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Committee on the Peaceful Uses of Outer Space
Scientific and Technical Subcommittee
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International cooperation in the peaceful uses of outer space: activities of Member States

I. Note by the Secretariat

1. In the report on its forty-seventh session, the Scientific and Technical Subcommittee of the Committee on the Peaceful Uses of Outer Space made a recommendation, endorsed by the Committee on the Peaceful Uses of Outer Space at its fifty-third session (A/65/20), that the Secretariat continue to invite Member States to submit annual reports on their space activities (A/AC.105/958, para. 19).

2. In a note verbale dated 13 August 2010, the Secretary-General invited Governments to submit to the Secretariat their reports by 22 October 2010.

3. The present document was prepared on the basis of reports received from the following Member States after 22 October 2010: Czech Republic, the Philippines, the Republic of Moldova, the Russian Federation.

4. The replies contained in the present document were not formally edited. The replies will be made available by the Secretariat, edited and in all official languages of the United Nations, in addenda 2 and 3 to document A/AC.105/977.

II. Replies received from Member States

Czech Republic

[Original: English]
[6 January 2011]

The Czech Republic, as a country from Central Europe, has been inherently focusing its space science and technology efforts towards its broader involvement in

European structures. Space-related activities in the Czech Republic are coordinated by Czech Space Office (CSO), which was founded in November 2003 as a private non-profit organization, when the Czech Republic became ESA´s cooperating state. became ESA´s cooperating state. The CSO provides support to Czech science, education, R&D and business sectors and serves as first contact point towards the international space community. The CSO carries out a broad range of activities at national as well as international level; e.g. coordination, consulting, negotiations, networking and planning. It also represents the Czech Republic at international events and in various European space organizations.

For a small country like the Czech Republic, an international cooperation is the most efficient approach how to benefit from the space science and technology. The CSO coordinates Czech relations with international and particularly European space community. The CSO takes every opportunity to show the current and potential benefits of the space technology to national economy. and society. The CSO is financed by Ministry of Education, Youth and Sports. The mission of CSO is to increase the participation of Czech organizations in national as well as international space projects and to support the Czech space community in getting access to information of technical, scientific and administrative nature.

The CSO maintains relations with main European space industry players like EADS Astrium and Thales Alenia Space, as well as with other key space companies and agencies as CNES or DLR. The Czech Republic is fully engaged in the development of the European space policy and European space programme through the participation of the CSO in the EU High Level Space Policy Group meetings and by providing consultancy services to the MEYS during the preparation for the meetings of the EU Space Council. For Example, the “1st EU-ESA International Conference on Human Space Exploration” took place in vicinity of Prague at Štiřín Castle in October 2009.

Prague became world centre of astronautics again after long 33 years, because between 27 September and 1 October 2010 hosted 61st International Astronautical Congress IAC. It brought more than 3 000 experts from all over the world. Congress also attracted more than 2 000 visitors from Czech general public and secondary schools together with universities. The Congress has grown throughout the years into a huge event, with exhibition and other associated events like UN/IAF Workshop or Space Generation Congress. The local organization of 61st International Astronautical Congress was entrusted to CSO.

In November 2008, the Czech Republic became the 18th ESA member state and committed itself to contribute approx. 45 million euro to the ESA programmes until 2013. Currently, more than a half of the total budget of space-related projects in the Czech Republic is funded through ESA. The ESA membership has opened new opportunities for Czech companies and institutions and their involvement in ESA projects has increased significantly compared to the five previous years, when the Czech Republic was a European Cooperating State.

The Czech Republic recognizes enormous benefits of the space for its economy and consequently for the lives of all its citizens. It also puts emphasis on using the space to understand the environmental challenges we face managing natural resources, advancing in many technological areas and developing useful space applications for humankind. The Czech Republic would like to further

enhance its involvement in many areas of the astronautics, space science and their applications on Earth, which is clearly demonstrated by appealing participation in ESA optional programmes.

Space science is a discipline exploring the near and far space, solar system as well as the Earth interaction with outer space. The Czech Republic has been involved in the two current space science missions investigating the Earth's magnetosphere and exploring the solar system, as well as in the missions under preparation to be launched in the next decade. These include the missions to the Sun, Mercury and last but not least astrophysics observatories. ESA plans a mission called Solar Orbiter to our nearest star. Two Czech academic institutes are involved in the preparation process to provide instruments for this mission. If the mission succeeds, it will be the most valuable contribution of the Czech Republic to the Sun research from outer space. The Czech Republic is also participating in another ESA mission, to the Mercury, BepiColombo. Scientists from Prague´s Charles University cooperate on the electron analyser development.

The Czech Republic participates in the European Programme for Life and Physical Sciences ensuring Europe's strong position in research by developing the capabilities on the International Space Station (ISS), mainly using the Columbus laboratory as well as other ISS and additional research platforms. Within the programme, European Laser Timing (ELT) experiment is being realised. Its main task is to synchronize the atomic clocks in space ACES (Atomic Clock Ensemble in Space) with others on the ground. The ELT payload in space includes Single Photon Avalanche Diodes (SPAD) detector developed in labs of Czech Technical University, Faculty of Nuclear Sciences and Physical Engineering. One-year 2010 mission of Czech medical doctor-researcher on Concordia station in Antarctica is also part of the programme activities.

The Earth Observation is a global initiative and the Czech Republic actively supports all international Earth observation initiatives and the sharing of results. The Czech Republic provides its support through ESA and EUMETSAT. At the last ESA Ministerial Council in 2008, the Czech Republic committed itself to co-finance the ESA-managed GMES Space Component programme. The CSO makes all efforts to develop the GMES initiative to meet the Czech requirements and closely cooperates with ESA to fulfil this goal. The Czech Republic also participates in the ESA Earth Observation Envelope Programme involving new European missions which will improve the understanding of our planet. One of them, the GOCE gravity mission, will provide measurements to be used for analysis by the Czech Research Institute of Geodesy and Cartography. Many Czech teams are involved in collecting and analysing results from the European largest and most sophisticated Earth Observation satellite Envisat. Because of widespread cloud cover, Czech research teams use the radar satellite data to monitor areas at risk of landslides and especially floods, the key environmental issues in the Czech Republic. The third ESA Earth Observation programme with Czech participation is the Meteosat Third Generation Space Segment Development programme, which promises a great number of opportunities for industrial development. Looking from the user perspective, the data from meteorological satellites are regularly used in national and regional weather forecasts by the Czech Hydrometeorological Institute.

Satellite navigation enables users to find out exactly where they are anywhere on the Earth using signals from orbiting satellites. Europe's Galileo satellite

navigation system will feature 30 satellites to provide the whole planet with a highly accurate global positioning system under civilian control. The Czech Republic already benefits from the applications offered by satellite navigation and actively supports the development of new technologies to exploit the potential of satellite navigation. The Ministry of Transport delegated CSO with local organization of European Satellite Navigation Competition. Czech institutions and companies have been submitting to competition their innovative ideas from area of GNSS applications for already 7 years.

The Czech Republic expressed its interest to become the seat of the European GNSS Supervising Authority and the Czech government makes efforts to happen so. Moreover, the Czech Republic participates in the ESA European GNSS Evolution Programme, which studies and develops technologies associated with future generations of the European GNSS Overlay Service (EGNOS) and Galileo systems.

Satellite telecommunication is one of the oldest space service domains with mature and fully functional commercial market. The Czech Republic is fully aware of that and therefore joined the ESA Advanced Research in Telecommunications Systems (ARTES) programme. Iris, a sub-element of the programme focusing on satellite solution for air traffic management, belongs to the ESA optional programmes with the highest Czech financial involvement. Czech consortium, whose task is the user terminal design, development and testing, is formed around the company Honeywell Czech Republic. Two software companies, Iguassu Software Systems and Evolving Systems Consulting, are also participating in the programme. Other sub-elements with Czech participation are ARTES 1, ARTES 3-4, dedicated to the development, qualification, and demonstration of telecom products, and ARTES 20, Integrated Applications Promotion, focusing mainly on the development, implementation and pilot operation of integrated space applications.

The space industry is one of the new emerging sectors in the Czech Republic. Several Czech manufacturing companies are or even have already supplied mechanical and/or electronic parts and sensors for satellites. Apart from companies which already proved the ability to deliver for space, there are many with a potential to transfer their technological skills into the space sector. The main Czech hardware competencies are as follows: materials thermal processing; high-precision mechanical parts and assemblies; PCB assembling in a clean room; mechanical, structural and environmental testing; high-quality opto-mechanical/-electronic devices; precise X-ray optical/mirrors/CCD cameras; radars and C4I systems; robotic systems and processes and nanotechnology products. In the field of software development, the major skills include: vehicles health monitoring, flight/ground segment software development, complex software solutions, solutions for safety-critical systems, digital image processing and signal processing. The main ESA programmes for space technologies development in which The Czech Republic participates are Basic Technology Research Programme (TRP) and the General Support Technology Programme (GSTP).

Philippines

[Original: English]
[13 January 2011]

2010 Activities of the Philippines on International Cooperation on Peaceful Uses of Outer Space

1. Hosting of the "Third Joint Project Team Meeting (JPTM) 2010 Conference", conference on Sentinel Asia Project on July 6-8, 2010 at the Hyatt Hotel, Manila

The 2010 JTPM is a conference of about a hundred experts from all over Asia which focused on the Sentinel Asia Project. The project is a collaboration of 52-member organizations from Asia that aims to help mitigate the devastating effects of disasters in the Asia-Pacific region through the use of earth observation technologies, speedy internet dissemination methods and Web-Geographic Information Systems mapping. Designed to make disaster-related data available to all Asian countries from delivery of information to provision of emergency services, Sentinel Asia complements the activities of existing disaster management regional agencies. Countries that do not have their own satellite reception facilities will find Sentinel Asia very useful and valuable in information gathering.

This year's meeting provided a venue to discuss important technical matters and administrative issues, including the promotion of Sentinel Asia as a partner in disaster management efforts. Sentinel Asia is a project under the APRSAF Asia-Pacific Space Agency Forum.

The 2010 JTPM is hosted by the Philippine Council for Advanced Science and Technology Research and Development Council, the Department of Science and Technology's lead agency in the development, integration, and coordination of the national research systems for advanced science and technology, including space technology applications and information and communication technologies. Organizing the event is the Japan Aerospace Exploration Agency.

2. National Disaster Coordinating Council (NDCC) Meeting with UN-SPIDER Mission on 09 July 2010 at NDCC Operation Center, Camp Aguinaldo, Quezon City

Mr. Shirish Ravan, Program Officer of the United Nations Platform for Space-based Information for Disaster Management and Emergency Response (UN-SPIDER) based in Vienna, Austria met with NDCC Officials and representatives from other NDCC member agencies to discuss availability of space-based information and come up with recommendations on how to strengthen collaboration for effective use of information for disaster risk reduction and management (DRRM). Specific objectives of the meeting were the following:

(a) Space-based information used during the 2009 typhoon season;

(b) Information preparedness for upcoming 2010 typhoon season;

(c) Lessons learned from the past and how to improve in the future;

(d) Opportunities to access space-based information;

(e) Closer working relations with UN-SPIDER.

The meeting was chaired by Director Ronald I. Flores, Civil Defense Executive Officer. After presentations by Mr. Ravan on the activities and support being provided by UN-SPIDER and Dr. Esperanza Cayanan, of the Philippine Atmospheric, Geophysical and Astronomical Services Administration (PAGASA) on the satellite applications in Meteorology and the use of satellites during Tropical Cyclone Ketsana, discussions on the use, availability and opportunities to access satellite data took place. Suggestive actions as a result of the meeting are as follows:

(a) Establishment by the NDCC of a forum of the organizations that participated in the meeting to improve preparedness in terms of space-based and geospatial information;

(b) NDCC to coordinate with the mapping agency to make a provision of the budget for easy procurement of satellite images;

(c) Inter-agency coordination — NDCC needs to develop capacity to use the data coming from all sources and coordinate with these agencies to use the expertise effectively. The Philippine Institute of Volcanology and Seismology (PHIVOLCS) will organize training on the use of SAR data jointly with JAXA for the benefit of other agencies in the Philippines;

(d) Enhance cooperation with UN-SPIDER — NDCC the focal point for UN-SPIDER should closely work with the UN-SPIDER who has expressed willingness to assist NDCC and offers technical advisory to establish mechanism in the country for effective use of space-based information for disaster management.

3. Technical Training on Satellite Precipitation Data Application in Sentinel Asia Success Story in the Philippines

In cooperation with Japan Aerospace Exploration Agency, the Technical Training on Satellite Precipitation Data Application was conducted at the PHIVOLCS in Quezon City on 27-28 September 2010. Participants include personnel from PAG-ASA, PHIVOLCS, Office of Civil Defense, National Mapping Resource and Information Authority (NAMRIA), Mines and Geo-science Bureau and other NDCC member agencies. This is a part of the project Sentinel Asia Success Story in the Philippines.

4. Application of space-based information on disaster management

The Philippine Atmospheric, Geophysical and Astronomical Services Administration (PAGASA), the national meteorological and hydrological service, continued utilizing space-based information for disaster management support. PAGASA makes use of meteorological satellite data for weather and climate monitoring and flood forecasting. Satellite data instantaneously provide up to the minute picture of the weather systems in the atmosphere most especially in areas where land-based observation is not available like over the Pacific Ocean. The meteorological satellite receiving facilities of the Philippines are as follows:

(a) National Oceanic and Atmospheric Administration (NOAA-AVHRR), polar orbiting satellite from USA;

(b) Moderate Resolution Imaging Spectroradiometer (MODIS), polar orbiting satellite from USA;

(c) Two (2) Multifunctional Transmission Satellite (MTSAT), geostationary satellite from Japan. One is installed at PAGASA Weather and Flood Forecasting Center in Quezon City and the other at Mactan PAGASA Station in Cebu City;

(d) Feng Yun Cast, geostationary satellite from China.

PAGASA has also installed meteorological buoy which transmits realtime data through with the aid of satellite communication facilities. Likewise, PAGASA will be using satellite communication for realtime data transmission of automatic weather stations all over the country. The Broadband Global Area Network (BGAN) will be used for fast transmission of data. BGAN is a global Satellite Internet Network with telephony using portable terminals. The network is provided by Inmarsat and uses three geostationary satellites called I-4 to provide almost global coverage.

5. Capacity building and training opportunities under the UN Program on Space Applications

As a continuing activity of the International Year of Astronomy and for the promotion of Astronomy to young students, the PAGASA and the Department of Science and Technology conducted the Regional Astronomy Olympiad which was held at the university of the Philippines on 19 February 2010. There were two category levels: College level with five (5) regions participating and High School level with participants from 10 regions. The top five winners in the high school level contest participated and received the Honourable Mention Award in the International Astronomy and Astrophysics Olympiad held in Beijing, China in October 2010.

Republic of Moldova

[Original: English]
[4 November 2010]

The present report was prepared by the Technical University of Moldova Institute of Electronic Engineering and Industrial Technologies of the Academy of Sciences of Moldova and entitled “Aerospatial activities in Programme’s framework. Exploitation of renewable energy resources in conditions of the Republic of Moldova and the development of Moldavian Microsatellite”.

1. Introduction

Land surface exploration is an area that is growing rapidly and the number of space images users is very large: in agriculture, geodesy and cadastre, ecology and environmental monitoring. The application of research/monitoring methods of captured images plays an important role in the national economy, but the high cost of images from space does not allow all users to benefit from these results. The high cost and the quality of these images is determined by many factors, both physical and technical, as well as by methods and processes of capturing images. Therefore, with the goal to provide solutions for the existing important problems of the

national economy, the Academy of Sciences of Republic of Moldova decided to promote some projects emerging in the space technology in the framework of the "Exploitation of renewable energy resources in the conditions of Republic of Moldova and development of Moldovan Microsatellite" programme.

In 2007-2009, the following projects were ongoing:

(a) Investigation and development of navigation and control systems for the microsatellite;

(b) Development of microsatellite stabilization, orientation and attitude control systems;

(c) Development of microsatellite electrical power supplying system;

(d) Development of video-monitoring and distance Earth observation system;

(e) Development of materials, structures (including nanotechnologies) and electronic devices for operation in extreme cosmic conditions";

In 2010, the following projects were ongoing:

(a) Development of materials, structures (including nanotechnologies) and electronic devices for operation in extreme cosmic conditions;

(b) Microsatellite orientation, stabilization, navigation and electrical power supplying systems;

(c) Orientation and stabilization methods on capturing images from long distances associated with real-time coding, compression, protection and transmission.

These projects are in concordance with the national priorities concerning the electronic data processing for cadastral use; for landslides forecast; for predicting the formation and movement of hail clouds; for monitoring the land lots; for the ecological monitoring of forests and aquatic evolution of the rivers and lakes, flood damages, hydrological services and others

2. General objectives of the project

The projects objectives are the development of microsatellite in order to analyze the orbit parameters, to make improvements in the satellite control, to test the on-board computer (research the algorithms for the satellite orientation and stabilization; realization of control algorithms of the satellite system status); to test the basic components of the computer; and, finally, to carry out research on the technologies of Earth observation aiming at the obtaining of information about the land surface of the Republic of Moldova, in particular. Another important objective is to conduct, encourage and promote the R&D in the field of space technology and contribute to the industrial development of the Republic of Moldova.

3. Microsatellite control and navigation systems

The navigation system is needed to ensure radio communication with the microsatellites in two-band radio carrier frequencies in both directions; to control the work of a multi-spectral scanner from the orders of the terrestrial station and of

the on-board computer on the basis of the navigation satellites GPS and GLONASS in any combination. The project ,,Investigation and development of navigation and control systems for the microsatellite" is implemented by the research team from the Faculty of Radio electronics and Telecommunications. The on-board computer was designed to control the power and the satellite's multispectral scanner, to ensure the monitoring and the control systems' functioning, to maintain the thermal regime, to ensure the measurements of telemetry system interactions, to supply with power all the systems of the microsatellite and to ensure communication with the non-oriented microsatellite or with other orientation problems. The following results have been obtained:

(a) Principle electric diagram of the onboard computer, which includes basic devices;

(b) Automatics and communication modems;

(c) Operating programs for the microcontrollers of the onboard computer;

(d) Electrical schemes of the emission-reception devices;

(e) Electrical schemes of the telemetric system;

(f) The operating model of the satellite navigation system;

(g) The operating model of the satellite control system.

4. Power supply system of the microsatellite

The power supply system of the satellite is intended at the generation, storage, distribution and regulation of electricity in all phases of the satellite operation on the orbit under cyclic programmes. The project ,,Development of microsatellite electrical power supplying system" was undertaken by the research team from the Faculty of Energetics.

A number of autonomous electric power supply systems have been developed on the basis of photovoltaic panels with different power converters.

Simultaneously, a whole series of devices developed by the Institute of Electronic Engineering and Industrial Technologies of AS RM (IIETI) was adapted in this project in terms of digital signal processing and the experience can serve as a basis for the implementation of a number of items for the collection and processing of data from spatial digital devices. Thus, technical solutions have been proposed, the design and execution of mock demonstrational elements for stabilized voltage converter correlated with the selection of the satellite solar battery panels was carried out. The constructive ways of schema-technical operating performance in extreme conditions have been established. They laid down the design and engineering features of the full device.

5. Microsatellite orientation and stabilization

The project "Development of microsatellite stabilization, orientation and attitude control systems" envisages the design of conceptual diagram of the control, orientation and regulation mechanism based on the using of systems for attitude control (solar transducers, magnetometer) and for the realization of orientation motions (electromagnetic coils, pitch flywheel); design of control, orientation and

regulation system for satellite flying trajectory (SDOSM) based on the interaction with the magnetic field of the Earth; design, research and simulation of SDOSM parts: magnetometer, solar transducer, mechanism for rectangular orientation with three degrees of liberty correlated isochronously with the three parts of the magnetic induction vector; mechanism of operational orientation with pitch flywheel; inertial mechanism for passive operation and regulation of flight; determination of functional characteristics of SDOSM parts; modelling of orientation-regulation system functioning.

The research team of the Department of Theory of Mechanisms and Machine Parts, involved in the implementation of this project, has experience of various researches on developing separate systems of driving mechanisms for the orientation and management of devices based on cosmic planetary transmissions of high. These proposed electromechanical modules present special constructions with high-accuracy planetary transmission and with the formation of special transducers for precise positioning of the space flight apparatus or of the basic units. In order to reduce the production costs and weight, and increase the efficient operation under insufficient lubrication, the authors have developed two modules with electromechanical high accuracy gears and sliding bearings, made of plastic. These modules have electromechanical constructive simplicity, satisfactory performance compared with the planetary transmission and harmonic dimensions, low weight and a low production cost.

In the near future at the Technical University of Moldova will be released the special stand for testing in vacuum conditions the orientation, stabilization and control microsatellite's attitude.

6. Earth observations, video monitoring and telecommunications

The remote Earth observations from the satellites and the distribution of the remote-sensing data should help to solve very important problems. Therefore, this project "Development of video-monitoring and distance earth observation system" is the central project of aerospatial "Moldavian Microsatellite" programme. This project is promoted by the Centre for Space Research at the Technical University of Moldova. The system of video monitoring and telecommunications of microsatellite was developed on the basis of multicolour CMOS image sensor to ensure the exploring of the Earth's remote area with a resolution of 10-:-15m. It was decided that the system must be endowed with a multi-spectral scanner, which allows research of the land surfaces in the visible and infrared ranges. Certainly, the remote sensing with portable ground stations and low-cost space systems has an important role. A key feature of the space system is directly down-linking to one or numerous small ground stations, excluding the need for a centralized processing and a distribution system. The advantages are real-time access to observations, smaller databases and ease of information distribution, even in areas not well served by communications systems.

7. Construction materials and microsatellite reliability

The project "Development of materials, structures (including nanotechnologies) and electronic devices for operation in extreme cosmic conditions" is provided under the leadership of academician Kantzer Valery,

Institute of Electronic Engineering and Industrial Technologies (IIETI) of Academy of Sciences of the Republic of Moldova.

The main objectives of this project are:

(a) Research and development of new materials and elements of spatial devices and terrestrial station building blocks of MS;

(b) Design and implementation of verification stands in extreme elements apparatus MS;

(c) Development and adaptation of developing materials and devices of IIETI, previously performed for other uses, for spatial devices, connected to technical requirements and operating in extreme cosmic conditions.

This project is composed of the following directions of investigation. First, there is a series of works previously performed in IIETI, including some work related to missile equipment and cosmic technology. It can also be mentioned the important aspect of the institute profile, concerning the investigations of materials properties at cryogenic and ultra low temperatures. Another aspect is part of the wide range of IIETI concerns in electronic devices and sensors, including the collection and processing of digital information.

8. The scientific results, implementation and the beneficiaries

The presented programme will contribute to the education of youth and renewal of student scientific and industrial potential of the Republic of Moldova; it will create a liaison between the students and the research laboratories and industrial sectors; attract young inventors; create new jobs; preserve the intellectual potential of the country; develop scientific and technical directions of the national economy in the Republic of Moldova; contribute to the professional orientation of pre-university graduates.

Besides educational, scientific and technical problems, this programme will allow to solve a number of concrete problems of the national economy of the Republic of Moldova: to realize the territory monitoring in order to measure soil moisture; to estimate cultivated agricultural land; to monitor and evaluate the degree of crop maturation; to perform various cadastral works; to monitor roads; to monitor forests, rivers and lakes; to determine the extent of the river's overflow, to set the danger of ice clouds appearance; to obtain photo and video information for the country districts of interest, etc. The scientific, technical and instructive potential of the country and its world authority is determined by the possibility of realization of advanced technology and science-intensive projects.

The economic aspects of realizing such a complex project is very difficult to estimate. Monitoring the territory of the Republic of Moldova will permit in the future to:

(a) Obtain high-accuracy images for cadastral works;

(b) Receive information about the cultivated agricultural lands (land area treated, and the degree of ripening of agricultural production, the quantity of harvest, setting the level of soil humidity);

(c) Conduct environmental monitoring of regions;

(d) Oversee the processes of formation of clouds with the threat of hail and security services against hail, for the future.

At present the cost of providing these types of services on the world market arrives at values of up to several thousands USD. This instructive-educational project will help develop professional customs for students; will ensure continuous contact between science and the manufacturing industrial domains; it will also increase the youth creativity and will allow creating new jobs, preserve the country's intellectual potential and will be based on new scientific and technical fields in Moldovan agriculture. It will contribute to the guidance of graduates of pre-university educational institutions.

9. International cooperation in the framework of aerospace issues

At this phase of the programme and with account of the subsequent development cooperation relations will be expanded with several universities of the EU, Germany, Romania and Russia, where similar projects have been performed. The following cooperation activities in the framework of this programme can be described: Participation of our collaborators in regional and international conferences is one of the priority activities. In the last year our delegation: academician Ion Bostan, professors Dulgheru Valeriu, Secrieru Nicolae and Bostan Viorel participated in the CRAS 2009 conference in Bucharest, Romania. Besides this conference's works, we had several meetings with other delegations. For instance, Academician Ion Bostan, Head of the Moldovan aerospatial programme has discussed with Chris de Cooker, Head of the ESA International Relations Department about the future cooperation and involvement of Moldovan researchers in the ESA aerospatial programmes. Academician Ion Bostan and Marius-Ioan Piso, director of ROSA - Romanian Space Agency and the University "Polytehnica" of Bucharest have discussed about an agreement of bilateral cooperation promoting international relations in the field of high technologies. The main areas of cooperation include the development of small satellites and ground control systems for satellites.

It was established that we have similar needs at regional level that demand some new solutions. For instance, we are ready to coordinate the satellite programmes to address our specific needs and other developing areas that require special capabilities related to sensor parameters, such as specific spectral bands, spatial resolution, time resolution, cost of image, autonomy and investment level in ground equipment, and the expertise required for their utilization.

Another field of cooperation is the exchange of experience in image data collection and processing for the purpose of monitoring the flood damages in our region and for the agricultural applications. The research team from Technical University of Moldova together with team of the Institute for data communications systems from the University of Siegen (Germany) works on the common project "Orientation and stabilization methods on capturing images from long distances associated with real time coding, compression, protection and transmission". To improve our experience in telecommunications, these problems have been discussed with Professor Doctor Karl Cristoph Ruland, Head of Institute for data communications systems. It was decided to cooperate on the common problem, that is rather actual, because the application of research/monitoring methods on captured images plays an important role in telecommunications and data processing, but the

high cost of the space images does not allow all users to benefit from these results in the exploring of the land surface in agriculture, geodesy and cadastre, ecology and environmental monitoring. Highly-qualitative images can be achieved with objective lenses with a big focal distance and with a high-resolution, which are installed on large aircrafts (satellites, orbital stations, aircrafts), but afterwards the cost of these images increases. Another situation is the case of small aircrafts on which high-quality objective lens can not be installed. This, however, lowers the quality of images if the problem would be treated traditionally. Important factors affecting the quality of images are not only lens parameters, but the dynamics of aircraft movement, lack of stability, object orientation, that results in essential distortion of captured images. Often, to get a result it is required to repeat the operations, which is not always possible.

It is proposed to solve the problem of capturing images complexly by using light aircrafts, applying new technologies, methods and processes of orientation and stabilization of the aircraft, simultaneously capturing images, and compressing, codifying and transmitting data in real time to the recipient. This will increase the quality and will reduce the total cost of images. As a result, the images will be obtained without distortion, with a much smaller volume, coded in order to protect them and sent to recipients.

Representative of our team, Vladov Mihail from the Centre for Space Research of the Technical University of Moldova, made a presentation at the Conference "Scientific and technical centre of spatial missiles" in Samara, Russia, and has concluded an agreement of cooperation. The protocol of intention on scientific and educational cooperation in the field of aerospace activities between Samara State University and the Technical University of Moldova includes:

(a) Implementation of joint research and development work in the aerospace field;

(b) Participation in the development and implementation of joint projects in the field of scientific-educational small satellite, including remote sensing of the Earth;

(c) Contribution of interuniversity exchange of students and university teachers to integrate into the international educational space;

(d) Joint participation in organizing and conducting conferences and seminars on topics of interest to both parties.

Also, there is an agreement between our Centre for Space Research of the Technical University of Moldova and the Institute for Space Research, Bulgarian Academy of Sciences, concerning bilateral cooperation and promoting of international relations in the field of high technologies. The main areas of cooperation include the development of small satellites and ground control systems of satellites.

Other representatives of our team, Bodean Ghenady and Blaja Valery participated in the United Nations/Austria European Space Agency Symposium on Small Satellite Programmes for Sustainable Development 21-24 September 2010, where they have established relations with researchers from many countries.

Conclusion

The programme “Moldovan Satellite” is at an early stage, but a number of promising results have been obtained for the successful implementation of this programme. We hope to cooperate with other countries in developing this instructive-educational programme, that will help to develop the professional skills of the students, will ensure continuous contact between science and the manufacturing industrial domains, it will also increase the interest of youth creativity and will allow creating new jobs, preserve the country’s intellectual potential and will constitute a basis for new scientific and technical fields.

Russian Federation

[Russian]
[13 December 2010]

1. Introduction

The national activities of the Russian Federation in 2010 in the use of outer space for peaceful purposes were carried out by the Russian Federal Space Agency (Roscosmos) under the Russian Federal Space Programme, the Global Navigation Satellite System (GLONASS) special federal programme and other special programmes, in cooperation with the Russian Academy of Sciences, the Ministry of Defence of the Russian Federation and other clients and users of space information and services.

As at 1 October 2010, the Russian Federation carried out 23 carrier rocket launches. A total of 30 space objects (20 Russian space objects and 10 space objects belonging to other countries) were launched.

The following Russian space objects were launched:

(a) 2 manned Soyuz TMA spacecraft (Soyuz TMA-18 and Soyuz TMA-19);

(b) 4 unmanned Progress-M cargo vehicles (Progress M-04M, M-05M, M-06M and M-07M);

(c) 1 communications satellite (Gonets-M);

(d) 1 Tekos experimental satellite;

(e) 6 Glonass-M satellites;

(f) 1 Globus-1 communications satellite;

(g) 5 Cosmos satellites (Cosmos-2462, Cosmos-2463, Cosmos-2467, Cosmos-2468 and Cosmos-24xx).

The following space objects were launched on behalf of foreign clients: Intelsat 16, EchoStar 14 (United States of America), CryoSat-2 (European Space Agency (ESA)), AMC-4R (SES-1) (United States of America), SERVIS-2 (Japan), Arabsat 4B, Prisma (Switzerland), Picard (France), TanDEM (Germany), EchoStar 15 (United States of America).

A total of 20 space objects were launched by 16 carrier rockets from the Baikonur launch site. Seven space objects were launched by five carrier rockets

from the Plesetsk launch site. Three space objects were launched in two launches from the launch silo at the Dombarovsky launch base (Orenburg region). Russian module of the International Space Station (ISS) (Mini-Research Module 1 — Rassvet ("Dawn")) was launched aboard United States space shuttle Atlantis STS-132, a reusable space transportation system, in May 2010.

2. Main results

(a) Manned flight programme

In 2010, the Russian Federation, in accordance with its international obligations regarding the development and operation of the International Space Station (ISS), launched two manned Soyuz TMA spacecraft and four unmanned Progress-M cargo spacecraft, controlled and tracked the flight of the Russian segment of the ISS and implemented a planned programme of research and experiments.

(b) Programmes on space technology applications

Space communications, television transmission and navigation

The orbital network for space communications, television transmission and navigation includes the following space objects: Ekspress-A, Ekspress-AM, Ekspress-MD1, Yamal-100, Yamal-200 (communications, television), Ekran-M, Bonum-1 (television channel NTV), Gonets-D1, Gonets-M (communications), Glonass and Glonass-M.

In 2010, work continued within the framework of the special federal programme GLONASS to support, develop and use the GLONASS system, including the construction of new-generation satellites with improved performance characteristics.

As of 1 October, there are 21 Glonass satellites in the orbital network, on three orbital planes. The system provides coverage of 98 per cent in the Russian Federation and 87 per cent globally.

It is expected that by the end of 2010, no fewer than 24 satellites will be operating on a continual basis in the GLONASS network and test flights of the new-generation GLONASS-K satellite with additional new navigation signals will begin.

Within the framework of the activities of the International Committee on Global Navigation Satellite Systems (GNSS), established at the initiative of the United Nations, and of cooperation with experts from other countries, work is being undertaken to define the principles governing the compatibility and complementarity of all existing and emerging satellite navigation systems. The results of this work are being taken into account in determining how best to modernize GLONASS in order to ensure global access for all users.

Remote sensing of the Earth, meteorological observations, environmental monitoring and natural disaster management

In the Russian Federation, hydrometeorological and natural resource satellites are used in environmental monitoring, research and socio-economic applications.

The Russian Federation's two-tier hydrometeorological system for remote sensing of the Earth involves the use of Meteor and Elektro hydrometeorological satellites.

Currently, the satellites Resurs-DK1, Monitor-E and Meteor-M1 are in orbit. Work is nearing completion on the development of new-generation hydrometeorological satellites (Elektro-L1 geostationary satellites).

The Resurs-DK1 satellite obtains remote sensing data for the purposes of:

(a) Creating records of land resources;

(b) Thematic mapping of land;

(c) Monitoring of emergency situations and assessment of their consequences;

(d) Geological mapping and mineral exploration;

(e) Monitoring and control of the state of forests and agricultural crops and harvest forecasts;

(f) Monitoring and control of land development and irrigation;

(g) Monitoring and control of ice and snow cover over inland water bodies;

(e) Environmental monitoring.

In order to achieve the most comprehensive possible monitoring of the environment, work is under way to establish and build up a system of specially designed space facilities for that purpose within the framework of the Federal Space Programme (FKP-2015). The following will shortly become operational:

(a) Geostationary meteorological satellites (Elektro-L) for the observation of large-scale processes in the atmosphere and on the Earth's surface in the tropics;

(b) Polar-orbiting meteorological satellites (Meteor-M) at relatively low altitudes (800-1,000 km) for the global integrated observation of the atmosphere and the Earth's surface;

(c) Real-time optico-electronic observation satellites (Resurs-P and Resurs-PM);

(d) Satellites for oceanographic monitoring (Meteor-M3);

(e) Observation satellites using high-precision radiolocation for all-weather surveying of the Earth (Arkon-2M);

(f) Satellites for the monitoring of disasters and the investigation of potential earthquake precursors (Kanopus-V);

(g) High-precision observation satellites for cartographic purposes.

Work is in progress to set up the multi-purpose space system Arktika, which will include radiolocation observation satellites and hydrometeorological satellites for observation of the Arctic region.

In 2010, work continued on developing the main Earth remote sensing information centre. New stations for receiving, processing and storing data are being set up and a data collection system for Eurasia has been launched.

Natural disaster management using space technology

One of the priority areas of the space activities of the Russian Federation involving Earth remote sensing is the development of space technologies and information support for natural disaster management, including:

(a) The forecasting, continuous and near-continuous monitoring, detection and tracking of hazardous phenomena in the atmosphere and at sea (such as hurricanes, gales, typhoons and ice formations) using data obtained in various regions of the optical and radio (ultra-high-frequency) ranges of the electromagnetic wave spectrum from Meteor and Elektro satellites;

(b) The monitoring, detection and tracking of floods using data from Meteor and Resurs-DK1 satellites (new space technologies for the provision of information to facilitate natural disaster management are to be developed and applied);

(c) The detection and tracking of forest fires that cover an area of more than 40 hectares, using the smoke plume and data from Meteor-M and Resurs-DK1 satellites obtained in the visible and infrared ranges of the electromagnetic wave spectrum.

(c) Space research programmes

During 2010, the Russian space sector participated successfully in foreign projects in the area of basic space research. The main results of space research were obtained during observation programmes conducted on board the International Gamma-Ray Astrophysics Laboratory (INTEGRAL) of ESA.

Research continued on cosmic rays and corpuscular flows within the framework of the Russian-Italian Mission (RIM) Payload for Antimatter Matter Exploration and Light-nuclei Astrophysics (PAMELA) project. The recorded number of antiprotons and positrons exceeds by an order of magnitude any other figure established by global statistics in that area to date.

In the field of planetology, studies of Mars and Venus were continued using Russian instruments (the Planetary Fourier Spectrometer (PFS), the Ultraviolet and Infrared Atmospheric Spectrometer (SPICAM), OMEGA Visible and Infrared Mineralogical Mapping Spectrometer, Analyser of Space Plasma and Energetic Atoms (ASPERA), High Resolution Stereo Camera (HRSC) and MARSIS Sub-Surface Sounding Radar Altimeter) on board the European spacecraft Mars Express and Venus Express. Further research of the planets' surface and atmosphere was carried out and the data obtained are being processed and analysed.

Work continued on board the American Mars Odyssey spacecraft to detect and localize subsurface aqueous ice on Mars using the High Energy Neutron Detector (HEND) instrument complex, which the Russian Federation helped to develop (HEND makes it possible to register fast neutron flows from the surface of Mars caused by the action of solar winds). It is planned to continue the research during further experiments on board the Lunar Reconnaissance Orbiter of the National Aeronautics and Space Administration (NASA) of the United States, using the Lunar Exploration Neutron Detector (LEND).

In 2010, Russian and European experts continued to process the results of the scientific experiments carried out during the flight of the Russian unmanned spacecraft Foton-M3.

A major programme of research on zero gravity physics, space materials science, space biotechnology and space biology was carried out.

(d) International cooperation

In 2010, Roscosmos contributed to the following main areas of international cooperation in the study and use of outer space for peaceful purposes:

(a) The launch of foreign payloads using Russian facilities;

(b) The construction of launch facilities and adaptation of Soyuz-ST carrier rockets for launch from the Guiana Space Centre, in cooperation with ESA, France and a number of European space enterprises;

(c) Cooperation in constructing advanced facilities for the future launch of heavy payloads (Ural project);

(d) Partnership in the construction and operation of the International Space Station and in scientific research on board the Station;

(e) Cooperation in the development of new materials, bioproducts and other substances under microgravity conditions (using Foton-M satellites; the next launch of a Foton-M spacecraft is planned for 2013);

(f) Establishment of a Spektr-R X-ray observatory, with the extensive cooperation of foreign partners (ESA, the German Aerospace Center (DLR) and NASA);

(g) Fulfilment of the Russian Federation's commitments to COSPAS-SARSAT (Sterkh spacecraft; one satellite is currently undergoing test flights; the second is being prepared for launch in the near future).

In order to foster international cooperation, inter alia within the framework of facilitating implementation of the resolution entitled "The Space Millennium: Vienna Declaration on Space and Human Development", adopted by the Third United Nations Conference on the Exploration and Peaceful Uses of Outer Space (UNISPACE III), the Russian Federation proposes the following activities:

(a) Carrying of payloads manufactured by other countries on Russian Meteor and Resurs satellites;

(b) Carrying of Russian scientific instruments on board foreign satellites within the framework of such projects as the NASA Lunar Reconnaissance Orbiter (the LEND instrument) and the Mars Science Laboratory (the Dynamic Albedo of Neutrons (DAN));

(c) Participation of the Russian Federation in the Global Monitoring for Environment and Security (GMES) programme and that of the Group on Earth Observations (GEO) (global monitoring of conditions in near-Earth space, the atmosphere, the Earth's land surface and water resources, and forecasting and monitoring of natural and man-made disasters, including monitoring of forest fires

and forecasting of earthquakes and other emergency situations, using Meteor-M, Resurs-DK and other satellites);

(d) Participation of the Russian Federation in the implementation of the Global Earth Observation Systems of Systems (GEOSS) 10-Year Implementation Plan;

(e) Participation in the work of the International Committee on Global Navigation Satellite Systems (ICG), which was set up as an unofficial body to promote cooperation on matters of mutual interest related to civilian satellite-based positioning, navigation and timing services, commercial services and the compatibility and interoperability of ICG systems.

Proposals have been drawn up for the Russian Federation to join the International Charter "Space and Major Disasters", which provides for the coordination of Earth observation and the exchange of data and information in the event of natural or man-made disasters.

Operation of the ISS as a permanently manned facility continued in 2010. Since 2009, the Station's international crew has increased to six persons. The Russian Federation, in addition to enhancing its segment of the Station and conducting a variety of scientific experiments aboard that segment while at the same time fulfilling its international obligations, uses manned Soyuz spacecraft and Progress cargo spacecraft to maintain and service the ISS and ensure the safety of the crew in the event of emergency situations.

A plan for the further development of the Russian segment of the ISS is under implementation. In 2009 and 2010, two mini research modules were put into operation. A multi-purpose laboratory module is to be launched in 2011. In light of the decision taken by the heads of ISS partner agencies to extend the operation of the ISS until 2020, Roscosmos invites all interested partners in space activities to take part in conducting research and experiments aboard the Russian segment of the ISS.

The Russian Federation has the necessary range of facilities of proven reliability for the launch, at various inclinations, of payloads weighing from several hundred kilograms to 20 tons into near-Earth orbits. The Soyuz (Soyuz-2) and Proton (Proton-M) carrier rockets have been upgraded and work is under way to develop future launch vehicles, including the Angara family of carrier rockets. For light satellite launches, Dnepr carrier rockets — and in some cases Sterkh and Rokot carrier rockets — are used.

To date, the Russian Federation has concluded numerous international agreements on cooperation in the exploration and use of outer space, including 42 inter-agency agreements signed by Roscosmos on joint space projects, launching methods and other areas.

(e) Space debris

Work on resolving the problems of space debris is included in several sections of the Federal Space Programme of the Russian Federation for the period 2006-2015.

Russian developers and operators of spacecraft and launch vehicles are subject to the requirements of the National Standard of the Russian Federation GOST R 52925-2008, entitled “Space technology: General requirements for space facilities to mitigate the man-made pollution of near-Earth space”. The Standard has been brought into line with the provisions of the Space Debris Mitigation Guidelines of the Committee on the Peaceful Uses of Outer Space (COPUOS).

The principal measures to mitigate space debris applied to Russian carrier rocket stages, boosters and satellites in 2010 included the following:

(a) Full elimination of the possibility of structural components, parts and fragments from Breeze-M, DM-2 and three-stage Soyuz-2 carrier rockets being discarded in space;

(b) Selection of justified design features for the structural components of spacecraft and installation of meteorite shields on high-pressure units in order to prevent their rupture and destruction (Monitor-E, Resurs-DK1, Resurs-P, Spekr, Elektro-L, Bion-M and Breeze-M);

(c) Replacement, aboard the Ekran satellite, of batteries that use silver-cadmium accumulators — which are vulnerable to destruction as a result of explosion caused by the gases that they produce — with nickel hydrogen batteries;

(d) Elimination of intentional break-ups on all carrier rockets, boosters and satellites commissioned by Roscosmos;

(e) Depressurization of the fuel tanks of boosters following their transfer to a disposal orbit;

(f) Burning off of fuel remnants from the propulsion unit of the launch system following separation of the space object and the discharging of on-board accumulator batteries, and removal of reaction wheels, gyroscopes and other mechanical devices;

(g) Removal of fuel remnants under high pressure and discharging of chemical power sources on Ekspress-AM and Gonets satellites;

(h) Following completion of the flight mission of the Fregat booster, removal of the booster from orbit with subsequent splashdown in a predetermined location in the Pacific Ocean;

(i) Movement of Earth remote sensing satellites of the “Monitor” series following completion of mission from operational orbit to a lower orbit that ensures deceleration of the space object and burn-up in the atmosphere;

(j) The design features of the Sterkh satellites ensure less time in orbit owing to modification of the configuration of solar panels and other moving surfaces.

In the Russian Federation, work is being carried out to define the parameters of the space debris model (space debris prediction analysis) more precisely using compiled experimental data, to forecast man-made pollution of near-Earth space by establishing possible future scenarios of such pollution during the period from 2025 to 2030 and in the longer term up to 2110 and to compare the results obtained with the corresponding results obtained by foreign models.

An important factor in dealing with the problem of space debris is to establish an inventory of the objects polluting near-Earth space within the geostationary orbit. To that end, the Keldysh Institute of Applied Mathematics of the Russian Academy of Sciences has organized an international network of observatories — the International Scientific Optical Observation Network (ISON) — to make astrometric and photometric observations, as a result of which it has been possible to record objects throughout the geostationary orbit. By the beginning of 2010, ISON facilities were tracking 1,467 objects in geostationary orbit (compared to the 1,016 objects on which data is provided by the space surveillance systems of the United States of America), including 892 satellites (391 operational and 501 non-operational), 250 carrier-rocket stages, boosters and apogee kick motors.

At the Keldysh Institute of Applied Mathematics of the Russian Academy of Sciences a system for the prediction of near-collisions in the geostationary orbit using ISON measurements has entered into pilot operation and the first forecasts have been issued at the Mission Control Centre of the Central Engineering Research Institute.

(f) Near-Earth objects

The main activities carried out as part of research on the problem of preventing collisions of asteroids and comets with the Earth include:

(a) Timely detection and monitoring of the movement of potentially dangerous celestial bodies;

(b) Determination of the characteristics of such bodies and timely risk assessment;

(c) Selection of methods and measures for actively influencing near-Earth objects, or development and implementation of other measures to reduce the risk to the population.

In order to ensure that the above-mentioned tasks are carried out, a space segment comprising facilities for the detection and tracking of dangerous objects may be created, the work of which would ensure improved quality of forecasts; advanced unmanned spacecraft may be used to study dangerous small celestial bodies at close range and to install beacons aboard spacecraft located in companion orbits near celestial bodies or on their surface. In addition, measures have been taken to actively influence celestial bodies that pose a threat to the Earth and to reduce the risk of their collision with the Earth.

Any measures to mitigate such threats would require the coordination of international efforts and expansion of the base of knowledge of the properties of near-Earth objects through the use of spectrographic analysis and near-Earth object fly-bys and landings.

The Russian Federation supports and is participating in the implementation of the recommendations of the Scientific and Technical Subcommittee of COPUOS regarding the continuation of work in this area under the workplan for 2011, which envisages the expansion of joint activities to observe and analyse near-Earth objects at the national and international levels, the improved coordination of observations, the development of mechanisms for international cooperation and interaction in conducting observations and the establishment of a methodology for the

development of procedures relating to the prevention of the threat at the international level.

Two international conferences on the threat to Earth posed by asteroids and comets have been held in the Russian Federation, organized by the Institute of Astronomy (Kazan, 21-25 August 2009) and the Institute of Applied Astronomy (Saint Petersburg, 21-25 September 2009) of the Russian Academy of Sciences. The results of research conducted in the above-mentioned areas were discussed at the two conferences.

Roscosmos has drawn up proposals for the use of space telescopes to observe asteroids and comets in space.

Roscosmos agencies are currently examining the scientific and environmental aspects of implementation of the following proposals:

(a) The mission of a Russian spacecraft similar to Phobos-Grunt to the asteroid Apophis with the aim of increasing the precision of predictions of the asteroid's "close encounters" with the Earth in 2036 and subsequent years, and research on the asteroid's physical and chemical characteristics;

(b) The construction of space telescopes capable of guaranteeing the detection and high-precision definition of the trajectory parameters of small (similar in size to the Tunguska meteorite) hazardous celestial bodies that cannot be detected using ground-based telescopes, and also for the high-precision calculation of Apophis' orbit.

(g) Space weather

The Russian Federation has more than 20 years of experience in conducting observations of and research on space weather phenomena. The Applied Geophysics Institute of the Federal Service for Hydrometeorology and Environmental Monitoring (Roshydromet) is both the main national centre for space weather forecasts and the European regional centre for reporting on space weather. Instruments for the observation of space weather operate on Russian Resurs-DK satellites and on the hydrometeorological satellite Meteor-3M, which was launched in 2009. In addition, a geophysical system of instruments is being installed on advanced Elektro satellites and in the Arktika space system.

Work has been stepped up in the Russian Federation to establish a system for monitoring the heliosphere and the Earth's atmosphere, consisting of ground-based and space-based segments.

The space-based segment comprises five satellites aboard which, inter alia, the following equipment is to be installed: radiophysical systems that use a wide range of frequencies (ionosondes) for monitoring the state of the ionosphere; equipment for the measurement of ionizing radiation; a system to monitor magnetic and wave activity; a dual-frequency transmitter of radio signals at frequencies of 150 to 400 MHz; GPS receivers; and a diagnostics system to monitor solar activity.

The new system will include a ground-based complex for receiving, processing and distributing information.

The deployment of the system will make it possible to perform tasks relating to the monitoring of and response to natural and anthropogenic effects on the upper atmosphere, the ionosphere and near-Earth space.

The incorporation of the system in existing ground-based networks of measuring instruments will significantly increase the effectiveness of the overall system for the monitoring and forecasting of space weather.

(h) Nuclear power sources in outer space

Work in the Russian Federation to ensure the safe use of nuclear power sources in space is currently being carried out in the context of a project to construct a transport energy module with a megawatt-class nuclear propulsion system, implementation of that project having begun in 2010. The following international documents are being used in connection with that work as the main guidelines for ensuring safety:

(a) Principles Relevant to the Use of Nuclear Power Sources in Outer Space;

(b) Safety Framework for Nuclear Power Source Applications in Outer Space.

The transport energy module, which contains a nuclear power facility and an electrically powered cruise propulsion system fed by that facility and is intended to propel the space object and supply power to all its systems, is being developed in full conformity with the relevant United Nations documents.

In connection with the development of the transport energy module and in accordance with the provisions of the relevant international documents, national regulatory documents such as the General Regulations governing the Safety of Nuclear Propulsion Systems, the Regulations governing the Nuclear Safety of Nuclear Power Reactor Facilities aboard Unmanned Spacecraft and the Regulations governing the Radiation Safety of Nuclear Power Sources in Space are currently being prepared in the Russian Federation with due regard to the provision of the Safety Framework for Nuclear Power Source Applications in Outer Space that states that “activities occurring during the terrestrial phase of space NPS applications, such as development, testing, manufacturing, handling and transportation, are addressed in national and international standards relating to terrestrial nuclear installations and activities”.

Organizations that use nuclear power sources in space strive to achieve the fundamental goal of ensuring safety by complying fully with the relevant governmental and intergovernmental directives, requirements and procedures. The measures necessary to ensure such compliance in carrying out the transport energy module project have been implemented, including the establishment of a working group on regulatory documents relating to the nuclear and radiation safety of megawatt-class nuclear propulsion systems, the group comprising experts in that subject from all agencies participating in the project. The design and development processes thus ensure the highest possible level of safety. Information is provided to the public in a timely manner through the mass media.

The recommendation to ensure the highest level of safety that can reasonably be achieved, as contained in the Safety Framework for Nuclear Power Source Applications in Outer Space, is reflected in the selection of the height of the initial

orbit for the transport energy module, aboard which the nuclear reactor is being installed. As is known, the lower the initial orbit, the more effective the use of nuclear power sources. According to the Principles Relevant to the Use of Nuclear Power Sources in Outer Space, the use of nuclear power sources in low Earth orbits is permitted provided that those sources are stored in sufficiently high orbits after the operational part of their mission). In such cases, a highly reliable operating system should be used to ensure the effective and controlled removal of the reactor to the sufficiently high orbit. However, the use of such a system reduces the level of safety. For that reason, at the current stage of design of the transport energy module, a sufficiently high orbit has been chosen as the initial orbit and as the orbit to which the transport energy module may return when operating in orbital transfer mode. Thus, safety has been given priority over effectiveness.

Following completion of the mission or in the event of an emergency situation, the reactor of the nuclear propulsion system will be brought to a subcritical state using the corresponding system, in line with the requirement set out in the Principles Relevant to the Use of Nuclear Power Sources in Outer Space that safety systems should be designed, constructed and operated in accordance with the general principle of defence in depth. Pursuant to that concept, foreseeable safety-related failures or malfunctions must be capable of being corrected or counteracted by an action or a procedure, possibly automatic. The reliability of systems important for safety is ensured, inter alia, by redundancy, physical separation, functional isolation and adequate independence of their components. The construction of the reactor for the nuclear propulsion system of the transport energy module complies fully with these principles.

The requirement established in the Principles Relevant to the Use of Nuclear Power Sources in Outer Space that the sufficiently high orbit must be such that the risks of collision with other space objects are kept to a minimum will also be met. In addition, the construction design of the reactor facility of the transport energy module will be selected on the basis of its resistance to damage caused by micro-meteorites and fine fragments of space debris.