United Nations A/AC.105/931/Add.1

General Assembly

Distr.: General
13 January 2009

Original: English

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*

Addendum

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* The present document was prepared on the basis of a reply from a Member State received on 4 December 2008.

V.09-80145 (E) 210109 220109

II. Replies received from Member States

United Kingdom of Great Britain and Northern Ireland

[Original: English]

1. Introduction

1. The United Kingdom, through the British National Space Centre (BNSC), maintains an active role in addressing the space debris problem by encouraging coordination at the national and international levels to reach agreement on effective debris mitigation solutions. Central to this is the membership of BNSC in the Inter-Agency Space Debris Coordination Committee (IADC), which is an important forum for achieving international consensus on space debris mitigation. BNSC contributes to IADC by participating in cooperative research activities and working with other member space agencies to formulate debris mitigation solutions and guidelines. In April 2008, the United Kingdom participated in the twenty-sixth meeting of IADC, which was hosted by the Russian Federal Space Agency in Moscow. An important topic at the meeting was the need to investigate, in more detail, methods for effective management of the growing debris population.

2. Another key area in which the United Kingdom is actively involved is the development of a series of spacecraft engineering standards for mitigating space debris. Contributions have been provided by United Kingdom experts in BNSC, industry and academia to the International Organization for Standardization (ISO), of which the United Kingdom chairs a working group tasked with coordinating all work on space debris mitigation standards under development within ISO. In drafting the standards, care has been taken to align them, as far as possible, with the IADC space debris mitigation guidelines. The first standard in the series is due to be published in 2009.

3. To meet its obligations under the United Nations treaties on outer space, the United Kingdom operates a licensing scheme to permit the launch and operation of United Kingdom satellites in outer space. BNSC, as licensing authority, is responsible for issuing the licences. The conformance of satellites and launch vehicles with debris mitigation guidelines and standards is an important consideration in the decision to grant a licence. During the past year, the British company QinetiQ has supported BNSC in evaluating licence applications from several space system operators, including Paradigm (Skynet 5C), Inmarsat (Inmarsat-4 F3 and other satellite relocations), SES Satellite Leasing (AMC 21), Telenor (Thor 2) and Surrey Satellite Technology Ltd. (Deimos 1 and DMC 2).

4. The space debris community in the United Kingdom has continued to make notable contributions to measure the debris population and model its long-term evolution, improve impact protection in spacecraft and develop debris mitigation solutions. A selection of this work is summarized below.

2. Observation of space debris

5. In late 2008, the United Kingdom participated in a re-entry prediction campaign organized by IADC. The campaign object was the early ammonia separator (COSPAR ID 1998-067BA), an item that was jettisoned from the

International Space Station and returned to Earth on 3 November 2008. The technical lead for risk object re-entry prediction in the United Kingdom is Space Insight Ltd., which provides support to BNSC on a range of activities related to space situational awareness. That operational support includes, among other things, information on anticipated re-entries of risk objects and, using the Starbrook system, the monitoring of platforms licensed under the Outer Space Act of the United Kingdom in order to ensure the compliance of the licensee's activities with the obligations of the United Kingdom under the United Nations treaties on outer space. In addition to fulfilling its national regulatory role, BNSC also uses Starbrook to take observations that, in turn, form the contributions of the United Kingdom to the IADC campaigns to measure the debris population. In 2008, such debris surveying activities focused on the medium-Earth orbits (MEOs), which are populated by Global Positioning System (GPS), Global Navigation Satellite System (GLONASS) and Galileo navigation satellites.

6. The United Kingdom continues to play a central role in preparatory studies for a future European space situational awareness system. QinetiQ and Space Insight Ltd. are partners in a consortium led by the National Office for Aerospace Studies and Research (ONERA) of France, in the framework of which a study is being conducted to examine the enabling techniques and technologies that will be required by the space situational awareness system. QinetiQ has been responsible for defining the technical requirements, carrying out a technical analysis of the system's feasibility, defining and trading-off system-level space situational awareness architecture and defining future space situational awareness services and service levels. The study has covered areas of space surveillance (radar and optical, in both ground and space-based domains), space object identification, space weather, near-Earth objects and data centre architectures. Currently, work is being done to define and trade-off options for orbiting space surveillance assets, including options for a dual space surveillance and space weather platform that exploits the potential synergies between the two systems.

7. Space Insight Ltd. has partnered with the Spanish company GMV in another study, presently in the final stages of negotiation with the European Space Agency, to investigate strategies for the observation of MEOs that will focus on the detection and characterization of faint and uncorrelated objects in the region where GPS, GLONASS and Galileo satellites are orbiting.

3. In-situ measurements of space debris

8. A research group at the University of Kent at Canterbury, United Kingdom, has continued to work on impacts in space by using its in-house light gas gun. Much of that work has focused on understanding how dust and residues are captured through the Stardust mission by the National Aeronautics and Space Administration (NASA) of the United States of America, in collaboration with groups in the United Kingdom (i.e. the Natural History Museum, Imperial College London and the University of Leicester) and laboratories in the United States. In addition to capturing cometary dust at 6.1 km/s, work is now being done, in collaboration with the University of Heidelberg in Germany, to capture interplanetary and interstellar dust at speeds of up to 25 km/s.

9. The University of Kent group has continued its work on new sensor techniques for deployment in low-Earth orbit (LEO), in collaboration with the NASA Orbital

Debris Program Office and a consortium of United States institutions (i.e. the United States Naval Academy, the Naval Research Laboratory and the University of West Virginia). Researchers at the University of Kent have tested two new types of sensor and worked on penetration ballistic limits and acoustic signal propagation in targets after impact.

10. Another research project, which the University of Kent group has recently initiated, concerns hydrocode modelling of impacts. While focused on activities related to the Stardust mission, this work also looks at cratering in foils and metals for a wide range of speeds and sizes typical of impacts in LEO and interplanetary space. Of particular interest are impactors made from non-compact, aggregate material. A necessary element of the hydrocode modelling research project is the comparison of simulation results with impact tests performed using the light gas gun.

4. Debris environment modelling

11. Working with delegates from other agencies involved in IADC Working Group 2 (Environment and Databases), BNSC has helped to define the parameters for a new study aimed at assessing the benefits of active debris removal that commenced in October 2008. The University of Southampton's Debris Analysis and Monitoring Architecture for the Geosynchronous Environment (DAMAGE) evolutionary model, which was upgraded in 2008 and validated against the LEO-to-GEO Environment Debris (LEGEND) model of NASA, will be used to investigate the stability of the current LEO debris environment before addressing the issue of active debris removal. The upgraded DAMAGE model has also been used to parameterize the online, interactive Fast Debris Evolution (FADE) model (http://www.soton.ac.uk/~hglewis/research/debris/FADE.html) and provide data for an ongoing study of space debris mitigation using networks. Researchers at the University of Southampton are also developing an empirical model of the thermosphere using satellite drag data with the aim of understanding and forecasting long-term density changes.

5. Spacecraft debris protection and risk assessment

12. The United Kingdom continues to participate actively in IADC Working Group 3 (Protection). The focus of effort within the group during 2007 was the production of a report, under the leadership of the United Kingdom, to assess the feasibility and options for implementing impact sensor networks on a variety of spacecraft. The purpose of such networks would be to provide operators with real-time data on the occurrence of impacts and their association with spacecraft anomalies or failures. A first version of the report was issued at the twenty-sixth meeting of IADC.

13. The Crashworthiness, Impact and Structural Mechanics Group at Cranfield University has continued its collaboration with Los Alamos National Laboratory of the United States and the Ernst-Mach-Institute of Germany to develop the non-linear finite element code, "LLNL-DYNA3D", in conjunction with a smooth particle hydrodynamic method. The code is used to model the protection capability of spacecraft materials to hypervelocity debris impacts.

6. Debris mitigation

14. During the past year, the United Kingdom has contributed to a number of IADC Working Group 4 (Debris Mitigation) activities, including: the long-term presence of objects in geostationary orbit, investigation of a geostationary orbit station-keeping zone, best practices for collision avoidance in geostationary orbit during relocation and re-entry risk assessment processes and thresholds. At the end of the twenty-sixth meeting of IADC, a representative of the United Kingdom was selected to take over the two-year chairmanship of Working Group 4.

15. The disposal of satellites at end-of-life is a key recommendation of the IADC Space Debris Mitigation Guidelines. In accordance with those guidelines, the space system operator Paradigm, on behalf of the Ministry of Defence of the United Kingdom (which was advised by QinetiQ), successfully planned and re-orbited the Skynet 4D satellite to a graveyard orbit in January 2008.

16. Research is continuing at Cranfield University's Space Research Centre to develop engineering solutions for disposing spacecraft at end-of-life. One project is currently studying a drag sail concept to de-orbit spacecraft from LEO. That involves developing a hardware prototype and computational tools to calculate aerodynamic forces for arbitrary spacecraft configurations. Another project focuses on designing a space tug satellite to inspect, service and re-orbit spacecraft in geosynchronous orbit. Spacecraft health monitoring is also being studied to support the development of disposal phase operations and design.

17. Finally, technical experts of the International Standardization Subcommittee for Space Systems and Operations (ISO TC20/SC14), of which the United Kingdom is project leader, have been developing a top-level space debris mitigation standard (designated ISO 24113) for publication in 2009. The standard defines the high-level quantitative requirements applicable to all elements of unmanned systems launched into or passing through near-Earth space, including launch vehicle orbital stages, operating spacecraft and any objects released parting the course of normal operations or disposal actions. The requirements contained in the standard aim to slow the increase in space debris by ensuring that spacecraft and launch vehicle orbital stages are designed, operated and disposed of in a manner that prevents them from generating debris during their orbital lifetime. Methods and processes to enable compliance with such requirements will be provided in a series of lower-level implementation standards, the first of which is also due to be published in 2009.