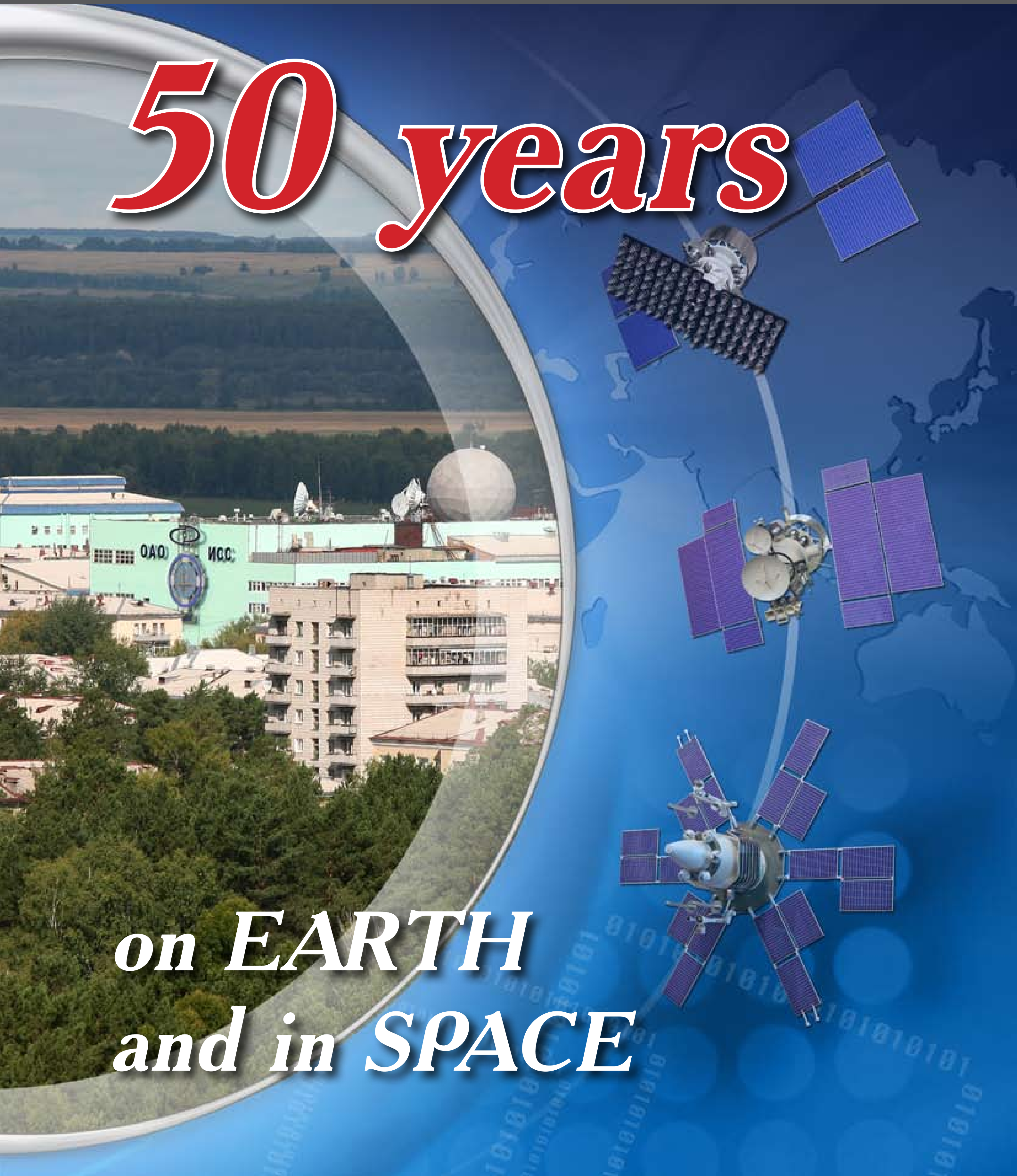
RESHETNEV
COMPANY

INFORMATION SATELLITE SYSTEMS

№8, 2009



50 years on EARTH and in SPACE

- **MARCH 3, 2008**
  THE FEDERAL UNITARY ENTERPRISE
  "ACADEMICIAN M.F. RESHETNEV NPO PM" WAS
  TRANSFORMED INTO THE JOINT-STOCK COMPANY
  "ACADEMICIAN M.F. RESHETNEV "INFORMATION SATELLITE SYSTEMS"

- **OCTOBER 23, 1997**
  NPO PM WAS NAMED
  AFTER ACADEMICIAN M.F. RESHETNEV

- **AUGUST 1, 1977**
  NPO PM WAS ESTABLISHED BY JOINING THE
  DESIGN BUREAU OF APPLIED MECHANICS AND
  MECHANICAL PLANT

- **MARCH 6, 1966**
  DESIGN BUREAU-10 WAS RENAMED
  DESIGN BUREAU OF APPLIED MECHANICS

- **AUGUST 18, 1964**
  THE COMPANY LAUNCHED ITS FIRST SATELLITES,
  11K65 (KOSMOS) LAUNCH VEHICLE AND
  THREE SMALL KOSMOS SATELLITES (№38,39,40)

- **DECEMBER 18, 1961**
  THE SUBSIDIARY OF DESIGN EXPERIMENTAL BUREAU-1
  WAS REORGANIZED INTO AN INDEPENDENT ENTERPRISE,
  NAMED DESIGN BUREAU-10

- **JUNE 4, 1959**
  AT THE SUGGESTION OF SERGEY KOROLEV,
  DESIGN EXPERIMENTAL BUREAU-1 OPENED
  A SUBSIDIARY IN KRASNOYARSK-26 (NOW ZHELEZNOGORSK)

An official address of Nikolai Testoedov, the General Designer and Director General of the JSC "ISS", to the customers and partners in connection with the company's 50th anniversary.

Fifty years ago, in faraway Siberia, the father of Russian cosmonautics Sergey Korolev founded a subsidiary of OKB-1. It was headed by the talented designer and scientist Mikhail Reshetnev. Having followed the path of glory for 50 years, honored with Orders of Lenin and the Red Banner, the enterprise has asserted itself as the leader in the Russian satellite-building industry.

Today, due to close cooperation with foreign and Russian companies, the ISS has become a key executor of Federal and foreign projects. Looking back to its glorious past, the enterprise looks forward to its promising future. I am certain that with a wealth of invaluable experience gained by the enterprise during its history, the company's personnel will meet all the targets on the road to success.

Nikolai A. TESTOEDOV,
General Designer and Director General

RESHETNEV COMPANY

JSC "Academician M.F. Reshetnev "Information Satellite Systems"

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‘Our country has been successful in the manufacture, operation and development of rocket and space technology for over half a century. We have gained unique experience which is now applied in many spheres of Russia’s social and economic activities, as well as abroad. The success achieved is mainly determined by the scientific, industrial and technical potential created in the process of the formation of Russian cosmonautics’.

Anatoly N. PERMINOV,
Head of the Russian Federal Space Agency.

‘The national interests of ensuring defence and safety require enhancing the military effectiveness of the country’s space assets. It does not so much concern the numerical strength of the national constellation as regards the qualitative characteristics of the space systems and complexes, intended to provide up-to-date information support for the armed forces and the weapons systems, in view of the country’s technical and economic capabilities.’

Major General Oleg N. OSTAPENKO,
Commander of the Russian Space Forces.

‘It is hard to imagine the present and the future of the communications industry without reliable satellite systems. In this regard your enterprise is one of the major pillars of the industry. The results of the company’s 50-year activity are impressive. Two thirds of the Russian orbital constellation is made up of satellites manufactured by the JSC “ISS”. The management of the communications, radio and television broadcasting industry as well as the success of Russia’s switch to advanced digital broadcasting technologies mainly depend on the conscientious work of the ISS’s personnel.’

Igor O. Shchyogolev,
Minister of Communications
and Mass Media of the Russian Federation.

ANNIVERSARY

DEVELOPMENT STRATEGY

Fifty years is an important milestone in the company's history. Today the JSC "Academician M.F. Reshetnev "Information Satellite Systems" is the acknowledged leader in the Russian satellite industry. At present 2\3 of the Russian orbital constellation is composed of spacecraft manufactured by the Siberian Company. In general, more than 1200 satellites and over 40 space systems and complexes have been created by the enterprise and deployed in orbit in the last 50 years. Another success criterion is the high technical level of the spacecraft. When compared by parameters, such as service life, unpressurized design, power supply capacity and number of transponders, Siberian satellites prove to be highly competitive with the world's best spacecraft.

The company's current strategic concerns are the implementation of the Federal Space Program, GLONASS Federal Target Program, Government Defence Order and the international contracts. As for the prospective lines of the company's development, the most essential task is to work for the future, i.e. to create commercial satellites with a view to the future market demands. Therefore, the company never stops conducting scientific research and experimental development activities, thus accumulating the know-how for the manufacture of future satellite generations.

Another important strategic objective is standardization. It is impossible to manufacture a different satellite every 2-4 years. That is why, the company has developed a number of standardized satellites, with masses ranging from 800 kg to 3.5 tons, which are approached in the same way through consolidated design solutions, unified avionics and mathematics, standardized components, and uniform requirements for quality, continuity and functional redundancy.

The next task is to create reliable and long-lived satellites. That is the reason why the company places a great emphasis on the component selection and application of highly reliable, foreign and Russian avionics which is thoroughly tested in cooperation with experimental centers. What is more, the most crucial devices and systems are duplicated so as to provide uninterrupted operation of a spacecraft.

Another priority line of the company's development is the re-equipment carried out within the framework of the major federal programs, including the Technical Re-Equipment of the Military Industrial Enterprises Program set for the period up to 2020. The company's profits are invested in production: in the construction of new production facilities and the procurement of equipment. Only with up-to-date production and experimental facilities can the enterprise keep at the forefront of the satellite industry.

The JSC "Information Satellite Systems" is also involved in active cooperation with foreign companies. However, there is one clearly-defined cooperation principle. Foreign manufacturers are engaged only when the Russian market has no counterparts to offer, or available products fail to meet the severe requirements imposed by the space technology market.

The cooperation between the ISS and its foreign partners has changed considerably in the last 15 years. When implementing its first international contract for the manufacture of the SESAT satellite, the enterprise simply purchased a payload in France. With all the subsequent satellite projects the company gradually scaled back the number of procured items by setting up their manufacture. Thus, the ISS initiated the manufacture of honeycomb panels. At present the company also makes high-accuracy antennas for geodetic satellites, and shaped antennas for its new data relay satellites. Whenever possible, the company engages Russian enterprises. For instance, the JSC Scientific & Production Center "Polyus" has developed a lithium-ion battery control unit at their own expenses for the AMOS 5 satellite that is currently being built by the ISS. Likewise, the JSC "Saturn" is currently engaged in the development of the lithium-ion battery to be used in the ISS's advanced satellites. Today most Russian enterprises prefer cooperation as the most effective way of development.

One of the company's most important strategies relates to human resources management. The number of the ISS employees has increased by 15% in the last three years. Almost all the new-comers are young engineers and workers. To multiply the intellectual potential and pursue the knowledge transfer with continuity the company has arranged six target-oriented sub-faculties at the enterprise, concluded contracts with the leading Russian universities and colleges for the preparation of specialists and has gone into strategic partnership with the Academy of Sciences to provide advanced training for the staff members.

As for the social programs, the company's policy is moving in the direction of providing support for those who need it most, i.e. young specialists and veterans. Middle-aged employees are socially more or less immune, whereas pensioners need actual support, and young specialists – interesting work, accommodation and decent salaries.

When it comes to the company's financial standing, there is a clearly defined plan for the enterprise to keep to. Its concept lies in the idea that labour efficiency must exceed the rate of salary growth, which, in its turn, must outrun inflation. Consequently, regardless of the inflation the social welfare of the company's employees is kept respectable. At the same time the company has enough funds to carry on its re-equipment and social programs.

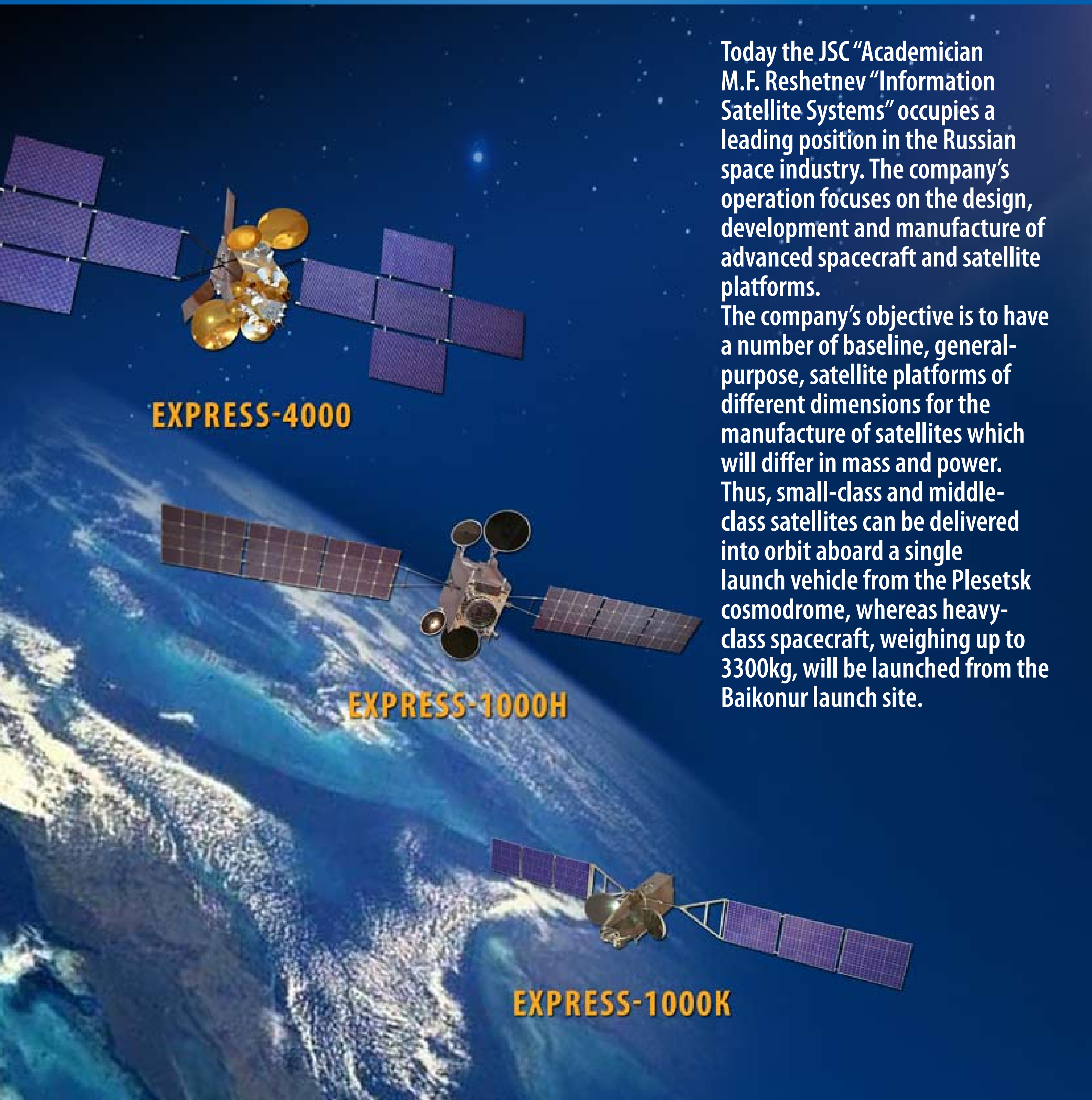
Successful completion of the main, goal-oriented activities will definitely ensure the Reshetnev company sustainable development and guarantee a secure position on the global satellite market.

Nikolai A. TESTOEDOV,
General Designer
and Director General.

GENERAL-PURPOSE platforms for new-day satellites

Today the JSC "Academician M.F. Reshetnev "Information Satellite Systems" occupies a leading position in the Russian space industry. The company's operation focuses on the design, development and manufacture of advanced spacecraft and satellite platforms.

The company's objective is to have a number of baseline, general-purpose, satellite platforms of different dimensions for the manufacture of satellites which will differ in mass and power. Thus, small-class and middle-class satellites can be delivered into orbit aboard a single launch vehicle from the Plesetsk cosmodrome, whereas heavy-class spacecraft, weighing up to 3300kg, will be launched from the Baikonur launch site.



Nowadays the space market demands satellites built on high-power platforms, with a service life no less than 15 years. A platform is a standard module of essential service systems, such as the power supply system, motion control, attitude and orbit control subsystem, thermal subsystem, telemetry data management and transmission. Built on a modular basis, a general-purpose platform allows manufacturing a number of satellites with different technical characteristics.

The JSC "Information Satellite Systems" applies a modular platform design concept to satellite-building. The main advantages of the modular principle are the reduced satellite-building time, lower costs of work, higher quality and reliability of spacecraft.

At present no customer pays for the development and manufacture of satellite prototypes. Consequently, it is essential to manufacture spacecraft on the base of general-purpose platforms which have already confirmed their flight standards and qualification. Nevertheless, satellite devices and systems, as well as the payload elements differ from satellite to satellite, which depends on the frequency band, number of channels and spacecraft criteria. Since the JSC "Information Satellite Systems" is the manufacturer of most Russian satellites, it has a unique possibility of installing new technically-advanced devices and systems into operational satellites being used in on-going programs. Thus, new devices undergo flight development tests, in which they are tested for fatigue and durability. By the time the need arises to install them into a new satellite, they will have already gained their flight qualifications. Thus, the enterprise tests new devices aboard operational satellites.

Today the JSC "Informational Satellite Systems" is developing a few satellite series based on the Express -1000 and Express-2000 platforms. Nevertheless, the ISS's specialists never seem to be satisfied with what has been achieved, and so continue to expand the model range of the platforms and to increase their efficiency.

The ISS manufactures three versions of the Express-1000 platform, i.e.Express-1000K, Express-1000H and Express-1000SH. The platform mass is determined by a satellite's total mass and is calculated with a view to multiple satellite launches by a Proton-M/Breeze-M launcher. Thus, the total mass of a satellite built on the Express-1000K platform can not go beyond 1200 kg; 1700 kg is the limit for a satellite based on the Express-1000H platform, and no more than 2200 kg is allowed for Express-1000SH. All the modifications of the Express -1000 platform have the same design concept, on-board control and propulsion subsystems, attitude and orbital control systems.

The advanced Express-1000H platform is one of the most powerful platforms of the Express-1000 series. It is intended for the AMOS 5 and TELKOM 3 telecommunications satellites.

The Express-2000 platform and its version, Express-4000, in fact have evolved from the Express-1000H platform and are designed to provide more power resources and increased dimensions for the payload module.

Express-2000 and Express-4000 are analogous in terms of the design concept, applied technical solutions, the composition and characteristics of the on-board service systems, as well as their basic interfaces with the payload module and performance specifications. The same is the structure of the platforms. It is a load-carrying structure, in the form of a central tube with the load of the instrument and honeycomb panels. The Express-2000 and Express-4000 platforms differ in applications and equipment composition of their service modules.

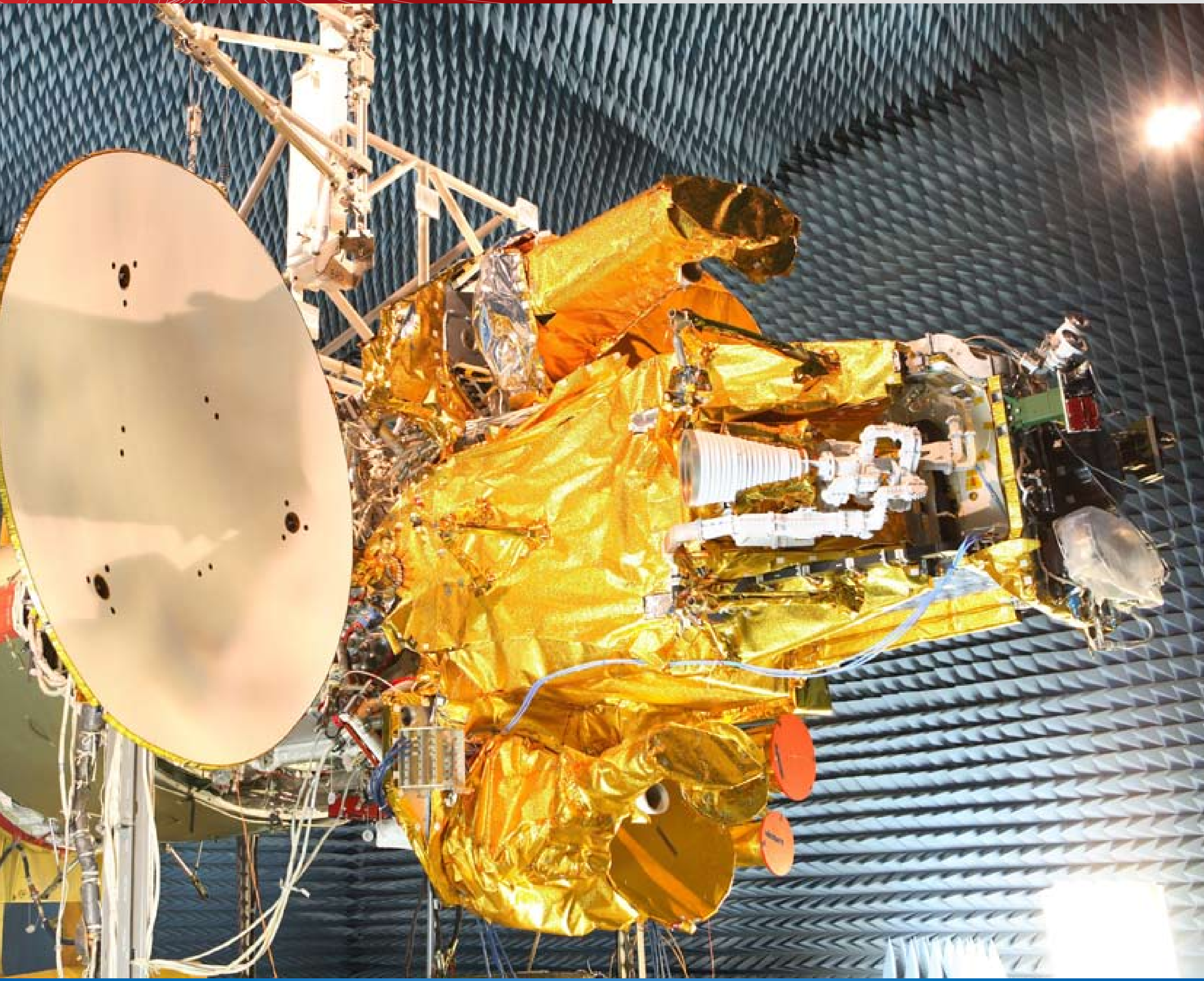
The Express-2000 platform is intended for the internal market, to satisfy the needs of those customers who make great demands on the information security of satellites, which places certain restrictions on the use of foreign equipment and on-board software items. The Express-2000 is intended for the Loutch-4 data relay satellite. Besides, it will be the base platform for the Express-AM5 and Express-AM6 satellites, which are expected to replenish the Russian orbital constellation in 2012. The competitive tender for their manufacture was won by the JSC "ISS" in early May.

The Express-4000 platform is intended for the international market and commercial projects.

The distinctive features of the ISS's current and future platforms are their extended service life, increased power supply for the payload and the improved service systems/payload weight ratio. The development of the new satellite platforms enables the enterprise to create a number of new satellites for different applications and a wide range of customers, as well as strengthen the company's position on the national and international markets.

Requirements for the Express-1000 and Express-2000 platform series are as follows:

- Service life of the Express 1000/2000–based satellites - 15 years;
- Probability of the faultless operation of the platforms at the final phase of their service lives – 0.9;
- Probability of operation of the Express1000/2000-based satellites in any slot in GSO as designated by the customer;
- Positioning accuracy for longitude and latitude ±0,05°;
- Sufficient on-board fuel reserve to transfer a satellite to any other slot on the orbital arc at a speed of 2° per day.



SPACE COMMUNICATIONS

One of the priority activities of the JSC "Information Satellite Systems" is the design and manufacture of telecommunications satellites. Produced at the level of the international quality standards, the ISS's reliable satellites are the pride of the company. Nowadays, due to the 50 years' experience of satellite-building, the "Information Satellite Systems" manufactures new-day telecommunications satellites on advanced middle- and heavy-class platforms.

Satellite telecommunications: first steps

The first communications satellite developed by NPO PM (now the JSC "ISS") was the experimental satellite Strela-1. Its launch enabled the first information exchange between remote subscribers via satellite communication. The nonoriented, small-class satellite worked in the "e-mail" mode and consisted of a solar cell carrier and a pressurized satellite body carrying a load of instruments. The further experimental development of Strela-1 satellites generated the creation of the Strela-1M system.

Strela-2 was more complicated than Strela-1 in terms of design and equipment performance. The Strela-2 satellite had a one-axis magnetic attitude control system with a pointing accuracy of 10° and weighed almost 800kg. Like Strela-1, it was an experimental satellite, and as a result of its development, a new system, Strela-2M, was created.

The launch of the Molnia-1spacecraft on April 23, 1965 initiated establishment of the national satellite communications system. Molnia-1 was built under the guidance of OKB-1, in particular, Academician S. Korolev. Straight after the first successful launch of the spacecraft, all relevant activities were assigned to the Reshetnev Company. Thus, on May 25, 1967, the first Siberian Molnia-1 satellite appeared in space. Later that year another two satellites were launched, on August 31 and October 10. As a consequence, the satellite communications system, unique in the whole world, was set to work in the late 1970s. Based on the Molnia-1's platform, a series of satellites with improved performance characteristics and new repeaters was later developed.

Another important milestone in the company's telecommunications history was the development of the Raduga spacecraft. It was the first Russian geostationary satellite to combine the latest technical solutions, such as a sophisticated antenna complex and a repeater with six C-band transponders.

Later Raduga and Molnia-3 formed the core of the Integrated Satellite System which provided telephone links for towns and cities via earth stations, and enabled transmission of TV signals to three broadcasting zones (Orbita-1, -2, -3 programs). Thirty two Raduga spacecraft were launched into designated orbital positions in GEO within 1975-1996; and with every new launch it was a more perfect, more complex satellite. As a result of the constant development, Raduga demonstrated improved performance specifications, high reliability and a longer service life, twice as much as before.

The invaluable experience gained from the successful development of Raduga satellites facilitated the company's rapid progress with other geostationary communications satellites.

New technical solutions

In the late 1970s, there appeared a need for a new technical means which would allow increasing cost-effectiveness of the TV broadcasting satellite system. Such became the Ekran system, based on the similarly-named satellite, developed and manufactured by the JSC "ISS".

To provide high-frequency energy concentration within the required service area, the Ekran satellite was equipped with a large, foldable, onboard, transmitting antenna. Besides, the satellite was capable of high-precision orientation accuracy, which allowed minimizing radiation beyond the guaranteed service area. The Ekran satellite enabled reception of the first colour television program with high picture quality via simple receiving devices equipped with Yagi Uda antennas.

At a later stage the Ekran satellite was modernized in order to improve its performance characteristics. As a result, instead of one channel, the satellite employed a two-channel repeater. The first modernized version, Ekran-M, was launched on December 27, 1987. It is worth mentioning, that despite the three-year guarantee, satellites of the Ekran series managed to orbit for 6.4 years on average.

In 1975 the government entrusted the Reshetnev Company with the task of creating a geostationary communications satellite for civilian applications. As a consequence, within the period of 2.5 years the enterprise developed and manufactured the Gorizont spacecraft. Satellites of this series combined the best technical solutions which had been elaborated in the previous satellite projects. Thus, the design-layout was borrowed from the Raduga satellite, whereas the high-precision attitude and orbital control system was taken from the Ekran. The commissioning of the Gorizont satellite enabled a channel carrying capacity growth in the systems Orbita and Intersputnik. Later on, Gorizont spacecraft were regularly launched into the geostationary orbit and carried out their civil and governmental missions to the full. Thus, Gorizonts were used to cover the events of the Moscow Olympic Games in 1980.

In 1982 the enterprise started manufacturing modernized Gorizont satellites. As a result of the improvement, two more channels were added to the repeater equipment. The first of them was intended to establish communication links between the ships of the Ministry of the Navy and the major stations by means of the "wave" system, whereas the second channel was to provide high-frequency Ku-band offering. Undoubtedly, these innovations enhanced the satellite's functional and operational capabilities, and formed the basis for further successful development of communications satellites.

In general, thirty three Gorizont satellites were manufactured and delivered into the geostationary orbit; most of them orbited for 12 years, i.e. four times longer than targeted.

Breakthrough into the international market

The condition of the national orbital constellation of communications satellites turned so critical in the late 1970s that its replenishment and modernization became a matter of national importance. At that time NPO PM's objective was to get integrated into the international division of labour, which prevailed in the world's space industry. As a consequence, it was decided to equip the company's new satellite platforms with foreign payloads. Thus, the enterprise started ordering the repeater equipment from the French company Alcatel Space. The spacecraft of that series were named Express-A, and had a seven-year service life.

The Express-A1 satellite was launched on October 27 , 1999. However, it was lost as a result of the launch vehicle's failure. Express-A2 and Express-A3 were successfully delivered into orbit on March 12 and June 24, 2000. To substitute the lost Express-A1 satellite Express-A4 was launched on June 10 , 2002. It is still performing its mission in the 14°W orbital slot.

In the process of interacting with the leading foreign companies within the scope of the Express-A project it became clear that despite the economic difficulties, the Russian space industry retained its production and intellectual potential. For instance, the Reshetnev company had a great number of unique developments and technologies that could compete with foreign ones or even surpass their level. So, the combination of the national and foreign experience promised to be productive and mutually beneficial.

The first joint project was the manufacture of the SESAT satellite, also known as Eutelsat W4. Implemented successfully, the project laid the foundations of a more general international cooperation. The contract with the European Telecommunications Satellite Organization was awarded to the Reshetnev Company and Alcatel Space as a result of the international tender. The participation of the French company, one of the leading foreign manufacturers of satellite payloads, enabled the Russian manufacturers to apply the best foreign technologies, which they lacked, to the SESAT satellite. The Reshetnev Company was responsible for the design, development, manufacture and in-orbit delivery of the satellite. The enterprise was also involved in the creation of the payload's structure and its integration with the liquid temperature control system.

The application of the latest technologies to the SESAT satellite, as well as the payload's considerable power resources allowed installation of eighteen high-capacity Ku-band transponders. These are capable of distributing service zones between two fixed shaped antennas and one steerable circular antenna. The satellite's service life is 10 years. The satellite itself, all its onboard systems and equipment, as well as materials and components comply with the European quality standards.

The first telecommunications satellite, manufactured by the enterprise under the international contract, was successfully launched into orbit from the Baikonur launch site on April 18, 2000. The SESAT satellite is still in operation, serving the EUTELSAT fleet from 35,9°E. The satellite's service areas encompass European Russia, Western and Eastern Siberia.

Nowadays the JSC "Academician M.F. Reshetnev "Information Satellite Systems" participates regularly in international tenders, presenting its advanced satellite telecommunications projects. As a consequence, the company has already won two contracts for the manufacture of telecommunications satellites. The first one is AMOS 5 ordered by the Israeli communications service provider SPACECOMMUNICATION LTD., and the second is TELKOM 3 for the Indonesian operator PT Telekomunikasi Indonesia Tbk. Both satellites will be based on the high-performance unpressurised platform Express-1000.

New generation of the Express-AM telecommunications satellites

The successful operation of the SESAT satellite provided for EUTELSAT's orbital constellation, and the satellite's high-performance technical and operational characteristics attracted the attention of the federal unitary enterprise "Russian Satellite Communications Company", the operator of the Russian national orbital constellation of communications satellites.

The SESAT's platform, qualified in accordance with European standards, allowed applying the modular design principle to satellite-building. The modular concept enabled the enterprise to manufacture spacecraft in the shortest possible time by integrating different, autonomously-developed and tested payloads into the same platform. The results of the platform qualification tests performed within the scope of the SESAT project proved the platform's power supply and temperature control systems to have considerable power and capacity reserves. Besides, with the advent of national photocells the platform power budget was further increased without changing the area of the solar arrays. All those factors contributed to further improvements in the platform performance and lifetime, and became prerequisites for the realization of the orbital constellation renovation program. Thus, as a result of the modernization of the service module used in the SESAT satellite, the Express-M platform appeared. It became the baseline platform for the new Russian telecommunications satellites of the Express-AM series ordered by the Russian Satellite Communications Company.

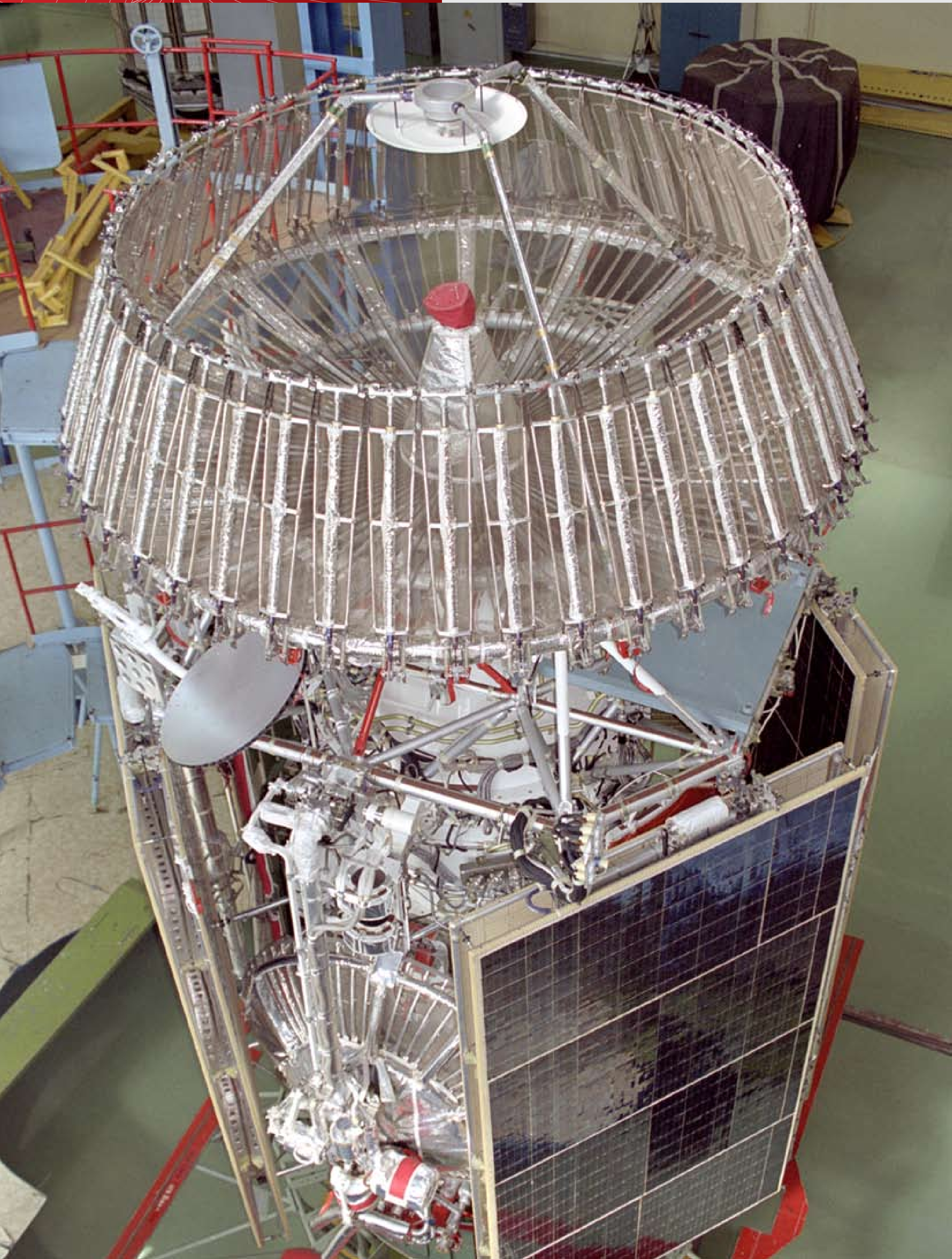
The payloads for the Express-AM spacecraft were provided by the French company Alcatel Space and NTSpace (Japan). The Reshetnev Company was responsible for the development, qualification, manufacture and delivery of the payload module structures, made of honeycomb panels with the built-in liquid cooling loops. The enterprise also provided the L-band antenna-feeder devices.

In accordance with the contract, the enterprise manufactured Express-AM22, Express-AM11, Express-AM1, Express-AM2, Express-AM3, Express-AM 33 and Express-AM44 telecommunications satellites, which were launched during the period from December 2008 to February 2009.

Upon successful completion of the testing and in-orbit acceptance operations, the satellites were injected into the targeted orbital positions and put into normal operation.

At present the Russian orbital constellation occupies 10 orbital positions in GSO, i.e. 14°W, 11°W., 40°E, 53°E, 80°E, 96,5°E, 99°E, 103°E, 140°E and 145°E. These slots were assigned to Russia's civilian C-, Ku- and L band satellites by the International Telecommunications Union. The aggregate orbital frequency resources allocated to Russia in C- and Ku-bands add up to 26 GHz, with the possibility of using two polarizations included.

Today the company's main priority is the creation of high-performance unpressurized platform series, which could compete with their foreign counterparts and form the basis for all the ISS satellite projects. It is the company's accumulated scientific and technical know-how that secured its victory in the competitive tender for the manufacture of the telecommunications satellites Express-AM5 and Express-AM6, held by the Russian Satellite Communications Company. These conceptually new spacecraft will employ the ISS's heavy unpressurized platform Express-2000 to provide fourteen-kilowatt power for the payload.



SIBERIAN LOUTCHES

In accordance with the Federal Space Program the JSC "Academician M.F. Reshetnev "Information Satellite Systems" is proceeding with work on the creation of the multifunctional space relay system (MSRS), Loutch. With the launch of up-to date relay satellites Russia will gain informational independence in terms of delivering connectivity to low-earth–orbit objects, such as launchers and boosters, unmanned and manned space vehicles and the Russian segment of the International Space Station.

In February 2009 the company entered into a State contract that stipulates manufacture of an additional Loutch-4 data relay satellite to be used alongside with the Loutch-5A and Loutch-5B spacecraft that are currently being built for the Loutch MSRS.

Loutch MSRS

This is the second contract between the JSC "ISS" and the Federal Space Agency for the establishment of the Loutch multifunctional space relay system. The first contract was made in 2005 and involved a set of operations on the development of two middle-class spacecraft: Loutch -5A and Loutch -5B based on the advanced Express-1000 platform. However, the plans were later revised. As a result, the Federal Space Program was rectified and then approved by the Government of the Russian Federation in 2008. It was decided to include a third spacecraft in the system, the Loutch-4 data relay satellite, with a greater technical advantage over the first two satellites. Loutch-4 will be built on the Express-2000 platform developed for heavy-class spacecraft. The satellite mass will total approximately 3 tons. It will be delivered into orbit by a Proton–M / Breeze-M launcher.

The Loutch-4 spacecraft will comprise a payload module with the repeater equipment, performing the same functions as in Loutch-5A and Loutch-5B, and a number of additional functions. In particular, the satellite will have a satellite-to-satellite KA-band communication channel and an experimental transponder for the mobile personal satellite communications system. In accordance with the terms of the State contracts, the Loutch-5A spacecraft is scheduled to be launched in December 2010, Loutch-5B is to be injected into orbit in December 2011 and Loutch 4 will be delivered to its designated position in December 2013.

Mission

Data relay spacecraft are designed for relaying low-altitude spacecraft data. The term "low-altitude" refers to all spacecraft operating in orbits at an altitude of up to 2000 km. Relay satellites are designed for receiving and processing telemetry and target data in real-time and its transmission to various receiving points located on the Earth's surface. One of the main tasks for relay satellites to perform is to provide data reception and data transmission from the International Space Station.

The period within which the Russian segment of the International Space Station is able to communicate with mission control centers is only 2.5 hours per day. During the remaining time our cosmonauts have no communication with the Russian MCC; they are in no communication during space walks either, which is absolutely unacceptable. In case of emergency only a mission control center can make adequate decisions and give appropriate recommendations to the crewmembers.

Today Russia purchases US satellite communication services provided via data relay satellites orbiting over the Atlantic. It costs our country several million dollars annually. With the launch of Russia's own data relay satellites, the country will gain complete independence when communicating with the International Space Station and will be also able to provide data relay services for other countries.

What is a third satellite needed for?

Russia has been allocated three orbital positions in GSO for the Loutch system: at 16° W longitude over the Atlantic, at 95° E over the Indian Ocean and at 167° E over the Pacific Ocean. When three data relay satellites are placed into these orbital positions almost all the Earth's surface except "polar caps" will be visible. Besides, the simultaneous operation of the three satellites will enable low-altitude spacecraft to interact with mission control centers located on the territory of Russia almost all the time.

It was initially planned to place Loutch-5A and Loutch-5B into orbital positions at longitude 16° West over the Atlantic Ocean and at 95° East over the Indian Ocean. However, in 2007 a Presidential Edict was issued to initiate construction of a new launch site, Vostochny, in the Russian Far East. Vostochny will be located at the site of the former Svobodny Cosmodrome. The new launch site is being built for launching carrier rockets of all types including heavy launch vehicles.

Phase 1 of the construction work is to be completed in 2014-2015. The overwhelming majority of launches will be performed eastwards; consequently, rocket trajectories will run over the Pacific Ocean. Currently, there is no possibility to receive telemetry data during this flight phase. Only a relay satellite set at 167° E will enable observation of all trajectories beginning from the Vostochny Cosmodrome, and consequently, it will be possible to receive data from any launcher or any booster. The possibility of tracking launchers and boosters lifting off from the Vostochny Cosmodrome was one of the reasons for the introduction of a third data relay satellite into the Loutch system.

Background

The ISS first started to manufacture data relay satellites in the late 1970s.The first of them, Loutch, was injected into the geostationary orbit in October 1985 to provide communication with the Buran space shuttle. Later the Loutch spacecraft served the Mir space station and was also used to perform a number of other missions. In 1995 Loutch-2 was launched into orbit; its mission lasted for three years. The last of the older generation data relay satellites came out of action in 1998. Since then Russia has not had its own spacecraft of this type. New data relay satellites that are being built by the JSC "ISS" will continue the mission of the Loutch satellites. Moreover, new satellites will have a number of additional functions. Unlike Loutch and Loutch-2

which had a three-year lifetime, Loutch-5A and Loutch-5B are expected to operate in orbit for 10 years, and Loutch-4 is expected to run for 12 years.

Extension of the Federal Space Program

At present ROSCOSMOS, the federal authority responsible for the formation of all conceptual directions of the Russian space industry development, is entrusted to prepare a draft federal space program covering the period until 2020. The JSC "ISS" prepared a proposal to support and develop the constellation of data relay satellites up to 2020. Loutch- 5A and Loutch -5B are expected to be replaced with multifunctional spacecraft. The first in this line is the Loutch-4 data relay satellite. It is worth mentioning that this spacecraft will be performing the same missions as satellites of the US Advanced Tracking Data and Relay Satellite System (ATDRSS).

The ISS provides payload modules

Spacecraft for the Loutch MSRS are being built in time-tested cooperation with other Russian space enterprises. Moreover, to implement the project the JSC "ISS" engages foreign partners, in particular the European company, Thales Alenia Space, and its branches located all over Europe, and the Japanese firm, Sumitomo. Sumitomo manufactures low-noise amplifiers and transmitters. Thales Alenia Space supplies power amplifiers and some other components of the on-board repeater equipment. Today these companies are making component parts of payload modules for the Loutch -5A and Loutch -5B spacecraft.

In cooperation with the Russian enterprises the JSC "ISS" has elaborated all the required design documentation for the Loutch -5A spacecraft. At present the satellite and its constituent parts are undergoing ground experimental tests. The satellite components are scheduled to be completed in the second half of the year, after which they will be prepared for the assembly. The foreign components supplies for the Loutch-5A spacecraft are due in the second quarter of 2009.

It is important to note, that to manufacture the payload modules for Loutch-4, Loutch-5A and Loutch-5B the ISS's specialists are applying a new development scheme. It differs from the previous ones in that, that for the fist time the ISS has taken full responsibility for the integration, assembly, adjustment and output characteristics of the payload modules for these spacecraft. Besides, the company manufactures a large number of PLM's components: the structure, the thermal control system, mechanical systems, the antenna feeder system including all feeder circuits and RF elements, and the antenna pointing system. All that points to the fact, that the company has considerably increased its share of satellite-building work and has reached a new level of satellite-building technologies.

SATELLITE NAVIGATION OF THE 21ST CENTURY

Development of satellite navigation is one of the principal conditions for successful performance of a great many economic, scientific and production tasks. Space navigation technologies have been widely applied in various fields of Man's activities, as well as in all the spheres of social, military and state policies of the developed countries.

Traditionally, the JSC "Academician M.F. Reshetnev "Information Satellite Systems" has been the only enterprise in Russia engaged in the development and manufacture of navigation satellites and systems.

It started with Tsyclon

The history of space navigation begins at the enterprise and covers more than one generation of spacecraft. All in all, the ISS-Reshetnev, jointly with the cooperating enterprises have created two generations of radionavigation systems. The first one was based on the spacecraft Parus and Nadezhda, whereas the current, second-generation systems employ Glonass, Glonass-M and Glonass-K satellites.

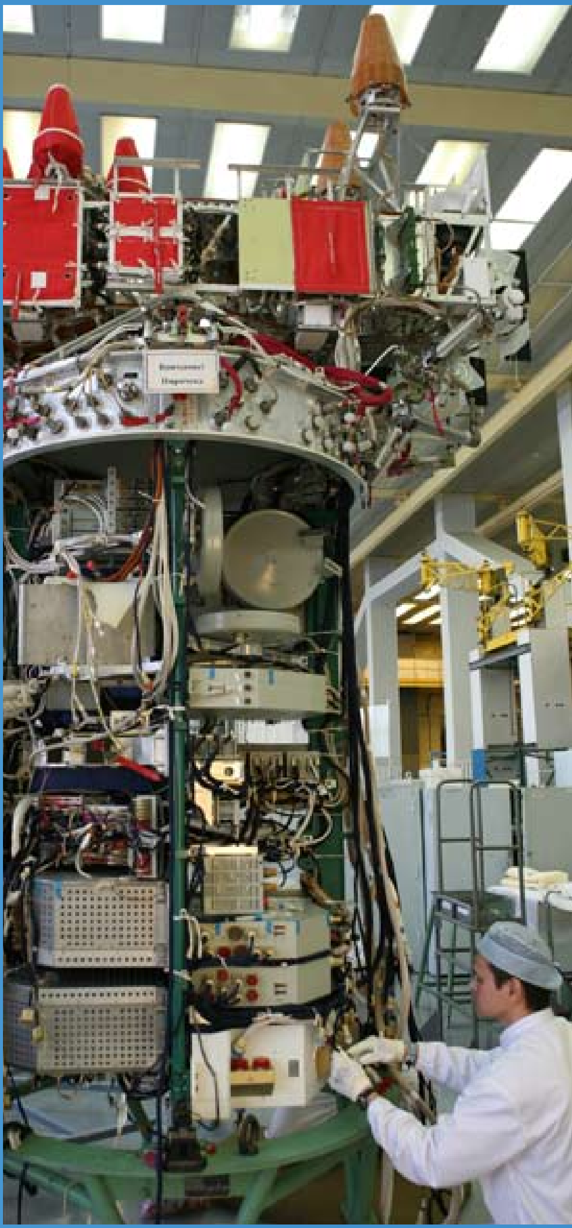
Having established the world's first integrated satellite navigation and communications complex, the enterprise became the father of satellite navigation in the USSR. Leaping ahead, it is worth mentioning, that the Reshetnev Company also played a leading role in developing other navigation systems, such as Tsyclon, Tsikada and Glonass.

Tsyclon's information characteristics were quite different from the American counterpart's, which only allowed determination of plane coordinates. The Soviet radionavigation satellite was equipped with a repeater designed to provide radiotelegraphy communications between submarines and ships of the naval forces and costal surveillance posts. The satellite was also capable of sending an additional radio signal at a frequency of 10 GHz. Communications were provided both within the radio visibility zones and globally, with a transmission delay. The additional radio signal was intended to correct the ship's navigation system. So, the satellite's increased functional load enabled it to perform both navigation and communications missions, thus, generating the definition of the navigation- and communications system.

The original attitude control system, developed for Tsyclon by the Siberian specialists, became a remarkable achievement in the Russian satellite industry. The invention was granted more than 40 copyright certificates.

The first navigation and communications satellite Tsyclon was delivered into orbit in 1967. The second one, named Kosmos-220, was launched in May, 1968. By the start of the 1970s, the enterprise had completed the deployment of the full-scale satellite navigation system. The first Siberian navigation satellites enabled their users to determine their coordinates once in two-three hours with an accuracy of 1 km.

In 1970 the experimental navigation and communications complex was put into trial operation. In general, 25 spacecraft of the Tsyclon series, with a six-month service life, were launched into orbit. Further work on the first-generation, low-orbit, navigation satellites was carried out within the scope of the Tsyclon-B project. While the military navigation system was undergoing its operation phase, a civilian navigation satellite was developed. The first spacecraft, named Tsycada (also known as Kosmos-883), with a two-year service life, was launched on December 15, 1976. All in all, twenty one satellites of this type were launched into orbit.



A hope for people in distress

The Siberian Tsycada spacecraft generated creation of a new satellite intended for the Russian segment of the International Search and Rescue System.

In 1977 at the working meeting held in Washington, representatives of the USSR, USA, France and Canada agreed to create two independent orbital constellations within the scope of the space search and rescue system intended for ships and airplanes suffering distress. Both subsystems, yet employing different satellites, were to complement each other due to their compatible performance specifications. The Soviet system was named COSPAS, and the foreign one – SARSAT (Search And Rescue Satellite-Aided Tracking).

In January 1978 the Council of Ministers of the USSR passed a resolution to initiate work on the establishment of the space search and rescue system COSPAS. The satellites were equipped with a special radio complex that relayed signals to determine geographical coordinates of special emergency

beacons, which turned on automatically aboard ships and aircraft suffering distress. It ensured effectiveness of search-and-rescue operations. Satellites of the COSPAS-SARSAT system were named Nadezhda. The first of them was launched in 1982.

With the two-year target life, the satellite successfully operated for almost 6 years. The Nadezhda spacecraft, jointly with two American weather satellites formed a new, functionally-integrated segment of the International Search and Rescue Satellite-Aided System, though based on autonomous satellites. The COSPAS system was put into operation in December 1987.

Global Navigation System

Development of a new satellite navigation system, originally named GLONASS, was assigned to the team of specialists under the guidance of M.F.Reshetnev. Over 100 design versions were proposed for the system, including those which were intended for low, high and geostationary orbits. Finally, it was decided on the medium circular orbit. The Russian project stipulated creation of a permanent orbital constellation to consist of 24 satellites (8 spacecraft in each of the three planes) and to operate in medium orbits. It was planned to perform a multiple satellite launch atop a heavy-lift Proton launch vehicle, capable of delivering three satellites at once.

The draft design, preliminary data, design documentation and technical requirements for the on-board systems were completed in the late 1970s. The novelty of the tasks for the Glonass satellite to perform demanded a great deal of intellectual effort. In October 1982, three Siberian satellites, Kosmos-1413, Kosmos-1414 and Kosmos-1415, developed by NPO PM and manufactured by the Production Association Polyot, were launched. One of them was a real satellite, whereas the other two were mock-ups.

Launch of the first navigation satellite was an important milestone in the history of NPO PM. By that time the enterprise had already gained experience of establishing and operating navigation systems based on low-altitude satellites Tsyclon and Tsycada. However, the Glonass spacecraft was completely different from all its prototypes. In particular, it required new ground controls. With the assistance of both military and civilian specialists the necessary equipment was assembled within a year; software was installed, and preliminary tests were conducted in the Satellite Operation Center.

In 1993 the system consisting of twelve Glonass satellites was put into operation. By the end of 1995 the number of satellites was increased up to the optimal quantity so that the system could stand on par with America's highly-precise satellite navigation system. The on-going reforms hit the country's raw nerves: society, economy, science and science-intensive production. In fact, investments in many space programs, including GLONASS were cut off. Left unreplenished for several years the system degenerated. In spite of all the attempts to restore it, no noticeable results were achieved.

The revitalization of the GLONASS system began in recent years with the advent of the second-generation navigation satellites. The system modernization and development is the subject of special attention of the President of the Russian Federation Dmitry Medvedev, the Chairman of the RF Government Vladimir Putin and the Vice Chairman of the RF Government Sergey Ivanov.

The GLONASS system is to be replenished with the second-generation, medium-orbit Glonass-M satellites. That is currently one of the prime tasks of the JSC "Information Satellite Systems". The system is to form the basis of Russia's geoinformation space. It will enable the country to advance its national and regional economies, improve the living standard of millions of people, ensure the national defence capability and population security.

At the start of 2009 the national orbital constellation numbered 20 satellites, which is sufficient to provide high-precision navigational sighting over the entire territory of the Russian Federation. In 2010 the GLONASS orbital constellation is expected to comprise 24 satellites, which will ensure high-precision navigational sighting over the whole globe.

The Federal Target Program stipulates development and manufacture of the Glonass-K spacecraft which is intended to have a longer lifetime, improved performance specifications and increased number of navigation signals. The launch of the first Glonass-K satellite is scheduled for 2010. It will be delivered into orbit in tandem with two Glonass-M spacecraft by a Proton-M/DM launch vehicle.

In 2008 the Government of the Russian Federation adopted amendments to the Federal Target Program GLONASS (Global Navigation Satellite System) stipulating further development and improvement of the national constellation. In accordance with the amendments, it is projected to form reserves of orbital and ground backup satellites. In total, the orbital constellation is to contain 30 satellites counting the orbital reserve. It will ensure steady operation of the constellation, satellite availability, and operational reliability of the GLONASS system. Implementation of these program activities will definitely ensure further development and effective use of the Glonass system by introducing advanced satellite navigation technologies in the interests of the country's social and economic development, national security and leading positions on the global satellite navigation market.

REVIVAL of space geodesy

Today's Russia has sufficient financial and manufacturing resources to develop different branches of science and technology. One of the country's most important tasks is to regenerate space geodesy so much needed for Russian science to update cartographic models of the Earth and its geophysical parameters. To carry out this governmental task, the JSC "Academician M.F. Reshetnev "Information Satellite Systems" is currently creating the next-generation geodetic spacecraft GEO-IK-2, intended to perform high-precision geodetic measurements.

The history of Russian geodesy dates back to 1965, the year of the creation of the first paper geodetic vehicle Sphera. The satellite itself was developed and manufactured by NPO PM (now JSC "Information Satellite Systems"), and launched into the near-polar orbit from the Plesetsk launch site on February 20th 1968. It employed the flashing light warning system to enable determination of the satellite's position relative to the stars with a precision of 3-6 arcseconds. The satellite also had radio technical equipment to determine its Doppler velocity with a precision of 0,1m/s.

The exploitation of the Sphera satellites in the 1970s allowed solving a number of scientific and practical problems. Due to these satellites, a unified world geocentric coordinate system was established; elements of orientation of the 1942 coordinate system (CS-42) were reviewed and specified; the planet's geophysical parameters were evaluated and the 1977 Earth model was created. All that allowed a more effective use of geodetic data. Besides, now less time was spent on equipping the national geodetic network with triangulation station marks.

Another milestone in the history of Russian geodesy came with the creation of the GEO-IK geodetic satellite, which was launched into the near-polar circular orbit from the Plesetsk cosmodrome on January 22nd 1981. The satellite was designed to perform a greater number of missions, including specification of the Earth's configuration and expansion coefficients of the planetary gravitational field, and studies of the Earth's fine structure. The GEO-IK satellite was equipped with high-precision radio-technical apparatus, including ranging equipment, a Doppler, laser reflectors and a radar altimeter. The last of the GEO-IK satellites stopped its in-orbit operation on February 5th 1999. In the aggregate, the GEO-IK's mission lasted for 20 years. As a result, there appeared two geodetic Earth models, Parameters of the Earth set for 1986 (PZ-86) and 1990 (PZ-90); the SK-95 coordinate system was put into effect. All in all, eighteen Sphera and fourteen GEO-IK satellites were launched into orbit.

To improve the accuracy of geodetic measurements in accordance with the customers' requirements, the Reshetnev Company proceeded to the development of the GEO-IK-2 geodetic satellite in the mid 1980s. The first version was unified with the Estapheta spacecraft and consisted of a pressurized container, five meters high and two meters in diameter, a boron-aluminum astroplate, solar arrays and gas-liquid temperature control system radiators with a cooling capacity of 3.5 kW. The satellite weighed 4.5 tons. To provide the pointing of the radio altimeter's antenna axis against the local gravitational vertical with an accuracy of 15 arc minutes, the satellite employed a precision attitude and orbital control system, with the gyro device being the "heart" of the system. Its "eyes" were the three devices of the precision astro-measuring system. The mass and the power consumption of the attitude and orbital control system made up 500kg and 1000 W correspondingly. The altimeter's mass and power consumption were 210kg and 500W. The solar array, a unique mechanical system with a total area of 75 m^2, provided a smooth deployment of a five-meter, three-link antenna boom and solar panels.

The manufacture of the satellite was assigned to Krasmash (Krasnoyarsk-based machine-building plant). The spacecraft was to have been launched in 1994-1995 by a Zenit launch vehicle. Nevertheless, the events of the early 1990s interfered with the work completion. With the state financing reduced, the enterprise prepared a new satellite design. The satellite was planned to be launched atop a Soyuz-2 launch vehicle.

However, neither the first design concept nor the second had ever materialized. In 1977 the government discontinued the project financing. Yet, a number of technical solutions found for the GEO-IK-2 satellite were later utilized in the company's next spacecraft. Thus, as a result of the second concept development there appeared the Glonass-M satellite. After the economic situation had stabilized in 2001, the financing of the GEO-IK-2 project was considerably increased.

At present the JSC "Information Satellite Systems" is completing the ground experimental development tests of the GEO-IK-2's third version that is being built in accordance with strict technical specifications for measurement systems. The satellite consists of a pressurized container, that is 1.3 m in diameter and length, heat-regulation shutters, honeycomb panels (with a radiator), and an astroplate with an antenna assembly and rigidly fixed solar arrays.

The satellite is unified with other spacecraft manufactured by the JSC ISS. The satellite unification speeded up the process of its development. In particular, some elements of the electric power supply system and the thruster units of the propulsion system were taken from the Glonass-M spacecraft, parts of the attitude and orbit control system were borrowed from SESAT, Express-AM and Loutch-4.

The GEO-IK-2 satellite is the basic element of the similarly-named geodetic satellite system intended for performing geodetic analyses. For instance, the GEO-IK system allows determination of the Earth's gravitational field parameters; creation of high-accuracy geodetic networks in the geocentric coordinate system; observations of the continental plateaus movement, tides and the Earth's rotation speed. Besides, with the help of the GEO-IK system position coordinates of ground points can be determined with high accuracy, which is crucial for regional geodetic networks, remote sensing of the Earth, determination of the geoid and monitoring of the ice conditions.

The GEO-IK-2 system will consist of two spacecraft to perform geodetic measurements and determine orbit characteristics (height above the sea surface). The satellites will be injected into the sun-synchronous orbit with a mean altitude of 1000 km at an inclination of 99.4° by a Rokot /Breeze KM launch vehicle from the Plesetsk cosmodrome. To carry out their missions the satellites will employ the following equipment: the Sadko radio altimeter manufactured by Thales Alenia Space, the Doppler system, the onboard synchronizing device, laser retro-reflectors, on-board ranging equipment and the Doppler receiver. These are the satellite's basic instruments qualified for operation in space.

At present the JSC "Information Satellite Systems" is conducting dynamic tests to verify the dynamic strength of the spacecraft. It is planned to launch the first GEO-IK-2 satellite in December 2009. Its launch will herald the revival of the Russian geodetic satellite constellation and the resumption of the geodetic satellite system after a lapse of twenty five years.

THE NEW ERA of small satellites

It is already a year since the launch of the small satellite Yubileiny manufactured by the JSC "Academician M.F. Reshetnev "Information Satellite Systems" in cooperation with other Russian enterprises. The successful launch of the satellite performed on May 23, 2008 heralded a new milestone in the history of the small-class spacecraft. The Yubileiny project was also remarkable for its educational mission, as it brought together students and scientists of the Siberian State Aerospace University and young specialists from the Information Satellite Systems.

By the beginning of the 21^{st} century the Information Satellite Systems had already gained a wealth of unique experience of manufacturing small-class satellites. Besides the large series of Strela-1 and Strela-1M satellites, the enterprise also manufactured radio amateur satellites of the Radio family. The company's recent Zeya, Mozhayets and Yubileiny spacecraft have also made an important contribution to the development of space technologies. By the way, the Siberian Mozhayets and Yubileiny spacecraft (launched in 2002 and 2008 correspondingly) are still carrying out their missions successfully.

Small satellites are used to test new ideas promoting informatization of modern society. They are effective means of mastering space technologies to facilitate the country's economic and social development; besides, they are attractive for a large group of radio amateurs and "creative young minds".

One of the Russian Federal Space Agency's projects, Space and Education, involves a wide use of space assets for exchanging information between universities and colleges. Small satellites are ideal for such educational programs; yet they fail to offer the fullest scale of educational possibilities.

Yubileiny's various missions

The Yubileiny satellite was created by the joint resolution of the Federal Space Agency, the Space forces of the RF Ministry of Defence and ROSTO's Central Council (Voluntary Association for Assistance to Army, Aviation and Fleet) within the scope of the program commemorating the 150^{th} anniversary of K. Tsiolkovsky, the 100^{th} anniversary of S.Korolev and 50^{th} anniversary of the launch of the first artificial satellite.

The project schedule was approved by Roscosmos and the Space Forces in July 2007. The satellite design, manufacture and testing were assigned to the ISS. The creation time was unprecedented. The project was launched in June 2007, and in August, after the necessary design documentation had been prepared, the enterprise proceeded to the manufacture of the spacecraft. The work progressed on schedule: the satellite was complete in October, and in November it was subjected to electrical testing. Six months after the project launch, the satellite was ready to be shipped to the launch site.

Unusual was also the economic aspect of the project, for the satellite was created on a voluntary basis. It was designed, developed, manufactured and launched at the expense of the project executors. The JSC "ISS", as the prime contractor, was responsible for every project milestone, from the elaboration of design documentation to satellite testing.

While working on the Yubileiny spacecraft, the ISS specialists developed and manufactured an advanced, unpressurized, multifunctional platform which is now expected to become baseline for an entire series of small spacecraft with masses ranging from 30 to 100 kg.

Yubileiny is a kind of a space laboratory used to conduct scientific experiments and tests of new equipment. It allows testing and improving remote sensing technologies, which is unprecedented experience in the history of the Reshetnev Company. Besides, it was used for testing the improved three-axis magnetic-gravitational attitude and orbit control system, created by the ISS.

An important contribution to the creation of the satellite was also made by other Russian space enterprises. Thus, Yubileiny's three new Earth and Sun orientation devices were provided by the JSC "Geophisika-Cosmos". The JSC "Saturn" supplied new-configuration gallium arsenide solar arrays. With the satellite launch, the new devices and systems got their flight qualifications.

A part of the project work was performed by scientists and students of the Siberian State Aerospace University, who developed nano-coatings to protect the on-board equipment from space radiation. To conduct scientific research and experimental activities, the satellite was equipped with sensors protected by different types of coating. As a result, the best protective coating was singled out; now it is planned to be utilized in new space technology, including the ISS's advanced satellites.

Apart from its scientific and technical missions, the small-class Yubileiny spacecraft served an important educational purpose. It was used as a teaching aid for training students within the scope of the project-oriented approach to the preparation of young specialists. The essence of the training method is that students get involved into the satellite-building process, from concept development to satellite-in-orbit control. It enables them to acquire the required competences, improve their educational and professional levels and solve complex technical problems.

At present the satellite provides voice and video transmission for radio amateurs all around the world. Now it is transmitting information about the Information Satellite Systems, its achievements and prospects, thus commemorating the 50th anniversary of the renowned Reshetnev Company.

Science, education and manufacture

The Yubileiny satellite introduced a new milestone in the history of education. Nowadays the Siberian State Aerospace University is creating a manufacturing base to assemble small-sized spacecraft in accordance with the Agreement on Strategic Partnership signed between the JSC "ISS", Aerospace University, Krasmash (Krasnoyarsk Machine-Building Plant) and the Krasnoyarsk Scientific Center (the Siberian Branch of the Russian Academy of Sciences). A series of small-sized satellites is to be built by students by 2012. When involved in the project, every participant is certain to be challenged by its scientific, technological and educational opportunities.

To implement the assigned tasks Nikolai Testoedov, the Director General of the Information Satellite Systems, and Gennady Belyakov, Principal of the Siberian Aerospace University signed an order in 2008 to establish a scientific and educational center "Space systems and Technologies". The Center's main mission was defined as a promotion of collaborative effort between scientists, students and the ISS specialists with regard to the design, manufacture and in-orbit testing of small-sized satellites. The joint efforts are beginning to show results. Thus, the preparation of the first group of SIBSAU's students for the participation in the Students' Small-class Spacecraft project was over in early 2009. By involving students into the satellite-building process the Information Satellite Systems prepares talented "space engineers", able to continue the tradition of the renowned satellite manufacturer. At present the JSC "ISS" jointly with SIBSAU are developing a new small-class satellite; 70% of work is assigned to the students.

Thus, due to the successful integration of science, education and manufacture, the Information Satellite Systems and Siberian Aerospace University have reached a new level of cooperation. The ISS as the principal designer and manufacturer of satellites will definitely benefit from the enormous scientific potential which the company is creating with the assistance of well-prepared, high-qualified young specialists.

ADVANCED TECHNOLOGIES

The Russian space industry is one of the few sectors that, despite the current economic conditions, tend to be demonstrating strong sustainability and besides, good progress in the development of the 21st century's advanced knowledge-intensive technologies. Modern spacecraft are characterized by an extensive use of new materials and technologies which prove to be effective as well as open possibilities for developing more sophisticated space technology.
The JSC "Academician M.F. Reshetnev"Information Satellite Systems" has pioneered a lot of new technologies in the last fifty years. Thanks to the accumulated experience and know-how, the company is today an acknowledged satellite manufacturer, whose spacecraft are highly competitive on the world's market.

Honeycomb structures

These structures seem rather unsophisticated at first sight. They resemble a "sandwich" with an aluminum honeycomb core bonded between two aluminum sheets. These honeycomb sandwiches are completed with special inserts which allow fixing the equipment and various structural elements.

The JSC "Information Satellite Systems" designs and manufactures three types of honeycomb structures. The first type is made up of load-bearing honeycomb panels used to form the basic structure. Panels of the second type are thermostated honeycomb panels with embedded liquid cooling loops and/or thermal tubes. Finally, the third type of panels is made of non-metallic materials and is used for special applications. When building a satellite, the company prefers a combined type that involves load-bearing and thermostated honeycomb structures.

In 2008 the Reshetnev Company launched production of large-sized honeycomb structures (3.5m×5.5 m). The first lot was designated for the test model of the Express-2000 platform. This satellite platform is intended to be used as a base platform for a series of advanced heavy-class satellites.

Nowadays the company is engaged in the manufacture of multi-layer honeycomb structures. At present they are made without embedded thermal control elements, but in the future the company is planning to. Multi-layer panels with carbon-plastic coatings were previously used in the ISS's antenna systems. Besides, the company has recently started manufacturing multi-layer panels with aluminum coatings.

Undoubtedly, the company is determined to develop the manufacture of honeycomb structures as they are essential for all its advanced satellite projects. Besides, the JSC "ISS" is prepared to manufacture and test honeycomb structures for Russian and foreign satellite-manufacturers on order.

Optical solar reflectors

Modern spacecraft employ a great deal of equipment. To prevent devices from overheating, it is essential to reject heat in outer space. It becomes possible due to the use of optical solar

reflectors, i.e. multi-layer composite coatings.

The JSC "Information Satellite Systems" has introduced a unique method of manufacturing solar reflectors. Their base is made of radiation-resistant glass, the rear side of which consists of a reflecting silver layer, protective nichrome layer and special nano-sublayers. The main distinctive feature of the composite coating is that it can reflect 90% of solar energy, whereas its emission is 86%. At present the Reshetnev Company is Russia's leading manufacturer of solar reflectors which stand on par with their foreign counterparts. Moreover, the company has introduced a new method of coating glass by applying a transparent electro-conductive nano-layer. As a result, the coating becomes electro-conductive; plus no deteriorating effect is produced on the optical coefficients.

Radio-absorbing honeycombs

Load-bearing honeycomb panels make up the core of the radiating system, with radiators mounted on one side, and cables and devices on the other. The use of aluminum honeycomb panels in this case is unacceptable, as the re-reflection of electromagnetic waves from the metal base will cause distortion of the gain frequency characteristics and the LP antenna feed pattern. To exclude the re-reflection effect on

the antenna signal, the ISS specialists have developed a radio-absorbing material. It consists of a polymeric honeycomb filler and a nichrome coating. To reinforce the radio-absorbing capability the ISS specialists offered a three-layer structure of radio-absorbing materials with different dimensions of cells.

In Russia there is no substitute for the invention. As for its foreign counterparts, their mass is twice as much.

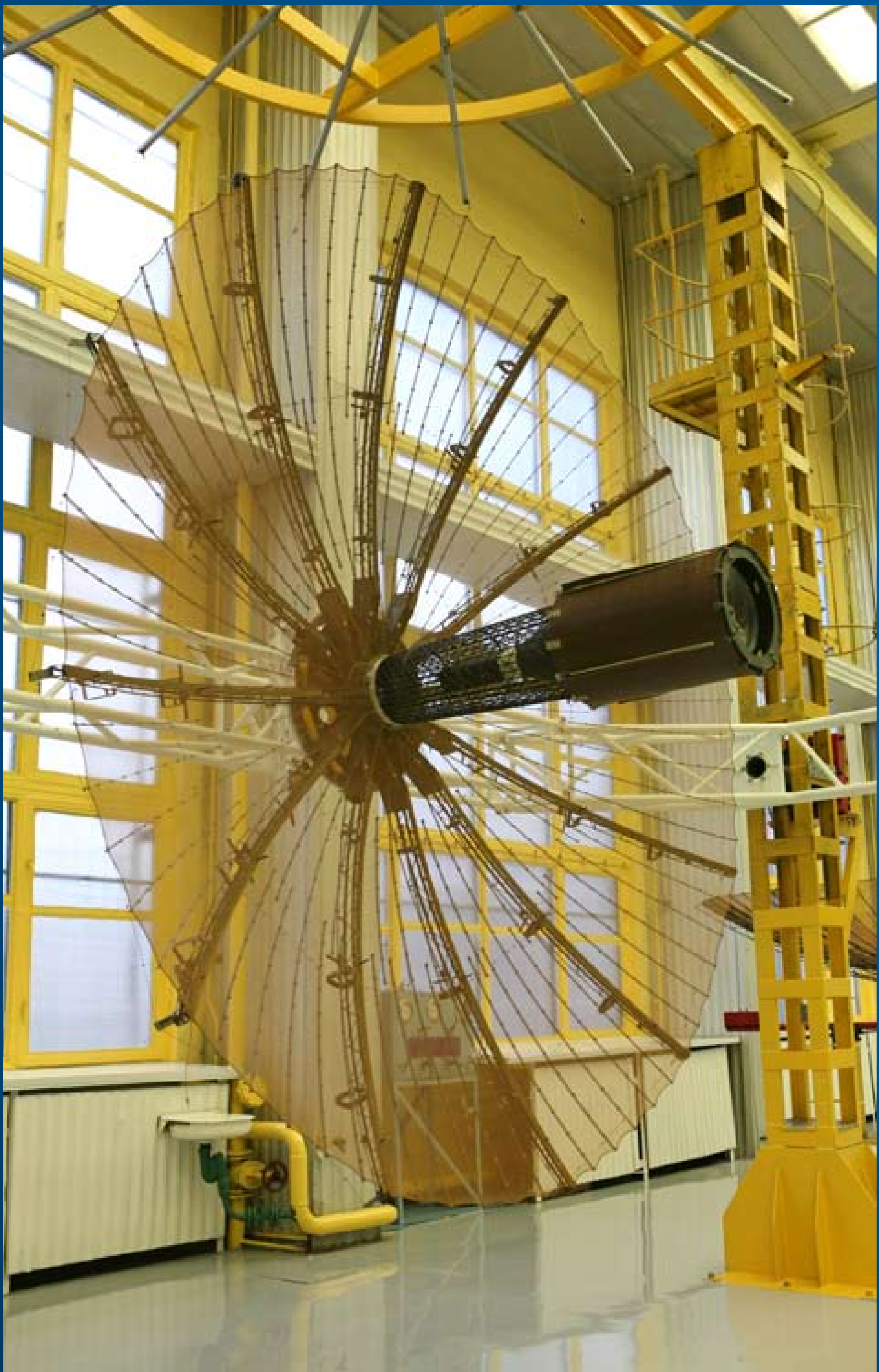
Radio–reflecting mesh

Advanced foldable antennas require a flexible radio-reflecting surface. The ISS specialists in cooperation with the Kosygin Moscow Textile University have developed a special radio-reflecting mesh made of fine tungsten wires (15 microns in diameter).

The mesh has a number of unique mechanical and technical characteristics. For instance, it is light and strong; it does not loosen or shrink; it quickly restores its form after mechanical effect and so ensures dimensional stability of a reflector.

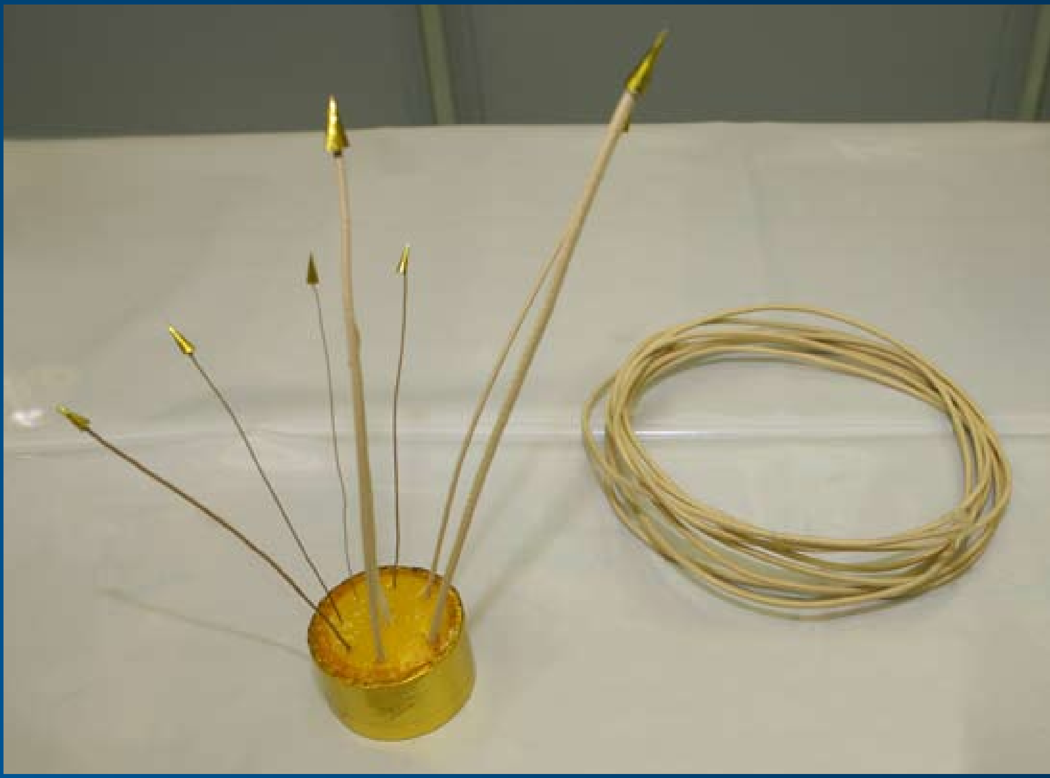
The required reflection coefficient (not less than 98%) was obtained in the course of developing the mesh-gilding technology. The ISS-Reshetnev has also introduced mesh-cutting and mesh-lacing methods.

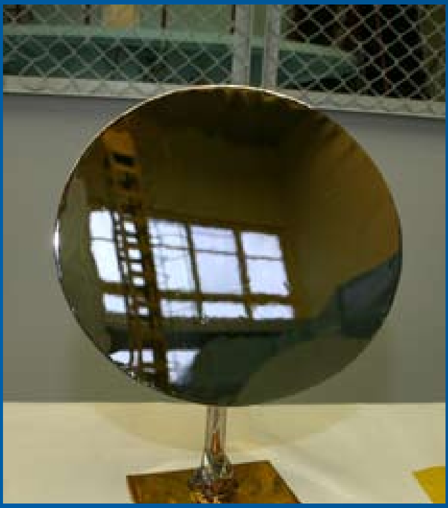
It is worth mentioning that no other Russian enterprise can handle technologies like these. The JSC "ISS" is also planning to launch the technology of gilding 15-micron tungsten wires. These will be used for knitting large-sized meshes; another aim is to reduce the size of laced joints.



Composite materials

Nowadays composite materials make up a larger proportion of new-day satellite materials. In particular, reflectors are made of composite materials. When in orbit, a reflector is illuminated in accordance with a cyclogram. No profile changes are allowed, even micronic. To solve the problem of uneven light intensity, the ISS specialists have developed a transparent reflecting coating to combine three properties: electro-conductivity, solar reflectivity and radio transparency. The coating covers the front surface of the antenna and reflects the solar light. Further improvements on the technology allowed applying the coating on both antenna surfaces. Speaking of the technical characteristics, the ISS-made coating is now one of the world's best space material samples.





Radio-transparent thermostatic coating

When a satellite moves in orbit, its antenna parts are exposed to different light conditions. That results in temperature fluctuations and can cause deformation of reflectors and radiators. To eliminate these processes, the ISS specialists have developed a radio-transparent thermostatic coating. It is a polyamide film coated with germanium and characterized by the properties of electro-conductivity, solar reflectivity and radio transparency. This coating material is used in reflector shields and radiators to protect them from overheating. It can be applied on either surface.

The radio-transparent thermostatic coating developed by the ISS-Reshetnev is a wonderful example of the latest satellite-building technology. In addition, the company has recently developed and experimented with a new thermostatic coating, reinforced with glass fabric.

Dimension-stable cords and tapes

When designing a foldable antenna, it is crucial to find answers to two fairly important questions: how to create a specified reflector profile and how to keep it unchanged in outer space?

To shape the structure of a foldable reflector as well as provide high accuracy of the reflector surface profile, the ISS specialists have developed high modular, dimension-stable cords and tapes. Thanks to the application of composite materials, they are flexible, highly transparent, creep- and radiation resistant, and have a low thermal expansion coefficient of carbon-plastic.

Flexible tape pins

Some of the ISS-made satellites are equipped with the passive, magnetic-gravitational attitude and orbit control system intended to orient a satellite's axis towards the Earth center. One of the system elements is a flexible, foldable tape pin. It is used for moving out a magnetic damper to the specified length.

The pin is a pipe with edges crossed at 180 degrees. When a satellite is in a stowed position, the pin unrolls into a tape and then reels onto the take-up drum. While a satellite is transferred to its target orbit, the pin reels off the drum, rolls into a pipe (owing to its elasticity) and moves out the magnetic damper.

At present tape pins are manufactured by UKRNIIMET. They are made of spring alloys with a density of 7.9 g/cm^3. To reduce the structure mass the ISS specialists have developed a polymeric composite material with a density of 1.4 g/cm^3 and a thermal expansion coefficient equal to 0.5*10-61/K.

The tape pin passed its flight qualification tests aboard the Yubileiny spacecraft. The device is designed to perform 50 movements and besides, is capable of retaining its elasticity in the course of time.

By its remarkable achievements, the Information Satellite Systems has been demonstrating over and over again its leadership in the Russian satellite industry. Yet the company's present position is not the reason for the enterprise to wrap up its innovative activities. On the contrary, the ISS-Reshetnev seems to be never satisfied with what has been achieved, and so has been always in search of new solutions.

RE-EQUIPMENT AS A SUCCESS REQUIREMENT

The JSC "Academician M.F. Reshetnev "Information Satellite Systems" will be provided with government funds within the framework of the GLONASS Federal Target Program to reconstruct and re-equip its production and experimental facilities so as to launch the Glonass-K spacecraft production.

The company started analyzing its equipment needs as early as 2000. As a consequence, there appeared a long-term re-equipment plan, with activities prioritized and main expenditure articles approved. Today, with all the equipment needs clearly defined, the company has found it easy to formulate its manufacturing requirements for the Glonass-K satellite project.

The project plan includes modernization of the company's existing production and experimental facilities, procurement of modern metal-working machinery and reconstruction of the utilities systems. In particular, it is planned to procure a five-axis machine unit intended for shaped antennas and large reflectors, as well as purchase equipment for the manufacture of antenna parts and antenna-feed items. Today these products must satisfy new technical requirements. For instance, the diameter of tuning screws used in modern antennas must keep within 0.3-1.2mm. The new equipment worth of 60 million roubles will enable production of such tiny items. It must be mentioned that to find a supplier of the equipment the company is planning to hold a competitive tender.

A significant amount of funds is to be allocated to the creation and equipment of the electrochemical workshop to combine electroplating and varnish-and-paint operations. Now these operations are split between four workshops. A site for the new workshop has been already allotted. With a view to business expansion, it was decided to set up the electrochemical workshop and a number of other production facilities on the adjoining territory. To tool up the electrochemical workshop with the latest machinery the company is planning to appropriate over 500 million roubles.

It is also important to mention that the new facility is going to meet all the ecological requirements. Thus, it is planned to reconstruct the treatment facilities so as to provide well-purified water for production purposes. By the way, the minimum use of water was stipulated a basic criterion when designing the new facility.

In general, the re-equipment project will run for three years. Over 800 million roubles will be spent on the equipment modernization and site preparation in 2009.


MODERNIZED GLOBAL NAVIGATION
SATELLITE SYSTEM
GLONASS-M
GLONASS-K
2003
2010
GLONASS
1982
GLONASS


TELEVISION NAVIGATION GEODESY
COMMUNICATION