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Committee on the Peaceful Uses of Outer Space

National research on space debris, safety of space objects with nuclear power sources on board and problems relating to their collision with space debris

Note by the Secretariat

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I. Introduction

1. In its resolution 62/217 of 22 December 2007, the General Assembly considered that it was essential that Member States pay more attention to the problem of collisions of space objects, including those with nuclear power sources, with space debris, and other aspects of space debris, called for the continuation of national research on that question, for the development of improved technology for the monitoring of space debris and for the compilation and dissemination of data on space debris, and also considered that, to the extent possible, information thereon should be provided to the Scientific and Technical Subcommittee of the Committee on the Peaceful Uses of Outer Space, and agreed that international cooperation was needed to expand appropriate and affordable strategies to minimize the impact of space debris on future space missions.

2. At its forty-fourth session, the Scientific and Technical Subcommittee agreed that research on space debris should continue and that Member States should make available to all interested parties the results of that research, including information on practices that had proved effective in minimizing the creation of space debris (A/AC.105/890, para. 83). In a note verbale dated 10 September 2007, the Secretary-General invited Governments to submit any information on the matter by 30 October 2007, so that that information could be submitted to the Scientific and Technical Subcommittee at its forty-fifth session.

3. The present document has been prepared by the Secretariat on the basis of information received from the following Member States: Germany, Japan, Poland and Saudi Arabia.

II. Replies received from Member States

Germany

[Original: English]

International activities

1. In 2007, Germany actively contributed to the development of space debris mitigation guidelines, regulations, requirements and standards. In particular, it contributed to the Space Debris Mitigation Guidelines of the Committee on the Peaceful Uses of Outer Space; to the Space Debris Mitigation Guidelines of the Inter-Agency Space Debris Coordination Committee; to the European Code of Conduct for Space Debris Mitigation signed by the British National Space Centre, the Centre national d'études spatiales of France, the German Aerospace Center (DLR), the Italian Space Agency and the European Space Agency; and to the efforts of the European Cooperation for Space Standardization and the International Organization for Standardization aimed at developing space debris mitigation standards.

Activities of the German Aerospace Center

2. On a programmatic level, DLR has tailored the national space debris mitigation guidelines to the needs of German space projects, using as a basis the

European Code of Conduct for Space Debris Mitigation. The possibility of applying the guidelines to the Environmental Monitoring and Analysis Program (EnMAP) and the Technologie Erprobungs Träger (TET) (Technology Test Carriers), both DLR projects, is being investigated. Representatives of the German space industry are expected to provide information to promote the national mitigation guidelines within the framework of a quality assurance and product safety workshop to take place in February 2008.

German research activities in the area of space debris mitigation

3. In Germany, research activities related to space debris mitigation cover various aspects, such as space debris observation technology, space debris environmental modelling and technologies to protect space systems from space debris and to limit the amount of new space debris that is generated. Financing is ensured either by the German national space budget or by the European Space Agency. In 2007, the following research activities were initiated and carried out:

(a) Development of the Advanced Impact Detector Assembly (AIDA), a calorimetric impact detector, for the on-orbit measurement of small orbiting debris and meteoroids;

(b) Development of a flight unit for AIDA;

(c) Improvement of a hypervelocity impact test facility for carrying out simulations of space debris impacts on spacecraft;

(d) Material investigations to simulate the fragmentation of spacecraft during re-entry;

(e) Analyses of the economic aspects and the sustainability of space debris mitigation measures.

Application of national space debris mitigation guidelines to German space missions

Environmental Mapping and Analysis Program[*]

4. EnMAP is a German mission that uses a hyperspectral satellite with 200 channels within the broad spectral range of 420-2,450 nanometres and with a high ground resolution of 30 metres. EnMAP will be carried out by a small satellite built with state-of-the-art bus technology (modified TerraSar bus) and will be sent into orbit approximately 650 km above the surface of the Earth.

5. The main tasks of the EnMAP mission are related to the global determination of ecosystem parameters as well as biophysical, biochemical and geochemical variables. EnMAP will also make it possible to perform analyses of natural disasters and land and water pollution. The mission data will be used for the preparation of future commercialized and operative services. The project is being carried out under German leadership with international partners.

[*] The original document submitted by Germany in English, including the images referred to in this document, can be found on the website of the Office for Outer Space Affairs of the Secretariat (http://www.unoosa.org/oosa/natact/sdnps/2007/index.html).

6. The possibility of applying the national space debris mitigation guidelines, adapted from the European Code of Conduct for Space Debris Mitigation, to the needs of EnMAP is being assessed.

7. The work includes analysing end-of-life measures (in particular, analysis of the passivation process and the implementation of disposal manoeuvres) and re-entry safety measures (in particular, assessing the possibility that debris stemming from spacecraft may reach the Earth's surface, investigating the related risk to the population and property on the ground and assessing the potential risk of harmful contamination of the Earth's environment).

Technologie Erprobungs Träger (Technology Test Carriers)

8. The goal of the TET programme is to find new technologies that can be applied to space projects. It focuses on carrying out in-flight demonstrations and on testing components and spacecraft subsystems for use in power generation, guidance, navigation and control, among others.

9. DLR provides in-flight opportunities for testing new technologies on various platforms and satellites. The programme is based on the use of the TET microsatellite, which is a German-built satellite that weighs about 120 kg and has a payload capacity of about 40 kg.

10. A TET satellite will be launched into low-Earth orbit by DLR. The planned mission duration is one year. In addition to assembling, integrating and testing the system, DLR will operate the satellite and provide all data collected to interested users.

11. The possibility of applying the national space debris mitigation guidelines, adapted from the European Code of Conduct for Space Debris Mitigation, to the needs of the project will be investigated within the framework of TET. Special focus will be placed on prevention measures (e.g. mission-related objects, fragmentation), end-of-life measures (e.g. passivation, de-orbiting and disposal) and re-entry safety.

Japan

[Original: English]

1. Activities related to the study of space debris in Japan, mainly conducted by the Japan Aerospace Exploration Agency (JAXA) and Kyushu University, have focused on the areas described below.

Ground-based space debris observation

2. Optical telescopes are routinely used to observe objects in geosynchronous orbit and to determine those objects' orbital characteristics. Research is under way to develop software that can automatically detect smaller objects in geosynchronous orbit. Objects in low-Earth orbit (LEO) are observed using radar telescopes. Research to better observe objects in LEO is being carried out using high-speed

tracking optical telescopes. Furthermore, the light curves of some spacecraft have been observed and their tumbling motion characteristics have been analysed.[1]

Modelling of debris population

3. The following debris modelling and analysis tools are being developed in Japan:

(a) The low-Earth orbital debris environment evolutionary model, to predict future debris distribution, being developed by Kyushu University in collaboration with JAXA;

(b) The Debris Mitigation Standard Support Tool (DEMIST), to help assess the compliance with the JAXA space debris mitigation standards and to assess debris-related risks in orbit;

(c) A debris collision risk analysis tool, to calculate the probability of collision for each space system component.

4. A study was conducted to identify commonalities among the world debris environment models, the results of which were reported to the International Organization for Standardization, the Inter-Agency Space Debris Coordination Committee and other international bodies. Results revealed that the distribution of small debris in LEO differs among those models. In particular, the size of the debris ranges from 100 micrometres to several millimetres.[2] The results also indicate the need to conduct more in-depth research on small debris. Recently, JAXA has begun a basic study to develop in situ measurement devices to detect small debris ranging from 100 micrometres to several millimetres.

Hypervelocity impact testing

5. A shaped charge impact device was designed. The correlation between tests using shaped charge impact devices and a two-stage gas gun was measured to improve design standards for protection against debris impact. In addition, the correlation between low-speed impacts and high-speed impacts was analysed. The analysis tool was improved using those results.

6. Kyushu University and the Orbital Debris Program Office of the National Aeronautics and Space Administration of the United States of America have collaborated on a series of impact tests on microsatellites. Three target satellites weighing approximately 1,300 g each were used for those tests. The impact speed was about 1.7 km per second; the ratio of impact kinetic energy to satellite mass for the three tests was about 40 joules per gram. Impact phenomena were captured using an ultra-high-speed camera. The fragments numbered approximately 1,000-1,500, depending on the angle at which the impact hit the inner layers. Details of those three tests and the results of preliminary analyses will be presented at the

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[1] The original document submitted by Japan in English, including the images and annexes A to C referred to in this document, can be found on the website of the Office for Outer Space Affairs of the Secretariat (http://www.unoosa.org/oosa/natact/sdnps/2007/index.html).

[2] The original document submitted by Japan in English, including the images and annexes A to C referred to in this document, can be found on the website of the Office for Outer Space Affairs of the Secretariat (http://www.unoosa.org/oosa/natact/sdnps/2007/index.html).

Scientific Assembly of the Committee on Space Research in Montreal, Canada, in July 2008.

Electro-dynamic tether to accelerate orbital decay for post-mission spacecraft

7. It is not sufficient to mitigate the amount of debris generated to preserve the orbital environment, because a chain reaction of collisions among existing debris has already been observed in specific orbital regions. The best way to improve the environment would be to remove large objects from densely populated orbital regions. The concept that every new launch should be accompanied by the removal of a spent satellite might be included in an agreement in the future. A technical solution would be the electro-dynamic tether system, which slows unused space objects and reduces their orbital lifetime. The results of recent research and development activities related to electro-dynamic tether systems aimed at on-orbit demonstrations by JAXA are available on the website of the Office for Outer Space Affairs (www.unoosa.org).

Mission assurance and safety

8. Since 1999, JAXA has controlled the launch window for all launches to avoid close approaches to manned orbital vehicles. During the past two years, two of seven launch operations were determined specifically to shorten launch windows. For major operating satellites, JAXA researchers are studying collision avoidance manoeuvres to avoid impact with orbital debris. Catalogued data for orbital objects have been provided by the Government of the United States. Conjunction prediction is monitored daily. In cases where a high collision probability is predicted, more accurate radar observation is conducted. Collision avoidance manoeuvres would be carried out in cases when the distance between two objects is obviously dangerous. During 2006, JAXA experimented with some observations using radar. JAXA is preparing a rehearsal for collision avoidance manoeuvres for the beginning of 2008.

Assessment of debris mitigation measures

9. For all projects, JAXA imposes debris mitigation standards and ensures that no mission-related objects are released. Moreover, orbital break-ups are prevented through design and operations, as well as through the removal of spacecraft from useful orbital regions once a mission has been terminated. Compliance with the standard is reviewed after each life-cycle phase as part of the activities carried out in the framework of the system safety programme.

Poland

[Original: English]

Two projects related to space debris were prepared and conducted in 2007. The first, which involved the use of a small satellite with a technology demonstrator, was conducted by students of the Warsaw University of Technology. That project has entered the integration and ground test phase. The second project was prepared by Polspace Ltd in the framework of the Plan for European Cooperating States and was related to the observation of used satellites and other orbital debris.

Saudi Arabia

[Original: English]

Through its participation in the committees for the follow-up of the recommendations of the Third United Nations Conference on the Exploration and Peaceful Uses of Outer Space (UNISPACE III), Saudi Arabia has actively studied issues related to space debris and the use of nuclear power in outer space. Saudi Arabia has also conducted studies and carried out research in cooperation with specialists at Saudi universities and international organizations.