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Item 7 of the provisional agenda*
Space debris

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

I. Introduction

1. At its fifty-seventh session, the Scientific and Technical Subcommittee of the Committee on the Peaceful Uses of Outer Space agreed that Member States and international organizations having permanent observer status with the Committee should continue to be invited to provide reports on research on space debris, the safety of space objects with nuclear power sources on board, problems relating to the collision of such space objects with space debris and the ways in which debris mitigation guidelines were being implemented (A/AC.105/1224, para. 109). Accordingly, a communication dated 16 October 2020 was sent to Member States and international organizations with permanent observer status, inviting them to provide their reports by 13 November 2020 so that the information could be made available to the Subcommittee at its fifty-eighth session.

2. The present document has been prepared by the Secretariat on the basis of information received from five Member States, namely, Denmark, Finland, India, Japan and Myanmar, as well as from the International Organization for Standardization and the United Nations Institute for Disarmament Research. Further information provided by Japan and the International Organization for Standardization, which includes figures related to space debris, will be made available as a conference room paper at the fifty-eighth session of the Subcommittee.

* A/AC.105/C.1/L.387.

II. Replies received from Member States

Denmark

[Original: English]
[2 November 2020]

Mapping of space debris

In the field of mapping space debris, the National Space Institute of Denmark (DTU Space) works on the development and verification of autonomous debris detection from spacecraft in order to use this method for selected space missions to demonstrate efficiency and range.

A fully fledged mapping effort is being discussed with the European Space Agency with a view to engaging in a systematic effort, using existing space infrastructure in the short term (starting in 2020).

Finally, it is planned to create a full-scale profile of natural debris ranging in size from 0.8 to 5.2 AU (1 AU = 149,597,871 km) using the Juno mission of the National Aeronautics and Space Administration (NASA) of the United States of America to demonstrate the methodology.

Active removal of space debris

DTU Space conducts the following:

(a) Studies on natural orbit decay mechanisms, carrying out the development, launch, operations and verification of highly autonomous target detection, tracking and rendezvous to an accuracy of 7 cm;

(b) The development and verification of autonomous formation flight sensors for non-cooperative targets;

(c) Studies on capture mechanisms;

(d) Studies on directed energy de-orbiting technology.

Technology for the self-removal of spacecraft

Aalborg University and GomSpace conduct research on technology for the self-removal of spacecraft, a project funded by the Horizon 2020 European Union framework programme for research and innovation. The project started on 1 February 2016 and ended on 31 March 2019.

The technology uses a universal post-mission disposal module to be carried into orbit by any spacecraft to ensure its proper disposal at the end of its service lifetime, whether planned or unscheduled, owing to spacecraft failure. The module is to be independent of the spacecraft.

Safety of nuclear power sources on board and problems relating to their collision with space debris

In 2019 and 2020, Denmark did not conduct any research at the national level on the safety of space objects with nuclear power sources on board and problems relating to their collision with space objects.

Finland

[Original: English]
[13 November 2020]

National space situational awareness strategy

A national strategy for space situational awareness was prepared during 2018–2019, in collaboration with research, industry and administration partners. The National Space Strategy, adopted in 2013 and updated in 2018, recognizes sustainable use of space as one of the key areas where Finnish industry and academia have the potential to achieve breakthrough solutions for innovative data products and services at the international level. The new space situational awareness strategy is aimed at national 24/7 operational services that will be reliable, up to date and available to all Finnish users from 2020 onwards. The strategy recognizes the global nature of space situational awareness phenomena and therefore recommends the active participation of Finland in international space situational awareness activities in relation to research, technology, the economy and legislation.

Space surveillance and tracking activities in Finland

Before 2017, there were no nationally operated satellites; therefore, the need for and interest in national space surveillance and tracking activities has remained low, except for the occasional cases of re-entry involving the potential risk of the object falling into Finnish territory. In recent years, however, Finland has launched several small satellite missions and the trend towards launching more, both for research and commercial purposes, is evident. Finland already has some existing instrumentation capable of space surveillance and tracking, unique expertise in relevant observational techniques, both radar (European Incoherent Scatter Scientific Association (EISCAT)) and optical (satellite laser ranging). Additionally, several seminal studies on the observation of space debris have been carried out, including for the European Space Agency (ESA). The importance of space surveillance and tracking assets is now rapidly growing, with investments in new space technology and economy.

In space surveillance and tracking observations, a satellite laser ranging system has been available nationally for measuring accurate distances to satellites since 1978. The Finnish Geospatial Research Institute (FGI) operates the Metsähovi Geodetic Research Station, which is one of the core stations in the global geodetic network, providing observations for maintaining global terrestrial and celestial frames of reference, precise determination of the orbits of navigation and Earth observation satellites and Earth orientation in space. One of the major instruments available at the station is a modern satellite laser ranging telescope system. With the newest, state-of-the-art satellite laser ranging system expected to be operational in 2020, Finland will also have the possibility of contributing to the main endeavour in space surveillance and tracking: the mapping of space debris. The system will be one of the cornerstones of the Finnish space surveillance and tracking facilities. FGI has been actively promoting the adoption of the so-called retro reflectors for the planned national satellite payloads, allowing them to be tracked in the future with high accuracy by the national satellite laser ranging system.

EISCAT radars have been used in several satellite and debris observation campaigns and have proved to be the best radars in Northern Europe for studying space debris and making accurate orbit determinations. In 2017, the EISCAT Association started construction on the next-generation radar system, EISCAT_3D, which will outperform the current radars in several ways, including in its capacity to track space debris. Finland is one of the countries that has made a significant investment in the new radar system, and one of the receiver stations will be operated in Finnish Lapland. EISCAT_3D is anticipated to be operational in 2021.

In space surveillance and tracking research, efforts have been focused on using the unique capabilities of the nationally available observational systems. For example,

FGI carried out several projects in the period 2016–2018, including on the feasibility of using the Metsähovi satellite laser ranging system for space debris observation, and on the characterization of debris objects by means of satellite laser ranging observations by developing methods and software for spin-state determination and coarse classification. In addition, FGI has further studied the optimal strategy and satellite laser ranging instrumentation for debris observation and produced an upgrade plan for improving the feasibility of tracking non-cooperative targets.

A project being carried out by FGI and the University of Helsinki is aimed at measuring Earth radiation pressure by means of very high-precision observation of satellite orbits. This provides information on all the forces acting on an orbiting object and supports the tracking of satellites and debris.

The Finnish Centre of Excellence in Research of Sustainable Space combines science, technology and new commercial space activities into one programme. The Centre, led by the University of Helsinki, plans to build and launch small satellites with the goal of understanding the Earth's radiation environment holistically and developing de-orbiting technologies and next-generation radiation tolerance. The first satellite is nearing launch readiness, with payloads related to understanding the radiation losses to the atmosphere and de-orbiting the spacecraft. The satellite design is detailed in a paper by Palmroth and others published in 2019.[1]

For satellite re-entries, FGI and the Finnish Meteorological Institute (FMI) provide expertise to the Ministry of Interior Affairs by monitoring satellite orbit predictions provided by international services such as the ESA re-entry service. This was successfully demonstrated in 2013 with the re-entry of the Gravity Field and Steady-State Ocean Circulation Explorer. Based on the exercise, FMI and FGI started, in 2019, preparatory work for the permanent national service according to the plan of the national space situational awareness strategy. The service will use national capabilities, together with information obtained from the ESA Space Safety programme and the new European Union space programme. These programmes are designed to enhance the profile of Europe in space surveillance and tracking and space weather and will be launched during 2020–2021. Finland continues to actively seek collaboration with the European Union Space Surveillance and Tracking (EUSST) framework, aiming to be a fully fledged participant in the future.

Provisions Related to Space Debris in the National Act on Space Activities

The Finnish Act on Space Activities (63/2018) underscores the importance of the sustainable use of outer space and avoidance of space debris. Avoidance of unnecessary environmental harm and space debris is one of the conditions for authorization under the Act, which prescribes that the operator must, in accordance with the recognized international guidelines, seek to ensure that their activities in outer space do not generate space debris. The operator must, in particular, restrict the generation of space debris during the normal function of the space object, reduce the risks of breakage and collision of the space object in outer space and strive to remove the space object from its orbit to a less crowded orbit or to the atmosphere after it has completed its mission.

India

[Original: English]
[16 November 2020]

The Indian Space Research Organization (ISRO) has been active in space situational awareness and management activities and research on space debris analysis, including atmospheric re-entry prediction, fragmentation and break-up modelling. ISRO has been carrying out re-entry prediction and analysis of risk objects, and participates actively in the annual re-entry prediction campaigns of the

[1] https://agupubs.onlinelibrary.wiley.com/doi/abs/10.1029/2018JA026354.

Inter-Agency Space Debris Coordination Committee (IADC). ISRO studies on active debris removal, spacecraft shielding, the threats due to large constellations and long-term evolution of space debris scenarios are in progress.

Over the years, ISRO has built the capability for collision avoidance analysis tools with a view to safeguarding its space assets. For all ISRO operational satellites in low Earth orbit, collision avoidance manoeuvres are performed in case of the close approach of another space object. All routine manoeuvre plans are also subject to analysis for conjunction assessment and cleared for execution accordingly.

Since 1996, ISRO has been an active member of IADC. Several measures in line with IADC/United Nations Space Debris Mitigation Guidelines are implemented in ISRO launch vehicles and spacecraft projects to limit the creation of debris. All polar and geostationary satellite launch vehicles are passivated at the end of their mission. Presently, all ISRO operational spacecraft in geostationary orbit have post-mission disposal capability. After completion of their service life, satellites in geostationary orbit are re-orbited into higher orbits and then passivated. ISRO debris mitigation requirements have been drafted and are under review for implementation in all ISRO projects and programmes in the near future. ISRO published its Space Situational Report for 2019.

ISRO does not currently have any nuclear-powered space objects that can pose a threat to safety in outer space. If such an object is planned for any future mission, ISRO will address safety issues in line with internationally accepted guidelines.

The Directorate of Space Situational Awareness and Management at ISRO Headquarters is working towards devising strategies for space situational awareness, establishing supporting infrastructure and developing an effective operational mechanism to protect Indian space assets in the space debris environment through coordination among ISRO/DOS centres, along with the necessary policy interventions. India has recently opened up its space sector to private players and accordingly, the necessary coordination and effective space situational awareness protocols are being formulated.

ISRO has established a multi-object tracking radar at Sriharikota, which was commissioned in 2015 to detect and track objects in low Earth orbit. ISRO is also establishing optical telescopes for the observation of objects in geostationary orbit, which are in the process of being commissioned.

In order to cope with increasing launches and a growing debris population, current space debris observation capabilities are planned to be enhanced and augmented by establishing additional observation facilities. The Network for Space Object Tacking and Analysis project has been approved by the Government of India. As a first step towards achieving this goal, a control centre for space situational awareness and management is ready to coordinate all space situational awareness- and space debris-related activities. A multi-object, state-of-the-art radar to track objects in low Earth orbit and an optical telescope to track objects in geostationary orbit are to be installed under this project within a three-year time frame.

However, there is a serious issue that requires the immediate attention of international bodies and agencies. The space arena is undergoing major changes, with space industries developing large numbers of constellations in low Earth orbit. These constellations pose challenges to the operation of conventional satellites and for ground-based space observation. Many of the constellations consist of nano and small satellites which do not have a manoeuvring system to alter their orbit to avoid a possible collision with space objects. The current scenario of hosting large constellations (some have already been developed and some are in the pipeline) makes the space debris scenario very complicated and multiplies collision threats to operational spacecraft. We urge all actors to work together to reach the best possible solution to mitigate the scenario, develop suitable regulations and controls for deploying multiple objects into low Earth orbit and utilize the precious natural resources of space in a safe and optimal way.

Japan

[Original: English]
[12 November 2020]

Overview

Responding to a request from the Office for Outer Space Affairs of the Secretariat, Japan reports that its debris-related activities are conducted mainly by the Japan Aerospace Exploration Agency (JAXA).

The following debris-related activities conducted at JAXA during 2019 and 2020 have been selected as examples of major progress and are set out below:

(a) Conjunction assessment results and research on core technology for space situational awareness;

(b) Research on technology to observe objects in low Earth and geosynchronous Earth orbits and determine their orbits;

(c) In situ microdebris measurement system;

(d) Development of a composite propellant tank;

(e) Active debris removal.

Status

Conjunction assessment results and research on core technology for space situational awareness

JAXA receives conjunction notifications from the Combined Space Operations Center (CSpOC). JAXA executed three debris avoidance manoeuvres for low Earth orbit spacecraft in 2019.

Core technology for space situational awareness

JAXA determines the orbit of space objects using radar sensors at Kamisaibara Space Guard Center and optical sensors at Bisei Space Guard Center, predicts close approaches using the latest orbit ephemerides of JAXA satellites and calculates the probability of collisions.

At present, JAXA is developing a new radar that can track smaller space debris than the present radar. In particular, altitudes around 500 to 800 km will be covered, which are the altitudes at which most of the JAXA low Earth orbit satellites are orbiting. JAXA is refurbishing the 1.0m and 0.5m telescopes to maintain their current capabilities. The new analysis system will be able to handle more data than the current system. JAXA also automates most processes as much as possible.

JAXA has developed tools to help plan debris avoidance manoeuvres, once JAXA has received a conjunction data message from CSpOC. Based on experience, all procedures for debris avoidance manoeuvres have been simplified and workloads reduced.

Research on technology to observe objects in low Earth and geosynchronous Earth orbits and determine their orbits

Generally, the observation of objects in low Earth orbit is mainly conducted by a radar system, but JAXA has been working to apply an optical system to reduce both construction and operational costs. A large CMOS sensor for low Earth orbit observation has been developed. Analysis of the data from the CMOS sensor with the FPGA-based image-processing technologies developed by JAXA enable the detection of objects in low Earth orbit measuring 10 cm or less. In order to increase the observation opportunities in relation to objects in low Earth and geosynchronous Earth orbits, a remote observation site in Australia was established in addition to the

Mt. Nyukasa observatory in Japan. One 25 cm telescope and four 18 cm telescopes are available for various objectives.

In situ microdebris measurement system

The space debris monitor is an in situ microdebris sensor focusing on micro- to milli- sized debris orbiting at under 1,000 km. The recent flight experience was conducted by H-II Transfer Vehicle "KOUNOTORI" (HTV) 5. Information based on actual measurements on this small debris is essential to properly understand the current situation of vast amounts of small debris orbiting near the Earth, because such debris is becoming a dominant risk factor in orbit.

The unique properties of the space debris monitor are its simple detection system which does not need any special calibration before flight and the potential to collaborate easily with other sensors. The monitor consists of a debris detection area and circuit areas. The debris detection area is made of very thin polyimide film and there are thousands of 50 μm-wide conductive grid lines capable of detecting the diameter of collided debris measuring from 100 μm to millimetres.

JAXA jointly collaborates with the NASA Orbital Debris Program Office to develop new in situ microdebris measurement in order to build a picture of the situation regarding small debris orbiting at under 1,000 km.

Development of a composite propellant tank

A propellant tank is usually made of titanium alloy, which is superior because of its light weight and good chemical compatibility with the propellant. However, its melting point is so high that such a propellant tank would not demise during re-entry, and it would pose the risk of causing ground casualties.

For several years, JAXA conducted research to develop an aluminium-lined, carbon-composite overwrapped tank with a lower melting point. As a feasibility study, JAXA conducted fundamental tests including a liner material aluminium compatibility test with hydrazine propellant and an arc heating test.

After the manufacture and testing of the shorter engineering model EM-1 tank, the full-size EM-2 tank was manufactured. The shape of the EM-2 tank is the same as the nominal tank which includes a propellant management device. Using this EM-2 tank, a proof pressure test, vibration test (with wet and dry conditions), external leak test, pressure cycle test and burst pressure test were conducted and all of them showed good results. The critical design review was completed.

This composite propellant tank has a shorter delivery period and lower cost than a titanium propellant tank. Experimental and analytical evaluation of demisability during re-entry is ongoing.

Active debris removal

JAXA has organized and structured a research programme which is aimed at the realization of low-cost active debris removal missions. The research and development of key technology for active debris removal has three major themes: non-cooperative rendezvous, capture technology for non-cooperative targets and de-orbiting technology to remove massive intact space debris. JAXA is cooperating with Japanese private companies to realize low-cost active debris removal on a commercial basis and is working to provide this key technology.

JAXA is also conducting the Commercial Removal of Debris Demonstration (CRD2) programme. The programme has two phases and aims to achieve the world's first active debris removal in partnership with private enterprises. Phase one, which involves demonstration of the key technologies, such as non-cooperative rendezvous, proximity operation and inspection of the H2A second stage is planned for launch in the fiscal year 2022. Phase two, which involves demonstration of the active debris removal and re-entry of the H2A second stage, is planned no earlier than the fiscal

year 2025. Astroscale Japan Inc. was selected as a partner company in phase one thorough a competition in February 2020.

Myanmar

[Original: English]
[13 November 2020]

As one of the States attending the UNISPACE+50 high-level segment held on 20 and 21 June 2018, Myanmar was congratulated and noted for participating in the historic anniversary of the first United Nations Conference on the Exploration and Peaceful Uses of Outer Space, supported by the Office for Outer Space Affairs. Myanmar will remain a member of the international space community with the aim of strengthening the use of space in achieving the Sustainable Development Goals.

As a developing country, the Government of the Republic of the Union of Myanmar is still formulating a space programme aimed at fulfilling the space aspirations of launching a national satellite and gaining control over strategic national communications and broadcasting. While operating its satellite system, Myanmar will emphasize space science, technology, law and policy for the benefit of the regional and multiregional community and also contribute to the achievement of global initiatives such as the 2030 Agenda.

As the national satellite project is at the planning stage, Myanmar has not faced the issues of space debris, nuclear power sources and related problems. Although Myanmar has not yet considered conducting research on those issues, it will focus on cooperation with the international community/organizations to develop space debris mitigation as an importance step in ensuring the secure and peaceful use of space while its own satellite system is in progress.

III. Replies received from international organizations

International Organization for Standardization

[Original: English]
[6 November 2020]

This information is provided in three parts: ISO standards addressing safe and efficient space operations; ISO standards addressing space debris mitigation; and a submission from the Ukrainian delegation participating in the development of ISO standards.

As demonstrated by the very active work programmes in not only space operations and space debris mitigation, but indeed across the entire ISO space standards work programme, these standards are important contributions to how the space industry and State actors are able to apply normative standards to improve space flight safety.

The cases provided by the Ukrainian delegation demonstrate how such ISO standards are applied in practice.

International standards for safe and efficient space operations

In today’s increasingly complex space environment, it is more important than ever to ensure a better global approach to space operations, safety and sustainability across all space sectors (civil, commercial, government, academia, etc.). Space standards fulfil a key role in providing a global approach by reducing duplication of efforts and leveraging expertise in the associated communities.

Working Group 3 (WG3) of ISO/TC20/SC14 provides an international focus for addressing all aspects of ground operations, launch and space flight operations, and

their supporting systems and equipment. WG3 coordinates and develops synergies with international, regional and national organizations and industries involved in space systems and operations, including space traffic management.

A standards framework for sustaining resilient space operations

One of WG3's key objectives is to ensure that internationally accepted standards exist for the operation, maintenance and disposal of components, equipment and space systems, including space vehicles, their attendant ground systems, and the information transfer and data communication system networks that are embedded within them. Additionally, WG3 seeks to facilitate commerce and safety in all aspects of space activity by developing standards and practices for the space enterprise and achieving international consensus for those standards and practices.

ISO space operations and support systems standards

The principal topic areas are data exchange and scheduling; launch and flight operations, including space traffic management; launch and flight safety, including space traffic management; and ground, launch and space support.

Standards in these areas contain, or incorporate by reference, an effective and realistic set of measures that can be adopted voluntarily, specified via commercial contract or mandated by national regulations. The qualitative benefits are common verification requirements and reporting formats to ensure the wide acceptance of qualification tests; enhanced safety of operations; interoperability through common taxonomies and data formats that enable efficient exchange among international partners and agencies; interoperable ground and space support equipment; and the preservation and protection of the space environment for future commerce.

WG3 future standards development initiatives

WG3 welcomes participation to help develop and maintain space system standards in the following areas: cyber protection and cyber security; human habitation in space; space traffic management; autonomous navigation and station keeping; collocation; inclined geosynchronous orbit operations; launch collision avoidance; on-orbit servicing; operations scheduling and mission planning; rendezvous and proximity operations; space domain awareness; and suborbital flight safety and flight operations.

Space debris mitigation standards

Private and public actors involved in space operations are increasingly aware of the threat of space debris. Some of these organizations have been applying measures to mitigate debris generation for many years. However, the population of debris continues to grow, and the probability of potentially damaging collisions is increasing correspondingly. Because remediating the space environment is challenging with existing technologies, the most effective way to ensure the long-term sustainability of space activities at present is to standardize the implementation of debris mitigation measures, including collision avoidance. Standardization will play a major role in coming years in helping regulatory bodies and operators create and apply, in an efficient manner, appropriate space debris regulations and best practices. ISO TC20/SC14, a "space systems and operations" standards committee comprising representatives from industry, academia and institutional organizations, has the skills necessary to meet this challenge. Responsibility for the preparation of debris mitigation standards is shared between all seven of the SC14 working groups and is overseen by WG7 (Orbital Debris Working Group).

An international approach to space debris mitigation

Since 2003, ISO has been transforming guidelines and best practices from across the space industry into a comprehensive set of international standards on space debris mitigation. Recommendations published by organizations such as the Inter-Agency

Space Debris Coordination Committee, the International Telecommunication Union and the United Nations, and regulatory bodies have been at the heart of this activity. A key objective of the ISO debris mitigation standards is to formulate these recommendations in such a way that they can be readily applied in a contractual agreement between a customer and supplier. This helps to avoid differences in interpretation during the procurement of spacecraft or launch services. The standards can also be used as the basis for national regulations on space debris mitigation, or they can be adopted voluntarily. Therefore, within an international context, the adoption of ISO debris standards will help to foster fair competition and promote the long-term sustainability of space activities.

The ISO space debris mitigation standards framework

The main aim of the ISO debris mitigation standards is to specify measures that, when implemented in the design, operation and disposal of a spacecraft or launch vehicle orbital stage, will prevent the generation of space debris. The standards are organized in a hierarchical structure. All of the high-level debris mitigation requirements are contained in a top-level standard, ISO 24113 (Space systems – Space debris mitigation requirements), the third edition of which was published in 2019. This is the most important debris standard. It contains an effective and realistic set of measures focused on preventing the release of objects during normal operations; post-mission disposal of spacecraft and orbital stages from the low Earth orbit and geostationary orbit protected orbital regions; prevention of on-orbit break-ups; and re-entry risk assessment.

Below ISO 24113 in the hierarchy, there are a number of lower-level implementation standards which define detailed measures, procedures and practices to support compliance with the requirements in ISO 24113.

The following implementation standards are currently available:

(a) ISO 11227 describes an experimental procedure for acquiring data to characterize the ejecta released when spacecraft materials are impacted by hypervelocity projectiles representative of space debris and meteoroids. Such data contribute to informed decisions being made with regard to the selection of suitable materials for external surfaces on spacecraft;

(b) ISO 14200 specifies a process for implementing meteoroid and debris environment models in the impact risk assessment of spacecraft and launch vehicle orbital stages. Guidance is provided for selecting and using the models and ensuring their traceability throughout the design of a spacecraft or launch vehicle orbital stage;

(c) ISO 16126 defines requirements and a procedure for assessing the survivability of an uncrewed spacecraft against space debris and meteoroid impacts to ensure the survival of critical components required to perform post-mission disposal;

(d) ISO 27852 describes a process for the estimation of orbit lifetime for satellites, launch vehicles, upper stages and associated debris in low Earth orbit-crossing orbits. It also clarifies modelling approaches and resources for solar and geomagnetic activity modelling, resources for atmosphere model selection and approaches for spacecraft ballistic coefficient estimation;

(e) ISO 27875 provides a framework to assess, reduce and control the potential risks that spacecraft and launch vehicle orbital stages pose to people and the environment when those space vehicles re-enter the Earth’s atmosphere and impact the Earth’s surface.

Furthermore, the following implementation standards will be published soon: ISO 20893 and ISO 23312 will define detailed space debris mitigation requirements and recommendations for the design and operation of launch vehicle orbital stages and spacecraft, respectively.

ISO has also published several non-normative technical reports for additional guidance:

(a) ISO/TR 16158 describes some widely used techniques for perceiving close approaches, estimating collision probability, estimating the cumulative probability of survival and manoeuvring to avoid collisions;

(b) ISO/TR 18146 and ISO/TR 20590 systematically guide engineers in the implementation of debris mitigation measures during all phases of the design and operation of spacecraft and launch vehicle orbital stages, respectively.

Statement provided by Yuzhnoye State Design Office (Ukraine), providing an example of how ISO standards are used to help ensure space flight safety

It is well-known that accidental explosions of upper stages and spacecraft are major contributors to the space debris population. Mitigation of these explosions and adherence to the other debris mitigation requirements contained in ISO 24113 (post-mission disposal, propellant and power systems passivation, prevention of mission-related debris release, etc.) constitute effective actions that can quantitatively reduce space debris generation by a factor of two or more.

Yuzhnoye State Design Office (Yuzhnoye SDO) experienced explosions of its spent Zenith second stages on 26 December 1992 and 26 March 1993, when a considerable quantity of remaining propellant (perhaps 2 tons) exploded approximately 27 to 30 hours after spacecraft separation. Similar explosions that occurred 16 and 29 years after launch in the Cyclone-3 upper stages were attributed to thermal-induced oxidizer tank pressure increases, and these have been fixed.

In accordance with ISO 24113:2019 debris mitigation requirements, Yuzhnoye SDO completed careful space debris mitigation evaluations of the Dnepr, Zenith, Cyclone and other launch vehicle systems under contract with the launch vehicle contractors. The focus was on ensuring the successful post-mission passivation of launch systems following integrated operations. Furthermore, special attention was given to ensuring that all residual energy in propellant and pressurization tanks was vented and that the physical and chemical interactions between propellant and its mechanical interfaces were controlled.

Thus, strict observance of ISO space debris mitigation standards (including ISO 24113, 20893 and 26872) were critical in ensuring the safe design and operation of new launch vehicles managed by Yuzhnoye SDO.

United Nations Institute for Disarmament Research

[Original: English]
[20 October 2020]

While the United Nations Institute for Disarmament Research has not carried out research specifically on the topic, some of the Institute's resources on relevant topics might be of interest:

(a) Daniel Porras, Eyes on the Sky: Rethinking Verification in Space (Space Dossier 4), Geneva, UNIDIR, October 2019: https://doi.org/10.37559/WMD/19/Space01;

(b) In May and June of 2020, the Institute hosted a series of four well-attended online events called the launch pad seminars, focused on space and missile issues. A video recording of each of these, including the first about space situational awareness and space security, can be found online at https://unidir.org/events/launch-pad-seminars-virtual-forumnew-ideas-space-security-and-related-matters;

(c) On 10 November 2020, UNIDIR is scheduled to co-host an online event with the Secure World Foundation on space situational awareness and verification. Information about this event will soon be available on the Institute's website.

(d) Before the end of 2020, UNIDIR will publish a further space dossier, the seventh in the series, outlining technical and policy-relevant dimensions of contemporary advances in space situational awareness capabilities. This will be available on the Institute's website from December.