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Committee on the Peaceful Uses of Outer Space

International cooperation in the peaceful uses of outer space: activities of Member States

Note by the Secretariat

Addendum

Contents

I. Introduction

1. In accordance with the recommendations of the Committee on the Peaceful Uses of Outer Space at its fifty-fourth session,[1] Member States have submitted annual reports on their space activities. In addition to information on national and international space programmes, the reports could include information on spin-off benefits of space activities and other topics as requested by the Committee and its subsidiary bodies.

2. The information submitted by Member States as at 30 November 1999 is contained in document A/AC.105/729. The information submitted by Member States between 1 December 1999 and 25 January 2000 is contained in document A/AC.105/729/Add.1. The present document contains information submitted by Member States between 25 January 2000 and 7 February 2000.

[1] *Official Records of the General Assembly, Fifty-fourth Session, Supplement No. 20* (A/54/20), para. 119.

II. Replies from Member States

Russian Federation

[Original: Russian]

1. The space activities of the Russian Federation in 1999 were conducted under the Federal Space Programme and also as part of international cooperation programmes.

2. The activities were carried out by the Russian Space Agency (RSA) (in collaboration with the Russian Academy of Sciences), the Ministry of Defence, the Ministry for Emergency Situations, the State Committee on Telecommunications, the Federal Geodesic and Cartographic Service, the Federal Hydrometeorological and Environmental Monitoring Service and other clients and users of space information and services.

3. In the course of the year, the Russian Federation carried out 26 space launchings, as a result of which 46 space objects were put into orbit: 14 of them were Russian (one manned spacecraft of the Soyuz TM series (Soyuz TM-29), two unmanned cargo spacecraft of the Progress series (Progress M-41 and Progress M-42), four satellites of the Cosmos series (Cosmos-2365 and Cosmos-2368), one satellite of the Molniya-3 series, one satellite of the Resurs-F1M series, one satellite of the Raduga-1 series, one satellite of the Foton series, two satellites of the Yamal-100 series and one satellite of the Okean-O series) and 32 of them were foreign satellites.

Main results

A. Manned space flight programme

4. In 1999 the crews of the Mir manned scientific research station continued their work. The experiments and studies carried out on Mir covered all basic aspects of manned space flight programmes, including: (a) space medicine and biology; (b) geophysics; (c) space technology; (d) environmental science; (e) natural resources; and (f) astronomy.

5. The programme of studies in geophysics, natural resources and environmental science included photographic observation and spectrometric analysis of individual land-covered and water-covered portions of the Earth’s surface; attention was given to cloud cover, notably to noctilucent clouds, and also to the intensity of subsurface wave formation in the oceans; micro-meteorite fluxes were registered, as were the temperature characteristics and vertical profiles of the atmosphere; the Earth’s ionosphere was studied, notably in connection with the characteristics of radio wave propagation; and methods of forecasting earthquakes were developed.

6. The scientific programme of the Mir space station also included measurements of the space-energy characteristics of cosmic radiation as well as measurements of high-energy charged elementary particle fluxes and of neutron fluxes in the station’s orbit; galactic and solar flares were registered; and astrophysical studies were carried out in the soft gamma radiation region.

7. Various devices and items of equipment were used to study the characteristics of physical processes, in particular convection, diffusion and heat and mass transport in molten metals and liquids; dynamic load sensors were developed and the characteristics of structural materials and the reliability of on-board equipment exposed to the effects of ionizing radiation were evaluated; finally, hydrodynamic processes in the fuel systems of space objects were studied.

8. Parallel to the research and experimental programme outlined above, preventive maintenance and rehabilitation work were carried out in the course of servicing the space station's equipment.

9. In 1999 the Mir station continued with its twenty-sixth major expedition and New Year 1999 was welcomed in by the Russian astronauts Gennady Padalka and Sergei Avdeev, who had set off to Mir in the Soyuz TM-28 spacecraft on 13 August 1998.

10. On 4 February 1999 the crew performed work connected with the Znamya experimental programme, the purposes of which include further refinement of methods of creating large thin-film structures during Earth orbit and the analysis of possibilities for illuminating dark portions of the Earth's surface from outer space by means of reflected sunlight. The experiment in question was carried out with the help of the cargo spacecraft Progress M-40 following its separation from the orbital station.

11. On 20 February 1999 the Soyuz TM-29 spacecraft was launched from Baikonur, carrying to the Mir orbital station an international team of scientists: Viktor Afanasev (Russian Federation), Jean-Pierre Haigneré (France) and Ivan Bella (Slovakia). In the course of their joint flight, the crew of five cosmonauts carried out a number of experiments under the Russian-Slovak "Shtefanik" programme and then handed over to the crew of the twenty-seventh major expedition.

12. On 28 February Gennady Padalka and Ivan Bella returned to Earth on the Soyuz TM-28 spacecraft. Gennady Padalka's flight had lasted 198 days, 16 hours and 31 minutes; the flight of the Slovak cosmonaut Ivan Bella had lasted 7 days, 21 hours and 56 minutes.

13. The flight of the crew of the twenty-seventh major expedition, consisting of Viktor Afanasev, Sergei Avdeev and Jean-Pierre Haigneré involved the following events, listed in chronological order:

(a) On 4 April the cargo spacecraft Progress M-41 docked with Mir;

(b) On 16 April Viktor Afanasev and Jean-Pierre Haigneré performed a spacewalk lasting 6 hours and 19 minutes and attached the French "Exobiology" device to the outer surface of the Mir station; the purpose of the experiment was to study the interaction of material from meteorites with biopolymer molecules, the results of which, the scientists hoped, might help to clarify the origins of life on Earth. They also put into free orbit an operating model of the first artificial Earth satellite;

(c) On 18 July the cosmonauts docked with the Progress M-42 cargo spacecraft, a further element in the orbital space station carrying additional equipment designed to prepare the Mir station for transition to unmanned flight;

(d) On 23 and 28 July Viktor Afanasev and Sergei Avdeev performed spacewalks lasting 6 hours and 7 minutes and 5 hours and 22 minutes, respectively. The main purpose of the spacewalks was to carry out the "Reflector" experiment to study the steps involved in the deployment and configuration of a new type of large parabolic antenna in outer space conditions;

(e) On 28 August 1999, following the completion of research carried out under the Federal Space Programme and the joint Russian-French Perséus project and further work required to prepare the Mir space station for the transition to unmanned flight, the crew of the twenty-seventh major expedition returned to Earth aboard the Soyuz TM-29 spacecraft. The duration of Sergei Avdeev's flight had been 379 days, 14 hours and 51 minutes; the flight of Viktor Afanasev and Jean-Pierre Haigneré had lasted 188 days, 20 hours and 16 minutes.

14. The scientific part of the programmes of the manned flights in the Mir station included research and experiments in all the main areas of interest for contemporary space flight: geophysics, exoatmospheric astronomy, the study of materials in outer space, medicine, biology and biotechnology.

15. The programme of geophysical experiments involved regular photographic observations as well as making a video recording and carrying out a spectrometric analysis of the Earth's land and water surface and of cloud cover. The characteristics of the atmosphere and ionosphere were also studied. Close attention was given to the study of ecological conditions in highly industrialized regions, to the origins of forest fires and to ocean streams and regions of intense subsurface wave generation. The development of methods for forecasting earthquakes continued on the basis of measurements of cosmic radiation characteristics and analysis of ionospheric parameters. Micro-meteorite fluxes in the orbital path and the overall radiation situation in the station's orbit were registered on a daily basis by automatic equipment.

16. As part of the programme of astrophysical experiments, observations of galactic and extragalactic X-ray sources and solar flares were continued, as were measurements of the space-energy characteristics of cosmic radiation.

17. With regard to work on space technology, great importance was attributed to the investigation of fusion and crystallization processes in various materials in conditions of weightlessness. Alongside these experiments, measurements were made of micro-acceleration produced in the station by the operation of equipment and the activities of the crew. One aspect of the in-flight analysis of materials consisted of studying the effects of exposure in outer space on certain elements of radioelectronic apparatus and on samples of structural materials placed on the outer surface of the Mir orbital station.

18. The medical experiments carried out on board the Mir station have traditionally included studies of the effects of weightlessness on the human body, both in the preliminary adaptation stage and during the whole flight. The reactions of the cardiovascular system, the vestibular apparatus and the central nervous system have been studied, as have metabolic processes and the overall psychological and physiological state of the cosmonauts. A broad range of experiments have been carried out with a view to devising prophylactic methods for coping with the unfavourable effects of weightlessness on human beings during prolonged orbital flight. In order to obtain additional information required for the further refinement of manned spacecraft, regular measurements have been made of noise levels, ionizing radiation, microflora composition and atmospheric parameters in the living quarters of the station and its modules.

19. The programme of experiments in space biology and biotechnology included studies on higher plants, on the effects of weightlessness and other factors involved in space flight on the development of bird embryos and the behaviour of amphibians, as well as research on the genetic characteristics of cells in various biological cultures.

20. During the last two expeditions of the Mir station, a whole range of technological experiments were also carried out. These included, in particular, the development of new regimes for remote control of cargo spacecraft, analysis of the dynamic characteristics of a space system weighing many tons and consisting of a base unit with various modules and transport craft, and studies on the efficiency of solar batteries with various photoelectric transformers.

21. The Mir station is now continuing orbital flight in an automatic regime.

22. In July 1987, the Mir station became the first true manned international space station (the first foreign visitor to the station was a citizen of the Syrian Arab Republic).

23. In addition to the major expeditions of Mir there have been 16 expeditions involving visitors that lasted from a week to a month. Fifteen of them were international in character, bringing to the station representatives of Afghanistan, Austria, Bulgaria, France, Germany, Japan, Slovakia, the Syrian Arab Republic and the United Kingdom of Great Britain and Northern Ireland, as well as the European Space Agency.

24. There have also been nine short expeditions (lasting 3-5 days) involving visitors brought to Mir by the American space shuttles. In the course of those missions, 37 astronauts from the United States of America have spent time at the Mir station (6 of them remaining for prolonged work as members of the major expedition crew); and there was 1 astronaut from Canada, 1 from France, 1 from the European Space Agency and 4 cosmonauts from Russia.

25. Altogether there were 10 American space shuttle flights to Mir: 7 by Atlantis, 2 by Discovery and 1 by Endeavour (for the first flight of Discovery no docking was foreseen).

26. The Mir station has seen 74 spacewalks and 3 exits into space to deal with the Spektr module, which had suffered a decompression failure. The total time involved in those spacewalks and exits was 354 hours and 20 minutes.

27. The spacewalks involved the following participants:

28 Russian cosmonauts;
3 Astronauts from the United States;
2 Astronauts from France;
1 Astronaut from the European Space Agency (a citizen of Germany).

28. The following spacecraft docked with Mir:

1 Spacecraft of the Soyuz T series;
29 Spacecraft of the Soyuz TM series;
18 Spacecraft of the Progress series;
42 Spacecraft of the Progress M series;
5 Modules (Kvant, Kvant-2, Kristall, Spektr and Priroda).

29. During the active lifetime of the Mir station, more than 23,000 scientific experiments and study programmes were carried out under Russian and international programmes, many of them unparalleled.

30. The main scientific work included:

(a) Observation of the eruption of Supernova 1987A in the X-ray spectral range;

(b) Ecological monitoring of the Earth with the help of the Priroda facility;

(c) Radiosensing of the Earth’s ionosphere, on behalf of the Russian ionosphere-magnetic service;

(d) Recording of charged particle bursts, which are precursors of earthquakes;

(e) Pilot-scale production of new materials, crystals and alloys in microgravity with the use of special high-temperature ovens: Krater, Gallar, Optizon and Queld;

(f) Prolonged exposure (up to 10 years) of structural materials on the outer wall of the space station;

(g) Investigation of low-temperature plasma in microgravity using the “Plasma crystal” device;

(h) Development of technology for deploying large structures (the Sofora, Rapana and Strombus experiments) and super-light antennas (the Reflector experiment);

(i) Development of a self-contained technical system for producing, on board the station, vital consumables for the crew (water, oxygen, foodstuffs);

(j) Approval of a unique system for sustaining the work capacity of cosmonauts during long flights (up to 1.5 years).

31. The Mir station became a unique flying test site for trying out many technical solutions and technological processes in real conditions—systems and processes that are to be used in the International Space Station:

(a) The Soyuz and Progress spaceships and the American space shuttle have been tested and approved as transport vehicles for carrying crews and equipment;

(b) The interaction of international crews on prolonged flights has been tried and tested;

(c) The technology required for maintaining the station in working condition over a period of many years (about 14 years in this case) has been tried and tested;

(d) Experience in dealing with abnormal situations and ensuring the safety of the crew and the viability of the station has been obtained;

(e) Experience has also been gained with the conduct of a number of international scientific programmes simultaneously by an integrated crew;

(f) Experience has been obtained with the problem of bringing together two different technical schools to create a space technology for joint use;

(g) Technology was developed for the joint control of Russian and American spaceships guided by two ground control stations: TsUP-M (Korolyov, Russia) and United States Ground Control (Houston, Texas, United States).

B. Applied space technology programmes, communications, television transmission and navigation

1. *Space communications, television transmission and navigation*

32. The orbital network of equipment for space communications, television transmission and navigation includes the space objects Gorizont, Ekspress, Yamal-100 (communications, television); Ekran-M, Gals (television); Gonets (communications); and the Global Navigation Satellite System (GLONASS) and Nadezhda (navigation and rescue operations).

33. In 1999 operation of the long-range telephone and telegraph communications system was maintained, as was the relaying of radio and television programmes and the transmission of data on behalf of various official authorities and industrial sectors of the Russian Federation and international communications by means of the Gorizont, Ekspress, Gals and Ekran-M spacecraft.

34. Activities aimed at finding reliable solutions to problems of communications and television transmission continued to receive priority in 1999.

35. In September 1999 Russia launched the Yamal-100 space objects, belonging to the Yamal Satellite Communications System, designed to provide support for the orbital satellite communications and television network of the Russian Federation.

36. There was continued operation of GLONASS, designed to provide positioning and time-reference support for civilian users at sea, in the air and on the ground.

37. The Nadezhda space satellites continued to operate on behalf of the International Search and Rescue Satellite System (COSPAS-SARSAT), which is designed to provide assistance to vessels and aircraft in distress.

2. Remote Earth sensing, meteorological observations and environmental monitoring

38. Priority areas of environmental monitoring are:

(a) Monitoring of factors that govern the weather situation;

(b) Ecological monitoring;

(c) Study of natural resources;

(d) Monitoring of man-made and natural emergency situations;

(e) Efforts to ensure rational utilization of the Earth's resources;

(f) Preparation of a dynamic model of the Earth.

39. At present, satellites of the Meteor, Resurs-O1, Resurs-F, Okean-O1 and Okean-O series are being used in Russia for the purposes of environmental monitoring; photographic observations of the Earth's surface are also being made from the Mir manned space station.

40. In order to deal with environmental monitoring problems as comprehensively as possible, Russia is planning a phased programme for the development and consolidation of all space equipment required for a future system for remote sensing of the Earth that will include the Meteor-3M, Elektro, Resurs-O1 and Okean-O satellites, as well as improved satellites of the Resurs-DK type and small space objects for remote sensing of the Earth.

41. The development and operation of the future system for remote sensing of the Earth from outer space are to be carried out in such a way as to ensure mutually beneficial collaboration with other countries and organizations that have themselves done useful work in the development and utilization of space equipmment for remote sensing of the Earth. This requires effective and economical forms of multiphase international cooperation in carrying out environmental monitoring and issuing warnings of natural disasters—arrangements that will guarantee the required exchange of space data, joint development of international projects and, ultimately, the integration of national space programme resources into a single comprehensive international system for remote sensing of the Earth.

42. Problems relating to the environment, the rational utilization of natural resources and the establishment of a natural disaster and catastrophe warning system have acquired enormous importance. With these aims in mind, work is being done with a view to the modernization of existing space complexes or the creation of new ones for efficient high-resolution observation of the Earth and all-weather observation of its seas; there is also a plan to involve defence facilities in the solution of social and economic problems.

43. In 1999 the operation of space systems of various kinds continued, including the Meteor series of weather satellites, an oceanographic space object of the Okean-O1 series and the Resurs-O1 device, which monitors natural resources.

44. On 17 July 1999 a Zenit rocket launched from Baikonur carried the Okean-O satellite, a joint Russian-Ukrainian project, into orbit. The purpose of the space vehicle is to investigate the Earth's natural resources, to observe the surface of its seas and to carry out monitoring operations with rapid and efficient transmission of the results to Earth.

45. On 28 September 1999 the Resurs-F1M space object, equipped for spectrozonal and panchromatic imaging, was launched. On 21 October 1999 the craft successfully completed its mission.

46. The first Meteor-ZM space object is nearing completion (launch is scheduled for the third quarter of 2000). This vehicle is also designed for meteorological observations and investigations of natural resources.

47. In 1999 the development and modernization of the principal terrestrial complex for the receipt, processing, storage and distribution of satellite information continued, and work was begun on the creation of a federal centre for remote sensing of the Earth. A number of new facilities have been established for the receipt, processing and storage of data, a system has been created for the collection of Eurasian data and possibilities for the efficient supply of information to users have been substantially improved.

3. *Space technology*

48. Studies in the sphere of space technology and the physics of weightlessness were directed towards the production in microgravity of new organic and inorganic materials and the refinement of the technologies and equipment required for their production, including commercial production. The use of both manned and unmanned spacecraft for those purposes will make it possible to grow crystals with properties that are unobtainable on Earth, thus providing the requisite scientific and technical process stock for the transition to pilot industrial production of materials in space. The main purpose of establishing the planned space assembly is to complete the development of basic technologies for the production of experimental batches of semiconductors and other items required for practical application in industry.

49. The year 1999 saw a further continuation of work under the space technology programme being carried out with the Foton space vehicle, in which the member States of the European Space Agency are taking part. Semiconductor materials produced in microgravity (cadmium telluride, gallium arsenide, zinc oxide, silicon and others) mark a five- to sevenfold improvement in their parameters in comparison with their counterparts produced on Earth. Biological preparations show a five- to tenfold improvement in purity compared with their analogues on Earth.

50. Technical experiments were continued in 1999 on the orbital space station Mir. A programme of experiments was prepared and a number of on-board technological systems were produced.

C. Space research programmes

51. Fundamental space research provides basic data contributing to knowledge of the universe, the processes at work in it and their impact on Earth. Such research makes possible human endeavours in space and on the celestial bodies and the conduct of manned flights to Mars in the new millennium.

52. Space technology can be used to conduct more detailed study of space radiation and high-energy particles and of solar-terrestrial interaction, as well as of the development of a heliogeophysical monitoring system being planned for the future. Complex research of the Earth's magnetosphere is being continued, in addition to study of the interaction of processes on the Sun and in the circumterrestrial plasma with life on Earth.

53. During the 10 years of operation of the Granat orbital observatory, which completed its work at the beginning of 1999, a detailed study was made of several dozen galactic and extra-galactic sources, representing possible black holes, neutrons stars (X-ray bursters and X-ray pulsars), X-ray novae and accumulations of galaxies and quasars; and a number of interesting and hitherto unknown objects were discovered. For the first time, sources emitting radiation in the annihilation gamma line of positronium were localized.

54. Under the Koronas programme, solar research is continuing in connection with the international Koronas-I project (research on dynamic, active solar processes and the properties of solar cosmic radiation and electromagnetic solar radiation in the radio, visible, ultraviolet, X-ray and gamma bandwidths). This programme will make it possible to obtain data necessary for locating the active parts of the Sun's surface, to investigate and identify phenomena reliably heralding solar flares and thus to reliably forecast solar activity.

55. It is planned to complete the design and launching of the Koronas-F space object. In 1999 work was completed on the international Advanced Photovoltaic and Electronic Experiments (APEX) project (AUOS-3), initiated with the launch in 1991 of the Interkosmos-25 satellite and the Magion-3 subsatellite, to study the effects of modulated electron fluxes and plasma beams on the Earth's ionosphere and magnetosphere.

56. Under the Interball project a system consisting of a tail probe and auroral probe has been set up in space for the purpose of conducting long-term fundamental research on processes taking place under the influence of solar radiation in the geomagnetic tail (upper and tail ends) of the Earth's magnetosphere. This research forms an integral part of the international programme for investigating the nature and mechanisms of solar-terrestrial interaction by means of spacecraft and ground-based observatories in various countries.

57. The probes have been fitted with scientific instruments designed by scientists and specialists from Austria, Bulgaria, Canada, Cuba, the Czech Republic, Finland, Germany, Greece, Hungary, Italy, Kyrgyzstan, Poland, the Russian Federation, Slovakia, Sweden, Ukraine and the United Kingdom.

58. The results of the research are extremely promising, as there is evidence to suggest that changes in the Earth's magnetosphere may be responsible for changes in atmospheric pressure and lead to the occurrence of droughts, cold snaps in various regions of the world and cyclone formations. There is a correlation between these types of phenomenon and fluctuations in animal populations, epidemic cycles, agricultural crop yields and climatic changes. The investigation and identification of patterns and mechanisms of interaction in the behaviour of the Sun and circumterrestrial plasma will provide the key to a closer understanding of the "secret" of life on Earth.

59. In 1999 the programme of experimental research was essentially confined to the study of solar-terrestrial relations and cosmology using the Koronus-I and Interball satellites and also the Conus-A instrument deployed under the Conus-Wind project (involving the American Wind spacecraft) and mounted on board the Cosmos-2367 space object as a supplementary payload.

60. In 1999, using scientific instrumentation on board the Koronus-I satellite, it was possible to take a large number of photographs of the Sun in single-temperature spectral intervals; over 50 solar events (flares, disappearing solar filaments) and the spectra of global solar oscillations were also recorded, together with data on the effects of magnetic storms on the structure of energy particle fluxes in the Earth's magnetosphere. Using the systems on board the Interball, data were obtained on the pattern of disturbance of the magnetopause of the Earth's magnetic field and on the plasma velocity field of solar wind in the tail of the magnetosphere and so on.

61. In addition to fundamental research, particular emphasis is laid on applied research projects for the forecasting of powerful magnetic storms giving rise to hazardous phenomena (induced currents) in power systems, power supply lines and data transmission networks.

D. Commercial uses of space technology in the Russian Federation

62. Space activities provide a basis for extensive exploitation throughout all sectors of the Russian economy of the scientific and technical, production and human resource potential of the rocket and space sector and of advances in space travel, space technology and rocket engineering, rocket and space engine manufacture, industrial engineering, control systems and instrument manufacture.

63. Two main types of spin-off benefit can be identified in the overall picture of ways in which the scientific and technical achievements of space and rocket technology can be redeployed in the national economy:

(a) Functional "space conversion", consisting of the application of the results of space activities, including "dual-purpose" space technology;

(b) Transfer of "high-tech" scientific technologies into different economic sectors.

64. In the first of these two areas, a total of 90 conversion projects have been prepared, 30 of which are functional conversion projects that do not require further development and involve a redeployment of the functions of space systems and their regular specialized equipment for the purpose of accomplishing tasks of a socio-economic or scientific nature.

65. The following space facilities are examples of technology that is contributing to the development of the social and scientific sectors of the economy: satellites for the investigation of natural resources (Meteor, Resurs-F, Resurs-O1, Okean-O, Okean-O1 etc.); communications and television transmission satellites (Gorizont, Ekspress, Yamal, Gonets etc.); space objects used for navigation and geodetic surveys (GLONASS, Nadezhda etc.); and space objects used for tasks relating to space technology and medicine (Foton, Bion).

66. By making appropriate use of space systems and technologies, it is possible to reduce expenditure on raw-material exploration and prospecting by a factor of 8-10, to ensure rapid and environmentally safe exploitation of the country's raw-material base, together with the construction of facilities in the fuel and energy sector, to permit real-time facility control, to perform environmental monitoring and accident prediction functions, to provide

information coverage for emergency rescue services, to monitor and assess the radiation situation in the vicinity of nuclear power plants, to monitor shipping, road and air traffic, to evaluate damage to the environment and the level of expenditure needed for environmental recovery measures and to assess the costs of post-accident clean-up operations.

67. In the second area, work is currently being done in connection with the economic applications of space technology in the Russian Federation with a view to the following:

(a) Utilizing more widely the advances of space travel and space technology (developing modern, competitive systems and equipment for use in civil aviation, sea and road transport, geodetic survey methods, control and communications systems);

(b) Deploying the expertise gained in the field of space and rocket engine design (increasing production in the fuel and energy sector, drawing on the most scientifically sophisticated technologies involved in rocket engine design, high-energy processes and solutions to problems in the areas of heat and mass transport, gas dynamics, materials science and strength of materials, and the design of powerful heavy-duty cryogenic fuel refining and feed systems);

(c) Deploying rocket and space engineering technology (increasing the production of equipment designed for environmental purposes and industrial safety, drawing on unique space and rocket technology to design ground equipment capable of effective use for fire-fighting and evacuation, systems for ensuring the survival and safety of ground and flight personnel at cosmodromes and launch sites, and the use of expertise and equipment required for working with large volumes of toxic and high-energy rocket fuels);

(d) Deploying space instrument technology (increasing production of medical equipment and equipment for the agro-food sector and construction industry, drawing on accumulated scientific, technical and organizational expertise and the advances made in the design of instruments and instrument systems for measurement, control and diagnostic functions in the testing and operation of space facilities).

68. It is planned to employ methods and technologies that will ensure high reliability and long service life in equipment designed for measurement, monitoring and diagnosis of the parameters of various technological processes—equipment with advanced technical specifications matching world standards.

69. Most of the new technologies constituting key elements of the new equipment generation (on-board computers, power sources, photoreceptor devices, new materials and substances etc.) and the most advanced technological processes developed and applied in the space technology sector are fairly general in character, only about 20 per cent of this technology having narrowly technical and specialized functions. Consequently, the potential exists for space technologies to be successfully applied in various sectors of the Russian economy.

70. Of particular interest, for example, are those technologies developed on the basis of highly advanced scientific research (rotational moulding, non-crucible melting, electron-beam and laser sintering, vacuum ion-beam and plasma treatment of products, infra-red photoreceptor devices, microelectronic circuits based on complementary metal oxide semiconductor (CMOS) structures, sensors based on functional electronics, fibre-optic communication lines etc.).

71. The high-strength steels and alloys developed for rocket and space technology, including those developed by means of ultra-high-speed crystallization of gaseous

condensation, beryllium alloys and composites, carbon-carbon composites, environmentally clean heat protection and heat insulation materials, adhesives and hermetic sealing materials have extensive applications in the construction, fuel and energy, transport and medical equipment sectors and in scientific research in high-energy physics.

72. In order to promote the efficient transfer of space technologies to commercial applications in Russia and to stimulate spin-off benefits, a series of interrelated studies have been conducted with a view to creating the necessary economic, organizational and regulatory infrastructure.

73. Work on the transfer of space technologies is being performed as an element of State policy and in accordance with the federal laws on space activities and on conversion.

74. In 1999 enterprises operated by the RSA took part in the 27th International Exhibition of Inventions, New Techniques and Products, held in Geneva, and were awarded prizes for 8 inventions (1 gold, 5 silver and 2 bronze medals) and in the 48th Eureka-99 World Fair of Innovation, Research and New Technologies, held in Brussels, where Russian companies won 11 awards (3 gold and 8 silver medals) and the RSA exhibit was awarded the Grand Prix of the World Periodical Press Organization.

E. International cooperation

75. Russia is participating in programmes for the construction of the International Space Station and in space systems for environmental monitoring, early warning of potentially destructive natural phenomena and other emergency situations, search and rescue of vessels in distress, tracking the movement of particularly important loads and moving objects and controlling the pollution of outer space.

76. RSA, in cooperation with other ministries and departments and enterprises engaged in the development of rocket and space technology, is contributing to international cooperation in the space sector in the following fields: the use of Russian launching facilities to launch foreign payloads; the carrying and insertion into orbit of small foreign space objects (Meteor-3M (1), in conjunction with microsatellite Badr-B of Pakistan, Maroc/Tubsat of Morocco and Tiung Sat-1 of Malaysia); the installation of foreign scientific instrumentation on board Russian space objects (Sage III of the United States on board Meteor-3M (1), Pamela of Italy on board Resurs-O1 (5) etc.); partnership in the establishment of the International Space Station; implementation of the Spektr project in the area of fundamental space research involving broad cooperation with foreign partners; implementation of projects in the field of space medicine and biology (Bion) and space technology related to the production of materials in microgravity (Foton) and meteorological projects; and expansion COSPAS-SARSAT, for rescuing vessels at sea and aircraft in distress.

77. Missions were performed in 1999 on the Mir orbital station under the programmes of the major expeditions with the participation of French and Slovak astronauts. In June 1999 the Mir-Shuttle programme was completed.

78. Work continued in 1999 in connection with the programme to establish the International Space Station. The partners in this major project are Brazil, Canada, Japan, the Russian Federation, the United States and member States of the European Space Agency. In establishing the International Space Station, extensive use is being made of the experience gathered over a period of more than 30 years in the former Soviet Union and Russia in orbital station operation. The operating and permanently manned Mir orbital station has been used for training cosmonauts and astronauts under real space conditions

for future missions on board the International Space Station. The work done over the previous four years in connection with the International Space Station resulted, on 20 November 1998, in the successful launch of the Zarya functional cargo block, which thus became the first element in the newly started construction of the International Space Station in orbit. The Zarya module was designed and tested at the Khrunichev State Scientific and Industrial Space Centre with funding by contract with the Boeing Company. The launching of the Zarya module and its flight control are the responsibility of the Russian partners. In the initial stage of assembly of the station, flight control of the module cluster, power supply, communications and the receiving and storage of fuel are all managed by the Zarya module.

79. Work was conducted during 1999 on the control of the first elements of the International Space Station; at the Baikonur launch site, the second element of the Russian segment of the International Space Station service module is being tested and prepared for launch. The launching into orbit of the service module will make it possible to commence the manned phase of International Space Station operations.

80. In Russia special conditions have been introduced, with regard to the implementation of international agreements in the area of space activities, for the development of international cooperation and the strengthening of Russia's position in the world space market. To date, inter-State and intergovernmental space cooperation agreements have been concluded and are being implemented with 15 States, including Argentina, Brazil, Bulgaria, Hungary, India, Japan, Sweden, the United States and member States of the European Space Agency. RSA has signed such agreements with the space agencies of 14 countries and the European Space Agency. Those agreements provide for the joint conduct with foreign partners of space projects, international space-related trade and the provision of commercial services involving the use of launching facilities, technological guarantees in respect of commercial satellite launches and the establishment of special customs regulations and duty-free importation of goods transported in connection with space cooperation.

81. RSA and the European Space Agency are currently engaged in finalizing a cooperation programme for the collection of remote Earth sensing data from the ERS-1 and ERS-2 satellites for use by scientific organizations in Russia and a number of European countries.

82. In 1999 further work was done on the commercial project Sea Launch with the participation of Russian, American, Norwegian and Ukrainian companies. The first demonstration launch of the Zenit-3SL carrier rocket from the Odyssey sea launch platform took place on 27 March 1999, followed on 10 October by the first commercial launch from the platform, by which the direct television broadcasting satellite DIREKTV 1-R was launched into geostationary orbit. This satellite, manufactured by the American Hughes Space and Communications Company, is designed to relay television programmes to 50 American states.

83. The Odyssey launch platform was located at the time of the launch in the equatorial region of the Pacific Ocean (on the Equator, at 154° W).

84. During 1999, a total of 32 satellites owned by various countries were commercially launched by Russian launching facilities.

United Kingdom of Great Britain and Northern Ireland

[Original: English]

The space strategy of the United Kingdom is contained in the brochure entitled *New Frontiers*, which has been distributed to the Scientific and Technical Subcommittee of the Committee on the Peaceful Uses of Outer Space at its thirty-seventh session.