RESHETNEV
COMPANY

INFORMATION SATELLITE SYSTEMS

March, 2008

"Express-AM" – the most powerful Russian satellites


The telecom satellite «Express-AM33» created by ISS-Reshetnev Company was successfully launched on January 28, 2008
WE ARE BUILDING BRIDGES OVER THE SPACE
RA-76840
EXPRESS-AM33

Dear colleagues,

Exploration and exploitation of the near earth space in XXI century has become one of the key developments indicating well-being of a state and its citizen's life amelioration. Today, the Russian military-industrial complex reformation is about to accomplish, the federal programs related to development of national orbital constellation of navigation and telecom satellites are running on.
Such major national projects as modernization of the space segment of the Global navigation satellite system GLONASS and replenishment of the telecom satellite orbital constellation are the priority tasks for the JSC «Academician Reshetnev «Information Satellite Systems « (JSC «ISS-Reshetnev Company») - an assignee of the FSUE «Academician M.F. Reshetnev research and development association of applied mechanics» (NPO PM).
In 2007, the «ISS - Reshetnev Company» built and put into operation six «Glonass-M» satellites within the frames of the Federal Program «Global Navigation System». These satellites ensure an 95% average availability of the navigation signal over the Russian territory and 83% over the globe.
The beginning of 2008 was marked with successful launch of the telecom satellite «Express-AM33». The satellite was built under the contract awarded by the Ministry of Information Technologies and Communications, Federal Space Agency and Russian Satellite Communications Company. Today, this satellite is the most powerful among others in the Russian orbital constellation. With the «Express-AM» satellites currently in use, the orbital constellation capacity increased 3 times.
In 2008, our company keeps on fulfilling the major national programs. Among the top priority tasks there is creating and launching six «Glonass-M» to provide users with navigation services all over the Russian territory. We shall continue developing a navigation satellite «Glonass-K» aimed at further replenishment of the orbital constellation GLONASS. To implement the program of the national satellite fleet renewal, a new satellite «Express-AM44» is scheduled to launch in the nearest future.
Another prospective field of activities for the ISS - Reshetnev Company is creation of small satellites. Today, the company is developing small satellites of the new generation with unsealed design. The first satellite of such design, a small spacecraft «Yubileiny» will be launched in 2008. In 2008 - 2012, we plan to build a series of small satellites for research-and-development and experimental missions in cooperation with the major Krasnoyarsk universities and companies.
These projects are mainly aimed at augmenting the Russian space industry potential. The state -of-art satellites built by «ISS - Reshetnev Company» in cooperation with national and foreign companies will favour Russia in moving to a new quality of communications, TV and radio broadcasting as well as in strengthening defense capacities of the country and will favourably present the country in the international scene.

Nickolay TESTOEDOV
General Designer and General Director
ISS - RESHETNEV COMPANY

RESHETNEV
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Information Satellite Systems

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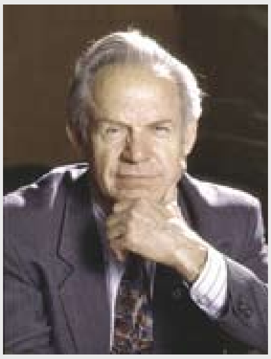
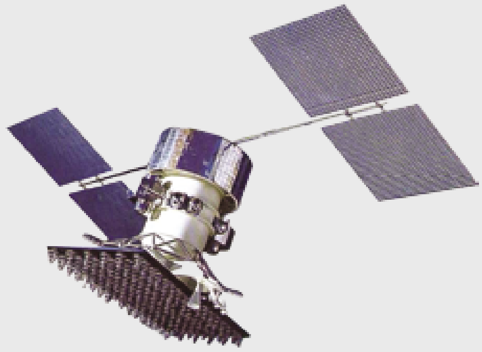


12 years since the death-day of Mikhail Reshetnev

12 years ago, on January 26, we lost Mikhail Fedorovich Reshetnev - the founder and top manager of NPO PM (now ISS-Reshetnev Company) since 1959. Within 36 years of his leadership NPO PM became one of the major companies of the space industry.

Mikhail Reshetnev is known as one of the outstanding scientists who contributed a lot to space exploration. In 1959 Sergey Korolev appointed him to a post of a head of the industrial design bureau's subsidiary enterprise in Krasnoyarsk region. This marked the beginning of the Siberian space industry development. In 36 years under Reshetnev guidance the enterprise became an up-to-date space company known for its unique spacecraft and space systems developments. Owing to his talent of a scientist and a manager, his persistence and responsibility Reshetnev could always attain national aims.

He managed to consolidate the people working at the company, to build up a large scientific, technological and production basis allowing NPO PM despite of strong competition to go further on creation of satellites of communication, TV-broadcasting, data relay, geodesy and navigation as well as to enter the international market.



20th anniversary of the satellite "Ekran-M" first launch

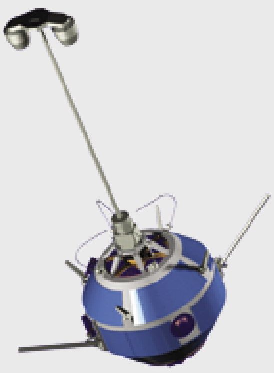
20 years ago, on December 27, 1987 the first satellite "Ekran-M" developed and built by NPO PM was launched into the geostationary orbit.

The satellite is a modernized version of the "Ekran" spacecraft. The satellite was designed to provide 24-hours direct TV and radio broadcasting throughout the Siberian and Russian Far East territory.

The satellite's mass is approximately 2000 kg, electric capacity - 1800W. It is equipped with two 300W transponders. In the late 1980-s, such capacity was the best showing ensured by a spacecraft.

The last "Ekran-M" was launched in 2001. Designed for 3-year lifetime, the satellite is still in use.

5th anniversary of the satellite "Mozhayets"



ON November 28, the small spacecraft "Mozhayets" built by NPO PM is already 5 years of age.

On November 28, 2002 the small satellite "Mozhayets" was launched from the "Plesetsk" launch site to be placed into the low circular orbit. It was developed and built by NPO PM specialists under the contract awarded by the Russian Space Forces.

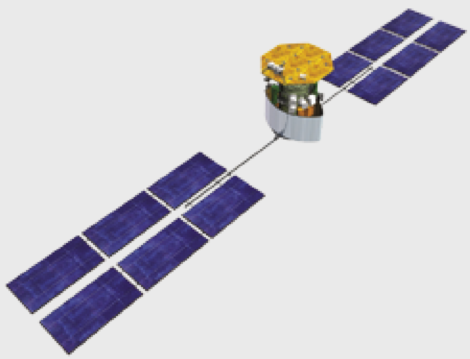
The satellite's mission is to obtain data related to electric and radiation fields that may influence the health of spacecraft systems. Moreover, it provides communications to the worldwide radioamateurs and is applied to for educational aims of the Mozhaysky military space academy as well as other large Russian universities.

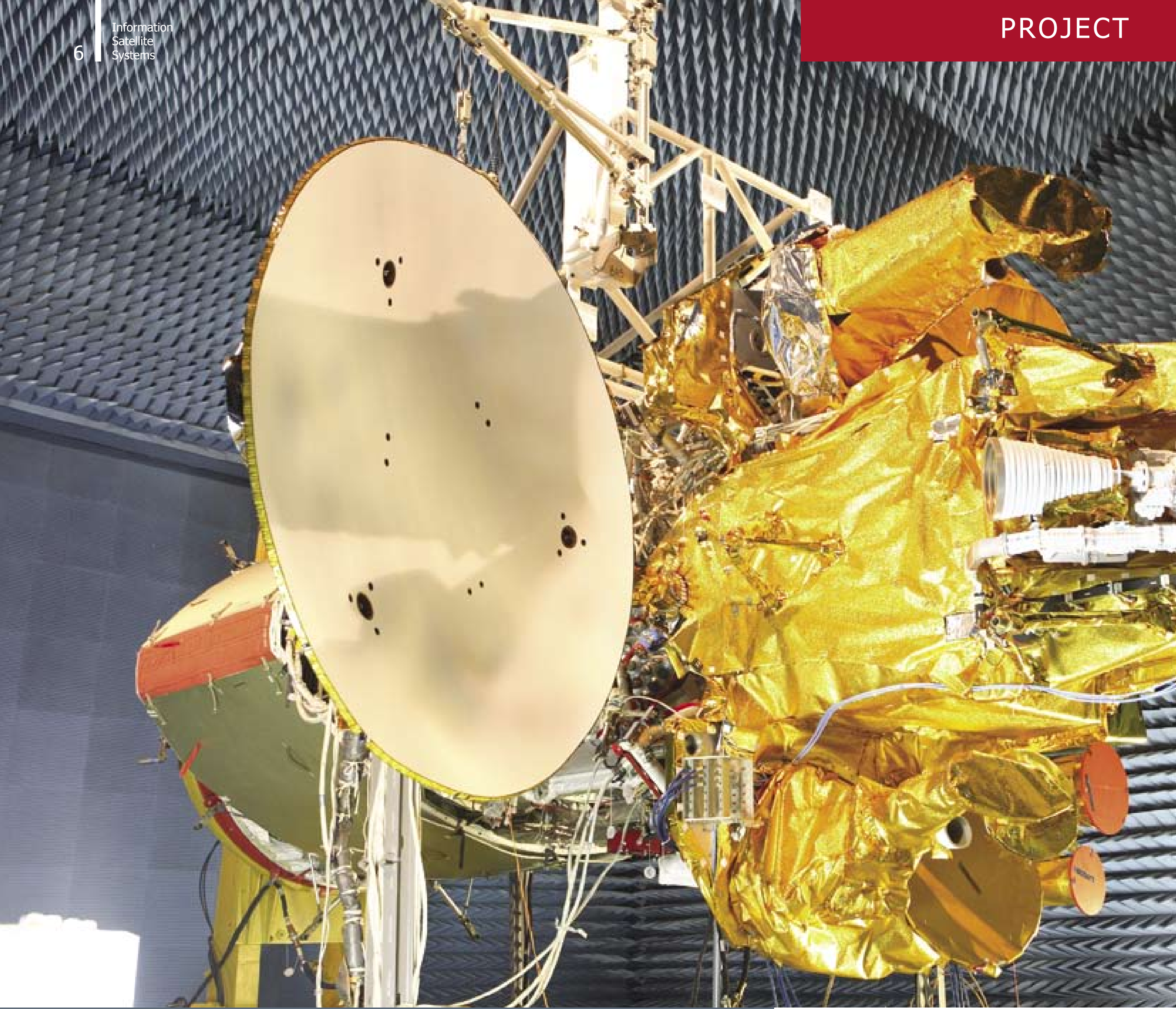
Initially, the satellite lifetime was to be 6 months only, but it has already 10 times extended its lifetime and is still functioning in the nominal operation mode.

"Raduga-1M"

ON December 9, 2007 a new communications satellite «Raduga-1M»developed and built by NPO PM was launched from the Baikonur Cosmodrome.

The satellite is equipped with the advanced multi-channel repeaters operating in centimetric-wave and decimeter-wave bands thus ensuring a stable communication with mobile stations including some hard-to-reach mountain regions.





The "EXPRESS-AM" constellation

The "Express-AM33" satellite was successfully orbited on January 28, 2008. The JSC "ISS-Reshetnev Company" (former NPO PM) built the satellite under the contract awarded by the Information Technologies Ministry, Federal Space Agency and Russian Satellite Communications Company. The 6th satellite of the "EXPRESS-AM" family was built and launched in accordance with the Russian telecom satellite constellation replenishment program.

Fulfillment of the "EXPRESS-AM" program

On August 25, 2001 the Russian Government signed the decree # 625 ensuring the governmental support in deploying and operating the national civil communications and broadcasting satellite systems.

In 2001, the Russian federal space program for 2001-2005 was approved announcing the provision of the global communications and broadcasting services all over the Russian territory to be of the high priority for the Russian space industry.

The target could be hit as soon as the national satellite constellation was replenished by launching the «EXPRESS-AM» telecom satellites of a new generation.

Reshetnev association of applied mechanics, a leading manufacturer of different class and mission spacecraft, was entrusted with this task.

The state contracts for development, production and transportation of the five «Express-AM» satellites took effect on September 4, 2001.

Within five years (2001-2005) following the contracts conditions, NPO PM developed and built satellites «Express-AM22, -11, -1, -2 and -3».

After the fifth «Express-AM» satellite had been put into service, the civil comsat national constellation successfully underwent replenishment with satellites of a new generation.

Owing to the new satellites with a higher capacity Russia kept its orbit and frequency resource as well as tripled the capacity of its satellite segment. The quality of communications and TV& radio broadcasting considerably increased. The fact that «Express-AM3» integrated capacity was 3.000 times better than that of the satellite «Molnia-1» launched in 1967, and almost 50 times better than that of the «Gorizont» satellites (which are being launched since late 1970-s) indicated the technical progress achieved with «Express-AM».

Owing to the «Express-AM» satellites the national orbit constellation floating along the geostationary orbit (40˚E - 140˚E) was added with 3 L-band, 67 C-band and 70 Ku-band transponders having power up to 140W and bandwidth up to 72 MHz.

The «EXPRESS-AM» program made a success and predetermined its further development. The Russian Federal space program for 2006-2015 approved by the Russian Government decree (# 635, October 22, 2005) determined the stages and terms of realization of the prospective satellite communications and broadcasting systems. Within the frame of this program on September 17, 2004 the Ministry of Information Technologies, Roscosmos, Russian Satellite Communications Company (RSCC) and NPO PM signed a state contract for procurement of two telecom satellites «Express-AM33» and «Express-AM44» equipped with more powerful transponders to solve various multimedia tasks.

The contract signed by RSCC took effect on July 1, 2006. In 18 months the first satellite «Express-AM33» was built and transported to the spaceport to undergo pre-launching operations. It was for the first time that a spacecraft was created in such an unprecedented period that usually takes 27 months.

The satellite development and creation were speeded up since it was necessary to inject the satellite till the end of February 2008 to be on time with the presidential elections.

The final stage of the contract will be injecting and putting into service the «Express-AM44» satellite, which is now undergoing operations according to the schedule approved by the customer. «Express-AM44» is scheduled for launch during second half of 2008.

The most powerful Russian satellites

All satellites of the "Express-AM" family were designed to provide secured mobile communications services for the Russian president and other top government officials, to provide federal TV and radio program broadcasting and its transferring into digital mode, deploy the government and corporation satellite communications networks needed for the State authorities, build satellite networks for the special-purpose data transmitting, fulfill the federal program "E-Russia". Moreover, the "Express-AM" satellites will provide commercial communications and broadcasting services including digital radio broadcasting, telephony, data transmission, wide-band Internet access, and videoconferencing.

The «Express-AM» satellites are being created based on the heritage of the scientific and engineering developments successfully implemented in the previous NPO PM programs as well as high qualification and large experience of the specialists involved.

They build the «Express-AM» satellites enjoying the advantages of the combination of national and foreign co-operation and space technologies.

Features	Express-AM22	Express-AM11*	Express-AM1	Express-AM2	Express-AM3	Express-AM33	Express-AM44	Total number
Orbit position, deg.	53 в.д.	96,5° E.	40° E	80° E	140° E	96,5° E	11° W	7
Launch date	29.12.2003	27.04.2004	30.10.2004	30.03.2005	24.06.2005	28.01.2008	July 2008	
Commission date	09.03.2004	01.07.2004	01.02.2005	16.06.2005	-	March, 2008		
Spacecraft mass, kg	2542	2543	2542	2551	2555,5	2579	2600	
Payload mass, kg	593	598	589,6	599	599	601	624	
Actual number of transponders:	24:	30:	28:	29:	29:	27:	27:	194:
-Ku	24x54 МГц (103,5W)	4x54 MHz (120W)	18x54 MHz (95W)	12x54 MHz (4x140W, 8x101W)	12x54 MHz (4x140 Вт, 8x101 W)	16	16	102
-C	-	26:1X40 MHz (110W), 25x36 MHz (15x70 W, 10x40W)	9:1x40 MHz (120W), 8x36 MHz (40W)	16:4x72 MHz (100W), 1x40 MHz (100W), 11x36 MHz (60W)	16:4x72 MHz (100W), 1x40 MHz (100W), 11x36 MHz (60W)	10	10	87
-L	-	-	1x0,5MHz (30W)	1x0,5MHz (30W)	1x0,5 MHz (30W)	1	1	5
Number of transponders equivalent to 36 MHz	36	32	~37	~38	~38	~36	~36	253
Design in-orbit lifetime, years	12	12	12	12	12	12	12	

* Decommissioned on March 29, 2006 in view of malfunction caused by a sudden collision with other space object

The design of all satellites represents the module structure scheme: a service module (satellite platform) and a payload module are built separately thus allowing to reduce time and costs of a satellite's creation.

The «Express-AM» satellites are based on one of NPO PM most updated geostationary unified platforms with a sealed (pressurized) design - the «Express-M» platform also known as «platform 727». The «Express-AM» satellites feature more output power than previous Russian communications and broadcasting satellites of the «Express-A» family earlier launched into the geostationary orbit.

The equipment for the satellite platform is being created by the Russian companies-subcontractors of NPO PM including Research and production centre «Polyus» (Tomsk), TsENKI (Moscow), Research and production enterprise «Kvant» (Moscow), Design bureau «Fakel» (Kaliningrad), IRZ (Izhevsk), «Saturn» (Krasnodar), RNII KP (Moscow) and foreign companies as well in particular, Astrium (Germany), Sodern (France).

Thales Alenia Space France (TAS), a supplier of payload modules for the «Express-AM22, -11, -2, -3, -33, -44» satellites, has been cooperating with NPO PM to build 11 telecom satellites. The «Express-AM1» payload module was built by the Japan NEC/Toshiba Space systems.

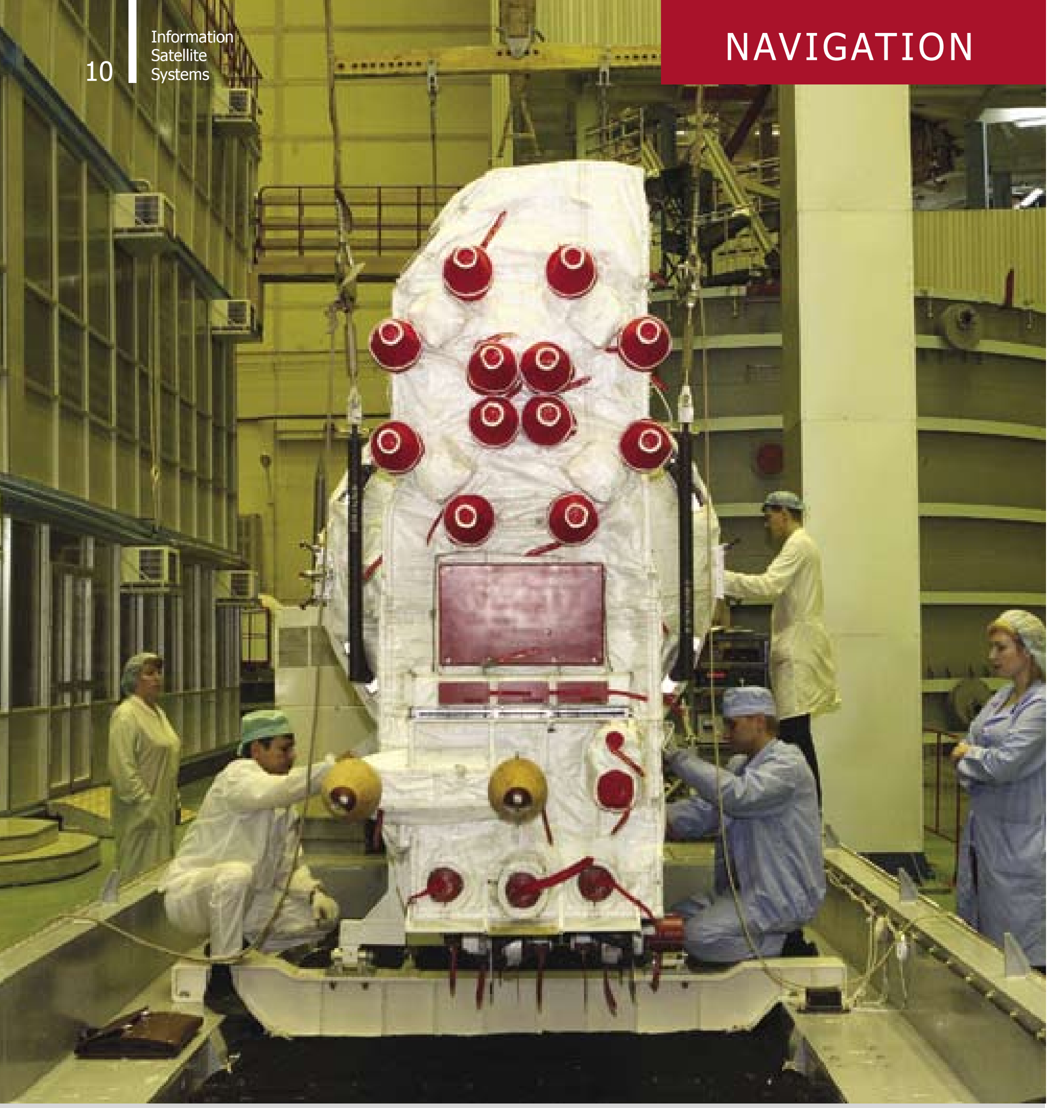
Being the prime contractor for satellites, NPO PM is also a subcontractor of Thales and NEC («Express-AM1») chosen to develop and create payload structures and L-band transponders. When developing the payload structure NPO PM specialists created a new technology of building honeycomb panels with embedded thermal control fluid loops. It became the company's «know-how» recognized by its partners and customers. The technology being well-adopted at NPO PM allowed to create a light-weigh payload structure for «Express-AM44» within shortest time, which is scheduled to launch together with «Express-MD1».

Since the project was developed in cooperation with the foreign manufacturers the new satellites obtained technical features corresponding to the world standards. All satellites of the «Express-AM» family carry shaped antennas. With steerable antennas the operators are able to faster react on new demands of the market.

The program of the national satellite constellation replenishment made a success and contributed to development of information technologies and communications. Today, the «EXPRESS-AM» satellites are the most powerful Russian satellites that provide communications and broadcasting services to a large number of users all over the Russian and CIS territory, in Europe, Middle East, North Africa and Asian-Pacific region.

Elena MATVEYEVA

References are made by Alexander DOSTOVALOV, the "EXPRESS-AM" Program Manager, ISS-Reshetnev Company



The GLONASS system space segment

Efforts resume of 2007

The Federal purpose-oriented program «Global navigation system» announcing creation and launch of six «Glonass-M» satellites in 2007 was speedily and comprehensively accomplished by Reshetnev association of applied mechanics (now «ISS - Reshetnev Company»), partners and subcontracted companies.
Last year the satellites were launched twice: 3 satellites in October (block #36) and 3 satellites in December (block #37).

The NAVIGATION satellites dedicated to replenishment of the GLONASS orbital constellation are usually launched from the Baikonur Cosmodrome according to the group scheme: three modernized «Glonass-M» satellites are injected by one launcher.

The first of three «Glonass-M» satellites comprising the block # 36 was transported from Krasnoyarsk to the Baikonur Cosmodrome on September 12; in few days the second satellite arrived to the launch site, followed by the third one on October 3. Since the satellites were manufactured and underwent electric tests one by one, the dates of their delivery were also specified in consequence. Consequent delivery terms allow to avoid problems at the technical complex of the launch site where a satellite is mated with a launcher. The block #36 integrated with the launcher would have been launched on October 25, 2007, if not postponed till October 26 since it was the Kazakhstan national holiday. The launcher blasted off at 10:35:24 according to Moscow standard time.

The block of three «Glonass-M» satellites (##18, 19, 20) was placed into the orbit close to the calculated one which is 1914 km high with inclination of 64.83 degrees. in the third orbital plane.

After a cluster of satellites had separated from the upper stage each of the satellites was radio contacted to examine its state and determine orbit parameters. The satellites separated within

the radio visibility range available for the ground control segment.

In fact, after the group separation the satellites float in orbit too close to each other thus impeding the parallel contact with the ground control segment because of the mutual radio noise-interference of the satellites. Consequently the satellites come into radio contact one by one stipulating their entry into the system done in turn. It takes the ground control segment about 1.5-2 hours to damp the satellite and put it into the Sun acquisition mode and 1.5-2 hours more to put it to the Earth acquisition mode. Considering this time range and a «in turn» scheme it appears impossible to complete entering at least Sun acquisition mode with 3 satellites being available within the radio visibility range (the radio visibility range is available for the ground control segment for 4-6 hours). Therefore the «Glonass-M» onboard control subsystem (OCS) is installed with an automatic Sun acquisition program as to succeed without the ground control segment support and to be able to work in orbit autonomously within few days. The automatic program starts running after the propulsion unit has been warmed-up and prepared for work.

If necessary the ground control segment may provide satellite control during the initial modes.

The Earth acquisition mode is carried out following direct commands sent by the ground control segment. When the satellites of the block #36 made their first turn being within the radio visibility range available to the ground control segment, the latter managed to speed up the Sun and Earth acquisition modes of two satellites, and to complete the Sun orientation mode for the third one. The next day all three satellites were put into nominal Sun orientation mode with a spacecraft body and antenna unit being pointed to the Earth and solar arrays being continuously pointed to the Sun, with the help of the relevant electric drives. According to the program the satellites had further to be drifted to the specified orbital operation points. The orbit control maneuvers and spacecraft drift to the operating point are also carried out by the commands of the ground control segment, as the orbit parameters shall be radio controlled to ensure precise placement of a spacecraft into the operating point within the orbital plane.

The satellites launched on October 26, 2007 were placed in the following orbital points:

The point #19 – 07.11.2007, the point #20 – 14.11.2007, the point # 17 – 27.11.2007. The time of satellites drifting into its orbital operating points varies depending on the distance between spacecraft initial and operating points that may be very large. Eight days later, after receiving statistics on the orbit parameters and onboard time base drift the ephemeris time data was calculated and first loaded onto the satellite SW program. At this time the satellite is considered to be ready for service. The same exercise is further recurred two times a day.

The block #37 comprising 3 satellites was successfully launched into the orbit on December 25, at 22:32:34 according to Moscow standard time.

The satellites were transported to the spaceport on 15th and 21st of November and on the 3rd of December. The satellites were assembled in a block and integrated to the launcher according to the schedule without any discrepancy.

The block of 3 «Glonass-M» satellites (##21, 22, 23) was placed into the orbit close to the calculated one, to 1914 km height with inclination of 64.83 deg. in the second orbital plane.

All three satellites successfully underwent initial acquisition modes as the satellites of the block #36.

The satellites launched on December 25, 2007 were placed in their operating points and put into service:

The point #13 – 08.02.2008, the point #9 – 25.01.2008, the point #11 – 22.01.2008.

As soon as the three satellites of the block # 37 are put into service the navigation system will ensure 95% navigation signal availability over the Russian territory and 83% over the globe.

Civil users possessing a combined GPS/GLONASS receiver will have a perspective of a reliable global navigation service at no risk of loosing it during local wars.

Victor CHEBOTAREV,
TS candidate, principle design-engineer of the General Spacecraft and System Engineering department, ISS-Reshetnev Company

Small satellites

Heavy satellites with all-in-one design are in fact extremely expansive and require much time for development. Therefore most of their technologies may become obsolete by the time of launching. One of such space «dinosaurs» was a European 8.2 tons Earth remote sensing satellite «Envisat-1». It was the most expensive ($ 870 million) and the biggest satellite with doubtful future. An example of other alternative may be British Surrey Satellite Technology, a leading manufacturer of small satellites providing a spacecraft development in 1.5-2 years at $3-14 million cost.

The FACT that the worldwide space industry has globally changed also influenced small satellites popularity growth. In the beginning of the 21st century there appeared new countries joining the space community: Korea, Singapore, Malaysia, Thailand, Argentina, Chili and others. It's only a pragmatic reason that stipulates them to create their own satellites, which would become economically efficient and effective in the shortest time.

Among the largest manufacturers of small satellites today there are American, British, French, German and Israeli companies. They are actively entering the international markets of Asia and Latin America, offering their customers the turnkey systems or co-operative development. The number of small, mini- and micro satellites launched with remote sensing mission has increased in dozens and they are still on demand. Foreign manufacturers classify the satellites according to a spacecraft mass sizing: pico- (up to 1 kg), nano- (1-10 kg), micro- (10-100 kg), mini- (100-500kg) and heavy satellites (more than 1000 kg). Each of the satellite group was appointed with a concrete mission related to the Earth remote sensing issue.

Small spacecraft can adequately substitute larger satellites to provide the detailed earth mapping photography with meter resolution and high metric performance. Spacecraft payload may carry additional equipment to ensure scientific researches, communications, oceanographic survey and other.

Mini- and macrosatellites can provide a 6-10 meter resolution earth mapping (accuracy of data reference is from 100 m to 2 km), and from hundreds of meters up to 2 km resolution in a wide band to detect fire locations, to make photographs of the natural calamity zones, to ensure environment and weather monitoring.

Nano- and picosatellites are designed to optimize new technologies and carry out space experiments. Particularly, the picosatellites with small cameras were used to provide photo inspection of the external elements of the manned stations and spacecraft structures.

Launch of the American 720 kg satellite «Ikonos-2» taken place in 1999 proved the fact that small satellites can be technically competitive against the heavier ones. Owing to the «Ikonos-2» onboard equipment they photographed the Earth surface with 1meter resolution and coordinate reference accuracy up to 2-3/ 10-12 meters.

Despite its small size the satellite was operating effectively and supported by new technologies where the major were solid-state radio electronic devices and microcircuits, laser gyrosystems, GPS receivers, solid-state charge-coupled device including instruments and lightweight optics, more efficient solar panels, photocells and storage batteries, small-sized and lightweight solid-state memory devices, onboard computers and newly developed MEMS.

The updated navigation phase-metric GPS receivers can accurately determine flight profiles without any support of the ground instrumentation complex. The prospective laser gyroscopes and attitude control system's star trackers assisted by GPS receivers ensure high performance of image control (several meters) without applying to ground support.

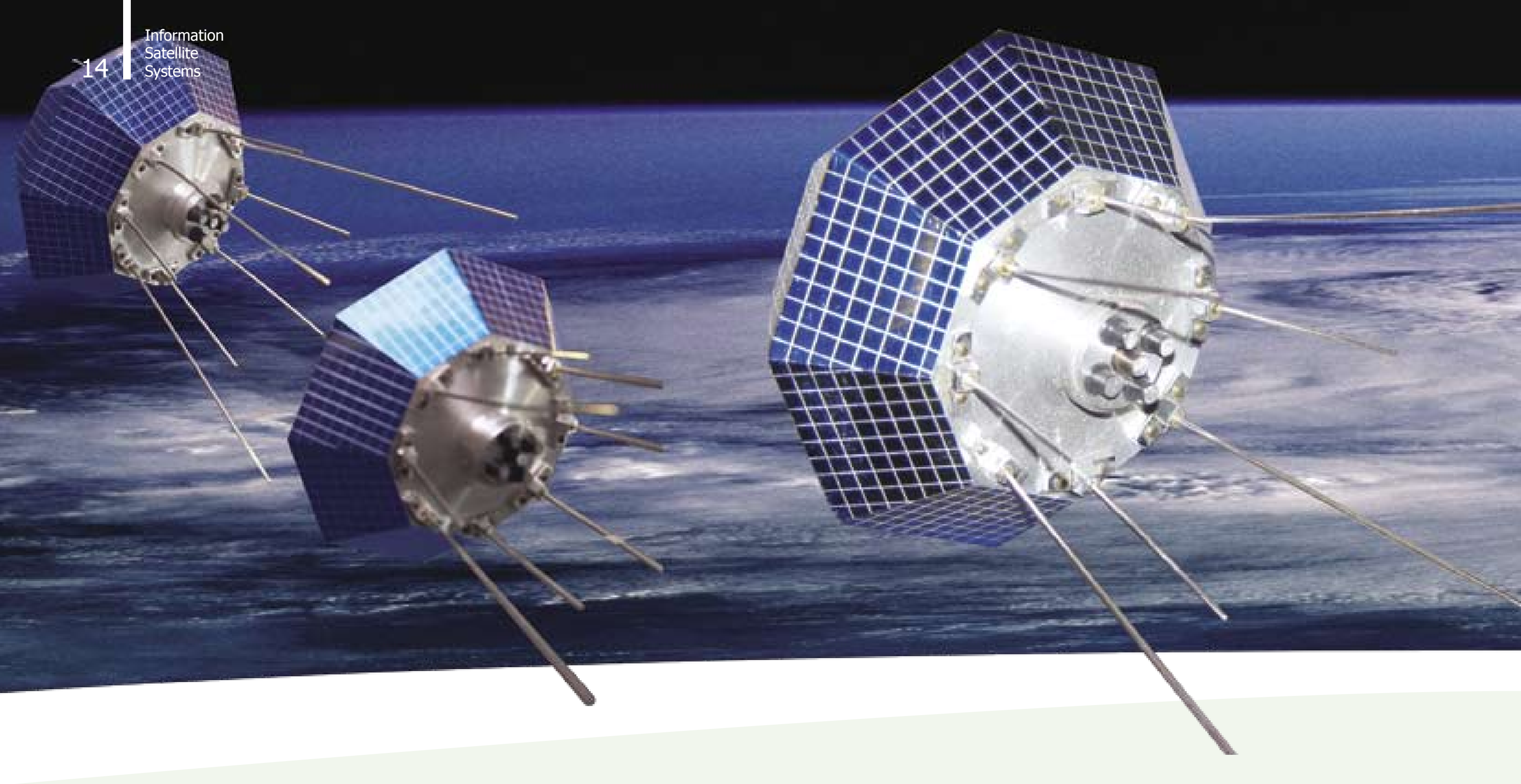
There are three groups of American military industrial companies SpaceImaging-EOSAT, OrbImage and Earth Watch, which are the leading developers of small remote sensing satellites. They created the first high-resolution small satellites Ikonos, Orbview, QuickBird of dual purpose.

The calculated lifespan of a small spacecraft is about 3-5 (up to 7 years) with EPS power of 600 ... 1200 W. They all use long-focus multi-mirror electro-optical systems with 10-meter focal length, 0.4-0.6 meter mirror diameter and charge-coupled device matrix.

The inclination of a camera optical axis may be ensured within ±30-50° by turning the spacecraft body or with help of adjustable mirrors. Thus enlarging the cover range up to ±350-450 km on both sides from the nadir point and provide three photography modes (single block, band-pass, area or mosaic). The minimum size of a shot is 8x22 km, photography may last for 100 ...1000 km. Resolution capacity for panchromatic photographing is 1 meter, for multispectral from 4 to 5 meters. Within 24 hours about 600 shots can be provided. The onboard high-performance computer provides geometric and radiometric correction as well as multiple data compression while being downloaded (data rate is 150-300 Mbites/sec.). Ground stations are receiving data in X- and S-bands.

The SSTL Company at the Surrey University (GB) is known as the largest European manufacturer of mini- and micro satellites and a creator of 14 Uosat spacecraft. Mini satellites may cost several dozens of millions dollars, while micro satellites only $ 3-10 millions since their development require involvement of a lesser number of specialists. Relatively simple shape and structure of these satellites simplify their design efforts and owing to their small size they require no unique test benches that usually turn out to be more complicated and expensive than a satellite itself. The ground segment - flight control equipment - also becomes less complicated, and data may be received and treated by an ordinary PC. Mini satellites are installed with the three-axis attitude control and determination system that uses laser gyroscopes; star trackers, power wheels and magnetic damp bars. Micro satellites are usually equipped with the gravity stabilization system that uses an extendable boom. One or three electro-optical systems are the main equipment. The size of the charge-coupled device matrix can be compared with those used on small spacecraft, but their optical systems are rather short focus. Photography is made only in nadir. Due to not very high accuracy of the attitude control system, the photographed images may be of poor data reference (from several hundreds meters to 2 km), thus reducing the sphere of their mapping and military applications. The electric power system capacity varies from 100 to 600 W.

The new technologies are changing micro- and mini satellites' design. The German micro satellite DLR-TubSAT (45 kg) features with high performance that can be compared with small satellites for some parameters. Since its onboard attitude control subsystem was equipped with a laser gyroscope, three wheels and two star trackers, it ensures the targeted axes direction of a spacecraft with accuracy up to 0.02°. Three optical systems form the spacecraft's payload. The main of them has 1-meter focal length allowing making 6-8 meter resolution images (the best showing for the micro satellites).



Some analytics doubt economy reliability of «The small ones» and say that their only advantage is reducing financial risks in case of a launch failure. But it's not only risks reduction. Another advantage is a possibility of building multi satellites constellations with global Earth coverage. What makes such systems appreciated is their high reliability and frequency of monitoring any Earth region. Today all leading space nations in Europe are developing the projects of their small satellite remote sensing systems. These systems will comprise from 2 to 10 small satellites carrying different equipment with 1-5 meters resolution.

The economical efficiency of a multisatellite orbital constellation is defined first by the cost of a single satellite particularly by the cost of its launch. Today the most cost-effective means of launching are the Russian conversion rockets discarded and set to destroy. There are hundreds of them in Russia. The launch cost is $ 8-14 millions each. A number of the western small satellites manufacturers are already using them.

Micro satellites technologies make possible creation of a principally new planetary research complex. It is based on 1to 10 kg satellites. Certainly the whole mass of the research equipment installed on a small satellite can't be this reduced. Therefore several satellites identical in design are launched at once, each of them carrying 1 or 3 measuring instruments in order to provide the needed experiments. If one of the satellites crashes the space mission won't fail moreover it will go on normally if there's a spacecraft duplicate.

But the most exciting thing is that these satellites do not require rocket boosters! A special propulsion unit can be used to push small satellites from the near-earth orbit into the interplanetary trajectory.

Evidently the main technical problem for a small spacecraft will be its structural elements and research instrumentation that can withstand ultrahigh overloads and changes of high amplitude magnetic field to be encountered by a satellite during the launch phase.

Two last decades the specialists have been developing equipment able to resist ultrahigh velocities. They succeeded in 1980-s after had created RF-transmitters used on ballistic projectiles and able to withstand 6000 g-overloads. A photo unit based on a charge-coupled device passed tests with 20000 g-overloads and was used as a prototype of the same unit of the planetary penetrator built by NASA.

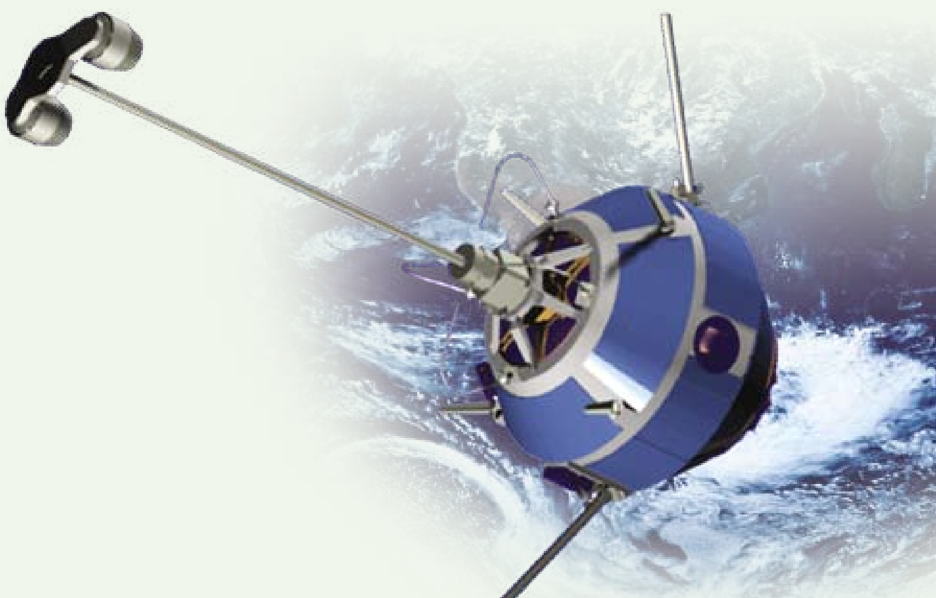
The parts designed for the special propulsion unit, are thought to be able to withstand even higher launch overloads. Then the space equipment will comprise a new class of automatic vehicles that could considerably enlarge the range of its capabilities. These spacecraft could shorten the time of delivering the purpose designed equipment to the targeted planet and make flights to the Mercury and to the near-solar space more easy, which are known to be more power-consuming than flights to Mars. For registration of the fields and space particles the satellites could be injected to the orbits with the planes considerably deflected from the ecliptic one thus setting the other difficult task for the traditional space equipment. Launching a large number of satellites in a strictly determined sequence can be carried out in order to provide researches in the sphere of space physics, in particular, search of gravity waves. Finally, the issue of the special propulsion unit application to protect the Earth from meteoroids needs to be thoroughly studied.

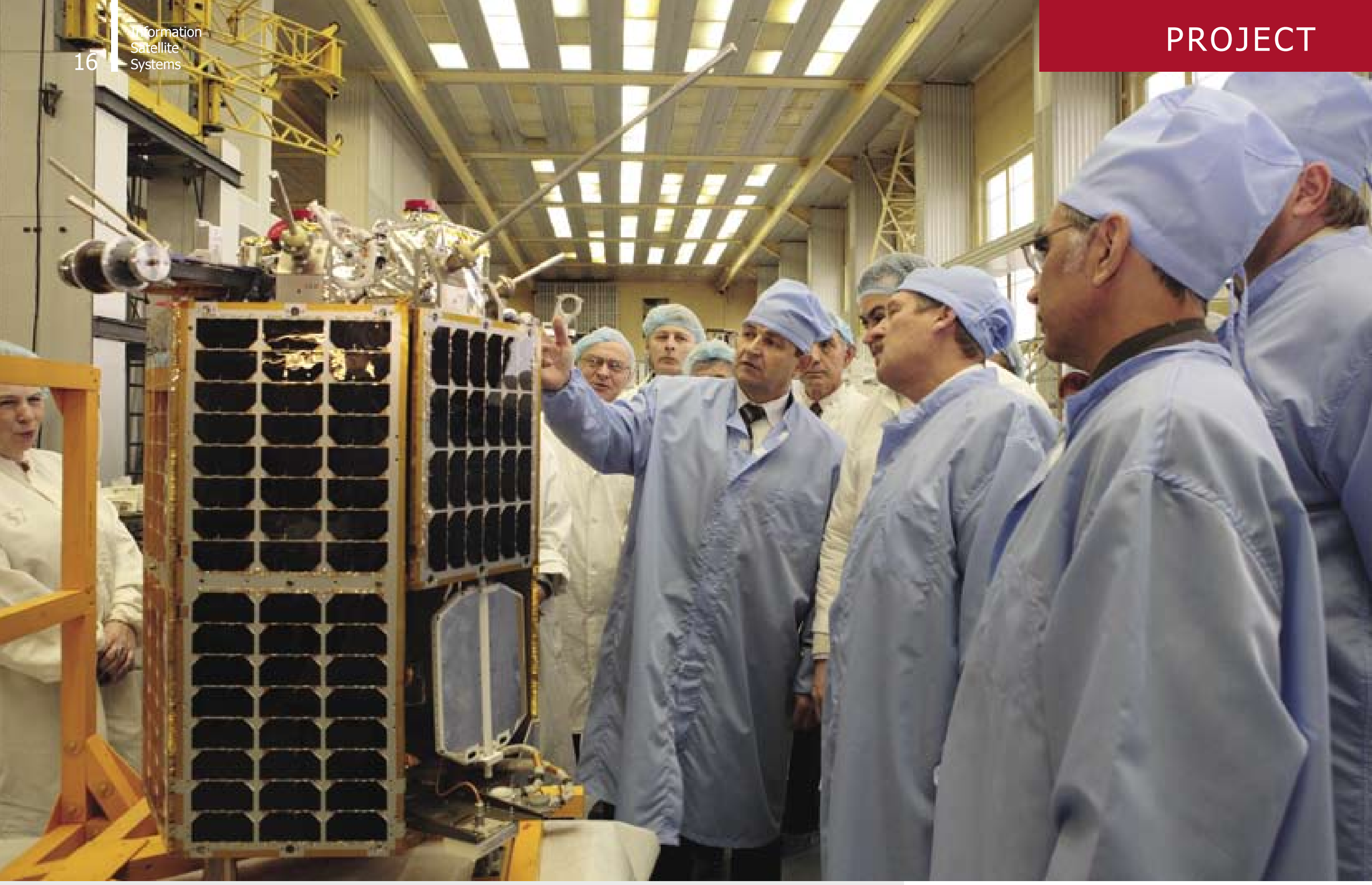
In February 1994, the academician M.F. Reshetnev said in his interview for the «Megapolis-Express» paper: «...the world is tending now to use the LEO communications satellites. It can be explained, first, by their low price, second, by the fact that with these satellites the users will apply to simple and inexpensive terminals. It's only now that other countries got interested in the LEO satellites, here, in Russia; we've been using them for decades. We are now building a new satellite «Gonets» based on one of the mentioned above spacecraft. It will be a small, lightweight and comparatively cheap satellite. 36 of these satellites will constitute a system...»

Russia is rather experienced in launching micro satellites. Besides «Strela-1» and «Strela-1M» they launched radioamateur satellites «RS». The student design bureau «Iskra» at Moscow Aviation University made a large contribution to the creation of micro satellites. In 1978-1992, seven small satellites were launched including «Iskra», «Radio-1», «Radio-2», «Iskra-1,3», «MAK-1», «MAK-2». With these satellites they proved new solutions addressing non pressurized designs, studied parameters of the thermal control system, tested solar arrays of a new type, experimentally optimized short-wave band radio control and proved the capability of a satellite control outside the radio visibility range. Since 1986, the design bureau «Iskra» specialists were working on the spacecraft belonged to the «Spectr» family («MAK-1, 2») to ensure geophysics researches concerning the weak interactions within the systems Earth-Sun, Earth-Moon, Earth-atmosphere and ionosphere and near-satellite surrounding. The passive small satellites of the «Pion» family were launched in 1989-1992 to study the atmosphere. The 87 kg micro satellites «Zeya» and «Mozhaets» developed by NPO PM in cooperation with the Mozhaysky Academy (launched on 4th March 1997 and 28th November 2002) were used to optimize navigation technologies, estimate radiation flux influence on the onboard equipment capacity, and for educational mission. The 20.5 kg small spacecraft «Kolibri-2000» (launched on 19th March 2002) was the first satellite developed within the frames of the International program (with Russian and Australian cooperation) for research and educational missions. The small satellites were launched into orbits with 500-2000 km apogee and a wide range of inclinations: from 0 deg. (equator) to 100-100 deg. (polar and solar-synchronous orbits).

For the large territory of Krasnoyarsk region the small satellites are important since they could improve communications and remote sensing in order to timely receive information related to forest fires, animal migrations, ice drifts on the Siberian rivers, mineral resources, ecology, natural and industrial abnormalities. Small spacecraft will also be used to test new satellite technologies and equipment.

Valentin RAYEVSKY
Doctor of TS, professor at the Siberian State Aerospace University. Chief specialist at the design and test department of attitude control and correction system, ISS-Reshetnev Company.





“Yubileiny” is a next generation small satellite

The «ISS-Reshetnev Company» (the former NPO PM) has created a new small satellite «Yubileiny» to date the 50th anniversary of the launch of the first Russian (URSS) artificial earth satellite. Among other missions the satellite will solve a wide range of educational, research and technological tasks.

Background

In December 2004, the Russian Federal Space Agency (FSA), Space Forces of Ministry of Defense and Army, Air Force and Navy assistance society (AAN AS) came to the decision to create a jubilee radio amateur satellite and launch it in 2007 as to celebrate the 50th anniversary of the space era. The aerospace vehicle laboratory (Russia, Kaluga) was entrusted with creation of the satellite.

In order to provide the satellite project interface control there was established a public committee comprising representatives from FSA, Space Forces, AAN AS, strategic rocket forces, Russian science academy, Moscow Aviation University, Russian space and space forces veteran associations.

At first NPO PM took no part in the project but later, in 2007 the Committee Chairman addressed to NPO PM general designer and general director Nickolay Testoedov asking for NPO PM assistance in developing and creating the satellite’s attitude control system and solar arrays and provide the launcher adaptation.

NPO PM agreed and in May 2007 its representatives - the project manager Sergey Galochkin and the engineering manager Andrey Yakovlev visited the aerospace vehicle laboratory in Kalu-

ga, and Khrunichev State Cosmic Research and Production Center in order to study the satellite technical basis and to review the issues related to its further development and launch. By that time the aerospace vehicle laboratory had created the DOKA (onboard control equipment) and developed the spacecraft layout design.

During their visit to Khrunichev State Cosmic Research and Production Center the representatives of both companies reached an agreement to launch the «Yubileiny» satellite with other spacecraft built for the Russian Ministry of Defense.

In July 2007, the administrative board of FSA and Space Forces approved the terms within which the «Yubileiny» should undergo final operations and be launched. Reshetnev NPO PM was entrusted with the spacecraft designing, building and testing activities.

The satellite was created on a tight almost unprecedented schedule. Spacecraft design efforts began in July 2007. In August, the design documentation was completed and the manufacture started. At the same time they constructed a full-scale model of the satellite to examine its vibration strength and the rocket separation reliability, and the satellite mass simulator was provided as well. According to the schedule the satellite was built by October and next month was undergoing electric tests. In six months the satellite was ready for transportation to the spaceport.

The financial issue of the project was not «traditional» yet. Since the satellite had to be created on a voluntary basis it had no special funds. Thus, the satellite was developed, built and would be launched at the expenses of the companies-co-contractors of the project. Being a head company of the Corporation, NPO PM took responsibility for every stage of work from releasing the design documentation up to spacecraft tests. While creating «Yubileiny» the company's specialists developed and built a multifunction unpressurized platform, which would be the baseline one for the future 30-100 kg satellites developed by NPO-PM.

Russian space companies and organizations contributed a lot to creation of the «Ybileiny» spacecraft. In particular, the NPP Geofizika-Cosmos company created the satellite's Sun and Earth sensors, the Saturn Company developed and built solar arrays, Lavochkin NPO provided gallium arsenide cells, the Ramensk instrument building company created a small magnetometer MA-6. The Siberian State Aerospace University (SSAU) research workers and students developed RADEK - devices covered with recently developed nanocoatings to protect the spacecraft electronic components against radiation impact.

Merging of scientific, educational and manufacturing issues favoured to creation of a state-of-art multifunction and structurally complicated satellite though at first it was planned as an analogue of the first artificial earth satellite with only 10 kg mass and low power capacity.

Satellite mission and structure

The satellite «Yubileiny» is dedicated to educational, scientific research and experimental missions. First, the satellite launch will help to fulfill the Information Program foreseeing solutions of the major tasks of space exploration (voice messages, SSTV slides, signal imitation of the first artificial earth satellite); secondly it will help to establish conditions under which the Russian universities could study the data transmitted by the small satellite; and thirdly, it'll help to carry out science-and-technologic experiments:

- Prospective Sun and earth sensors flight proficiency;
- Receiving data related to the Earth's planetary emission within infrared wavelength band;
- Researches of spatiotemporal emissions of the Earth atmosphere day and night radiation within visible spectral range;
- Testing the estimation methods of the satellite attitude control concerning the data provided by the experimental solar sensors and small magnetometer MA-6;
- Proving efficiency of the nano-coatings developed by the SSAU to protect the spacecraft electronic components against radiation;
- Providing flight qualification for a prospective multifunction unpressurized platform intended for the 30-100 kg satellites;
- Testing the piggy-back injection (3 in a cluster) technology using the «Rokot» launcher.

Structurally the satellite represents an unpressurized instrument module formed by a hexagonal frame with attached solar arrays and three lateral webs: top, bottom and central ones.

The onboard equipment is installed inside the instrument module as well on the outer surface of the top panels.

The top panel of the satellite that faces the Earth during the satellite operation is equipped with attitude control system devices, in particular, magnetometer and diagonal balancer booms, receiving and transmitting antennas and research equipment including three Earth sensors to receive data on the Earth's planetary emission within infrared wavelength and spatiotemporal researches of the Earth atmosphere day and night radiation within visible spectral range.

The spacecraft central panel carries the DOKA-B equipment comprising the onboard computer; receiving equipment operating in 145 MHz band; transmitting equipment operating in 435 MHz band as well as the onboard radio navigation equipment.

The spacecraft bottom panel is equipped with magnetic and gravity attitude control system ensuring the satellite X-axis orientation towards the Earth in a nominal operation mode, navigation equipment antenna, experimental Sun sensors and the RADEK equipment, which is to prove efficiency of the nano-coatings developed by the SSAU to protect the spacecraft electronic components against the radiation impacts.

Solar arrays panels installed on the satellite's frame are made of the three-junction gallium arsenide cells. The solar arrays will supply power to the onboard equipment when in the illuminated orbits. The frame design allows the required size of the solar array effective area with the satellite being in different positions relative to the Sun. During the orbital eclipse periods the equipment is powered with the nickel metal hydride battery. The EPS battery is not an individual element. Its components are incorporated into the command and power unit where all power supply automatics is installed, these are the DOKA-B equipment components.

The peculiarity of the «Yubileiny» lies in its passive thermal control subsystem: the necessary temperature is provided by the uncontrolled ratio of optical coefficients characteristic for the surfaces of spacecraft structural elements, MLI, electric heaters and heat pipes that ensure the thermal mode for the DOKA-B equipment.

The DOKA-B software ensures electric heaters control which is as follows: if the temperature sensors indicate temperature fall till 0˚C then the electric heaters are switched on, if the temperature rises up to 5˚C, the electric heaters are switched off. The flight software estimates an average temperature according to data of the three temperature sensors. The electric heaters are controlled considering the average temperature.

Spacecraft nominal operation mode

The satellite «Yubileiny» is injected in a cluster with satellites developed for the Russian Ministry of Defense. In 30 seconds after the satellite separation from the ascent unit the initial preparation mode is switched on. Above all, the DOKA-B powers the pyro cartridge to deploy the145.8 MHz antennas, makes the receivers ready to get the ground control commands, and supplies power to the magnetometer coil. Then the attitude determination and control system undergoes damping and magnetic orientation. In total, it takes no more than 4 days to accomplish all operations.

After conformation of the stable magnetic orientation mode within the radio visibility range the Satellite Control Center sends the commands «current coil off», «HDM release» and «moving out» the diagonal booms.

The gravity boom is passively moved out, the diagonal booms are deployed and the spacecraft comes into 3-axes gravity orientation mode.

It takes 1 day to damp the satellite till it reaches the stable gravity orientation after moving out the gravity boom.

After checking the satellite systems, the data related to the first artificial satellite launch is downloaded. The transmission lasts for 4 minutes. Within this time the following data is downloaded: a call signal and TM-data (10 seconds); a voice message (1 minute); a pause (50 seconds the first artificial satellite imitated signals (10 seconds); an image (1 minute); a pause again (50 seconds).

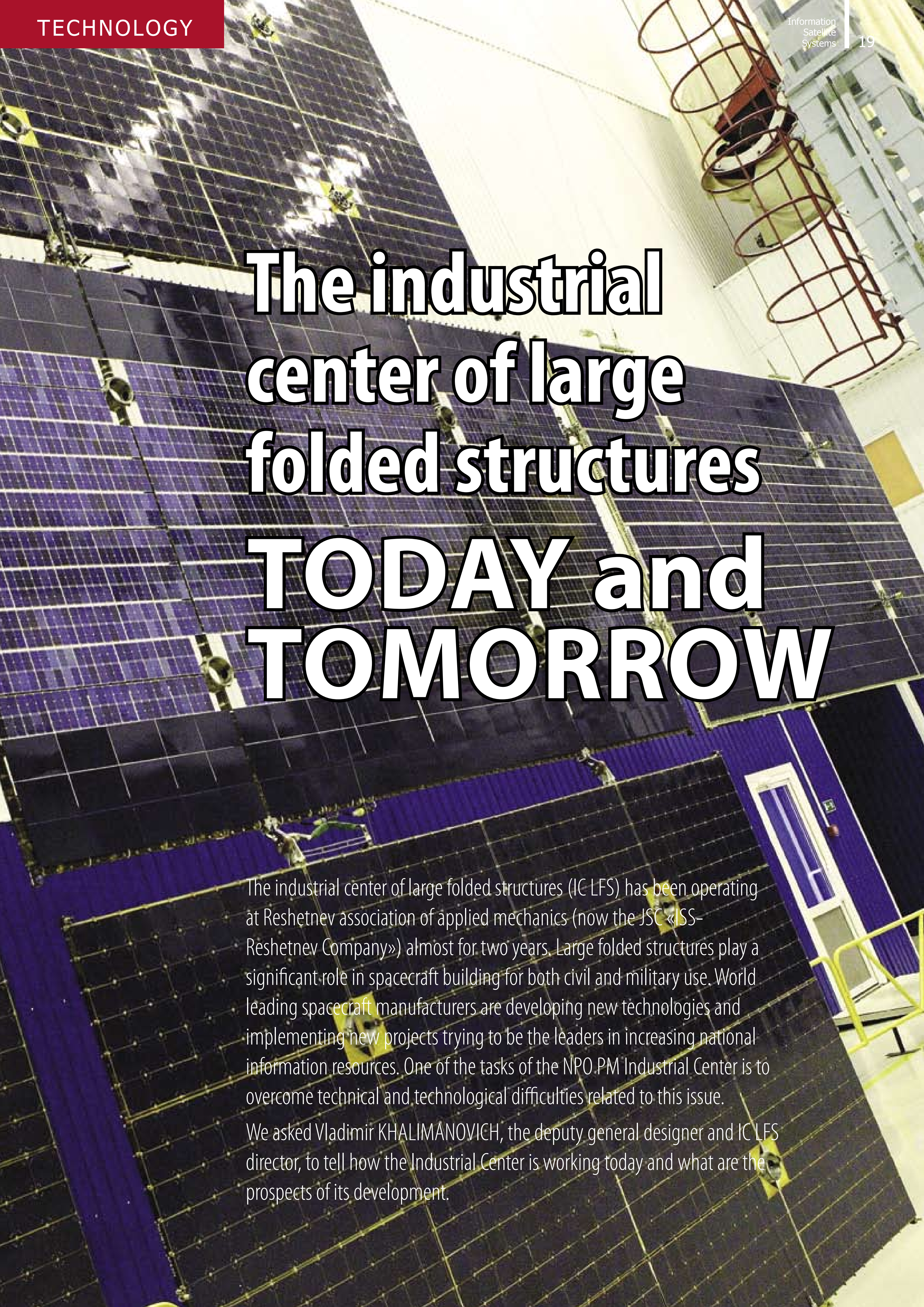
The onboard spacecraft data is transmitted via a radio channel in the 435 MHz international frequency band of experimental and radioamateur communications, in cyclic mode, in narrow-band FSK mode.

Voice messages and images can be received in any place of the Earth when the satellite floats above within the radio visibility ranges. Any standard radio equipment can receive the signal in this frequency band requiring no additional technical means.

The onboard navigation equipment is switched on once a day for 10 minutes to determine, without the ground support, the parameters of the spacecraft motion along the near earth orbit. The onboard equipment meant for the satellite-based navigation can use the signals of GLONASS and NAVSTAR (GPS) systems in any combination.

Sergey GALOCHKIN –
the «Yubileiny» Project Manager,
Svetlana MALEYEVA –
the design manager

The satellite «Yubileiny» - is the first among other small satellites of a new generation developed by NPO PM and based on unpressurized platform. As the project was successfully realized the company managed to start a new production line of small satellites. Every company participating in the satellite's development and creation benefited in a substantial scientific and technological basis for their future work, also made their own contribution to training of highly qualified personnel for the Russian companies of rocket and space industry.



The industrial center of large folded structures TODAY and TOMORROW

The industrial center of large folded structures (IC LFS) has been operating at Reshetnev association of applied mechanics (now the JSC «ISS-Reshetnev Company») almost for two years. Large folded structures play a significant role in spacecraft building for both civil and military use. World leading spacecraft manufacturers are developing new technologies and implementing new projects trying to be the leaders in increasing national information resources. One of the tasks of the NPO PM Industrial Center is to overcome technical and technological difficulties related to this issue.

We asked Vladimir KHALIMANOVICH, the deputy general designer and IC LFS director, to tell how the Industrial Center is working today and what are the prospects of its development.

– What does NPO PM benefit from the Industrial Center?

– Accommodated at the NPO PM facilities the Industrial Center brings lots of advantages. First of all, it favours to recognition of our success in implementing the latest projects and our potential for the future ones. Secondly, it ensures a possible financing to the research and technology development via the Federal Space Program. We just need to be active. Thirdly, the contracts awarded to the Center stipulated a new level of development efforts following the customer's demands.

Any product serves as an impartial assessment of its producer. When we reviewed some of our accustomed solutions and the information exchange with our customers, we became able to define the ways of creating a competitive production.

Creating a state-of-art spacecraft is impossible without ensuring high technical level of all subsystems concerned. We hope that the Industrial Center will solve these major tasks.

– What kinds of work are being carried out at your center today?

– In 2007 we worked out the Industrial Center Development Program till 2015. The program defines the Center's major activities, from solving relevant fundamental tasks up to creation of concrete space products. To be more exact it foresees creation of antenna onboard reflectors with diameter of few dozens meters, solar arrays of more than 70 m^2, electromechanic units, pneumatics and hydroautomatics, new materials, coatings, etc. These are our «traditional» subject matters. But all newly developed products are specified by their technical level. We are running out our technological knowledge accumulated within recent years, so we are in need of new technical solutions based on achievements of the space material science, MEMS and nanotechnology, modeling techniques. Space equipment elements in some way lost their unique characteristics. The space market today is standardized enough in terms of the output parameters of constituent parts and assembly units, which should be not only ensured but also upgraded.

The Center possesses experimental capabilities, developed math modeling system allowing to provide other companies with services related to this issue. At present we have designed, built and transported solar arrays to Lavochkin NPO for their spacecraft of two different types, now we are developing rotary drives for RKK Enegry (Moscow), an antenna pointing drive and solar arrays for the «Phobos» spacecraft. We also signed contracts with the design bureaus «Arsenal» (St. Petersburg) and «Progress» (Samara), Machine building entity (Reutov), and some international companies.

– What prospects do you see for the Industrial Center?

– We've got a technological basis to produce honeycomb panels. The panels are designed and built following the advanced technologies and meet all specification requirements applied to structural panels and cooling panels. In 2008 we plan to ensure delivery of our products to other space companies. Honeycomb panels are being modified by many other companies so we should go further in our work. Today, NPO PM is working on implementing composites in our products. If we talk about one of our most complicated satellite with a large number of antennas we'll see that 70 % of its structure is made of polymer composites, which is extremely significant.

The space technologies of building polymer composite structures differ from those used in aircraft industry and rocket production because of its specific requirements and operating conditions. To meet these requirements we are developing a range of new products, including precision reflectors for antenna systems, super light structural «laced» (isogrid) panels and many others.

Today the space industry is in great need of developing and providing electromechanical units. We have got good results to answer this need. Further modernization of the available units is needed with regard to the world market requirements, as well as design and technology solutions. We have already received some proposals related to our production, which is needed more and more. And that gives us a hope for the further development.

Irina CHAIKINA

From SILICON to GALLIUM ARSENIDE

The history of solar arrays development has been running for 50 years already. Within this time they have experienced a lot of changes. Owing to great persistence of our designers, technologists and workers the silicon arrays efficiency increased form 7-8% to 15-16%, and solar panels specific mass reduced from 10 to 3 kg/m2. The photocells of a new generation based on gallium arsenide allowed to increase arrays efficiency up to 30%. Therefore on board electric subsystem became able to feature a far greater output of 15-20 kW.

As the third artificial earth satellite was launched into orbit, solar arrays became the main spacecraft's electric power sources. First satellites could operate in orbit only for few days and they were powered by storage batteries. It was evident that spacecraft designed for practical missions needed a long operating power supply system. These were solar arrays that became an onboard electric power generator. Solar arrays are mainly characterized by their efficiency that initially was only 8% for the first satellite. In more than 40 years, it raised up to 15% (only related to silicon photocells).

In 1970-s, the USSR and the USA started developing solar arrays and other alternative power supply systems, in particular, radioisotope generators and nuclear power sets. There were great debates on which one was better and more reasonable to use in space: radioisotope generators, nuclear power sets or solar arrays. Russia launched a spacecraft with a radioisotope generator- a small communications satellite «Strela» developed by NPO PM (now «ISS - Reshetnev Company»).

Later all discussions stopped and space energy developers became more focused on solar arrays since their specific mass performance was rather high and they had a good potential to experience further improvement. Under these circumstances NPO PM benefited a lot: with solar arrays conforming to all requirements (specific mass characteristics, efficiency, safety and costs parameters) NPO PM satellites could fulfill their missions. The Russian specialists also mastered the technology of producing high-efficiency single-crystalline silicon photocells and were enjoying monopoly from the first space explorations till 1990-s. While developing the technologies they managed to increase photocells efficiency from 7-8 % up to 15%, though theoretically it could be 22-24%. The efficiency was improving along with capability of solar arrays to resist destroying space factors impact, space radiation first of all, thus prolonging spacecraft lifetime up to 10 years. Today the Russian spacecraft solar arrays use silicon photovoltaic cells that cost $40K - 60K for 1m2.

Owing to recently achieved characteristics, solar arrays of 6 kW with 60m2 panels could generate power for the biggest Russian geostationary telecom satellites of the «Express» family.

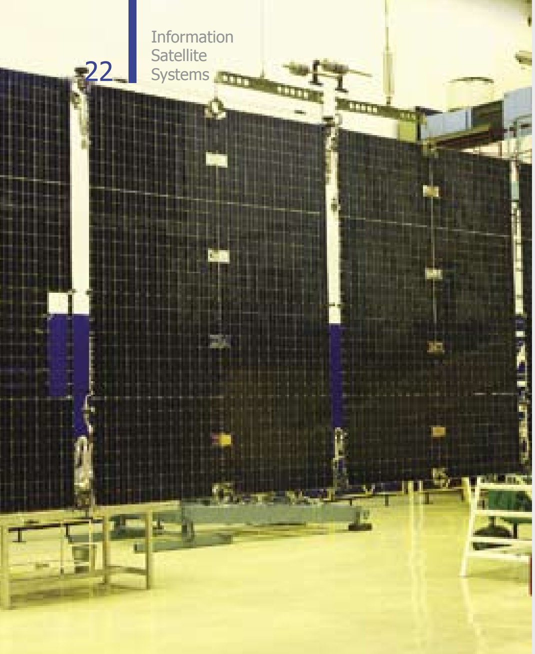
With growing competition at the international space market, related to satellite communications first of all, manufacturers had to increase power capability of their space platforms. At the end of the last century the major satellite manufacturers made an industrial leap after the on board electric sets had been supplied with a far higher level of output power that raised from 3-5 up to 15-20 kW. It became real with a revolutionary substitution of silicon for other materials relating to the III and V groups of the Mendeleev's table. Generally, they were called gallium arsenide solar cells. American companies were the first in developing technology and ways of producing gallium arsenide photovoltaic cells. Theoretically, these photocells may be 30% efficient. The photocells production is based on nano technologies, able to create the so-called hetero-structures, i.e. n-p-transitions that are few microns thick. When the cells successfully underwent flight tests, at first in a single-junction way with 19% efficiency, they stipulated their own development: creation of two- and three-junctions. Today there are photocells produced in lots by the western companies that can operate with 29-30% efficiency, which makes them two times better than those made of silicon, with a better radiation hardness and thermal resistance. In the nearest future the specialists have a perspective of producing cells with a larger number of n-p-transitions and efficiency of 33-35%, which later could be 42%. So it becomes more real to generate up to 20-25 kW power for a space geostationary communication platform with 90-100 m2 solar panels.

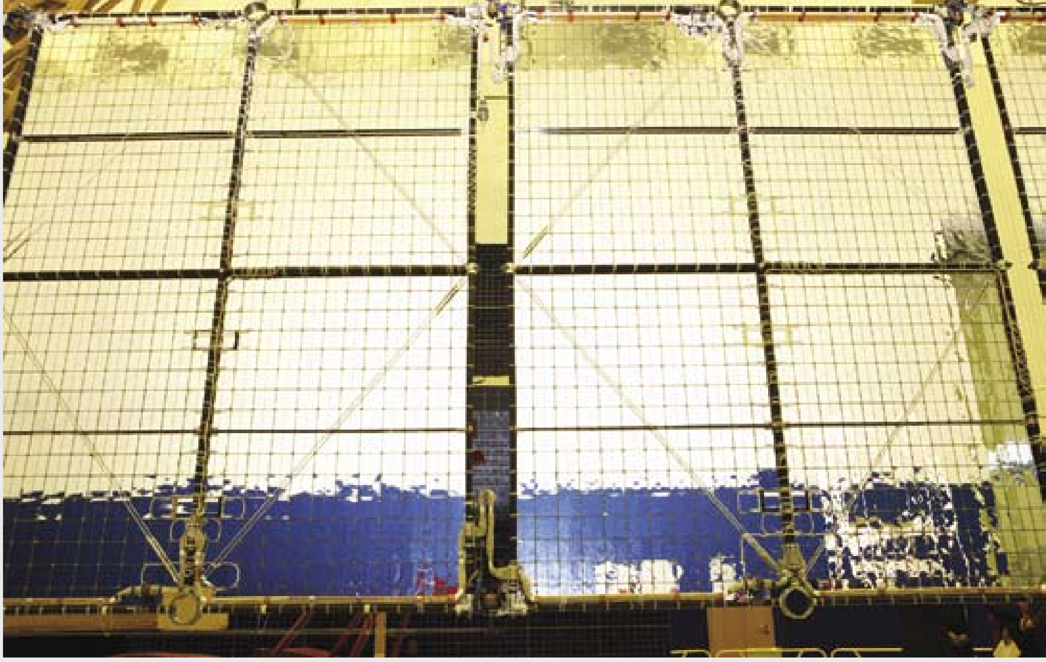
The Russian industry doesn't know such a production, at least haven't known till these days. The leading Russian solar arrays manufacturers JSC «Saturn» (Krasnodar) and JSC «Kvant» (Moscow) lately have been purchasing the equipment for gallium arsenide photocells production. The specialists have already set on studying and optimizing the new technologies. And now the Russian spacecraft manufacturers have a chance in a year or two to use Russian gallium arsenide photovoltaic cells corresponding to the international standards.

Therefore it is planned to equip NPO PM prospective satellites with solar arrays based on equivalent to gallium arsenide multi-junction cells.

Irina CHAIKINA

We thank Victor KUDRYASHOV, Deputy associate administrator, for his assistance when writing this article.





The "ISS - Reshetnev Company" is developing new technologies for the Russian satellites

The enterprise producing spacecraft solar arrays has gained a great experience allowing it entering the international market. The JSC «ISS - Reshetnev Company» (the former NPO PM) designed, manufactured and delivered solar arrays for the spacecraft «Electro-L» and «Spektr-R» built by Lavochkin NPO.

The first steps in building solar arrays for these two spacecraft were made in 2004 after NPO PM and Lavochkin NPO (Moscow region, Khimki) had signed a contract for the solar arrays design and manufacture activities. According to the contract the NPO-PM was charged with solar arrays for Lavochkin NPO two satellites «Electro-L» and «Spektr-R».

The contract works were carried out by several stages to be finally accomplished in 2007. In order to shorten the ground experiments dates NPO PM built an array wing for the «Electro-L» and «Spektr-R» solar arrays to undergo the testing.

The «Electro-L» solar array wing was transported to the customer together with the hold-down and deployment mechanisms. For NPO PM it was the first solar array designed for the spacecraft «Electro-L» that used the GaAs three-junction photovoltaic cells. The high efficiency of the cells (27%) ensured considerable increase of a spacecraft power capability without enlarging the solar array mass.

In late 2007, they completed producing traditional silicon solar arrays for the spacecraft «Spektr-R», which is a unique space radio telescope. NPO PM has also designed a new electric drive that is now used in NPO-PM own products. It's worth mentioning that the products developed by NPO PM will operate in the orbit with the apogee of 330 000 km. The «Electro-L» and «Spektr-R» solar arrays were created in cooperation with the JSC «Saturn» (Krasnodar) where the photogenerated equipment was designed and manufactured.

While designing mechanical devices for both satellites the specialists applied to a «unification» method. They could use the same hardware to provide ground experimental tests for both satellites, thus reducing test duration and costs.

Implementing the contracts for Lavochkin NPO they mastered production of solar arrays as an independent element. Now NPO PM specialists can develop and test the arrays separately from the spacecraft.

While creating solar array mechanical units, the specialists developed the standardized hold-down mechanisms for the array panels and hinged joints for the panels' deployment. It significantly improved the design quality, simplified manufacturing operations and shortened the qualification test dates.

The experience gained from these contracts will further improve NPO PM spacecraft performance.

The NPO PM production was highly appraised by Lavochkin NPO which later decided to further cooperate with the company. NPO PM won a contract for production of a stopbeam antenna drive and a solar-cell frames that will be used on a spacecraft «Phobos-Grunt». The spacecraft will land on the Martian moon surface, take a soil probe and fly back to the Earth. The spacecraft will be launched in 2009.

It should also be stated that development of space technologies can't rest on what has already been achieved. The Americans, for example, make larger investments to the future development and improvement of their solar arrays and as they say they can develop four-junction and five-junction photocells very soon. What will be our response?

Irina CHAIKINA

JSC "Research & Production Enterprise "Geofizika-Cosmos" (Moscow)

GEOFIZIKA - Cosmos
www.geofizika-cosmos.ru

JSC "Research & Production Center "Polyus" (Tomsk)

JSC "Research & Production Enterprise "Kvant" (Moscow)

JSC "Research & Production Enterprise of Space Instrument-making" (Rostov-on-Don)

JSC "Siberian Devices and Systems" (Omsk)

JSC "Testing Technical Center - NPO PM" (Zheleznogorsk)

Joint-stock Company TTC NPO PM

JSC "NPO PM - Small Design Bureau" (Zheleznogorsk)

NPO PM MKB

JSC "NPO PM - Razvitie" (Zheleznogorsk)

JOINT STOCK COMPANY NPO PM RAZVITIE

JSC "Sibpromproekt" (Zheleznogorsk)

SibProm proekt

RESHETNEV
COMPANY

ONE TEAM

EREMEYEV Gennadij Karpovich,
FSUE "Siberian Devices and Systems", Deneral Director.

In 1976, graduated from the Chelyabinsk technical university (diploma with distinction). From 1976 till 1983, worked as a design-engineer and deputy chief inspector at Omsk electromechanical plant. In 1983, held positions of head of the department, production chief, and chief engineer. Since 1996, has been working as a general director of the FSUE «Siberian Devices and Systems». Gennadij EREMEYEV was awarded with the Medal of Honour and the Korolev Medal for his contribution to realization of the federal space programs.

FSUE "Siberian Devices and Systems"

The "Siberian Devices and Systems" company was established in 1959 by the Government decree addressing the development of space industry. The enterprise produces electromechanical (including gyroscopic) devices for the rocket control systems. For almost 50 years of its history the company made large contributions to development of the Russian rocket and space industry.

Space achievements

The enterprise has been working on the rocket-and-space issue since its foundation. In 1961 its specialists put into lot production their first developed device - programmable pulse sensor for the rocket flight control. The following years were devoted to realization of different rocket-and-space programs and projects.

Since late 1960-s, the «Siberian Devices and Systems» has been producing flap drives for thermal systems of spacecraft «Venus», «Mars» and control thruster drives for the «Kosmos-ZM» rocket. In 1969, they produced drilling machines for the space station «Moon-16» that brought the first probe of the Moon soil to the Earth. In 1973, the enterprise started producing spacecraft attitude control and determination systems. Later, they started manufacturing complexes of command devices for the «Zenit» rocket and in 1986 for the «Energy» rocket. In 1969, the enterprise was

awarded with the Red Banner of Labour for successful accomplishment of state missions, high production performance and a large contribution to development of the new rocket-and-space equipment; in 1976 it was also awarded with the October Revolution Banner.

In 1990-s, the «Siberian Devices and Systems» mastered production of rate gyro sensors for the ISS and the «Yamal» spacecraft, discrete angle sensors, solar array control units and antenna drives for the «Express» and «Glonass» satellites. Since 2002, they have been producing shutters control linkage for solar array and antenna drives equipped with control units for the «Glonass-M», «Meridian» and other satellites. In 2006, the enterprise set on producing deployment mechanisms for the light-protective hatches, spotbeam antenna drives and baffle assembly drives for the «Spectr-UF» satellite ordered by the worldwide space observatory.

Today the Federal state unitary enterprise «Siberian Devices and Systems» is offering its production to the ISS - Reshetnev Company, NPO «Polyus», Lavochkin NPO, RSI «Kometa» and others.

Production capacities

The «Siberian Devices and Systems» mastered the technologies of producing elements for the high-precision toothwheel, plastic and ceramics elements, multiplayer printed boards and microelectronic elements. They also mastered production of high precision sensing elements, floated and dynamic gyroscopes, accelerometers (string, liquid, and quartz). Every year the company organizes production of high precision instruments designed for different purposes. The Enterprise has gained quite a large experience in producing and exploiting the purpose-designed equipment. It was operable even after expiration of its design life, including the open space conditions.

Other activities

At present the enterprise is busy with the products made for the rocket and space purposes and also for other industrial purposes. They set up production of oil-and-gas equipment to substitute the foreign one, including pumping jack control units, inclinometers and magnetic devices. The «Siberian Devices and Systems» is now one of the three leading companies producing household energy meters.

Today the enterprise possesses the technological capabilities to widen the range of its production: from the large-sized fine mechanics used for submarine ventilation systems to microelectronics used for cryptographic equipment.

To meet the diversification purposes, the company is developing and producing antenna drives for the radiolocation systems, dosing pump electric drives, turbojet engines and service control systems used for the oil-and-gas storage and field facilities. The fire and explosion hazardous equipment is accompanied with necessary certificates and licenses. The electromechanic drives based on non-contact valve servo-electric engines are reliable in use, ensure high torque moments and are able of a momentary holdup, provide accurate positioning.

Today, the company is demonstrating its production expansion, technical upgrading and wage increase.

Quality system

Since its foundation the company has been showing a special attitude to the quality of its production. The quality system is certified in accordance with the quality regulations RK-98, GOST R ISO 9001-2001 and other federal standards.

The «Siberian Devices and Systems» was licensed to carry out space activities related to development, production, and repair of the control systems, electromechanic and electronic actuators, spacecraft devices.

Now, in accordance with the Russian Government decree and the Russian President decree the enterprise is a member of the corporation «M.F. Reshetnev «Information Satellite Systems». The «Siberian Devices and Systems» is the prime company developing and producing antenna electromechanic drives, solar arrays with current collectors' drives and other electromechanical systems.

ISLYAEV Shakhiazam Nasipovich,
TTC-NPO PM Director

In 1954 graduated from the Penzinskiy industrial university. Later was assigned to the Krasnoyarsky machine-building plant. During 1954-1959 worked as an engineer, a foreman, a senior foreman, a head of laboratory. In 1959 was assigned to the subsidiary enterprise of the Industrial Design Bureau 1 (Krasnoyarsk - 26).

From 1959 till 1999 Shakhiazam Nasipovich was working at NPO PM. It was here that he worked his way up from a group manager to a deputy general designer. He headed the groups of scientists creating onboard radio-electric equipment, antenna-feed systems, and onboard systems; providing reliable work of communications satellites, television, geodesic and navigation systems.

Under his guidance there were established a unique laboratory and experimental facilities; developed and introduced methodology and principals of full-strength engineering related to the ground experimental testing, spacecraft and onboard systems exploitation; there was created a new scientific solution related to the methods of increasing spacecraft longevity and its technical reliability.

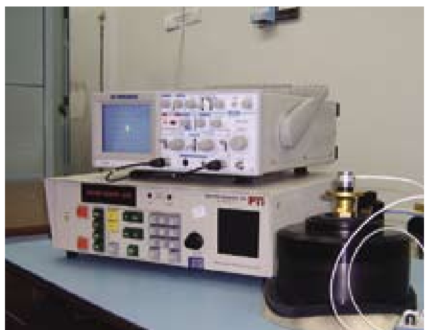
In 1999 he became a director of NPO PM subsidiary enterprise - FSUE «Testing technical center-NPO PM» that was reorganized into the JSC «Testing technical center - NPO PM» in 2003

Meet the Testing Technical Center - NPO PM

The present rather complicated radio-technical systems and complexes including large lifespan satellites as well, are equipped with thousands of EEE components. For instance, the Russian equipment installed in spacecrafts equivalent to those of the "Express-AM" family packs more than 120 thousand EEE components.

The PARAMETERS of high performance characteristics of a satellite and its equipment (running time, failure-free operation) depend on quality, resource and reliability of the components installed. Concerning the fact that there are no such production lines specially meant for the space industry as they have it in the Western Europe and the USA, and that the Russian EEE components are still of low quality, special attention is paid to equipping satellites with high-reliable components only.

Today, this specific task is being solved by additional component tests performed at different testing centers, one of which is known as JSC «Testing technical center-NPO PM» (TTC-NPO PM). The enterprise was established in May 1999 on the base of the NPO PM testing technical center that earlier was NPO PM subsidiary enterprise till July 2003.



TTC-NPO PM underwent certification to become the second provider of the EEE components for the «Voenelectroncert» system. The company was awarded by Roscosmos accreditation as a testing technical center and an EEE certification entity. TCC - NPO PM was accredited as a testing laboratory to work for the «Military Register» system and was certified by Roscosmos to carry out space activity, particularly to provide the rocket and space equipment with high-reliable components.

The TTC-NPO PM main task is to provide high-reliable equipment, first of all for space missions, with EEE components of required quality and reliability. With this regard all components undergo additional screening tests with the scope conformed by the Russian Ministry of Defense Institution. The TTC testing and diagnostic instrumentation are used in combination thus automating the processes of estimating the electric components parameters; recording, computing and storing the relevant results. Today TTC-NPO PM tests 60% of all EEE components used by ISS -Reshetnev Company and other companies of the ISS Corporation.

For the last 7 years they carried out tests of electric components for 27 satellites.

The «Sesat» satellite built by ISS-Reshetnev Company (former NPO PM) for Eutelsat that has already been operating for 7 years proves effectiveness of TTC tests. The satellite's EEE components underwent tests in accordance with ESA requirements. The Testing technical center applies to the database that registries all types of electric components and allows estimating their quality (concerning the manufacturer, date of production, test stage, etc). The final permission for usage of the EEE components that passed the additional screening is given based on the results of the destructive physical analysis (DPA) carried out by TTC-NPO PM.

The destructive physical analysis reveals technological defects that cannot be detected by traditional testing. Concerning the DPA results the parts undergo additional tests and receive further recommendations on their usage and application in equipment production. If the DPA results are negative the defective parts are prohibited to install.

It becomes evident that the low quality of components caused by production technology and detected while testing complicates equipping the satellites designed for a long lifetime mission. The additional screening carried out by TTC - NPO PM can solve this problem. The Testing technical center also applies its experience and ideology to other non-space equipment designed for military and civil users. For instance, TTC - NPO PM tested the electric components to be used in nuclear industry and communication lines.

TTC - NPO PM offers the following services:

- Procurement and supply of EEE components to install into purpose-designed equipment;
- Incoming inspection of EEE components;
- Additional screening and diagnostic testing;
- Destructive physical analysis of components;
- Development of test software programs;
- Support in selecting foreign components ;
- Release of technical and accompanying documents for foreign components purchased;
- Foreign components testing.

In order to enlarge the scope of its services TTC - NPO PM is now fulfilling the program of modernization and upgrading its laboratories with state-of-art testing and diagnostic instrumentation.

BYKANOV Vyacheslav Georgievich,
JSC "NPO PM - Small Design Bureau" Director

In 1977 graduated from the Krasnoyask technical university with diploma of a machine engineer.

His working career started at FSUE «Academician M.F. Reshetnev NPO PM» in 1977, where he made up his way from a shop foreman assistant to a head of the design bureau. Vyacheslav Georgievich was awarded with the title «Veteran of Work».

In 2000 he was assigned a head of a new NPO PM subsidiary enterprise - «NPO PM - Small Design Bureau».

In July 2003 Vyacheslav BYKANOV became a director of the JSC «NPO PM - Small Design Bureau» and later was awarded with the Academician M.F. Reshetnev Medal, instituted by the Russian Space Federation.

Today he is also at the head of the regional employer industrial group «Krasnoyarsk builders union».

State-of-art developments of the Small Design Bureau

The JSC «NPO PM - Small Design Bureau» was established in 2000 as a subsidiary enterprise of the FSUE «Academician M.F. Reshetnev NPO PM» and a provider of products for civil and military applications. In 2003 the enterprise was reformed into the JSC «NPO PM - SDB».

AMONG the main activities of the SDB there are:

- Design, manufacture and supply of thermotechnical equipment and systems;
- Development and supply of dispatch systems based on computer software;
- Development and manufacture of technically complicated automatic systems comprising both software and hardware, to operate within a wide temperature range (from - 90°C to +60°C).

For seven years the company has realized a number of projects contracted by the largest Krasnoyarsk companies and enterprises. In particular, they developed, produced and supplied electronic street clocks for the «Soyuz» company and digital clocks for the GORTEPLOENERGO Company.

As per the contract awarded by NPO PM, they developed design documentation to modernize the drum vacuum filters intended for industrial sewage disposal. For NPO PM as well, they worked out and put into service an automated system controlling mass parameters of a range of products. Owing to modernization the operations previously manually carried out were then automated. In fact, all necessary measurements are carried out under operator's command by pressing several buttons on the computer keyboard. The test bench drives receive commands and change the angles of inclination, or replace loads, etc. Moreover, the operator can control mass and COG coordinates estimations and test record sheet printing.

The Small Design Bureau developed and put into service the digital 16-

channel control circuit for the shaker tests. It completely automated testing processes and helped to change the settings. The data is further printed in a form of a report.

Any mistakes are excluded when the process is computer operated thus guarantying no undesired vibration overloads that may appear during the manually operated process.

SDB developed, produced and installed the system providing geometric measurement data and control of the payload thermal field while testing in the NPO PM acoustic chamber. The measurements are automatically computed and remote control is provided, consequently the measurement works carried out at the acoustic chamber without man assistance. When acoustic absorbent experiences an unacceptable increase of the temperature a warning flash appears on the display. The test results are printed in a form of an engineering report.

The Small Design Bureau is now busy with one of its prospective activities - technique upgrading of the housing and communal services. Owing to its own production and design facilities the company can provide compatible heat-exchanging equipment able to operate under any severe conditions. The company was licensed to develop and produce heat equipment for individual buildings as well as for civil and industrial high buildings, food industry and nuclear power industry.

With off-the-shelf constituent parts, the company guarantees fast and reliable producing and delivery of heat exchangers, block heat exchangers, and pressure holding pump sets to customers. The equipment has Russian certificates and showed itself to good advantage when operating under hard conditions. Warranty period is 3 years.

A heat exchanger may be used independently or within a block heat exchanger providing control, heat consumption rating and supply from the external heat network (TPP or a boiler-house) to the systems of central heating, ventilation and hot-water supply used in houses, industrial buildings, cottages.

Efficient heat energy supply (98%) and a wide range of heat loads (20 kW - 25 mW) both favour to enlarging the sphere of heat exchangers application.

Using a block heat changer in combination with an automated climate control system they reduce heat consumption to 30-40% therefore meeting customer's demands and proposing him more comfortable conditions.

The company developed the dispatch system that links city thermal systems at one (several) dispatching desk according to the systems' command, control and telemetry options. It helps to provide operational control, detect and recover abnormal situations. As soon as the system is implemented the quality of building maintenance will be improved.

The JSC «NPO PM - Small Design Bureau» efforts are also aimed at designing and creating technically complicated ground systems to ensure required thermal modes during spacecraft and transponder tests. For example, the thermal vacuum chamber developed and produced as per the contract awarded by the FSUE «Siberian Devices and Systems» (Omsk). The chamber was designed to provide thermal vacuum tests of spacecraft automated actuators.

As per the NPO PM contract, they produced and supplied thermal control system simulators that can regulate temperature of a spacecraft payload heat carrier from -30˚ to +40˚. Electronic unit combined with a computer ensures automated checks and tests.

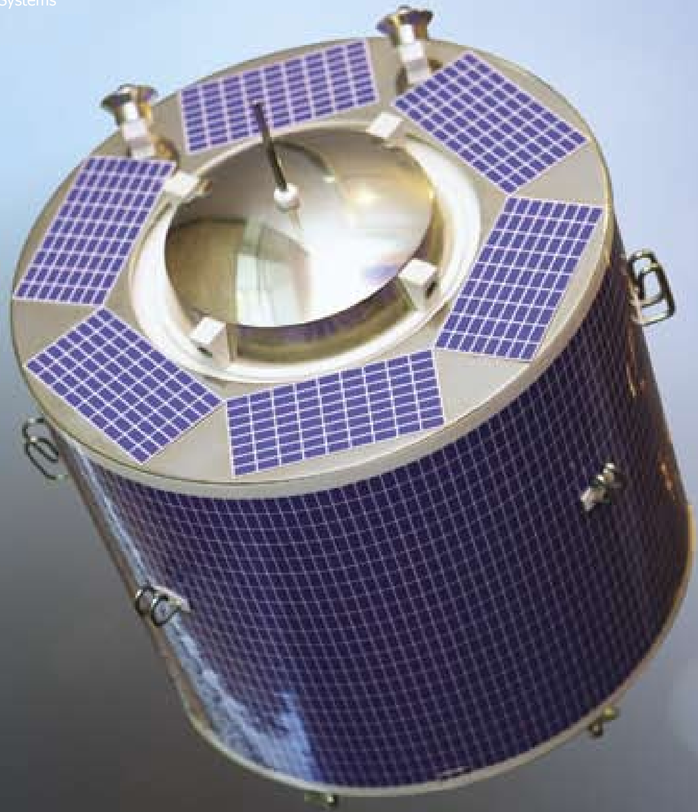
The company today is working on designing and manufacturing 2 kW refrigerating machines with main coolant circuit standing temperature up to -70˚C.

The SDB specialists are also developing the thermal mode provision system (TMPS) for NPO PM spacecraft shipping containers. TMPS is a complicated redundant computer-aided system using a remote control and providing inside temperature within the range of 5 to 35?C despite the ambient -40˚ to +50˚. The system is powered independently.

Offering its production to the Krasnoyarsk markets the Small Design Bureau tends to enlarge the scope of its activities, look for new national and foreign customers. To hit the target the company is constantly improving quality of production along with guarantying its reliability and reducing dates of project realization. In 2007 the company's quality management system was certified proving its conformance to the international standards ISO 9001-2001.

In 2006 the company became a member of the regional employer industrial group «Krasnoyarsk builders union». The Small Design Bureau participates in the purpose-oriented programs «Power efficient economics» and «Household maintenance» developed for 2002-2010.

To be in front lines the company is mastering new kinds of production that could meet customer demands. The JSC «NPO PM - Small Design Bureau» can provide all necessary conditions to successfully realize every project, including qualified personnel, production capacities and reliable partnerships.



40 years ago, on the 20th of February the «Sfera» satellite was injected into orbit unveiling a new epoch of space geodesy. The satellite launch allowed to create geodesic networks covering the whole globe surface and ensuring geodetic reference accuracy up to several meters. The «Sfera» satellite helped in clarifying the Earth's dimensions and shape as well as its gravity field parameters, which couldn't be revealed within a short period of time in a traditional way.

The spacecraft "SFERA" 40th anniversary

The SATELLITE was created on order of the USSR Military Survey Directorate of the Armed forces headquarters. NPO PM (now the JSC «ISS - Reshetnev Company») was the prime contractor on the project. The works began in 1963. Alexander Mitsko was given a new assignment of a project chief designer.

The satellite was designed to provide a world surface unified coordinate system, to build up geodesic «bridges» over continents and islands and to specify the Earth's gravity field parameters. In order to provide solutions for these tasks the satellite was equipped with on board geodesic equipment and a corresponding complex of ground equipment was created as well.

The satellite was developed, tested and prepared for launch by the specialists of NPO PM, subcontracting companies and customer's inspectors.

The first satellite «Sfera» was launched from the «Plesetsk» spaceport on February 20, 1968. The satellite was in use 19 months instead of 6 significantly exceeding its design life.

Totally there were 18 «Sfera» satellites injected into orbit. The last one was launched on December 26, 1978 and operated till May 1, 1980. The specialists managed to build up a geodesic complex based on these satellites. Owing to the «Sfera» satellites they created a model of the globe. Among other developers of the satellite awarded with the USSR State Prize there was an NPO PM specialist Vladimir Cheremisin.

The «Sfera» satellites stipulated the space geodesy development, and after they had been put into service the specialists set on developing a new geodesy satellite «Geo-IK». When building the satellite the developers relied on their experience of creating and producing the first space geodesic complex thus tracing a new step in space geodesy development. The satellite was equipped with a state-of-art and higher precise equipment: radio-altimeter, automation system and directional warning flashing light, on board Doppler equipment and range enquiry system, optical corner reflectors. On the whole they made 14 launches.

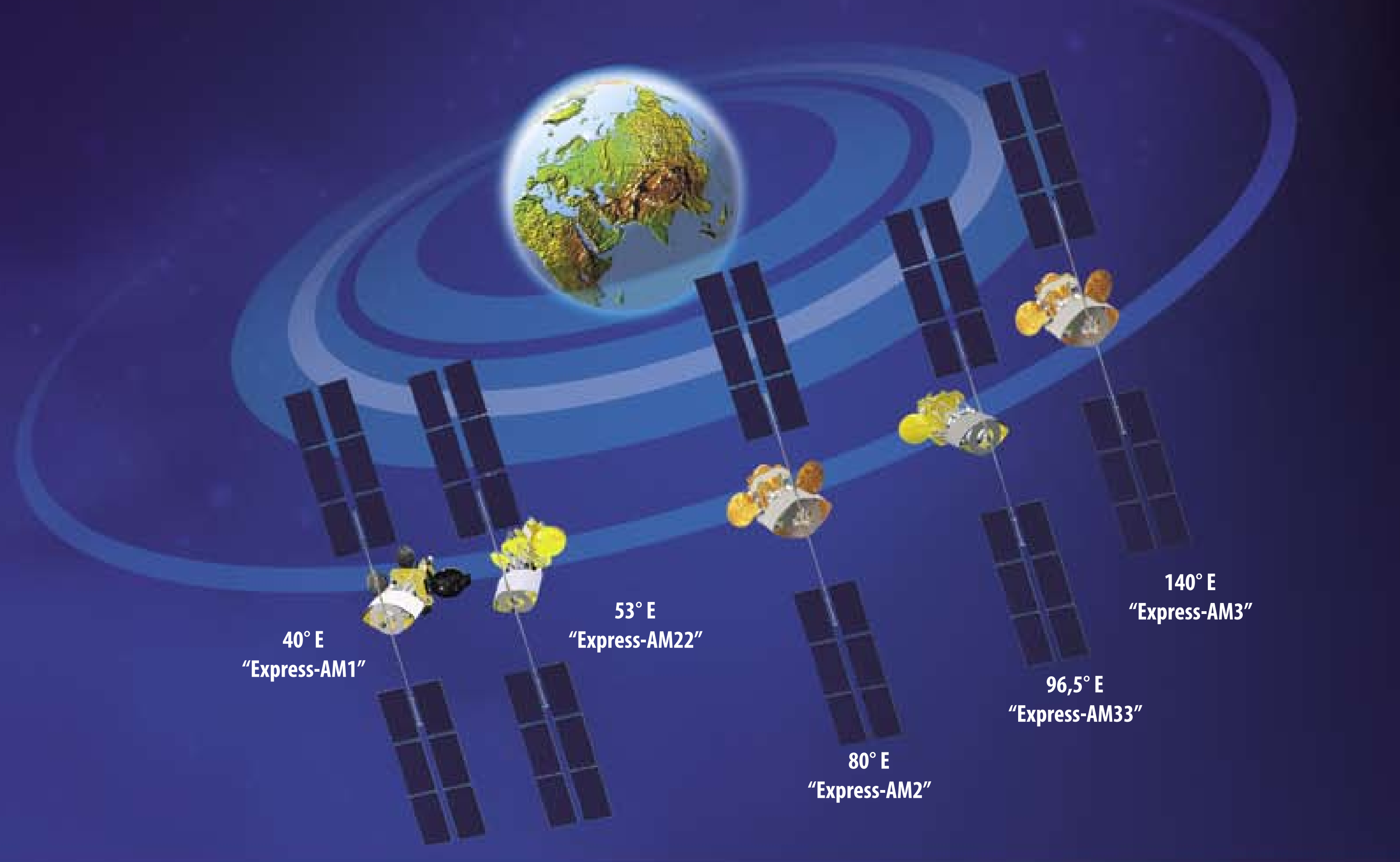
On April 24, 1985 this satellite was also put into service. It worked till February 5, 1999.

Today NPO PM is developing a satellite «Geo-IK-2» to be launched in 2009. Space geodesy is being further developed along with creating new satellites, which will carry higher precise equipment, new ranging methods and means in order to monitor the Earth's parameters.

We thank K. TRUTNEV – principle design-engineer at ISS-Reshetnev Company design department and V. CHEREMISIN - chief manager at ISS-Reshetnev Company business planning department for their assistance while writing this article

The «Express-AM» satellites provide multimedia capacities including TV and radio digital broadcasting, telephony, video conferencing and data relay, VSAT-based communication networks, Internet access provided all over the Russian territory and abroad, mobile communications services for the Russian president and other top government officials.

EXPRESS-AM orbital constellation



The «EXPRESS-AM» satellites are created according to the Russian Government decree (626) dated from August 25, 2001 and the Russian Federal Space Program for 2006-2015.