space debris are inactive man-made objects, such as spent upper stages, spent satellites, fragments or parts generated during launch or mission operations, or fragments from explosions and other break-ups".

No size limits of space debris have been expressly stated. Evidently, the upper limit is the largest man-made spacecraft, if and when it becomes inactive. The lower limit in size can be inferred from the text of the Report. It deals with impacts of submillimeter-size particles and with craters and holes extending from several millimeters down to micrometers.

This year , only the part dealing with measurements of space debris was detailed, while Modelling and Mitigation will be dealt with in the next two years. The text appears in the Report of the Scientific and Technical Subcommittee of its thirty-third session, section on Space Debris.

Conclusion

If and when the Legal Subcommittee takes up the matter of space debris, it will face a difficult task. The technical complexity of the phenomenon of space debris is evident. Most methods for reducing the risk of a collision or a close encounter of an active spacecraft with a piece of orbital debris are strongly dependent on the actual state of technology and science. In particular, they depend on the technical design of spacecraft and its parts. It seems that the amount of technical data and numerical parameters is higher in the field of space debris than in any other area on the present or past agendas of the COPUOS. The question of space debris will require a "sui generis" approach.