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RUSSIA'S NATIONAL AEROSPACE MAGAZINE

Take-off

december 2005 • Special edition for LIMA 2005 airshow

RMAF prepares to get Su-30MKM

while Su-30MKIs continue Indian service

MAKS 2005 highlights

Mecca of Russian military test pilots

Clipper: reusable successor to Soyuz?

Yak-130: "flying school-desk" for fighters

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Dear readers!

You are holding a special English-language supplement to Russia's *Vzlyot* (Take-Off) national monthly aerospace magazine. This issue coincides with the LIMA 2005 aerospace exhibition on Malaysia's Langkawi Island. LIMA has long outgrown its national status and developed into a prominent regional event, which attracts not only Malaysian officials but also potential customers from all over the Southeast Asia and Asia-Pacific region in whole.

The countries of the Asia-Pacific region have always been high on Russia's arms trade list of priorities. Suffice it to say that the region's China and India claim upwards of 70 per cent of Russian aircraft exports. The combined scale of Russian aircraft license production programmes pursued by the two countries is comparable. However, Russia's military and technical cooperation with the countries in the region does not boil down to these two importers only and has been given a new impetus of late.

Some South-East-Asian nations wished to field advanced Russian-made warplanes and helicopters in addition to the traditional Russian exports, such as Mil Mi-17 utility helicopters. As a result, Mikoyan MiG-29 fighters have been in service with the air forces of Malaysia, Bangladesh and Myanmar for a few years now. South Korea received an impressive fleet of Kamov Ka-32 utility helicopters. Traditional Russian partners have not been forgotten either. For instance, Vietnam is the first South-East-Asian nation to import second to none fourth-generation fighters, Sukhoi Su-27s, in the late 1990s to be added with even more effective Su-30MK2V aircraft last year. Recently Sukhoi fighters and Mil Mi-35 combat helicopters were imported by Indonesia.

Next year Malaysia will take delivery of its first Sukhoi Su-30MKM multirole fighters from Russia. This new version is based on the Su-30MKI fighter, which has been in operation with the Indian air force for several years now. See our cover story for details on the Su-30MKI and Su-30MKM programmes. Russia is also promoting its new Yakovlev Yak-130 combat trainer as a comprehensive pilot training solution for potential customers of Sukhoi and MiG fighters. An article about the Yak-130 is another highlight of this issue. We also offer you reviews of other aerospace programmes under way in Russia and CIS countries, along with the key events of the past several months in the life of Russia's aerospace community.

We try to provide our readers with most complete and trustworthy information about what is going on in Russian aerospace industry today, what advances are in the pipeline and how Russian-built aircraft are operating worldwide. With such information at hand, it is easier to analyse the situation on the global market and take right decisions. I wish the LIMA 2005 airshow participants successful work and want them to rest assured that Russian-made aircraft will not fail them.

Sincerely yours,

Andrey Fomin
Editor-in-Chief

www.take-off.ru RUSSIA'S NATIONAL AEROSPACE MAGAZINE
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Andrey Zhirnov

MAKS 2005 highlights

This year's key aerospace event in Russia was the 7th MAKS International Aviation and Space Salon held at the Gromov Flight Research Institute's airfield in Zhukovsky near Moscow on 16–21 August.

MAKS 2005 hosted 654 exhibitors from 40 countries, including 134 companies from outside the CIS. Bahrain, Belgium, Finland, Georgia, the Netherlands and Slovakia were for the first time represented at the exhibition. The six-day event attracted 512,000 visitors, including more than 122,000 aviation specialists. Over 387,000 entrance tickets were sold to general public. The total exhibition area was 945,000 sq m, including over 29,000 sq m of pavilions, almost 6,000 sq m of chalets (there were 71 this year) and almost 139,000 sq m of rented open areas including the static park. The exhibition included 221 static and flying aircraft (159 of Russia and CIS states and 62 of foreign countries); 84 fixed-wing and rotary-wing aircraft together performed 243 demonstration flights. Media coverage was provided by 591 accredited companies (including 178 foreign media resources), more than 2,500 journalists from 50 countries and 122 TV channels. The organisers and exhibitors held 101 news conferences during the show. The total car parking area of 777,000 sq m accommodated over 6,600 vehicles.

Alexey Mikheyev

This year's show became the most successful in the 12-year history of MAKS. According to preliminary assessments, more than $3bln worth of contracts and MoUs were signed at MAKS 2005. More than 220 business meetings and official signing ceremonies were held during the first three days alone. Among the most important documents signed at MAKS 2005 were the contracts for licence production of Saturn AL-55I engines in India, for Ilyushin Il-76MF deliveries to Jordan and for the purchase of the first ten Sukhoi RRJ passenger aircraft by launch customer Finance Leasing Company. Other key deals included a commitment for ten new-build Antonov An-124 Ruslan transports and cooperation agreements between Russian aerospace companies and EADS, Boeing,

Rolls-Royce, Finmeccanica, Alenia Aeronautica and Aermacchi. The Ilyushin-Finance Leasing Company (IFC) concluded the greatest number of contracts, selling Antonov An-148, Ilyushin Il-96 and Tupolev Tu-204 aircraft for a total sum of $1.6bln.

IFC signed seven lease agreements for 56 aircraft at the show, including 39 orders for the new An-148 regional airplane (see a separate article in this issue). Vladivostok Avia signed a lease agreement for two Tu-204-300 passenger jets. Two Tu-204-100s were leased by Kavminvodyavia. IFC also reached an agreement with Cubana de Aviacion SA of Cuba for two Tu-204-100 (or -300) passenger aircraft and one Tu-204C transport. Cubana also agreed the terms of delivery for two Ilyushin Il-96-300 long-haul widebody passenger aircraft in addition for the two already ordered (one such aircraft was displayed at MAKS). Volga-Dnepr Group signed a leasing agreement for eight Ilyushin Il-96-400T transports in addition to an existing firm order for two such aircraft. In all, during the first three days of MAKS IFC signed two agreements for ten aircraft of the Il-96 family and three agreements for the delivery of seven aircraft of the Tu-204 family, not counting the An-148 agreements.

The MAKS 2005 highlights were the Antonov An-148 regional jet; the first upgraded Ilyushin Il-76TD-90VD transport; the first Antonov An-140 regional passenger aircraft built at Russia's Aviacor plant; a pre-production Yakovlev Yak-130 combat trainer; a MiG-29BM fighter upgraded in Belarus; two flying testbeds by Radar-MMS – an Ilyushin Il-114LL and a Kazan Helicopters Ansat-LL helicopter; the first prototype of the Mil Mi-38 medium utility helicopter; the Kazan Helicopters Ansat-2TRs light reconnaissance/strike helicopter, a fuselage mock-up of the prospective Mil Mi-54 transport helicopter; a full-scale mock-up of the proposed Clipper reusable spacecraft, a variety of new UAV designs and much more.

The flying displays were extremely spectacular this time round, with such hits as the debuting Mikoyan MiG-29OVT superagile fighter, the Sukhoi Su-30MKI; Russian Knights, Swifts and Rus display teams; their colleagues from Italy (Frecce Tricolori) and France (Patrouille de France); French Air Force Mirage F1 fighters and an Italian Air Force G222 transport. This year's MAKS was honoured by the first-ever arrival in Russia of a USAF B-1B strategic bomber and the first flight in years of its Russian analogue, the Tupolev Tu-160. Tupolev was well represented at flying displays this year, treating the audience to grandiose five-ship flypasts during the first three days of the show of Tu-160, Tu-95MS and Tu-22M3 bombers together with Tu-204C and Tu-334 passenger aircraft.

Since its inception 12 years ago MAKS has transformed from a regional air show to a world-class exhibition. Its current distinctive traits, which stood out during this year's event, include a representative list of exhibitors, a comprehensive conference programme, a large number of official delegations, a numerous audience and mind-boggling flying displays. The recent tendency is towards an increasing role of MAKS as a business forum, with every new show seeing more business meetings, negotiations and news conferences and recording more contracts signed on the premises. All these factors combine to make MAKS one of the world-leading aerospace exhibitions. The next MAKS show will be held 28 August through 2 September 2007.

Alexey Mikheyev

Two Il-76MFs for Jordan

Sergey Sergeyev

His Majesty King Abdullah II bin al Hussein, the Supreme Commander of the Jordan Armed Forces, visited the MAKS 2005 air show in Zhukovsky, Moscow suburban. During the 17 August talks at the exhibition, the Jordanian delegation and the Rosoboronexport state arms exporting agency signed a "$100million-plus" contract to deliver two new PS-90A-76-powered Il-76MF military transports, with a payload capacity of 60t, to the Royal Jordanian Armed Forces in 2007. The contract is the first export deal for this re-engined Il-76 version. The two aircraft will be built by the TAPC plant in Uzbekistan.

The first Il-76MF has been in tests since August 1995. The aircraft differs from the Il-76MD baseline model in a new powerplant and a stretched fuselage for increased payload capacity. TAPC has built several Il-76MF airframes by now. Two of these may be completed under the Jordanian contract. The Royal Jordanian Air Force's current military transport fleet comprises four Lockheed Martin C-130Hs, two Casa CN-235s and two Casa C-295s.

China buys two Il-76 regiments

The Chinese People's Liberation Army Air Force (PLAAF) will receive a large batch of Ilyushin Il-76MD military transports and Il-78MK airborne tankers under a deal struck on 8 September with the Rosoboronexport Russia's arms exporter as the primary contractor. The contract, valued at about $1.5bn, was signed in Russia's Sochi Black Sea resort during the 12th meeting of the Russo-Chinese intergovernmental committee for military technical cooperation, co-chaired by Russian Defence Minister Sergey Ivanov and his Chinese counterpart Cao Gangchuan. According to press reports, the 38-strong batch of aircraft for the PLA will include at least four Il-78MK tankers. The airplanes will be built at Uzbekistan's Tashkent Aircraft Production Corporation (TAPC), and will be powered by NPO Saturn D-30KP-2 engines. According to the NPO Saturn press service, the company will deliver 240 such engines to China for a total sum of over $300m in 2006–2010.

The PLA already operates more than a dozen Il-76MD transports (one of then shown in the picture), which it purchased from Russia back in the 1990s, but it has not ordered Il-78 tankers before despite prolonged negotiations. China's need for an air refuelling capability has intensified after the 2000–2004 deliveries of 100 Russian-made twin-seat Su-30MKK and Su-30MK2 multirole fighters, which are fitted with in-flight refuelling system. The deal might have been further influenced by the recent Exercise Peace Mission 2005 of Russian and Chinese forces, which involved five Russia's Military Transport Aviation's Il-76MD aircraft.

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Egypt gets its first An-74

KSAMC

On 16 September a solemn ceremony of handing over the first Antonov An-74T-200A aircraft to the customer, the Arab Republic of Egypt, took place at the airfield of the Kharkov State Aviation Manufacturing Company (KSAMC), Kharkov, Ukraine. By that time the aircraft had completed its flight test programme which confirmed the declared characteristics of a new digital navigation equipment set installed for the first time on this military transport jet. The handing over of the first An-74T-200A to the Egyptian side was a starting point in implementing the Ukrainian-Egyptian contract on delivery of three aircraft with an option for another six ones. In future the contract also can be expanded to 18 aircraft.

AL-55I to be produced in India

Aviaselon JSC

On 16 August Director General of Rosoboronexport State Corporation Sergey Chemezov and chairman of Hindustan Aeronautics Ltd (HAL) aircraft corporation Ashok Baweja, attended by Russian President Vladimir Putin, bound the contract on licensed production of the AL-55I turbofan engine designed by Russia's NPO Saturn scientific production association at HAL's plants. The AL-55I is known as a winner in the Indian Air Force's tender for an engine to power the new Indian HJT-36 trainer aircraft, and late last July a contract on its development has been signed. The signed agreement stipulates that the Russian Side transfers to HAL the right to produce on licence these engines in India. NPO Saturn and UMPO JSC act as prime Russian contractors cooperating with HAL on risk sharing conditions.

Saturn's commercial director Vasily Danilov told our magazine's correspondent that the licence production contract foresees manufacturing in India of about 250 AL-55I engines featuring 1,700kgf thrust. In future their number may be increased up to 1,000 units, while India is also interested in developing and producing a more powerful 2,200kgf engine version for possible employment in its advanced HJT-39 twin-engine combat trainer aircraft.

In accordance with the AL-55I development contract in force since 1 August 2005, the first engine is to be delivered in 24 months, i.e. in summer 2007. Vasily Danilov says that NPO Saturn is presently developing units of the AL-55I engine, planning to finish the work by end 2006 when a first test bench run of the full-scale engine can occur. After trials on the test bench, the AL-55I is supposed to undergo flight tests on a flying testbed, possibly MiG-AT aircraft.

The AL-55I is a version of the AL-55 Saturn-designed advanced turbofan engine adapted to the Indian Air Force's HJT-36 aircraft. The AL-55 also can serve as a baseline model for deriving a whole family of turbofans and afterburning turbofans with thrust ranging from 1,700 to 3,500kgf for powering various trainers, combat trainers and light combat aircraft, including the Yak-130 and MiG-AT.

Russian engines for Chinese fighters

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Alexander Vatagin, Director General, Klimov Plant (St. Petersburg), announced that the enterprise delivered to China this October two first RD-93 engines for installation on the new Chinese FC-1 (Super-7) light multi-purpose fighter. This has started realisation of a contract on the delivery to China of 100 RD-93 engines worth of $267 mln, signed by Rosoboronexport in April this year. First 15 engines shall be delivered to China by Klimov Plant itself, and the rest – by Chernyshev Moscow Machine-building Plant. Before that, in 2002-2003, Klimov already delivered to China several RD-93 engines, subsequently used for powering three FC-1 prototypes (the first of them had its maiden flight on 24 August 2003). The RD-93 is a version of the series-produced RD-33 afterburning turbofan installed on MiG-29 family fighters, featuring a low-positioned gearbox and adapted for installation on the single-engine FC-1 aircraft. Like the basic turbofan, the RD-93 develops a thrust of 8,300kgf with afterburning, and 5,040kgf at full power. Considering good export prospects of the FC-1 fighter (for example, Pakistani Air Force plans to procure up to 150 such aircraft), the order volume for the RD-93 engines can subsequently increase and reach, by some estimates, 500 units.

The RD-93 is not the only engine delivered by Russian industry to power Chinese fighters. Another Russian plant, Salut Moscow Machine-building Production Enterprise, delivered to China 54 AL-31FN engines in 2002–2004 for powering prototypes and pre-production J-10 fighters. After having built nine prototypes by 2002 (the first performed its maiden flight in 1998) China started manufacturing a pilot batch of the J-10s. The ensuing full-scale production will demand new batches of the engines as the PLAAF may order, according to varied estimates, from 100 to 300 J-10 aircraft. It was the reason why in July this year Rosoboronexport signed a new contract worth of more than $300mln on the delivery of 100 AL-31FN engines manufactured by Salut, during the two-year period. The AL-31FN is a version of the series-produced Saturn AL-31F turbofan engine installed on Su-27 family fighters, with a low-positioned gearbox and the same thrust (12,500kgf with full afterburning). Salut is to deliver the next batch of the AL-31FN engines to China by this year-end, and to dispatch all 100 engines, as per the current contract, by the third quarter of 2006.

Andrey Fomin

SU-30MKIs CONTINUE INDIAN SERVICE

as RMAF PREPARES TO TAKE ITS FIRST SU-30MKMs

A year ago, in December 2004 Irkut corporation delivered the last of 32 Sukhoi Su-30MKI multirole fighters to India. Deliveries had been running since 2002, with the new aircraft inducted by two squadrons of the Indian Air Force (IAF). Simultaneously with the completion of the contract, Hindustan Aeronautics (HAL) in late 2004 launched license production of 140 Su-30MKIs. As a result, by 2020 the IAF will become one of the world-largest Flanker operators with a total of 190 fighters.
A further version of the Su-30MKI is a two-seat Su-30MKM multirole fighter currently under development by Sukhoi for Malaysia. Under an August 2003 contract from the Royal Malaysian Air Force, Irkut corporation will build 18 Su-30MKMs; deliveries are expected to begin in 2006.

Flanker's Indian move

India expressed her interest in procuring the Su-27 family fighters in the mid-1990s. The Indian Air Force (IAF) has traditionally operated a great variety of Soviet-produced aircraft, including several versions of the Mikoyan MiG-21, MiG-23MF and MiG-29 fighters, as well as the Sukhoi Su-7BMK and the Mikoyan MiG-23BN fighter-bombers, the MiG-25RB high-speed/high-altitude reconnaissance bombers, etc. Moreover, in the 1980s–90s India undertook license production of the MiG-21bis and the MiG-27M. The Russian MiG-29 and the French Mirage 2000 were the most sophisticated fighters in service with the Indian Air Force in the early 1990s. Trying to boost further development of the Air Force and expand its combat capabilities, the Indian authorities decided to shift their focus towards new fighters, developed by the Sukhoi Design Bureau.

The IAF first announced its intention to procure Su-30 fighters in February 1994. This was followed by several visits of Indian delegations to Moscow and Irkutsk, and in January 1995 top managers and engineers of Sukhoi and the Irkutsk plant visited the Nasik facility of Hindustan Aeronautics (HAL) which was expected to launch licence production of Russian fighters.

The Indian side expressed its interest in the upgraded twin-seater, advertised by Sukhoi since 1993 as the Su-30MK, i.e. the aircraft, which besides a two-man crew differed from the Su-27SK series production export version in an increased range and endurance due to the in-flight refuelling system, as well as formidable armament, including air-to-surface precision guided munitions. The Irkutsk Aviation Industrial Association (IAIA), now known as Irkut corporation played a key part

in promoting the Su-30MK to the Indian market. Chaired by Alexey Fedorov, IAIA had previous experience of cooperation with India: the company had in its time delivered MiG-23UB combat trainers to the IAF and transferred the production licence for the MiG-27M fighter/bomber to Indian industry.

The initial batch of aircraft was supposed to have been shipped to India from Irkutsk as soon as the contract had been signed. At first, the customer was to have received standard production Su-30K fighters without new avionics and armament (IAIA had already launched the Su-30 version to be fielded with the Russian Air Force into series production by that time), but then, following corresponding improvements, Su-30MK multirole aircraft could be delivered.

However, in the course of negotiations the Sukhoi Design Bureau suggested that India should not limit its capabilities to the export version of the Su-30MK and should procure an aircraft, which featured considerably higher combat capabilities. These combat capabilities were defined by a number of design solutions tested or being tested on the Su-27M, including an improved aerodynamic configuration with canards, the new fly-by-wire system, as well as a power plant with thrust vector control nozzles. In addition to that the aircraft was supposed to be fitted with a phased array radar. Thus, India would be able to field a fighter with unrivalled manoeuvrability and combat capabilities. By the way, Russia did not have a mass production aircraft like that either.

Piotr Butowski

Contract

The super-manoeuvrable multirole fighter, based on the Su-30MK, was yet to be developed. Nevertheless, India was quite upbeat about the proposal and agreed to finance design and development of the special Indian Flanker version, designated the Su-30MKI (I standing for Indian), and wait for the aircraft to be developed and tested.

At the same time, the Indian side put forward a number of additional requirements. The main requirement demanded that the fighter's avionics should be internationalised, i.e. along with Russian-produced systems the Su-30MKI was to be fitted with French, Israeli, and Indian components. The navigation, the display system, and the ECM suite were to be produced by foreign states, while the aircraft computer system was to be built around Indian CPUs.

The programme was planned to be carried out step by step for Indian pilots to master the new fighter as soon as possible. At the first stage they were supposed to get and learn to fly production Su-30Ks, and then as new systems and equipment were mastered, India would start receiving aircraft, which would gradually resemble the final design of the Su-30MKI. When the contract was fulfilled, aircraft of the initial batch were to be upgraded to the level of the Su-30MKI.

This approach was stipulated in the contract, signed by the Indian side, the Irkutsk manufacturer and the Sukhoi Design Bureau and brokered by the Rosvoorouzhenie State Enterprise in Irkutsk on 30 November 1996. The $1.8bln contract envisioned delivering 40 aircraft in four batches to India in 1997–2000. In 1997 the customer was to get

Sergey Pashkovski/ Sukhoi

Su-30MKI first flying prototype in a test flight with free-fall bombs weapons

the initial batch of eight Su-30Ks, in 1998 – eight aircraft with upgraded avionics, in 1999 – 12 aircraft with improved airframes and new avionics, and finally in 2000 – 12 Su-30MKI aircraft, fitted with thrust vector control engines. Along with the aircraft India was also to get the following armament: the R-27ER1/ET1, the R-73E, and the RVV-AE air-to-air missiles, as well as the Kh-29T, the Kh-31A, and the Kh-59ME air-to-surface missiles. Starting from 2001 aircraft of the initial batch were to be upgraded to the level of the Su-30MKI of the last batch, while the Indian HAL was promised a feasibility of launching license production of the Su-30MKI at its plants.

In the spring of 1997 Antonov An-124 Ruslan military transports ferried the first eight Su-30Ks from Irkutsk to India in four flights in strict compliance with the set timeframe. On 11 July 1997 the official ceremony of fielding the aircraft with the Indian Air Force took place at the Pune airbase. The new fighters entered the inventory of the IAF's 24th Sqn "Hunting Hawks", getting side numbers from SB 001 to SB 008.

Prototypes

In the meantime, the Sukhoi Design Bureau assembled the first prototype, featuring the airframe and the power plant similar to that of the Su-30MKI fighter. Test pilot Vyacheslav Averyanov took the aircraft based on series production Su-30 fighter, side number 56, for its maiden flight on 1 July 1997. Later on, having been repainted, the aircraft received side number 01. Main improvements, introduced to the first Su-30MKI prototype, consisted in modifying the aerodynamic configuration (introduction of the canards and corresponding changes to the wing leading edge root extensions) and installing the upgraded SDU-10MK fly-by-wire system, as well as fitting the aircraft with the AL-31FP thrust vector control engines.

The AL-31FP engine differed from the production AL-31F in that it was equipped with a hinged nozzle, swivelling within a sector of ±15 degrees. The nozzles swivelling axis were deflected by 32 degrees from the vertical plane of symmetry, which allowed the aircraft to get not only a vertical, but also a lateral thrust vector component, given differential deflection of nozzles of both engines. In addition to the automatic thrust differential alternation capability of both engines (the so-called different thrust control) it also enabled the aircraft to be controlled in all planes at extremely-low and zero airspeeds, when conventional aerodynamic controls were not effective. The thrust vector control system on the Su-30MKI is integrated into the aircraft fly-by-wire system and does not have any separate control knobs, but when necessary, it can be completely deactivated with the nozzles set in the neutral position.

The thrust vector control system, the innovative aerodynamic configuration, and the efficient fly-by-wire system provided the Su-30MKI with unique manoeuvrability. Test pilot Averyanov mastered such aerobatics on the aircraft as no other aircraft in the world is capable of carrying out. In early December 1998 he demonstrated his aerobatics on Su-30MKI No 01 at the Aero India 98 air show in Bangalore, enthusing spectators. Similar demonstration was slated for the

Pre-production Su-30MKI (side No 04) fulfils a test launch of a KAB-1500Kr TV-guided bomb

Sukhoi

Le Bourget air show, held the following June, but on the eve of the show, on 12 June 1999, Su-30MKI No 01 had an accident, caused by an error of the crew. Vyacheslav Averyanov and navigator Vladimir Shendrik managed to successfully eject from the aircraft.

By that time two prototypes had been participating in the Su-30MKI test programme: in addition to the first prototype, the second one, Su-30MKI No 06, was derived from the T10PU-6 aircraft in 1998, which in turn had become the second Su-30 prototype in 1988. It made its maiden flight on 23 March 1998. It was on this very aircraft that Averyanov completely righted himself in August 1999 two months after the crash in Paris by splendidly carrying out the demonstration flight, intended for Le Bourget, at the MAKS '99 air show in Zhukovsky near Moscow.

When the contract was signed, the Su-30MKI prototypes were supposed to have embarked on testing a new international avionics suite as early as 1997. However, the customer could not make up his mind as to the final composition of the avionics package. As a result the contract deadline was shifted, while Su-30MKI airframes, already produced in Irkutsk, found their way to the IAIA workshop, awaiting avionics. Given this environment, the deliveries timeframe was decided to be revised: now the initial batch of eight Su-30Ks, delivered to India, was to be followed by final versions of the Su-30MKI without any intermediate modifications starting from 2000. At the same time in the autumn of 1998 the agreement on delivering an extra batch of 10 production Su-30Ks (in addition to the 40 aircraft, stipulated in the 1996 contract) was signed. These aircraft, which by that time had been assembled by IAIA and fitted with Russian avionics, arrived in India from June to December 1999 and fielded with the same 24th Sqn at Pune getting side Nos SB 009 to SB 018.

International avionics suite

The final decision on the composition of foreign components to be incorporated into the Su-30MKI avionics suite was taken only in March 1998. In compliance with the fighter's layout, approved by the customer, the following Russian systems constituted the backbone of its weapons control system: the Tikhomirov NIIP-designed Bars (N011M) phased array radar (produced by the Ryazan State Instrument-making Plant, GRPZ), the OLS-30I (36Sh-01) optronic sighting system (produced by the UOMZ Urals Optical Mechanical Plant), and the Sura-K helmet-mounted target designator (developed and produced by the Ukrainian Arsenal plant).

The Su-30MKI data presentation system includes a head-up display (HUD) supplied by Israeli ElOp company as well as six 127x127mm (5x5in.) MFD55 colour multifunction LCDs, and one 152x152mm (6x6in.) MFD66 display supplied by French Thales (former Sextant Avionique) with three small displays quartered in each cockpit and a large one housed only in the rear cockpit. French Sagem is responsible for fitting the aircraft with the INS/GPS inertial and satellite navigation system.

The Su-30MKI computer system is based on Indian-produced digital processing units, developed by the DRDO state company within the framework of the Vetrivel programme. The ECM system of the aircraft is to be supplied by Israel and to be based on the Elta EL/M-8222 jammer. In addition to that the Su-30MKI is to be fitted with the Rafael Litening optronic targeting and navigation pod in order to provide the aircraft with the all-weather, round-the-clock air-to-surface capability. The rest of the avionics is Russian-produced. The Ramenskoye Instrument-making Design Bureau (RPKB) is responsible for integrating all components of the international avionics package of the fighter.

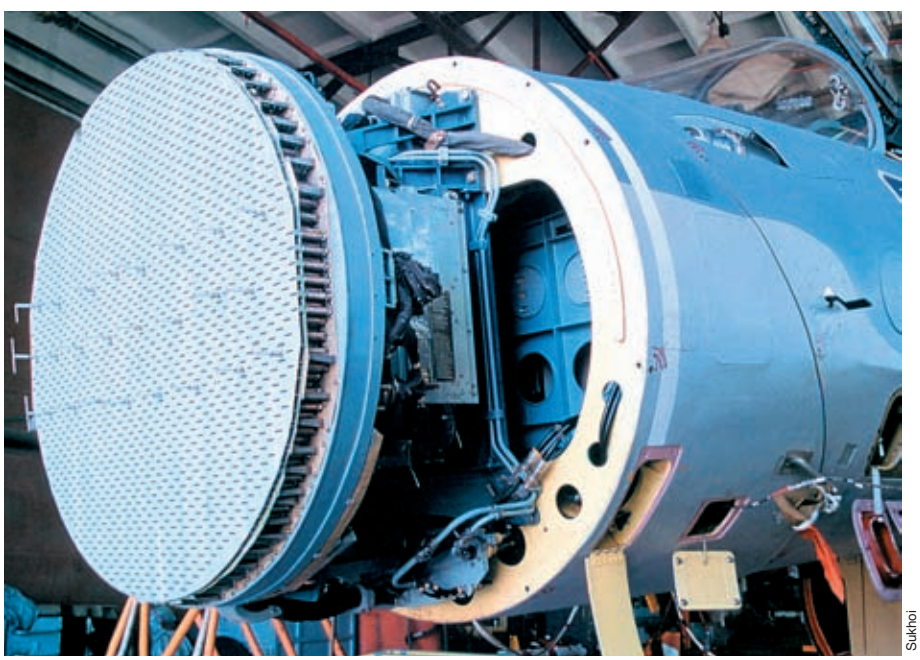
The Bars phased array radar, facilitating electronic beam scanning both in azimuth and elevation, is one of the primary features of the Su-30MKI avionics suite, which provides it with unique combat capabilities. A hydraulic actuator provides the phased array with an extra mechanical azimuth correction in order to increase the radar's horizontal surveillance sector. In the air-to-air mode the radar is capable of simultaneously tracking at least 15 targets, while still carrying out surveillance, simultaneously engaging four targets in a long-range missile combat, detecting the number of targets in a dense target formation, and designating the target acquired. In the front hemisphere the radar's detection range of a fighter totals 150km.

In the air-to-surface mode the radar is capable of detecting and tracking ground and sea surface targets in the map-making mode with a low (300x300m), medium (30x30m), and high (3x3m) resolution; detecting and prioritising moving ground targets; carrying out a low-altitude terrain-hugging flight; and designating the target acquired. The radar is capable of detecting a group of tanks at a range of over 40–50km, while a bridge or a

Bottom: *Su-30MKI's forward and backward cockpits interiors*
Right: *Bars phased-array radar on the Su-30MKI No 06 prototype*

Sukhoi

Sukhoi



Sukhoi

Andrey Fomin

Free-fall bombs attached to the IAF's Su-30MKI: each hardpoint under fighter's air ducts can be loaded by six OFAB-250-270 fragmentation/HE bombs

destroyer at a range of 120–150km. The electronically controlled beam of the Bars radar allows the air-to-air and air-to-surface modes to be synchronised: for instance, the radar is capable of tracking a ground target, while simultaneously carrying out air surveillance or engaging an air target.

RVV-AE active homing fire-and-forget medium-range air-to-air missiles and R-73E dog-fight missiles, as well as R-27ER1 semi-active homing medium-range missiles constitute the mainstay of the Su-30MKI's armament suite. In order to carry out pinpoint strikes against ground targets the aircraft may be armed with Kh-29T (TE) TV-guided missiles, Kh-59ME TV-command guided medium-range missiles, and KAB-500Kr guided bombs, while Kh-31A anti-ship missiles may be relied on to kill naval targets. In addition to that, in the future, the aircraft may be fitted with the BrahMos anti-ship missile, being developed by the Russian-Indian joint enterprise of the same name and based on the Russia's NPOmash-designed Yakhont anti-ship missile. Maximum weight of Su-30MKI's combat load equals 8000kg.

Deliveries

In September 2000, following the final agreement with the customer on composition of the avionics suite and delivery of operational AL-31FP power plants, IAIA assembled the first pre-production Su-30MKI, side No 05. On 26 November 2000 test pilots Vyacheslav Averyanov and Roman Kondratyev took the aircraft for its maiden flight. On 15 February 2001 it was joined by the second pre-production aircraft, side No 04, while in April of the same year they were followed by the third one (side No 02). Another pre-production aircraft side No 07 was manufactured to replace Su-30MKI No 01, which had been lost in Paris, while No 03 was sent to the SibNIA Siberian Aeronautical Research Institute for static tests. Thus, the Su-30MKI flight tests programme saw participation of one prototype (side No 06) and four pre-production aircraft (side Nos 02, 04, 05 and 07). Besides, other aircraft were involved in the tests as well. For instance, the Bars radar was tested on the T10M-12 (Su-27M side No 712) single-seat aircraft in addition to the Su-30MKI, while some other avionics systems were tested on Su-30 No 01-01 (one of the first Su-30MK demonstration aircraft with side No 603).

In late 2001 the first production Su-30MKI, designed to be delivered to the customer, was assembled and made its maiden flight in Irkutsk piloted by the crew of Sergey Bogdan and Leonid Smely. The first

Su-30MKI fighter (side No SB 040) in service with the Indian Air Force's 30th Squadron

Picture by Vassily Zolotov

batch, comprising ten production Su-30MKIs, was delivered to India by An-124 Ruslan military transports in June–August 2002, and on 27 September of the same year they were fielded with the Indian Air Force at an official ceremony, held at the Pune airbase and attended by the Indian Defence Minister.

The aircraft entered service with the IAF's 20th Sqn "Lightnings". The Su-30MKIs in the initial batch were assigned the numbers SB 019 to SB 028.

The first pilots to convert to the new type were those already having flown the Su-30Ks stationed at the same Lohegaon (Pune) air base. This approach to training facilitated prompt conversion: during the Aero India 2003 exhibition held at the Yelahanka air base in February 2003 IAF pilots in Su-30MKIs demonstrated aerobatic manoeuvres previously performed on the type only by Russian test pilots. The hit of the show was the flight demonstration by Wg Cdr Nirmal Singh Jamwal of IAF's 20th Sqn on the SB 022 fighter.

The IAF took delivery of the second, 12-ship Su-30MKI batch in December 2003; the remaining ten Su-30MKIs arrived in India during December 2004. On 26 December an Antonov An-124 transport carried the last two fighters to India, thus successfully completing the deliveries of all the 32 Su-30MKIs and 18 Su-30Ks under the November 1996 and December 1998 contracts. The aircraft of the second and third batches were assigned the numbers SB 029 to SB 040 and SB 041 to SB 050 respectively. Their arrival triggered the re-equipment of another Indian air unit, 30th Sqn "Rhinos". Today both Su-30MKI squadrons are stationed at the Lohegaon base near Pune. IAF's 24th Sqn with 18 Su-30Ks, which was previously stationed at Lohegaon, has been redeployed to the Baksi-ka-Talab base near Bareilly.

In 2004 IAF Su-30MKI pilots began training in air-to-air refuelling from Ilyushin Il-78MKI tankers, which had been delivered in 2003–2004 from Uzbekistan (Russia's Rosoboronexport exporting agency was the prime contractor in the tanker deal). The first public flypast of two Su-30MKIs and an Il-78MKI in refuelling formation was performed at an air parade in Mumbai in October 2004. Also in 2004, the USAF and IAF held the first joint exercise after a break of several years. During Exercise Cope India IAF Su-30Ks came out convincing winners in a series of simulated engagements with USAF Boeing F-15Cs. Experts believe that if the IAF had fielded its Su-30MKIs the outcome of the exercise would have been even more impressively in favour of Indian pilots. The IAF pilots' skills and the outstanding performance of their new warplanes were manifestly demonstrated by IAF's 30th Sqn pilots in the No SB 040 fighter at Aero India 2005 in Bangalore this February.

Sukhoi Su-30MKI basic specifications

Engines type	AL-31FP
Take-off thrust, kgf	2x12,500
Aircraft length, m	21.935
Wing span, m	14.7
Height, m	6.34
Wing area, sq.m	62.04
Normal take-off weight, kg	26,090
Max take-off weight, kg	34,500
Internal fuel, kg:	
- standard fuelling	5,270
- full fuelling	9,640
Max combat load, kg	8,000
Normal landing weight, kg	22,900
Max landing weight, kg	30,000
Max speed at sea level, km/h	1,400
Max speed at high altitude, km/h	2,120
Max Mach number	2.0
Service ceiling, m	17,500
Max rate of climb, m/s	270
Max g-load	9
Range, km:	
- without inflight refuelling	3,200
- with one inflight refuelling	5,200
Max endurance, h	10
Take-off run, m	750
Landing roll, m	650
Take-off speed, km/h	270
Landing speed, km/h	245

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Under the contract, each subsequent Su-30MKI batch differed from the previous batches in gradually approaching the final configuration set by the IAF. The aircraft of the first batch, which was delivered in 2002, fully met the final Su-30MKI standard in terms of airframe and powerplant, but their weapons control system had limited capabilities: these fighters could engage primarily air targets. The second batch, delivered in 2003, had the weapons control system upgraded to simultaneously engage four air targets and use Kh-31A anti-ship missiles. The third batch, delivered in December 2004, carried the final version of the weapons control system and could fully use all the available weapons delivery and navigation modes, including the application of all the air-to-air and air-to-surface weapons envisioned by the contract.

Now that the third Su-30MKI batch has been delivered, the previous two batches will be retrofitted in India to this final standard.

Indian Air Force

Since 2004 pilots of the IAF's 20th and 30th Sqns can refuel their Su-30MKIs in flight using Ilyushin Il-78MKI tanker plane

Licence production

Simultaneously with the final deliveries under the 1996 contract, HAL's Nasik plant started licence production of Su-30MKIs. As envisioned by the 28 December 2000 contract, the Nasik facility will build 140 Su-30MKI fighters until 2017–2018. Russian companies will also assist HAL plants with launching indigenous production of AL-31FP engines and avionics for the warplanes.

The multitier licence production plan stipulates gradual transition to fully indigenous construction of Su-30MKI fighters. In the first phase HAL will merely assemble airplanes from kits supplied by Russia. In the second phase Russia will be shipping separate systems and units; in the third phase separate parts and assemblies; and in the fourth phase HAL will only be receiving materials from Russia – by that time the Indian corporation will have gained competence in indigenous production of all Su-30MKI parts, assemblies, units and systems. HAL is expected to manufacture about 80 per cent of all the aircraft during this fourth phase (114 of the 140 warplanes stipulated by the contract, according to the Indian press).

In the autumn of 2004 HAL rolled out the first two Su-30MKIs assembled from kits supplied by Irkut corporation. The first Indian-assembled fighter performed its maiden flight on 1 October 2004. On 28 November 2004 this aircraft and the second Indian-built Su-30MKI were handed over to the IAF in a solemn ceremony at the Nasik plant. These two airplanes were assigned numbers SB 101 and SB 102. Russian test pilot Sergey Matveychuk and Wg Cdr K R Ajit performed a demonstration flight on Su-30MKI No SB 102 in the presence of the Indian defence minister, IAF Commander-in-Chief, HAL president and numerous guests.

HAL is expected to build another six Su-30MKIs by the end of 2005 and eight more during 2006. After that the annual production rate should increase to 12 aircraft. According to the Indian press, HAL may also build up to 920 AL-31FP engines under Russian licence.

Russian companies are assisting HAL in refurbishing and modernising its production facilities that will take part in Su-30MKI construction. These include the aircraft divi-

Licence production will increase the IAF's Su-30MKI fleet to 190 fighters by the end of the 2010s. Most of these aircraft will remain in service until the 2030s–40s and beyond, and will significantly influence the balance of powers in the region.

MKM for Malaysia

Sukhoi is working to develop its twin-seat Su-30MKI fighter, currently operated by the IAF, into the Su-30MKM version (the last 'M' standing for Malaysia) for the Royal Malaysian Air Force (RMAF).

In the late 20th century the RMAF announced a fighter requirement to supplement its fleet of Mikoyan MiG-29Ns and Boeing F-18Ds with longer-range multirole fighters. The front-running bidders were Boeing with its F-18F Super Hornet and Sukhoi with the proposed Su-30MKM derivative of the Su-30MKI. After several years of negotiations Malaysia opted for the Russian fighter.

Left: *Su-30MKI fighter (side No SB 026) of the IAF's 20th Sqn with full combat load of air-to-air weapons consisting of four R-27ER1, two R-27ET1, four RVV-AE and two R-73E missiles*

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sion in Nasik, engine division in Koraput, accessories division in Lucknow and avionics divisions in Hyderabad and Korwa. The key Russian specialists cooperating on the licence production programme are Irkut corporation (airframe production and final assembly), UMPO (AL-31FP production) and Ryazan State Instrument-Making Plant (the Bars radar). In 2002 Russia began handing manufacturing documents for the airframe, engine and avionics over to HAL, later followed by production equipment. Part of the requisite tooling will be manufactured in India. Retooling of HAL's facilities will be accomplished within several years. By the end of the decade Indian aerospace industry will be capable of independently building such hi-tech and science-intensive warplanes as the Su-30MKI.

The long-awaited $900mln contract for 18 Su-30MKMs was signed in Kuala Lumpur on 5 August 2003 by Russian President Vladimir Putin and the then Malaysian prime minister, Dr Mahathir Mohammad.

The Su-30MKMs will be manufactured by Irkut corporation. Deliveries will begin in 2006 and run until late 2007.

In March 2005 the Malaysian media published a statement by Deputy Defence Minister Zainal Abidin Zin, so announced that the RMAF would shortly retire seven of its 14 Northrop F-5E fighters, replacing them with Su-30MKMs.

The Su-30MKM will have the airframe, powerplant and aircraft systems similar to those of production Su-30MKIs. The major difference will lie in the avionics. Because of Kuala Lumpur's preferences in selecting armament vendors, the Su-30MKM avionics suite will comprise Russian- and French-made systems (limited use of equipment by German and South African manufacturers is also possible). Indigenous systems could also be used given Malaysia's growing competence in electronics technology.

The Su-30MKM avionics suite is under joint development by Russian companies and Thales of France. Like the Su-30MKIs, the Malaysian Su-30MKMs will carry the Russian-made Bars passive phased-array radar; however, the Su-30MKM will not have the Israeli-made HUD and jamming system found in the IAF version. Equally unlikely is the use of Indian-made systems such as the Su-30MKI's mission computer, radar computer, radar warning receiver, radio equipment and IFF system). Similar equipment by Russian, French and other foreign manufacturers is proposed for the Su-30MKM.

The RMAF fighters will be powered by NPO Saturn AL-31FP thrust-vectoring engines to be built by the Ufa-based UMPO plant. The same engines are used in the IAF's Su-30MKI, but the Su-30MKM's advanced powerplant will have full FADEC controls.

Sukhoi will use Su-30MKI prototypes and pre-production aircraft to fly-test the modified avionics suite. According to our sources, the first pre-production Su-30MKI (No 05) will be among the first platforms to fly with the avionics for Malaysia.

Irkut corporation launched Su-30MKM production in 2004. Construction of the first airframes has continued throughout 2005 and is to be completed in early 2006. Already next year Malaysia may take its first Sukhoi fighters, which will considerably strengthen the country's combat potential.

PAK FA to fly in four years

Speaking at a MAKS 2005 news conference, Sukhoi Director General Mikhail Pogosyan revealed the company's development schedule for the next-generation PAK FA fighter. The final design is to be completed by year-end, and is expected to be approved in 2006. Also next year Sukhoi will start drafting the engineering documentation. After production tooling is installed in 2007, work will begin on the first prototypes to be rolled out in 2008. Pogosyan says the PAK FA prototype will first fly in 2009.

In 2002 Sukhoi was selected PAK FA programme leader by the Russian Air Force. When the preliminary design was approved in late 2004, RusAF Commander-in-Chief Vladimir Mikhailov said that the maiden flight might take place before the end of 2007. According to Pogosyan's latest announcement, the first flight date has now slipped by two years. The revised schedule appears to be more feasible given the current amounts of funding for the programme.

New Su-35 in more detail

Separate details of the prospective Su-35 single-seat multirole fighter were made public recently during the MAKS 2005 air show. Sukhoi has been saying that the aircraft will shortly substitute the Su-30MK family in the international market, until eventually superseded by an export version of the planned PAK FA fifth-generation fighter. A Su-35 scale model was demonstrated in Sukhoi's pavilion at MAKS, and NPO Saturn showcased a full-size mock-up of the engine it is developing for the new fighter.

Yevgeny Yerokhin

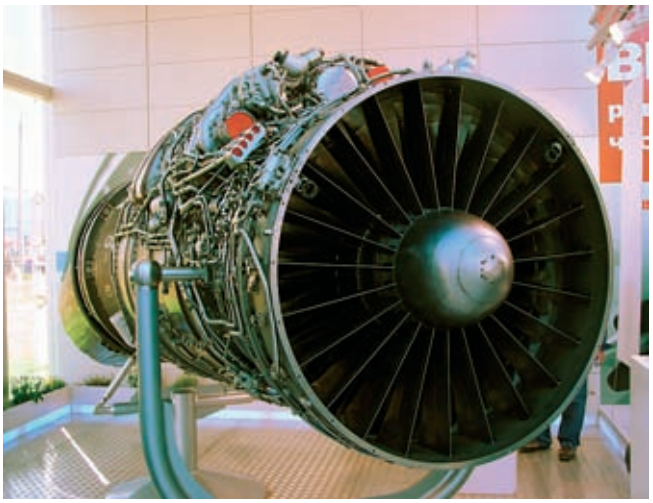
The new concept of the Su-35 was approved in May 2005. As distinct from the single-seat multirole fighter of the same designation that has been offered for export up to now, the renovated Su-35 has smaller vertical fins and no canards thanks to a new fly-by-wire system, which provides stability and controllability similar to those of the Su-30MKI.

The new engine for the Su-35, presented at MAKS under the "Article 117S" codename (its official designation could be AL-41F1A), is a radical upgrade of the production AL-31F design. The new powerplant incorporates technology developed under the AL-41F fifth-generation engine programme. The "117S" differs from the baseline model in a large fan diameter (932mm against the AL-31F's 905mm) for greater airflow, a more efficient turbine, a new combustion chamber and a digital engine control system. The maximum take-off thrust is increased from 12,500kgf to 14,500kgf. The new engine also has an extended service life, with the TBO increased from 500h to 1,000h, and the service life limit from 1,500h to 4,000h as compared to the production AL-31F. The first phase of the "117S" programme ended with successful bench tests at Saturn in 2003. Flight testing on board a Su-27M testbed (No. 710) started in March 2004 and successfully finished this summer after 30 test sorties with the testbed made its first flight with two engines of the type in June 2005. A similar powerplant could be installed on RusAF's future Su-27SM2 upgraded fighters.

The major innovation of the new Su-35 fighter as compared to in-service Su-27s will be an advanced, highly integrated avionics package. This will include the Tikhomirov NIIP Irbis multichannel radar with a rotating passive phased array, which can detect a fighter at 400km. In addition, the Su-35 will have the OLS-35 optronic sighting system currently under development at the UOMZ plant.

The Su-35 armament will include in-production unguided and guided air-to-air and air-to-ground weapons, those currently used with the Su-30MK family, and also prospective designs being developed for the PAK FA programme. The Su-35 scale model displayed at MAKS was armed with R-73 short-range air-to-air missiles, RVV-AE (medium-range air-to-air missiles and KS-172 two-stage ultra-long-range missiles, as well as Kh-31P/A and Yakhont air-to-surface missiles.

The KnAAPO production plant is expected to build the first Su-35 prototype next year. Sukhoi Director General Mikhail Pogosyan says the fighter may be offered for export "after 2006".



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MiG showcases MiG-29OVT and readies MiG-35 for tender

Grigory Butrin

One of the primary novelties, and certainly the main eye-catcher, of the recent MAKS 2005 air show flight programme was a prototype of the MiG-29M super-agile fighter (No 156), designated MiG-29OVT and powered by RD-33 engines with all-aspect thrust vector control (TVC) nozzles. Throughout the six-day show, MiG Corp. test pilot Pavel Vlasov took the fighter for daily demonstration sequences that included several new super-agility manoeuvres.

Alexey Fedorov, MiG Corp. Director General/Designer General who was appointed to his current post in October 2004, has recently summarised the company achievements under his leadership. Over the past year MiG Corp. has delivered, upgraded or repaired 37 aircraft for foreign customers. The company's primary export contracts were with Yemen (MiG-29SMTs delivered and upgraded), Eritrea (MiG-29SMTs repaired and upgraded), Sudan (MiG-29s delivered), South Korea (Il-103s delivered) and Slovakia (MiG-29s repaired and upgraded to NATO standards). The greatest efforts however are currently being invested in Indian contracts, especially in the programme to create MiG-29K and MiG-29KUB carrier-borne fighters. Fedorov says the programme is on target, with the first prototype flights scheduled for early next year. The company is also working on a project to modernise the Indian Air Force's (IAF) MiG-27Ms, and is developing a modernisation programme to upgrade IAF MiG-21bis fighters. "We hope other countries also consider our MiG-21 upgrade offer," Fedorov notes.

MiG Corp. is pinning great hopes on the IAF's planned Medium Multi-Role Combat Aircraft (MMRCA) tender for deliveries and licence production of 126 fighters. Alexey Fedorov believes his company has a good chance to win the tender, because the fighter it is planning to promote offers very good combat performance. "It will be an all-new airplane, to be designated MiG-35," he says, apparently referring to the new generation of MiG-29 versions currently known as the MiG-29M and MiG-29M2. These warplanes will include the thrust vectoring system demonstrated at MAKS 2005 in MiG-29OVT.

MiG Corp. also continues work in the interests of the Russian Air Force. According to Alexey Fedorov, the company next year will launch the effort to upgrade RusAF MiG-29 fighters to MiG-29SMT standard. In the meantime, the modernisation programme for RusAF MiG-31 interceptors is proceeding at a brisk pace. Fedorov says the programme is being properly financed, and that the first prototypes of the MiG-31BM upgraded version will enter official tests by year-end.

RVV-AE SAM version under development

The Vympel Design Bureau, operating as part of the Tactical Missiles Corporation, presented information and displayed a mock-up of a surface-to-air missile (SAM) in a launch container, based on the world-wide known RVV-AE air-to-air missile (AAM), at the recent MAKS 2005 air show.

Viktor Ratz, the Vympel Design Bureau Director General, told our correspondent that the development of the RVV-AE SAM version had already entered the final stage, and that the missile could be expected to make its appearance in the near future. The Director General believes that the missile faces good prospects both in the domestic, and the international markets.

The combat employment procedure for the SAM version of the RVV-AE missile is as follows. On receiving target designation data from a surveillance radar, the SAM is fired from the launch container, set on the launcher at an angle of 27–45° to the horizontal plane. At the same time the launch tube has to be deployed at the right azimuth angle depending on the real location of the target. After the launch the missile is guided and fully stabilised with the help of four differential ladder-type aerodynamic control surfaces.

The missile's guidance system comprises a strapdown inertial navigation system and an active multifunction monopulse Doppler radar homing head (the RVV-AE air-to-air missile is equipped with the 9B1348E homing head). The missile features a combined guidance to the target. Until the homing head locks in on the target, the missile boasts inertial guidance to a "mathematical" target. Calculations of such target's co-ordinates are based on data on the target's movements, transferred from the SAM command and control post. When the missile locks in on the target, it shifts to active homing, with the transition to the second homing mode carried out on a signal from the SAM's computer, detecting the range to the target sufficient enough for the homing head to acquire the target.

The development of the RVV-AE SAM version is still underway. However, it is quite obvious even now that on developing it, Russia will acquire both a good weapon for its own Armed Forces, and a trump card in competing with its main rivals in the international arms market.

Yevgeny Yerokhin

Kamov proposes army aviation system

Kamov company presented at MAKS 2005 its vision of further development of Russia's army aviation. According to Sergey Mikheyev, the company's Designer General, in-service and prospective army aviation forces should be integrated into a single system for better battlefield cooperation. Parallel with further improvements to the Ka-50 and Ka-52 combat helicopters, Kamov is developing and testing helicopter-based battlefield information solutions which could be used as part of the system. These include an AEW platform (considered to be named Ka-35), which is a land-based version of the in-production Ka-31 shipborne AEW helicopter; the Ka-60TR tactical reconnaissance helicopter with a ventral radar and two GOES gyro-stabilised optronic sighting/surveillance systems, a derivative of the Ka-60 transport and Ka-60U trainer designs currently undergoing tests; a GOES-equipped light observation helicopter based on the in-production Ka-226; and a GOES-equipped Ka-137 rotary-wing UAV.

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Kamov says the proposed army aviation system could initially rely on in-service Mil Mi-8AMTSh and Mi-24PN helicopters for its strike capability, to be gradually supplanted by the Ka-50, Mi-28N and Ka-52 types; Ka-52 could be used as airborne command post. A model diorama of the system, which was demonstrated at MAKS 2005, included one more aircraft type – a reconnaissance/strike UAV with coaxial rotors, fitted with a GOES sensor and armed with anti-tank missiles. Its possible designation is considered to be Ka-117. The army aviation system could additionally employ fixed-wing aircraft in anti-armour roles, such as Sukhoi Su-25T and Su-25TM (Su-39) ground attack aircraft carrying Vikhr anti-tank missiles and Sukhoi Su-24M front-line bombers with sensor-fused submunitions; target illumination could in this case come from helicopters.

Sergey Mikheyev believes that the commonality of modular, open-architecture avionics suites used in the aforementioned helicopters will contribute to stability of the proposed army aviation system by significantly cutting the parts count and simplifying conversion training.

Kazan Helicopters unveils new Ansat version

Kazan Helicopters has developed its successful Ansat light utility helicopter into the Ansat-2RTs armed observation version. The company expects to offer this two-seat version for export. The Ansat-2RTs prototype first took off on 29 July 2005, and later in the summer participated in static and flying demonstrations at the MAKS 2005 air show in Zhukovsky.

The Ansat-2RTs demonstrator has a completely refurbished fuselage, but inherits the rotors, power plant, transmission and bort number (902) from the first Ansat prototype. The new version carries a chin-mounted TOES-521 turret optronic sensor, and has four stubwing pylons for up to 1,300kg of weapons such as Igla air-to-air missiles, B8V7 launchers each containing seven 80mm S-8 rockets, or aerial bombs. A 12.7mm Kord-12,7 fixed single-barrel machine gun is mounted on the starboard side. The helicopter carries 26mm-diameter UV-26 flare dispensers for self-defence.

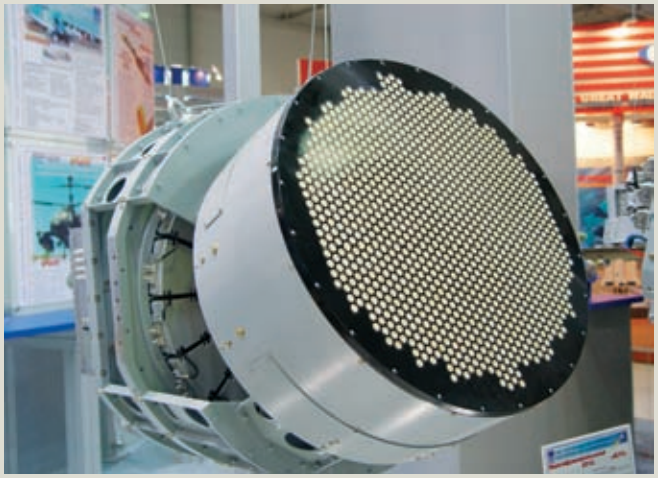
Like the Ansat baseline, the weaponised version has a maximum take-off weight of 3,500kg. The helicopter is powered by two 710hp Pratt & Whitney PW207K engines, has a maximum speed of 300km/h and maximum range of 650km.

Piotr Butowski

Active phased arrays debut at MAKS

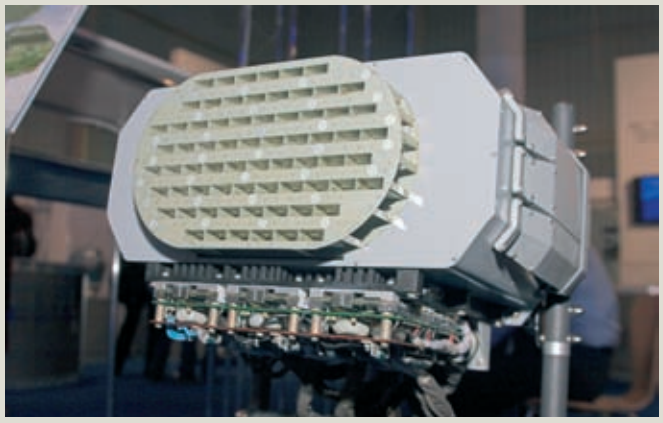
Russia's fifth-generation PAK FA fighter is planned to have an avionics suite built around a multifunction active phased-array radar (APAR). Such radars are more reliable than existing passive phased array-based systems: instead of a single transmitter an APAR has an array consisting of one thousand (or more) elements. Even with several dozens of elements disabled the radar remains operational. However, APAR developers have to solve challenging research and engineering problems. Three major Russian radar companies are currently working to develop APAR systems: Tikhomirov NIIP, which won the 2003 PAK FA radar tender; Phazotron NIIR Corporation and Leninets Holding Company.

Some results of these efforts were revealed at the MAKS 2005 show in Zhukovsky. Tikhomirov NIIP, Russia's primary APAR developer since 2001, showcased an operational compact APAR demonstrator codenamed Epolet-A or AFAR-68, which was built and tested in 2005. The new radar's antenna currently comprises 68 elements. The radar is derivative of the Epolet small-size targeting station for active and semi-active radar homing air-to-air missiles. Developed by Tikhomirov NIIP in the second half of the 1990s, this system consisted of the transmitter/receiver unit and two or more miniature passive phased arrays spaced across the aircraft and connected to the unit via long waveguides. It was the difficulty of fitting these waveguides inside the aircraft that moved the developer to create an active phased array version of the radar. The resultant Epolet-A APAR is an autonomous system that can be installed anywhere on the platform.



Andrey Fomin

According to the explanatory text, the Epolet-A demonstrator (Factory No 002) exhibited at MAKS "is built from Russian components, implementing a technology that fits various applications". The radar has a transmitter power of 8–10W for each of its 68 channels, with an efficiency factor of about 30 per cent and a receiver noise factor of 3dB. The accompanying description also read that "the technology behind the radar allows for developing active phased arrays of varied sizes and shapes for maximum utilisation of platform space". It is understood that the Epolet-A radar unveiled at MAKS is a technology demonstrator, but at the same time it is an operating APAR solution – an important step towards the creation of a full-scale radar for the fifth-generation fighter.

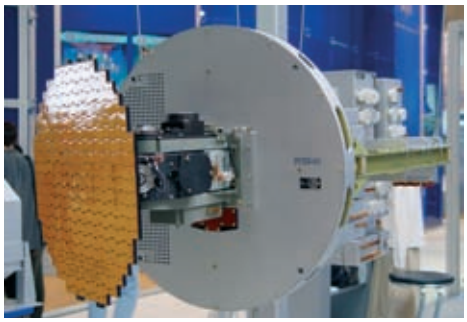


Yevgeny Yerokhin

Phazotron-NIIR used MAKS to showcase a mock-up of its new phased-array radar being a derivative of its well-known Zhuk family (its possible designation could be Zhuk-A). Although the developer did not explicitly announce the plan to fit an active phased array, this conclusion followed from the radar's 700mm-diameter antenna being deflected 20 deg upwards (towards the greatest target expectation), and also from the design parameters listed in the explanatory text. According to the text, the new radar will have a time between failures of 900h (as distinct from 200h for the Zhuk-MFE and Zhuk-MSFE passive phased-array models). The new development favourably compares to the Zhuk-MFE radar, which has a similar-size 700mm-diameter antenna, in terms of performance: Zhuk-A can simultaneously track 30 targets against the predecessor's 20, simultaneously engages eight targets against four, and has the look-up target detection range increased from 110 to 200km for the front hemisphere and from 50 to 80km in the aft hemisphere. Whether Phazotron's APAR will retain such excellent performance is a good question. The MAKS exhibit was just a mock-up; moreover, it included vestiges of passive phased arrays in the form of canary-coloured waveguides. What purpose these would serve as part of an APAR remains unknown.

Kopyo for Yak-130

Phazotron-NIIR unveiled a mock-up of a new small-sized radar for light combat trainers and light combat aircraft that could be developed from the Yakovlev Yak-130 aircraft. The Kopyo-Shch radar, a further development of the well-known Kopyo and Kopyo-M models designed for the MiG-21bis-UPG upgraded fighter and Su-39 attack aircraft (in pod version), will weigh 80kg and have a 500mm-diameter slot antenna. It will detect aerial targets at 80km, multiple ground targets at 25km and small stand-alone sea-surface targets at 150km.



Andrey Fomin

Alexey Mikheyev

MECCA OF MILITARY

Report from Akhtubinsk

On 21 September, the 929th Chkalov GLITs State Flight Test Centre of the Russian Defence Ministry, which was awarded the Order of Lenin and the Order of Red Banner, marked its 85th anniversary. The celebration provided for an open day at the Akhtubinsk airfield, once most protected and closed military installation in the South of the country, which involved an air show and a ground exhibition of aircraft and airborne weapons. Here is the report from our correspondents who attended the event.

Main Air Force test centre

The GLITs today is the main facility of the country's Air Force and Armed Forces in general which hosts tests of aircraft and airborne weapons prior to their commissioning. It became a tradition in Russia several decades ago that all new aircraft and equipment should past two stages of tests before fielding: the factory tests and the official trials. The former involve test pilots of air industry and are normally organised at the Gromov LII Flight Research Institute based in Moscow region's Zhukovsky, where most of flight test facilities of Moscow aircraft building companies and design bureaus are quartered, or directly at airfields of manufacturers. The factory tests see the maiden flight of the new aircraft, and are held to define the primary specifications of the vehicle, evaluate the performance of airborne equipment and recommend requisite retrofits and fine-tuning.

Afterward, the new combat plane is handed over to the customer, i.e. stands the official trials, in which military test pilots are usually engaged. Most of the official test flights, including all those in which combat employment and tests of new weapons are examined, are performed at the GLITs and its proving grounds.

However, since 1960s, joint flight tests involving representatives of the customer and the manufacturer have become normal practice. They are also split in two stages. At the first stage, usually referred to as Stage A, preliminary conclusion is drawn, which gives green light to the aircraft's mass-production. Simultaneously, the action plan is developed listing the measures to be taken to remedy the week points surfaced at the first stage. Then, the first production aircraft are rolled out for further testing during Stage B, which envisages overall tests of the aircraft as an end-result product with all its organic airborne systems and weapons installed. As a result of this stage, the official test completion act is signed, based on which the final decision on adopting the aircraft for service is made. Sometimes, a set of additional testing is required prior to the adoption, and most of the burden in this case falls on the shoulders of GLITs test pilots.

No plane, helicopter or airborne weapon system have been adopted for service with the USSR and then Russian Air Force and Armed Forces in general without prior proper testing at the GLITs, which was earlier known as the NII VVS (Air Force Test Research Institute). Apart from that, soon after 1991, when the Russian combat aircraft exports boomed, the GLITs hosted for tests all new aircraft modifications, elaborated under contracts with foreign customers.

Given the GLITs has a wide range of versatile test missions, a number of additional test centres were formed in some regions of Russia to assist the main installation headquartered in Akhtubinsk, Astrakhan region. For instance, most of new helicopters and transport aircraft are normally tested at the test centre based at the Moscow region's Chkalovsky airfield, while aeronautic vehicles stand trials in Volsk, Saratov region. As for highland tests, they are conducted in Nalchik, the Republic of Kabardino-Balkaria, as a rule. The GLITs also enjoys having a number of firing ranges and proving grounds in Russia and Kazakhstan to test airborne weapons. One of such facilities is headquartered in Groshevo in the vicinity of Akhtubinsk. The guests and participants of the 85th anniversary celebration enjoyed an opportunity to visit the proving ground. As for training of its test pilots, the GLITs operates a dedicated Air Force training centre deployed in Akhtubinsk.

Historical spotlight

The GLITs was founded on 21 September 1920 following the decree of the Revolutionary Military Council of the Russian Soviet Federative Socialist Republic that provided for an experimental airfield for testing new aircraft

TEST PILOTS

When the World War II broke out, three fighter air regiments, two bomber regiments and an attack regiment were tailored on the basis of the institute, as well as a reconnaissance squadron and three airfield maintenance battalions. Test pilots were assigned combat missions, and as soon as the forward edge of the battle area approached too close to Moscow, a top-level decision was made to redeploy the institute from the Chkalovsky airfield to Sverdlovsk, now Yekaterinburg. However, due to the urgent need for enhancing the tests of modified and new aircraft, former servicemen of the NII VVS were called back to duty from manoeuvre units.

The turning point in the war in 1943 allowed the institute to return to home base in Chkalovsky, and in 1943 it amalgamated with the Air Force Airborne Weapons Research Institute and the Air Force Special Services Research Institute so that the State Research and Test Institute of the Red Army Air Force (GNII VVS) was formed as the result, which was renamed the Air Force State Red Banner

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to be introduced within the organisation of the Main Directorate of the Red Air Fleet (RKVVF). The airfield was first placed at the Khodynka Field, which is now known as the Central airfield of Moscow. In 1922 it was renamed the Research Experimental Airfield, while in 1926 the Air Force Test Research Institute of the Red Army (NII VVS) was formed on its base. Ever since that time aircraft have been adopted for service with the country's Air Force only after positive conclusion is issued by the institute.

The increased amounts of work and further sophistication of testing equipment made it difficult for the institute to remain in the centre of Moscow. A decision was made in this light in 1929 to remove it to a new airfield, the construction of which started immediately in the vicinity to the Moscow region's Shchelkovo, merely 40km East of Moscow and near the train station of the Yaroslavl railroad, which is now widely known as the Chkalovskaya. Somewhere in the 1930s both the airfield and the adjacent village were renamed in honour of Valery Chkalov. The institute started redeployment from the Moscow centre to the airbase in Shchelkovo in 1932, but it was not completed until late 1935.

Research Institute (GK NII VVS) in same year's July.

The first years after the war ended saw the massive integration of jet engines into combat aircraft. Also, missile technologies progressed immensely, which required introduction of the State Central Firing Range of the Armed Forces Ministry in the vicinity of Kapustin Yar and Vladimirovka for missile tests in May 1946. In 1949, the range was blended with the GK NII VVS, with Vladimirovka in the Astrakhan region designated as the headquarters. Shortly afterward, it transformed into the Air Force Research and Development

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Top: *Tupolev Tu-160 which fulfilled fly-past over Akhtubinsk airfield at the celebration day under escort of a pair of MiG-31s arrived from Engels AFB*

Left: *unique demo flight of this MiG-29M OVT supermanoeuvrable fighter was performed by Mikoyan test pilot Pavel Vlasov*

Top center: *another star of air display in Akhtubinsk – Suklhoi Su-30MKI piloted by Sukhoi test pilot Vyacheslav Averyanov*

Top right: *Tupolev Tu-95MS had a flight over Akhtubinsk accompanied by two MiG-29s*

Right: *another guest of air show at GLITs – Tupolev Tu-22M3 which fly-past was escorted by a pair of Su-24Ms*

Firing Range, and then into the 6th Air Force State Research Institute (6th GNII VVS). It was there that all kinds of air-to-air and air-to-surface missiles were tested in 1950s, which subsequently armed Mikoyan MiG-19, MiG-21 and Sukhoi Su-9 fighters and interceptors, as well as Tupolev Tu-16 and Tu-95 bombers, etc.

In December 1960, a decision was made to mount a large-scale reorganisation of Air Force's research and development institutions. As the result, the Chkalovsky-based GK NII VVS, the Vladimirovka-based 6th GNII VVS, the Volsk-based Aeronautic Research and Test Centre and the Feodosiya-based 8th Flight and Test Centre of naval aviation were merged to form the Air Force State Red Banner Research and Test Institute (GK NII VVS), with headquarters in Akhtubinsk, a town nearby Vladimirovka railway station. The four research and test directorates of the new organisation were based there and included the test directorate of intercepting, tactical and short-range reconnaissance aviation, the test directorate of long-range aviation, airborne weapons and long-range reconnaissance, the test directorate of the surface-to-surface missiles, and the field test and measurement directorate, as well as two separate research air regiments, one equipped with long-range bombers and the other one combined.

The ex-headquarters of the GK NII VVS in Chkalovsky was transformed into an affiliate of the new institute, and included three research and test directorates: one involved in tests of military transport, passenger and training aircraft and helicopters, another one responsible for electronic and special equipment, missiles and airfields, and the remaining one entitled to test engines. Also, a separate combined aircraft research air regiment with aircraft and equipment maintenance section, testbed development section and spacecraft and aircraft search and rescue section were deployed in Chkalovsky.

Apart from those mentioned, three more directorates of the new organisation were formed at other airbases. The 3rd one for tests of anti-submarine weapons and air reconnaissance equipment shared the Kirovskoye airfield with a separate special purpose research air regiment in Crimean Feodosiya. The 7th directorate for aeronautic tests found location in Volsk, Saratov region, and the 10th directorate for tests of special airborne weapons was deployed in Engels, Saratov region. Moreover, several firing ranges and test stations were also subordinate to the institute's head General M. Finogenov, who was in charge in 1960s.

The organisation of the institute remained relatively the same, when it adopted a new name in 1965 and became the Air Force State Red Banner Research and Test Institute (GNIKI VVS) and later the 8th Air Force State Research and Test Institute (8th GNII VVS), while in 1967 the glorious name of Chkalov was conferred to it. In 1973, a school of military test pilots was formed in its organisation, which was then transformed into the Air Force Test Pilots Training Centre.

It would be senseless to particularise all the aircraft and weapons that passed tests at the institute in 1960–1980s, because the list of them would include all fixed-wing and rotary wing aircraft, air-launched missiles and unmanned aerial vehicles that have ever been

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developed and manufactured by the country's aviation industry for the Air Force, Air Defence Forces and Naval aviation, as well as those intended for exports. During this period the institute was successively directed by General I. Gaidayenko, General L. Agurin and General L. Kozlov.

GLITs today

A new name was given to the institute in 1989 again, and it became the 929th State Flight Test Centre (GLITs) of the USSR Defence Ministry, while its Chkalovsky-based affiliate was renamed the 1338th Test Centre within its new organisational structure. The Feodosiya based 3rd directorate of the GLITs turned alienated with the collapse of the Soviet Union. (Now it is the State Aviation Research and Test Centre of the Ukrainian Defence Ministry.) All the naval aviation test facilities and the technological backlog in this sphere, which were gained in intensive tests of the country's first shipborne Su-27K and MiG-29K fighters stationed aboard the Tbilisi aircraft carrier, were lost, and pilots and engineers from Akhtubinsk were forced to start the official tests of these systems from scratch. Quite other territory was selected for the tests in the North of Russia, where the Admiral Kuznetsov, now the aircraft carrier in service with the Northern Fleet of Russia, was based. Despite the great difficulties they had to face, the official tests of the first ever Russian deck-based supersonic fighter, the Su-33, were completed with flying colours.

The 1338th Test Centre in Chkalovsky adopted a new structure in 1992, with a squadron of Ilyushin Il-80 wide-body airborne command post aircraft and a squadron of Il-82 airborne relay aircraft entering its organisation in 1997 and 1995 respectively. The official tests of the aircraft were completed in one of the hardest period of institute's all life. Considerable reduction of defence expenditures and almost total cease of military acquisitions in the country, stuck in the economic crisis, could not but influenced the life of military test pilots, as the number of tests reduced several times and the headcount of both pilots and maintenance personnel decreased immensely. Under the circumstances, the tests of modernised Mikoyan MiG-29M and Sukhoi Su-27M fighters, Sukhoi Su-25TM attack aircraft, Myasishchev M-55 high-altitude recce plane were first delayed and then stopped entirely, while the trails of the Sukhoi Su-34 multirole frontline combat aircraft and the modernised Ilyushin Il-76MF transport kept going but at a very slow pace. During this period, the institute was headed by General Yu. Klishin, who was succeeded by General V. Kartavenko.

However, the negative trends had been little by little overcome by the late 1990s, and new export sales of Russian aircraft helped to achieve this a lot. Developed at the request of foreign customers, the Sukhoi Su-30MKI, Su-30MKK, Su-30MK2, Mikoyan MiG-21bis-UPG and MiG-29SMT upgraded multirole aircraft passed a large-scale testing at the GLITs, including combat employment flight tests, which gave green light to their sales abroad and helped subsequently implement the contracts.

The revival of the GLITs, benefited from the foreign contracts, helped intensify tests in the interests of the Russian Air Force on the threshold of the new millennium. Flight tests of the Su-34 resumed, which are planned to be finished in 2006. Special importance is attributed to the upgrade of fourth-generation aircraft in service, in the framework of which Sukhoi Su-27UBM and Su-30KN first and Su-27SM upgraded fighters passed tests in Akhtubinsk and were then returned to manoeuvre units of the Air Force. The modernisation effort has been taken on the Sukhoi Su-24M2 tactical bomber, the Mikoyan MiG-31BM interceptor fighter, and there are plans for the next year to take up tests of MiG-29SMT fighter upgraded for the RusAF. Flight testing of the new missile

Andrey Fomin

Sukhoi Su-34 multirole frontline strike aircraft now undergoes official tests in GLITs to be finished next year

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KAB-250L guided bomb. Russian Air Force hasn't got it in its inventory yet, but the bomb is offered for potential foreign customers to arm light combat aircraft

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Top: *Sukhoi Su-30MKK first flying prototype which made a lot of test flights in GLITs although it was developed for export use only*

Left: *Mikoyan MiG-29SMT upgraded fighter now is selling abroad only, but next year GLITs could witness tests of its version for RusAF*

Right: *this Su-24M has a new Kh-59MK anti-ship missile under its port wing*

system to equip the Tupolev Tu-95MS and Tu-160 strategic aircraft was successfully finished. Also, tests of other airborne weapons are now in progress. These are the few of test and research and development programmes currently under way at the GLITs, which since 1999 has been under command of Lieutenant General Yuri Tregubenko.

Results and future prospects

To sum up the activities of the Russia's leading flight and test centre over the past 85 years, it is necessary to mention that a total of 1,339 official tests and 1,782 special tests of aircraft and airborne weapons have been carried out by its specialists during this period, which was praised in the review of Russian Air Force Commander-in-Chief Army General Vladimir Mikhailov right on the eve of the anniversary celebration. The GLITs employed 92 Heroes of the Soviet Union, five of whom were conferred the title twice, and 14 Heroes of Russia. As of now, six Heroes of Russia are on its staff, with the present commander of the Centre, General Tregubenko, on top of the list. More than that, over 3,000 servicemen of the Centre were awarded orders and medals in peacetime. "The present-day activities of the Chkalov GLITs Centre, with due account of the reforms taken, is aimed at full-scale and quality testing of most advanced new aircraft and airborne weapons, and verification of cutting-edge achievements in aerospace industry. Centre's personnel take part in combat training and exercises, as well as in air shows and demonstrations of aircraft combat capabilities on a regular basis," Mikhailov said.

According to Mikhailov's First Deputy Colonel General Anatoly Nogovitsyn who also attended the anniversary celebration, "we can see the future of the Air Force long


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Sukhoi Su-25SM upgraded attack aircraft is to finish its official tests in GLITs by the year end


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***Top:** PBK-500U universal gliding cluster bomb fitted with SPBE-K self-homing submunitions*

***Bottom:** a highlight of this air show in Akhtubinsk – UPAB-1500 universal gliding guided bomb with extendable wing and modular homing system*


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***Bottom:** another novelty of precision guided munitions – KAB-500S guided bomb with satnav homing system*


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ahead owing to the GLITs. One can make an own forecast judging from the spectrum of weapons and aircraft exhibited at the ground exposition of the centre. A professional would see that these are not the examples already in mass-production. Each and every of the aircraft shown here are different from those operated in the field. Even most renowned models feature something new, like a new container, or a new missile or something else. These are exclusive aircraft, and only few are shown to broad public here, which have passed the tests at the centre. When the industry comes up with a new plane or weapon, we send them to the GLITs, and verdict it returns is in most cases final."

Speaking of the hardships encountered recently by the Centre, General Nogovitsyn said that "the headcount of the centre reduced, with only one third of the previous strength remained. And now that the number of contracts is booming, a good deal of tests should be performed. Therefore we are going to reinforce the centre. An extramural session of the Air Force military council was held here last year. We came to clearly understand that it is not only the Air Force that needs the centre, but the country's Armed Forces in general. And therefore we are taking all steps possible to improve its capabilities at the maximum."

Yet another high-ranking guest of the celebration in Akhtubinsk, Russian President's defence industry advisor Alexander Burutin, said after the demonstration of the new aircraft at the GLITs airfield: "We drew up a plan to develop experimental weapons and aircraft by 2005, for them to be further fielded in the Armed Forces by 2010. The work plan we had has been implemented so far. The industry has put certain types of new aircraft in small series production. The state defence order has been

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These Tupolev unmanned aerial reconnaissance vehicles are in RusAF's inventory since 1970s. Left picture shows a Reys (Voyage) tactical recce UAV while the right one – its heavier "brother", a Strizh (Swift) recce UAV, on their launchers

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Jet drones developed by Kazan-based Sokol Design Bureau. A Dan' (Tribute) drone (on the left hand) is well known thanks to several recent air shows while its Krylo (Wing) predecessor (on the right) haven't been shown ever since although it passed its official tests in GLITs in 1978 and was fielded as far back as during Soviet epoch

increasing by 20 per cent annually in the past several years. As for the 2006, we are expecting another 30 per cent increase in the defence budget for acquisition of military hardware. The Defence Ministry is planning to spend most of the funds, earmarked for the purpose, for the development of the Air Force and its Air Defence Forces component." Speaking of the role GLITs plays in the development and tests of new aircraft and the Centre's future, Burutin emphasised that "the mission of the centre will be not only to continue the tests of combat aircraft, but also to start up commercial aircraft test projects. It was a normal practice in the past that design bureaus focused main efforts on combat aviation, but now the situation changed and commercial projects begin to take a considerable part in their work. This will surely have only positive impact on both military and commercial issues".

Bottom: *A pair of Pchela (Bee) unmanned aerial reconnaissance vehicles developed by Yakovlev Design Bureau on two different launchers – on wheeled and fully-tracked transporters*

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Top: *A rare guest of recent air shows – a Tupolev Tu-142MZ long-range antisubmarine patrol aircraft being in inventory with the Russian Naval Aviation since early 1990s*
Left: *Antonov An-12PPS electronic warfare aircraft, a version of the An-12B transport. A few machines of the type were deployed in Akhtubinsk since 1970s*
Bottom: *Ilyushin Il-20M electronic intelligence aircraft and Myasishchev Il-22M airborne command post behind it. Both were derived from Ilyushin Il-18D turboprop airliner in early 1970s*

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Bottom: *Ilyushin Il-80 wide-body airborne command post of the Russian Armed Forces General Stuff. Derived from Il-86 airliner in mid-1980s it was first shown to general public during GLITs 85-years jubilee celebration. Four aircraft of the type now comprise a separate squadron of the GLITs 1338th Test Center at Chkalovsky airfield out of Moscow*

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Flight schools have been employing special easier-to-pilot and cheaper aircraft for training fighter pilots since almost the very origins of aviation. Development of such aircraft progressed simultaneously with development of combat aviation. Jet trainers made their appearance at the same time as fighter jets. At the moment fighter pilots fly third- and fourth-generation aircraft. The fifth-generation aircraft is expected to become operational in the near future. At the same time pilots keep on honing their flight skills on Alpha Jet, Hawk, K-8, L-39, and MB339 aircraft, designed as far back as the 1970s. However, new fighters require new skills from pilots. This fact results in the necessity to train pilots directly in manoeuvre units, which is quite expensive, as well as to procure special twin-seat versions of combat aircraft, etc. It is only natural that several projects of a new-generation trainer aircraft should be developed in the world in the past decade. Such projects include the German Mako, the Chinese L-15, and the Italian M346. However, the Russia's Yakovlev Design Bureau was among the first to embark on developing a new trainer, which resulted in designing the Yak-130 combat trainer, submitted for state tests this October.

Andrey YURGENSON

"FLYING SCHOOL-DESK"

The Russian Air Force issued tender on an aircraft for training tactical aviation pilots as far back as early 1991. The tender saw participation of four design bureaux: Mikoyan, Myasishchev, Sukhoi and Yakovlev. Without going into details (Take-off published the story this summer), it is only worth mentioning that the Yakovlev Yak-130D demonstrator made its first public appearance at the Le Bourget air show in June 1995, while in March 2002 the Yak-130 was announced an official winner of the Russian Air Force tender on developing a promising combat trainer to enter service with Air Force training centres and flight schools.

The Yak-130D underwent most of the flight tests in 2002 and proved that it was the very aircraft needed both in the Russian Air Force, and throughout the world. It was not for nothing that the Italian Aermacchi, the designer of the world-wide famous MB326 and MB339 trainer aircraft, decided to base its new aircraft on the Yak-130. The Italian company displayed the first two M346 prototypes in Paris this year. And it was not for nothing that the Chinese AVIC II Corporation invited the Yakovlev Design Bureau as an advisor, when developing its own new L-15 trainer aircraft. One can easily see the results by comparing the mock-up of the Chinese aircraft, demonstrated at Airshow China 2004 in Zhuhai, and previous Chinese developments. What is left in the contemporary trainer aircraft market? Basically, there are the European Mako trainer project, which is still lingering at the mock-up stage, and upgraded Hawks, designed as far back as the 1970s. All other projects are Yak-130's derivatives to one extent or another.

The Yakovlev Design Bureau embraced the comprehensive approach to solving the problem from the very outset. It aimed to develop an entire training aircraft system, which would comprise the trainer aircraft proper, and training hardware aids, such as display classrooms, procedure simulators, and functional simulators, which would be integrated by single software.

About a dozen various designs were examined in the course of the aircraft development, with four of the layouts studied in every detail. The work resulted in selecting the best design, which now allows the Yak-130 to conduct flights in almost all modes, inherent in contemporary and future combat aircraft. Advanced wing root extensions and the air intake layout enable the Yak-130 to conduct a stable controlled flight at an angle of attack of up to 40°. Air intakes, covered by special blinds at takeoffs, the landing gear, designed to sustain dirt runways, and outstanding take-off and landing characteristics allow the aircraft to operate from small-size rough airfields.

At the present time the Nizhny Novgorod-based Sokol Plant has manufactured two production-configuration Yak-130s. The second aircraft, Yak-130 No. 02, made its maiden flight on 5 April 2005. Yak-130 No. 01 had almost completed the factory flight tests by that time. The development of the light jet combat trainer is conducted in strict compliance with the state contract, signed by the Yakovlev Design Bureau and the Russian Defence Ministry. Both aircraft have been submitted for state tests, expected to be completed next year. They will soon be jointed by the third production-configuration aircraft to be manufactured and funded under a contract with the Air Force. In fact, it will be the first aircraft, totally owned by the Russian Air Force.

The Yak-130 will primarily replace the L-39 trainer aircraft in service with the Russian Air Force. The Krasnodar Military

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flight control system. It is a most significant feature. At the moment no other Russian aircraft can boast the same level of avionics digitalisation. The aircraft is fitted with cutting-edge Russian avionics, which allows one to hope that the Yak-130 will not grow obsolete for the next 15 years and will be able to compete with any western rival.

The integrated fly-by-wire control system provides for changing stability and controllability characteristics depending on the aircraft simulated, the automatic control system function, and the active flight safety system for the sake of training. The reprogramming system provides for a feasibility to change program-generated parameters of aircraft controllability and simulate stability and controllability characteristics of almost any contemporary combat aircraft.

The Yak-130 trainer is one of the major components of the training aircraft system, which also comprises ground-based training aids, simulators, basic training aircraft (for instance, the Yak-152), and the training control system. At the initial stage the Yak-130 may be more "tolerant" to mistakes of a pilot cadet, which will allow the latter to acquire correct skills faster. At follow-up stages (refining flight and dogfight modes) the reprogramming system will allow the trainer aircraft to simulate dynamic behaviour of such aircraft as the Mikoyan MiG-29 and the Sukhoi Su-30. Hypothetically, the system is capable of simulating almost any aircraft, for instance, the US F-18, the mathematical model being the only prerequisite. Another interesting feature consists in the fact that several such models may be loaded and switched over to during the flight.

The "glass cockpit" concept is another crucial feature of the Yak-130. Each of the two cockpits is fitted with three 6x8-inch colour multi-function LCDs and no electromechanical instruments whatsoever. The displays can simulate any cockpit management system of any fighter, which is another dramatic feature of the Yak-130, distinguishing it from previous-generation trainer aircraft.

The Yak-130 is versatile to the maximum extent possible and may easily be adapted to meet requirements of air forces of various states, as far as both its technical and flight characteristics are concerned. The Yak-130 is capable of fulfilling 80 per cent of the entire flight training programme. Employment of the Yak-130 combat trainer in flight schools, manoeuvre units, and combat training centres will allow maintenance costs to be reduced four- to five-fold, and service lives of combat and tandem-seat aircraft, currently employed for combat training of pilot cadets and manoeuvre unit pilots, to be husbanded.

It is also worth keeping in mind that the Yak-130 is a combat trainer, i.e. it combines capabilities of solving a wide range of training problems and simulating various combat aircraft with those of any combat aircraft. The Yak-130 is capable of carrying the entire range of Russian and foreign guided weapons.

FOR FIGHTERS and more

Flight School is expected to tailor several training air regiments, equipped with Yak-130s for instructing pilots in the skills required to fly upgraded Su-27SMs and fifth-generation aircraft, which are to become operational by 2015.

The production aircraft differs considerably from the well-known Yak-130D demonstrator displayed at various air shows. First and foremost, such differences have resulted from a different purpose of the Yak-130, which is a combat trainer. The design of production aircraft has significantly been streamlined: as compared with the demonstrator, it boasts better passive aerodynamics. The Yak-130 features a shorter length, a reduced wing area, and a smaller fuselage midsection. It has a tighter layout and a smaller weight. The fuselage nose has seen the most drastic changes. Its section has become more rounded, which means that the aircraft will be fitted with a radar in the future. Wingtips have been equipped with pylons for attaching air-to-air missiles or ECM equipment .

While the demonstrator was fitted with an analog fly-by-wire control system, production aircraft are equipped with digital systems only, including the quadruplex re-programmable

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The design of the airframe, aerodynamic characteristics, avionics, and the weapons control system allow the Yak-130 to be transformed into a light attack aircraft, a reconnaissance aircraft, or a shipborne trainer at the expense of minimal modifications. The Yak-130 will be able to discharge combat tasks with high efficiency and at a lower cost than existing fourth-generation and future fifth-generation aircraft in low-intensity conflicts.

VolgAero to launch SaM146 production

The VolgAero joint production enterprise of NPO Saturn (Russia) and Snecma Moteurs (France) was inaugurated in Rybinsk on 14 October. The enterprise will manufacture parts of the SaM146 engine currently under development by the Russo-French joint venture PowerJet for the Russian Regional Jet (RRJ) programme.

VolgAero covers an area of 22,500sq.m, including 9,600sq.m of workshops and 2,500sq.m of offices. By 2007 the enterprise will employ 280 staff; its annual output is expected to reach 70mln euros by 2012.

The enterprise will operate three production lines: those for rotating parts, mechanical/mechanically-welded casings and accessory components. It will have additional facilities for chemical, thermal and surface treatments. The workshop will be equipped with over 100 machine tools, including 21 numerical control machining cells.

VolgAero's work under the SaM146 production programme will be to manufacture the fan disk, low pressure (LP) spool, high pressure (HP) compressor casing, HP/LP turbine casings, supports for No 1 and 2 bearings, intermediate casing, exhaust casing and accessory components.

Apart from the SaM146 assignments the facility will produce components for other engines including Snecma's CFM56, and NPO Saturn's industrial gas turbines.

The enterprise will be co-run by NPO Saturn and Snecma representatives: Anatoly Zelentsov is appointed Director General and Jean-Jacques Boulanger executive director.

The inauguration ceremony was attended by a top-ranking bilateral delegation including Russian minister of industry and energy Viktor Khristenko, head of the Federal Agency for Industry Boris Aleshin, French ambassador to Russia Jean Cadet, Groupe SAFRAN vice-president Jean-Paul Herteman, Snecma Moteurs president Marc Ventre and Sukhoi Director General Mikhail Pogosyan.

Cadet read an address by French President Jacques Chirac, who referred to the VolgAero inauguration as the herald of "a new format" of cooperation between the two countries. "All the conditions are now in place for successful accomplishment of the RRJ programme," the address reads. Viktor Khristenko for his part expressed hope that the SaM146 engine will be certified by the first RRJ flight, which is tentatively set for April 2007.

According to Mikhail Pogosyan, the opening of VolgAero signifies the completion of the conceptual design phase and transition to full-scale implementation of the SaM146 development programme. Sukhoi expects to sell 755 RRJ aircraft until 2022, 30 per cent in Russia and 70 per cent abroad. Correspondingly, Sukhoi until 2020 will need 500 SaM146 engines for the domestic market (Russia and the CIS) and 1,200 for the foreign market.

NPO Saturn

NPO Saturn

Starting next year, the French government will invest 140mln euros in the SaM146 programme. The remainder of France's portion in the 50/50 project will be covered from assets of Snecma and its parent company Groupe SAFRAN. Viktor Khristenko says the Russian government has identified the RRJ programme as a priority industrial effort and will subsidise it for about $315mln during a period of three years, starting in 2006. Up to 30 per cent of this sum will be used to sponsor the Russian portion of the engine development programme.

Additional financial details were given by NPO Saturn Director General Yuri Lastochkin at the opening ceremony. According to Lastochkin, the Russian half of the SaM146 development work requires total investments of about $350mln. Of this sum, about $135mln will come from NPO Saturn's own funds; $84mln will be borrowed in the form of commercial loans; and the remaining $130mln will be state subsidies.

NPO Saturn expects to have totally reimbursed the state for subsidies by 2015. The SaM146 production programme is expected to bring the federal budget about $685mln in revenues by 2042. This sum will include $56mln directly from the VolgAero enterprise.

NPO Saturn promises the SaM146 engine to be smaller and lighter than the existing rivals, the CF34-10 and D-436-148. It will have a fan diameter of 1,224mm against the CF34's 1,346mm and the D-346's 1,360mm; will measure 2,235mm in length (against 2,290mm and 2,610mm) and weigh 2,132kg (against 2,313kg and 2,235kg). Complete with the nacelle by French manufacturer Aircelle (part of Groupe SAFRAN), the engine will weigh in at 2,150kg. The parts count will be 20 per cent lower than that of the rivals.

The developer especially highlights maintainability of the SaM146, with a quick engine change in under 2 hours and replacement of line-replaceable units in less than 30min. The SaM146 will offer 20 per cent lower maintenance cost than the competition, and will operate for 16,000 hours before the first shop visit.

NPO Saturn says the engine will meet the requirements of the international civil aviation market and the existing noise and emissions standards. The SaM146 will have a guaranteed 10dB noise margin below the ICAO Chapter 4 requirements, and its low-emission combustor will provide for an emission margin of up to 40 per cent below the current standards.

The engine will be certified by Russian, European and US authorities. Bench tests will reportedly begin in 2006.

Andrey Bystrov

Il-76 re-engining programme

Yevgeny Yerokhin

The first upgraded Ilyushin Il-76TD-90VD transport aircraft debuted at the MAKS 2005 air show in Zhukovsky this summer. This is the first of several airlifters to be modernised by the Tashkent Aircraft Production Corporation (TAPC) in Uzbekistan under a contract with the Russian freight carrier Volga-Dnepr. The upgrade programme installs four 14,500kgf Aviadvigatel PS-90A-76 turbofan engines and upgrades the aircraft's avionics. The first Il-76TD-90VD flew on 5 August 2005. Re-engined Il-76TDs will have their payload capacity increased to 50t and their take-off weight to 195t, and will meet the ICAO noise and emissions requirements. The Il-76TD-90VD has a reinforced wing and new engine pylons, an advanced digital flight and navigation system and a new instrumentation system with several colour liquid-crystal multifunction displays. The PS-90A-76 powerplant was flight-tested on the Il-76MF prototype and has by now completed official bench tests. The corresponding supplemental type certificate was awarded on 10 February 2004.

Volga-Dnepr is not the sole customer for Il-76 re-engining. Azerbaijan carrier Silk Way Airlines will purchase two PS-90A-76-powered Il-76TD-90s from TAPC, and the Russian Air Force will induct its first Il-76MD-90s in 2006.

On 18 August Gen. Vladimir Mikhailov, RusAF Commander-in-Chief, and Aleksandr Inozemtsev, Designer General and Director General of the Perm-based Aviadvigatel design bureau, signed the act of acceptance for the first PS-90A-76 engine. Gen. Mikhailov said at the signing ceremony that the RusAF plans to have 12 Il-76MD military transports re-engined to Il-76MD-90 standard at the Voronezh VASO plant during 2006. "With the Perm-built PS-90A-76 engines Il-76MD aircraft will meet the ICAO Chapter 4 standards, and will be able to fly without restrictions in any part of the world," he said. The new powerplant reduces the Il-76MD's fuel consumption by 17–19 per cent against the original D-30KP-2 engines. The re-engined aircraft has a 800–1,000km longer range, improved runway length and density altitude performance.

Radar MMS procures two flying testbeds

Andrey Fomin

The St. Petersburg-based Radar MMS Joint Stock Company, specialising in designing anti-ship missile radar homing heads (for instance, the enterprise has developed active radar homing heads for Kh-35 (3M24 Uran) and 3M54 Club missiles), has recently procured two new flying testbeds. One of them is based on the Ilyushin Il-114 regional airliner, while the other one on the Kazan Helicopters Ansat light helicopter. Both flying testbeds are designed to test and refine new avionics and optronics, developed by Radar MMS. Both testbeds were demonstrated at the recent MAKS 2005 air show.

Andrey Fomin

Il-114LL No 01-09 flying testbed (registration number RA-91003) was manufactured by the Tashkent Aircraft Production Corporation (TAPC) under a contract with the Russian Navy in April 2005. It is designed to flight-test avionics, as well as carry out integrated radar, photo, and thermal imaging survey of the ground and water surface in any weather by day and night. With this end in view the Il-114LL may be fitted with a side-looking radar, multi-function optronic surveillance equipment, an aerial camera, a telemetry data receiver and recorder, and information recording and display equipment, mounted on operators' control panels in the passenger cabin. In order to fly-test new avionics, designed by Radar MMS, the Il-114LL is fitted with an externally carried ventral pod, quartering devices to be tested.

In addition to that Il-114LL No 01-09 is the first aircraft of the type to be powered by upgraded Klimov TV7-117SM turboprop engines. The new engine is fitted with the new BARK-65 automatic digital control system. TV7-117SM is expected to complete certification tests by the turn of 2005, after which it will be mounted on other series production Il-114s.

The second flying testbed, namely the Ansat-LL helicopter (registration number 20440), was built at the Kazan Helicopters this July 2005 under a contract with Radar MMS. Unlike other production Ansats, its fuselage nose is designed to accommodate avionics, thermal imaging, and optical equipment to be tested. Just like the Il-114LL, the Ansat-LL may also be employed for integrated TV and thermal imaging survey of the ground and water surface. The helicopter's equipment may incorporate multi-function optronic devices, operating in the visual and the infrared wavebands, small radar cross-section target detection, acquisition, and tracking radar equipment, an automated helicopter navigation system, based on satellite and inertial systems, a weather radar, and information recording and display equipment, with the operator's workstation mounted in the helicopter cargo hold.

Be-200 returns from Italy and prepares for Eurocertification

The Be-200 multi-purpose amphibian has successfully completed its operations in Italy. In the period from 6 July to 17 September 2005 the Be-200 aircraft, belonging to the Russia's Beriev company, has flown forest fire-fighting missions within the framework of a leasing agreement between Beriev and Italian Sorem company, an official fire-fighting facilities operator for the Department of Civil Defence of Italy.

The Be-200 started its Italian tour on 17 July, and the very first day actively participated in putting out a vast crowning forest fire in a remote mountainous area in the island of Sardinia. It flew its missions together with Canadair CL-415 aircraft and fire-fighting helicopters depending on fire complexity and on-duty assets availability. There were occasions though when only the Be-200 could fly to fight fire because of adverse weather conditions. For example, on 23 August when the Skycrane helicopters and CL-415 aircraft, sent to fight a fire broken out on a steep mountain slope, could not operate because of strong air turbulence and were called off to their bases, the Be-200 flew alone to the fire area and extinguished it making two sorties.

The operational tour of the Be-200 in Italy lasted until 17 September. During the two months the amphibian has been flying its missions over complex mountainous terrain taking water in open sea areas in Tyrrhenian, Ligurian and Mediterranean Seas. During its tour in Italy the Be-200 has accumulated about 150 total flight hours and performed 63 missions with 435 water intakes and dropouts of more than 3,500 tonnes of sea water with liquid fire suppressant.

In the period when the Be-200 operated in Italy, the Russian Ministry of Emergencies received another aircraft of this type manufactured by Irkut Corporation on its order. The third Be-200ChS was handed over to representatives of the Ministry headed by the deputy minister, commander of aviation of the Ministry of Emergencies Rafail Zakirov in Irkutsk on 28 July. The acceptance programme included take-offs from and landings on water surface of the Baikal Lake, as well as sample water intakes and dropouts onto simulated fire spots.

Until recently the Ministry of Emergencies of Russia has operated two Be-200ChS: one based in Zhukovsky, out of Moscow, another in Khabarovsk. The third aircraft will also be put on duty in Khabarovsk. Last July the Be-200ChS has taken an active part in fire-fighting and search-and-rescue operations in the Far East. It suppressed, in particular, three seats of fire spots in the Primorye Region, and performed a number of search and rescue operations in the vicinity of Magadan. In accordance with the contract signed in 2001, Irkut Corporation shall deliver to the Ministry of Emergencies of Russia seven Be-200ChS amphibian aircraft altogether.

The Beriev company is now preparing a Be-200ChS-E modified version of the aircraft for certification in accordance with the European airworthiness standards. Acquisition of the European certificate will allow this amphibian to be delivered to western customers.

Be-103 certified in Brazil

On 3 August Brazil's Aerospace Technical Centre (Centro Tecnico Aerospacial, CTA) issued Type Certificate No. EA-2005T15 to the Russian Be-103 light multi-role amphibious aircraft, designed by the Taganrog-based Beriev company and produced by the Komsomolsk-on-Amur Aircraft Production Association (KnAAPO). Beriev and KnAAPO officials received the Certificate at the CTA headquarters, based in the Brazilian city of Sao Jose dos Campos, on 5 September. The Brazilian Certificate paves the way for the Be-103 to the Brazilian market. Sergey Drobyshev, head of the KnAAPO Directorate, dealing with Be-103, SA-20P, and Su-80 programmes, said that a preliminary agreement on delivering 14 to 50 aircraft of the type to Brazil in the next five to ten years had already been reached. The issue of establishing a joint venture, tasked with final assembly of the aircraft, in Brazil is under consideration. A delivery of the first two aircraft to the Brazilian MSA Group air carrier in late 2005 – early 2006 is being negotiated.

The work on certifying the Be-103 in China is underway as well. The Be-103 is expected to receive the Chinese Type Certificate by the turn of 2005. The Chinese authorities are known to have signed a contract with KnAAPO on procuring 20 amphibious aircraft. The Harbin-based FeiLong Airlines (Flying Dragon) air carrier will become the first Chinese end user of the Be-103. It has also signed an agreement on establishing a Be-103 maintenance centre in China. The first five Be-103s may be delivered to FeiLong Airlines as early as the turn of 2005, right after the aircraft receives the Chinese Type Certificate, with amphibious aircraft to fly from Komsomolsk-on-Amur to Harbin on their own.

In addition to that, a contract on delivering two Be-103s to Cyprus has recently been initialled. The Russian side has submitted an application for certifying the Be-103 in compliance with the European EASA standards. Given the fact that the Be-103 has already been certified in the US under the FAR-23 standards, its certification in Europe should not pose any problems.

Andrey Fomin

Mi-38 goes public

The Mil Mi-38 new-generation medium utility helicopter, the long-awaited successor of the worldwide famous Mi-8, made its first public appearance at the Zhukovsky-based MAKS 2005 air show this August. The helicopter prototype, designated RA-38011, which made its maiden flight in Kazan on 22 December 2003, has been undergoing tests at the test centre of the Moscow-based Mil Helicopter Plant in a town of Panki outside Moscow since late 2004. Helicopter designers hope the helicopter will be launched into mass production at the Kazan Helicopters in 2008. (The picture shows a Mi-38 demonstration flight at MAKS 2005 air show jointly with the upgraded Mil Mi-24VK-2).

Alexey Mikheyev

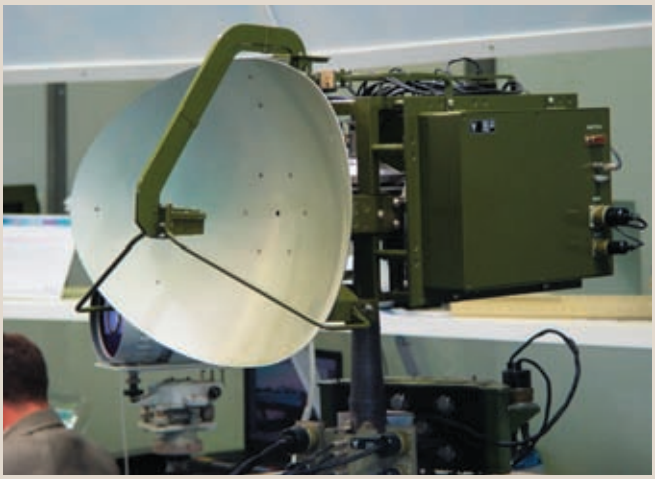
Mi-54 makes a comeback

Andrey Fomin

The Moscow-based Mil Helicopter Plant started disseminating information on its Mi-54 light utility helicopter development as far back as 1992. However, the helicopter development has progressed at an extremely slow pace ever since due to the lack of funds. Finally, the Mil Helicopter Plant displayed the wooden fuselage mock-up at the recent MAKS 2005 air show, which can only mean that the work on the project has been resumed. The Mi-54, included in the Special Federal Programme "Civil Aircraft Development in 2002–2010, and until 2015", is designed to airlift 12–13 passengers or up to 1,500kg of cargo (up to 1,800kg of externally mounted cargo). In compliance with design characteristics, the helicopter will feature a maximum take-off weight of 4,500kg (4,700kg with externally carried cargo), a speed of up to 280km/h, and a range of up to 600km.

Ryazan Instrument Plant introduces own helicopter radar

The new N025E dual-band helicopter radar, designed to be mounted on the Mil Mi-28N round-the-clock combat helicopter has become an unexpected innovation, displayed at the recent MAKS 2005 air show. The radar has been developed by the Ryazan State Instrument-Making Plant (GRPZ). The new radar, featuring a single reflector-type antenna, operates in SHF and EHF bands, using a quasi-continuous pulse for sweeping, and the digital signal processing technology in the receiving channel. The N025E radar incorporates a computer, designed by the GRPZ, which comprises an analog receiver unit, an analog-to-digital converter, a reprogrammable signal processor, and a radar and computer synchroniser. The aerial module is expected to be quartered in the rotodome above the Mi-28N main rotor hub. The radar may be used for ground mapping, and detecting mobile and stationary targets, as well as dangerous weather conditions and ground-based obstacles. According to GRPZ officials, the N025E radar is already undergoing bench tests at the plant, while the Mi-28N, which has recently been submitted for state tests, operates without a radar for the moment (the picture shows the first pre-production helicopter, which changed its hull number No. 02 to No. 024 and participated in the MAKS 2005 air show).



Andrey Fomin

Alexey Mikheyev

SERGEY MAKSIN:

The Urals Optical and Mechanical Plant (UOMZ) is one of Russia's flagship defence enterprises, developing and manufacturing military and civil optronics. At the present time UOMZ produces hi-tech optronics for the Air Force, the Navy, and the Army. The plant's products are used in avionics, mounted on MiG and Sukhoi family aircraft, as well as Mil and Kamov helicopters. UOMZ successfully fulfils a number of big-ticket international contracts as well.

The Urals Optical and Mechanical Plant had been headed by Director General Eduard Yalamov for a long time. Regrettably, he passed away on 21 July 2005 after a siege of acute disease. The Russian Federal Industry Agency announced a contest on filling the vacancy of the UOMZ Director General. On 6 September 2005 the tender committee of the Federal Industry Agency adopted a decision, appointing Sergey Maksin, the-then deputy Director General, Director General of the Urals Optical and Mechanical Plant. Our correspondent met the new UOMZ Director General and asked Sergey Maksin a few questions about his enterprise and its products.

UOMZ

Mr Maksin, you have just been appointed UOMZ Director General. Will you please describe the current state of affairs at UOMZ, and tell our readers whether your are satisfied with its current structure, and whether you plan any restructuring?

The UOMZ's current business strategy envisions focusing all efforts on clearly outlined workstreams, which enable the enterprise to remain stable, but at the same time to quickly react to shifts in demand and market trends. The plant features contemporary science-driven production capabilities. At the present time it comprises production facilities, the central design bureau, and an advanced sales and promotion network. Given the rapidly changing free market environment, streamlining the institutional framework is the basis of survival. The radical restructuring of the UOMZ, embarked on in 2005, has been caused by the introduction of corporate information system and changes in existing business processes.

This process may be said to have been started as far back as 2002, when UOMZ started pursuing a large-scale re-equipment programme, aimed at undertaking a comprehensive upgrade of the plant's production facilities, and maintaining them at a cutting-edge level. Under the programme, the enterprise procures state-of-the-art machine tools and equipment and introduces the corporate information system, based on GALS technologies. UOMZ has also recently introduced information technologies such as software support in the field of finances, sales, production, design, logistics, etc., as well as cutting-edge communications means. Within the framework of the project, aimed at establishing an integrated Enterprise Resource Planning system (ERP), UOMZ has created a corporate data communications network and is developing a multi-service corporate network, based on the IP telephony, which will allow the parent company and its subsidiaries to be integrated into a unified information space. The network is based on the ERP system, which in its turn is based on the Telemetry Checkout Equipment (TCE). I take pride in the fact that UOMZ has become one of Russia's first defence contractors to introduce such information technologies.

Restructuring, embarked on in 2005, holds true for all subdivisions without exception: principles of institutional frameworks and relations among subdivisions have been revised. The products sales and promotion service, civilian production, and the engineering service have seen the most drastic changes. First and foremost, it is caused by market demands and the plant's development priorities. The strategic objective of the enterprise consists in developing

DEVELOPING AND PRODUCING AIRCRAFT OPTRONICS IS A PRIORITY FOR UOMZ PLANT

Sergey Maksin was born in 1967. He has been employed by UOMZ for 17 years since 1989. In 1994–2001 he supervised establishing a network of UOMZ's sales offices in Russia and CIS member-states, which radically increased the sales volume and improved the after-sales services of the enterprise. In 2001 he was appointed UOMZ Deputy Director General for Economy, Finance, and Strategic Development. In 2005 he was appointed UOMZ First Deputy Director General. On 6 September 2005 the Russian Federal Industry Agency appointed him UOMZ Director General.

far back as 1994–2001, which allowed it to drastically improve the sales volume and after-sales services. At the present time there are a total of 21 affiliate offices and service centres of the Urals Optical and Mechanical Plant throughout Russia. Introduction of the product-regional structure increases the sales efficiency due to the internal competitiveness, and higher responsibility for and transparency in sales processes.

UOMZ design centres are established in Russia's main scientific centres. At the moment UOMZ operates a total of three such centres, based in Moscow, St. Petersburg, and Novosibirsk.

The ongoing restructuring is another development stage of the enterprise. Streamlining and improving the management system and the institutional framework constantly is a must for the enterprise to adapt to the rapidly changing environment.

What is UOMZ's current position in the defence industry? What has been done for UOMZ to secure its niche in backbone segments of the Russian defence industry, and what prospects are in store for it in this area?

On one hand, UOMZ is a self-dependent designer and manufacturer of aircraft optronics. On the other hand, the plant closely cooperates with Russia's flagship aircraft-building companies, as well as dozens of sub-contractors in the field of developing and mass-producing avionics. A total of about 100,000 people are involved in such cooperation.

The contemporary global market requires that the defence industry establish inter-branch and interdepartmental research and development centres and think-tanks. Establishing a large-scale integrated structure, in particular, an optronics instrument-making one, will be expedient, first and foremost, from the viewpoint of increasing competitive capabilities of enterprises of the corresponding industrial branch.

In June 2005 the Russian Government Defence Industry Commission adopted the work plan on establishing integrated structures in the Russian defence industry in 2005–2006. I believe your readers are aware that the Federal Industry Agency has already issued an order on establishing an integrated optronics instrument-making company, named "Optical Materials, Systems and Devices", which would integrate most of Russian optical materials and equipment researchers, designers and manufacturers. Our enterprise is all for the initiative. The work is already underway, and UOMZ is quite an active participant in it. Moreover, I have been appointed deputy head of the workgroup, tasked with establishing the integrated company. It is necessary for the new company to include such workstreams as optical science, technologies, and materials, optronics instrument-making, and laser technology.

the civil instrument-making industry, and increasing the share of civil products in the overall sales volume. It is a must to focus efforts and streamline business processes throughout the life cycle from designing new products up to promoting and selling them in the market in order to achieve the objectives specified successfully.

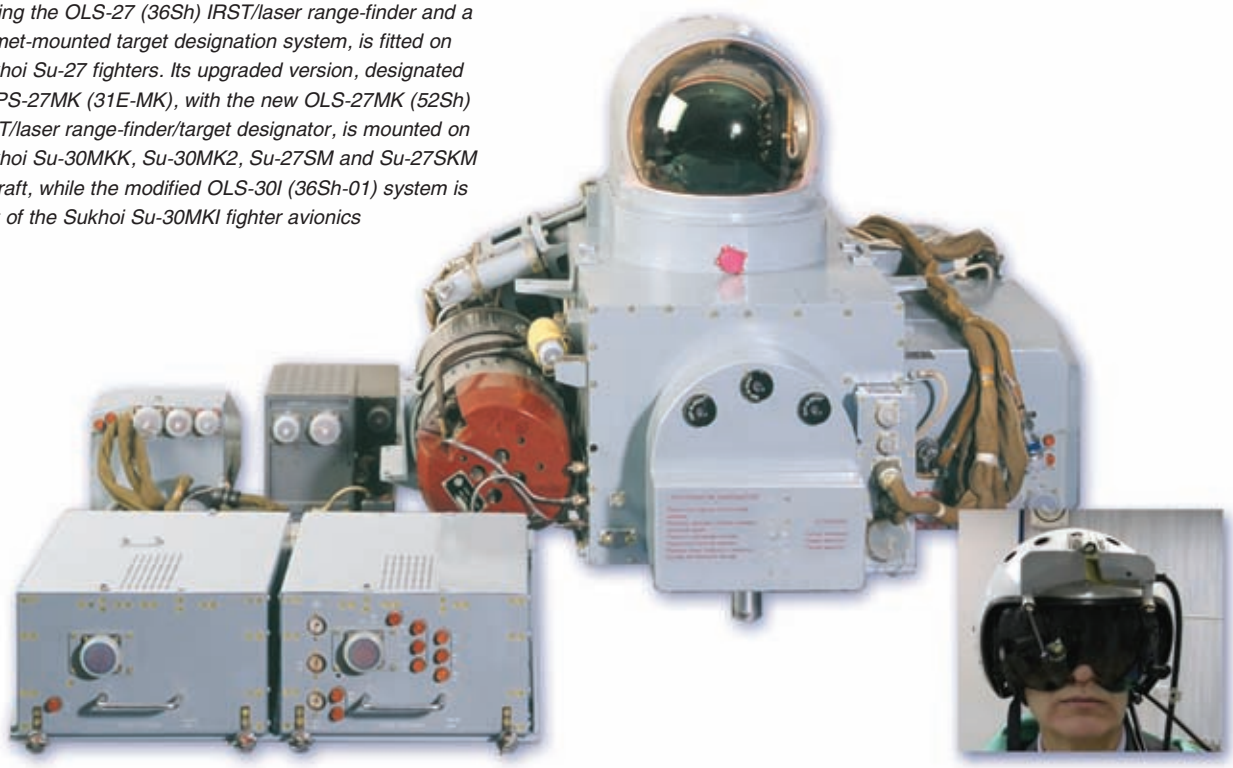
Transition to the section-free production pattern increases self-dependence and the burden of responsibility for the end product, shouldered by production managers, reduces the number of management levels, and steps up the process of adopting managerial decisions. Such a pattern will increase independence and reliability of each particular management level.

UOMZ established a network of sales offices in Russia and CIS member-states as

Establishment of such structure is undoubtedly aimed at increasing the efficiency of industry management, and facilitating its rapid financial, economic, production, and sci-tech development. I would say that the future of the Russian defence industry and science depends on integrated structures.

Since our magazine covers aerospace industry, our readers would, first and foremost, be interested in UOMZ's developments designed for airborne application. Could you please dwell on the enterprise's priorities in this particular sphere?

Airborne projects became the priority for our plant as far back as the 1970s – 1980s, when it developed and launched into mass production a number of the-then cutting-



The OEPS-27 (article 31E) optronic sighting system, comprising the OLS-27 (36Sh) IRST/laser range-finder and a helmet-mounted target designation system, is fitted on Sukhoi Su-27 fighters. Its upgraded version, designated OEPS-27MK (31E-MK), with the new OLS-27MK (52Sh) IRST/laser range-finder/target designator, is mounted on Sukhoi Su-30MKK, Su-30MK2, Su-27SM and Su-27SKM aircraft, while the modified OLS-30I (36Sh-01) system is part of the Sukhoi Su-30MKI fighter avionics

UOMZ

edge devices of tactical aircraft: the first national Fon aircraft laser range finder (mounted on Sukhoi Su-17M2 and Mikoyan MiG-27 fighter bombers – ed.), the Klen and the Prichal laser range finders and target illuminators (the former was fitted on Su-17M3, Su-17M4, MiG-27M and Su-25, while the latter was employed as part of the Shkval system, mounted on Ka-50 helicopters and modified Su-25T and Su-25TM (Su-39) attack aircraft – ed.), as well as the OEPS-29 (article 23S) and the OEPS-27 (article 31E) optronic sighting systems designed to be fitted on Mikoyan MiG-29 and Sukhoi Su-27 fighters respectively.

Development and production of science-intensive optronics, based on latest achievement in the sphere of applied optics, microelectronics, laser, television, and thermal imaging technologies, as well as precision electrical engineering, has remained the foremost priority for the Urals Optical and Mechanical Plant until now. The range of research and development, pursued by UOMZ, embraces all combat arms of the Air Force: our enterprise develops new system prototypes for aircraft in service with army, tactical, long-range and military transport aviation.

One of the most important workstreams in the field of aerospace projects consists in developing a family of gyro-stabilised optronic sighting systems (GOES) to be mounted on attack helicopters in the inventory of Army Aviation, Interior Ministry Forces aviation, and other Russian uniformed agencies. Further improvement of sights, designed to be fitted on Sukhoi and MiG-family tactical aircraft, accounts for a large share of the workload. Another priority focuses on designing externally mounted optronics target laser illumination containers, which will provide tactical fighters with additional capabilities, inherent attack aircraft and bombers.

Contemporary and future aircraft armaments face extremely tough requirements. They have to feature "one hit – one kill" capability and the target selection capability by day and night. Thus, developing new aircraft optronics, facilitating efficient employment of precision-guided munitions (PGM) by day and night, is a comprehensive task for the entire national defence industry, which requires further improvement of both optronics design and principles, and characteristics of optronic components, as well as new design and production technologies.

Being the country's flagship optronic sighting systems designer and manufacturer, the Urals Optical and Mechanical Plant continues conducting a wide range of works, aimed at improving tactical characteristics of such products. For instance, UOMZ fits all optronic sights, being developed and mass produced, with one of its cutting-edge developments, already launched into series production, namely the LDBG1 laser range finder with eye-safe radiation, meeting all specification requirements of all Russian armed services and combat arms, and armed forces of NATO member-states. In order to reduce the weight and dimensions of such systems, our enterprise has developed a two-wave laser range finder/target illuminator with an option of selecting the operating wavelength, which finds the range with the help of an eye-safe wavelength of 1.57 microns and provides target laser illumination for laser homing head missiles at a classical wavelength of 1.06 microns.

UOMZ has been appointed flagship contractor in the special comprehensive programme, aimed at developing the first national Modul-Avia second-generation thermal imager, comparable to the best similar systems, produced by French and Swiss companies. The thermal imager is designed to be fitted into aircraft optronic sights, but is also considered a promising product for all armed services. The thermal imager prototypes, designed by UOMZ jointly with a number of other defence enterprises,

demonstrated total compliance with specification requirements facing them. The thermal imager state tests are to be completed by the turn of the year, and in 2006 the plant will launch it into mass production and integrate into optronics systems.

Could you describe the work on developing future optronics for the next-generation combat aircraft, if possible? What will the vital features of such future systems be, as compared with those of the existing ones?

In late 2003 UOMZ won the tender, issued by the Sukhoi Design Bureau, the flagship designer of the next-generation tactical aircraft (PAK FA). The tender, which saw participation of a number of national aircraft instrument-building enterprises, was aimed at developing the multi-function integrated optronic system for the future fighter. I believe that the very fact of the plant's winning the tender proves UOMZ's authority within the national defence industry, which it has secured in the course of a long-term productive work in the aircraft instrument-making industry.

UOMZ

The Sapsan-E externally mounted laser target designation pod is designed to be mounted on the upgraded multirole Su-27/Su-30 and MiG-29 family fighters

The very term "new-generation aircraft" speaks for itself. The aircraft will feature totally different capabilities as compared with those of existing combat aircraft, first and foremost, as far as avionics are concerned. Its integrated optronics system is to discharge a wide range of tasks, facilitating the aircraft's combat and reconnaissance operations, defence capabilities against attacks from the ground and the air, and employment in any weather. The development of the optronic system is conducted in strict compliance with the plan adopted. Prospects of the enterprise's future scientific development depends heavily on the aforementioned project, the results of which will define further level of our developments both in the sphere of avionics, and other military optronics technologies. On the whole, the development of the new-generation aircraft, which is known to attract foreign investments, will offer a powerful incentive to the entire Russian defence industry.

Do optronic sighting systems, designed and manufactured by UOMZ for tactical aircraft earlier, undergo upgrade? How does the development of an optronic sighting systems for the Su-35 multi-role fighter and the Su-34 tactical bomber progress? What are the current results, and what further prospects are there in this field?

In the 1980s the Geofizika Scientific Production Association designed and the UOMZ launched into mass production the 31E and the 23S optronic sighting systems, which are still employed on Su-27 and MiG-29 fighters respectively. At the present time UOMZ upgrades these sights for tactical aircraft. Our enterprise manufactures and delivers to foreign customers the OEPS-27MK (article 31E-MK) optronic sighting systems, mounted on the Sukhoi Su-30MKK, and the OLS-30I (article 36Sh-01) infra-red search-and-track (IRST) laser range-finder, fitted on the Su-30MKI. Joint development of a qualitatively new optronic system for the Su-30MKI is being negotiated with the French Sagem Company, and the Indian HAL Corporation. An upgraded optronic sight, boasting greater range and reliability as compared with those of the 23S sight, has been developed for the MiG-29SMT fighter, and is now undergoing tests. One of its features consists in replacing the glass radome with the more modern one made of leucosapphire. The enterprise is developing a multi-function optronic system for the MiG-29MRCA fighter, which will enable it to engage air- and ground-based targets, counter enemy attack means, and operate in adverse weather.

The first prototype of the Sapsan external optronic target laser illumination pod has already been manufactured. The container, designed to be mounted on Su-27SM, Su-30MK3 and MiG-29SMT aircraft, is currently having its software fine-tuned.

The TV-laser sighting system, to be fitted on the Sukhoi Su-34 aircraft, has already completed joint state tests and is ready to be launched into series production.

Future prospects in the area will depend on the development of multi-function optronics for the Su-35 aircraft, namely an IRST/range-finder and an externally mounted optronics pod. The results of this work may be used directly in the aforementioned projects, aimed at developing an optronic system for the new-generation aircraft.

What does UOMZ offer to gunships and transport helicopters?

As was mentioned above, helicopter equipment development is one of the most important directions for the enterprise in the field of aircraft optronics. UOMZ pursues a wide range of research and development projects, aimed at developing new day-night gyro-stabilised optronic sights to be mounted on such cutting-edge rotary-wing aircraft as the Mil Mi-8, Mi-24, Mi-26, Mi-28, the Kamov Ka-50, Ka-52, Ka-60 and their versions.

The GOES-321M and the OPS-24N optronic systems, designed by UOMZ, fall within the aforementioned category. The GOES-321M system, boasting a thermal imaging channel and a laser range finder, allows a helicopter to go into action and employ unguided weapons by day and night. The system has already been launched into production, and has successfully passed operational service tests on the Mil Mi-8MTKO helicopters.

The OPS-24N system, which is part of the 9K113 upgraded guided weapons system for the Mil Mi-24VK/PK (Mi-35M) helicopter, comprises a television and a thermal imaging channels, a laser range finder, and a missile direction finder. It is capable of conducting day-night ground-based targets detection, acquisition, and designation, determining angular coordinates of such targets with high precision, laser range finding, and firing Shturm and Ataka missiles, as well as their versions. The OPS-24N incorporates the GOES-342 gyro-stabilised optronic system. It has completed preliminary tests and delivered to the customer for operational tests.

UOMZ is also developing a family of round-the-clock turret-mounted optronic navigation sights in order to enable gunships and transport helicopters to operate in poor weather conditions and at night, detect obstacles and landmarks. Unlike gyro-stabilised sights, designed to facilitate precise fire of unguided munitions and PGMs, turret-mounted sights do not require their light of sight to be highly stabilised, which considerably reduces their cost. The TOES-521 turret-mounted optronic system prototype, designed for the Mil Mi-28N helicopter and comprising a microbolometric thermal imaging channel, a TV stereo, and a laser range finder, has been tested as part of the avionics suit, and delivered to the Rostvertol company. The TOES-520 turret-mounted optronic system prototype, designed for the Kamov Ka-52 helicopter and incorporating a microbolometric thermal imager and a round-the-clock TV channel, has been developed, manufactured, delivered to the Kamov company, and tested onboard a helicopter.

UOMZ

The GOES-321M twin-channel system is successfully employed on modernised Mi-8MTKO helicopters

UOMZ

The GOES-342 four-channel gyro-stabilised optronic system, which is part of the OPS-24N sighting/surveillance system, mounted on upgraded Mil Mi-24VK/PK (Mi-35M) helicopters

UOMZ

The TOES-520 turret-mounted optronic navigation system designed for the Kamov Ka-52 helicopter

Are UOMZ optronics expected to be employed on civil aircraft? What has been done in this area, and what prospects do you anticipate?

Not only are UOMZ optronics expected to be employed on civil aircraft, but the objective has actively been pursued for quite some time. We have conducted a marketing analysis of the civil aircraft optronics market, studied the assortment and characteristic of devices, manufactured by flagship contractors in this area, and determined the major characteristics and the cost of such system for them to be highly competitive both in the domestic and the international markets. The conclusion is quite clear: the technology potential and production capabilities of our enterprise can stand up to the challenge, and the workstream should be considered one of the most promising ones.

This year the UOMZ Central Design Bureau has established a special design bureau, tasked with developing civil optronics, with the priority attached to aircraft optronics. We will embrace the following, quite obvious major principles, as far as civil optronics are concerned: we will capitalise on the our experience in the sphere of military optronics to the maximum extent possible, including development of systems, standardised in optronic module dimensions, featuring multiplex capabilities, and capable of being fitted with additional functional units at the discretion of the customer; we will simplify the design of such optronics as much as possible to reach an acceptable cost; and, finally, we will aim to increase the range and reduce the weight and dimensions of such devices by using foreign components.

At the present time we have taken the following major steps, insofar civil aircraft avionics are concerned. UOMZ has manufactured the SON-612 optic surveillance system, designed for remote air monitoring of power lines, and the SON-602 optic surveillance system for the helicopter-mounted oil mains laser gas detector, and delivered them to the Pergam Engineering JSC and the Neftegazaerokompleks JSC respectively. The SON-122 surveillance system prototype has been developed, manufactured, tested on the Kamov Ka-226 search-and-rescue helicopter, and delivered to Pergam Engineering.

UOMZ has also manufactured five GOES-520 gyro-stabilised optronic systems for the lighter-than-air fleet of Moscow municipal services under a contract with the Moscow administration. The optronic systems in question, mounted on air-balloons, are designed to monitor traffic and environment situation on the Moscow Belt-Way.

Our enterprise will have delivered three SON-312 surveillance systems, designed to be mounted on police Mil Mi-8 and Mi-171 helicopters, to the Ulan-Ude Aircraft Plant by the turn of 2005.

Under a contract with the Austrian Diamond Aircraft Company, UOMZ completed a delivery of the SON-112 surveillance system, tested on the Twin Star light aircraft, with the system to be integrated into the police surveillance and live footage systems. The SON-112 comprises the FLIR Systems Termovision thermal imager and two highly sensitive TV channels, a wide-field one and a narrow-field one.

The civil version of the aforementioned TOES-520 turret-mounted optronic navigation sight, designated TOES-520E, will be used as part of the police surveillance system, mounted on Bell 206 helicopter, under a contract with the German Wibka Company.

We believe that further development prospects in this area should envision expanding the product assortment and the consumer market.

UOMZ is known to have recently been granted the right to conduct independent foreign economic activities. How does the enterprise exercise this right? What contracts do you prefer to undertake on your own, and when do you prefer to act as a sub-contractor?

Since 2003 UOMZ has been one of the few Russian defence enterprises, authorised to carry out independent foreign economic activities in the sphere of aircraft spare parts deliveries and after-sales services. The right to independent defence cooperation opens new vistas for the enterprise, in particular, participation in establishing aircraft service centres in states, operating fixed- and rotary-wing aircraft, equipped with UOMZ avionics. UOMZ is an official optronics supplier to the Indian, the Malaysian, and the Chinese air forces, and it promotes partnership with these states.

Despite that fact that UOMZ is now authorised to get involved in foreign economic activities on its own and is quite successful in fulfilling direct deliveries, the enterprise still works closely with Rosoboronexport. First and foremost, such cooperation holds true for licensed production and devices, excluded from the authorised independent exports list.

The Urals Optical and Mechanical Plant hopes that its further cooperation with Rosoboronexport will be defined by its major workstreams, including deliveries of optronics and their spare parts for MiG-29, Su-27, and Su-30 fighters, as well as licensed production of devices for Su-30MKI and Su-27SK aircraft.

As far as UOMZ's new products are concerned, namely gyro-stabilised round-the-clock systems, designed to upgrade capabilities of earlier versions of Mil Mi-8, Mi-17, Mi-24 and Mi-35 helicopters, we expect Rosoboronexport to step up their promotion. The helicopter modernisation market is a very promising aircraft market niche both for Russian aircraft manufacturers and the government.

Being an optronics designer and manufacturer, entitled to independent defence cooperation, UOMZ believes that its major task consists in providing prompt after-sales services, insofar short-notice spare parts deliveries and repairs are concerned. With this end in view, the enterprise has embraced the "3+3" principle, meaning that spare parts are to be delivered within three months from the moment a corresponding contract is signed, and repairs are to be completed within three months from the moment a device is submitted to a service centre. In 2004–2005 UOMZ proved that it needed about 70 days for discharging each task.

In conclusion, our readers would like to hear about UOMZ's interests in Malaysia. It is common knowledge that UOMZ is a traditional participant in Malaysian exhibitions, and this interview will be published ahead of the next LIMA air show. What is your interest in the market?

At the present time UOMZ believes that defence cooperation development should envision both increasing the number and the scale of contracts with foreign customers, and establishing service centres in states, operating Russian aircraft. Our enterprise, which is an active partner of South East Asian states generally, and Malaysia in particular, plans to promote cooperation by establishing a service centre. The task is of paramount importance, since establishing a service centre, a consignment spare parts storage facility, and certain repair facilities directly on a customer's territory, is the only way to provide prompt after-sales services to a customer. The Malaysian Matra Company is UOMZ's exclusive partner in the country. We have already signed seven or eight contracts with quite a significant overall cost, with the latest one being fulfilled.

Generally, the South East Asian market seems to be very lucrative for us. Participation in the LIMA air show will certainly boost the UOMZ trademark in the market.

We are very grateful to your for the interview and wish you every success in discharging the duties of the UOMZ Director General!

UOMZ

UOMZ

The SON-612 (on the left) and the SON-112 (on the right) civil optronic surveillance systems. The former is employed by the Pergam Engineering Company for power lines remote air monitoring, while the latter is mounted on the Twin Star light aircraft under a contract with the Austrian Diamond Aircraft Company for conducting police surveillance and live footage

THE HEART OF YAK-130

THE AI-222-25 WILL SPAWN A FAMILY OF ENGINES FOR TRAINERS AND LIGHT COMBAT AIRCRAFT

Russia's new combat trainer, the Yakovlev Yak-130, has been recently ordered by the Russian Air Force and is being actively promoted to foreign markets. The high performance of this aircraft is largely due to an all-new powerplant comprising two new-generation AI-222-25 turbofan engines developed by Zaporozhye-based Ivchenko-Progress design bureau. Two Yak-130 flying prototypes are already powered by AI-222-25s, and a third machine will shortly join the testing programme. Certification ground tests of the engine will start in December 2005, after which it will enter production at Motor Sich in Zaporozhye and MMPP Salut in Moscow. The AI-222-25 will also be used as the baseline for a family of engines in the thrust range of 2,500 to 4,200kgf for a variety of newly developed and upgraded training and combat aircraft.

Ivchenko-Progress, which celebrated its 60th anniversary in May 2005, has extensive experience in developing engines for training aircraft. In 1947 it created the AI-10 piston engine to power the Yak-20 aerobatic aeroplane, followed in 1948 by the AI-14 (M-14) engine that is still in production and widely used on Yakovlev Yak-18, Yak-50, Yak-52, Yak-55 and Sukhoi Su-26 aircraft and their versions, including the newest Yak-54, Su-29 and Su-31.

In 1969 Ivchenko-Progress took the AI-25 engine of the Yak-40 airliner and developed it into the 1,720kgf thrust AI-25TL turbofan to power the Aero Vodochody L-39 jet trainer, which for many decades remained the main advanced trainer type in a number of countries including Russia and Ukraine. Motor Sich, a long-time production partner of Ivchenko-Progress, has to date built over 4,700 such engines, which power training aircraft in 38 countries. The AI-25TLK version is used on China's K-8J trainers. The AI-25T and TLM versions were in their time proposed for the installation on the Su-25 light ground attack aircraft and the MiG-AT trainer respectively. In the early phases of the Yak-130 development programme there were plans to install an AI-25TL-based powerplant.

Ivchenko-Progress drew from its AI-25TL experience in the late 1980s to develop the 2,200kgf DV-2 engine for Aero Vodochody's L-39MS and L-59 trainer and combat-trainer aircraft. The DV-2 entered series production at Slovakia's Povazske Strojarne enterprise. The manufacturer later joined efforts with the St. Petersburg-based Klimov plant to modify the design for powering the Yakovlev Yak-130D demonstrator; in 1996 through 2002 the aircraft was successfully flight-tested with two DV-2S engines, and was then used as the basis for the production RusAF Yak-130 combat trainer and subsequent modifications.

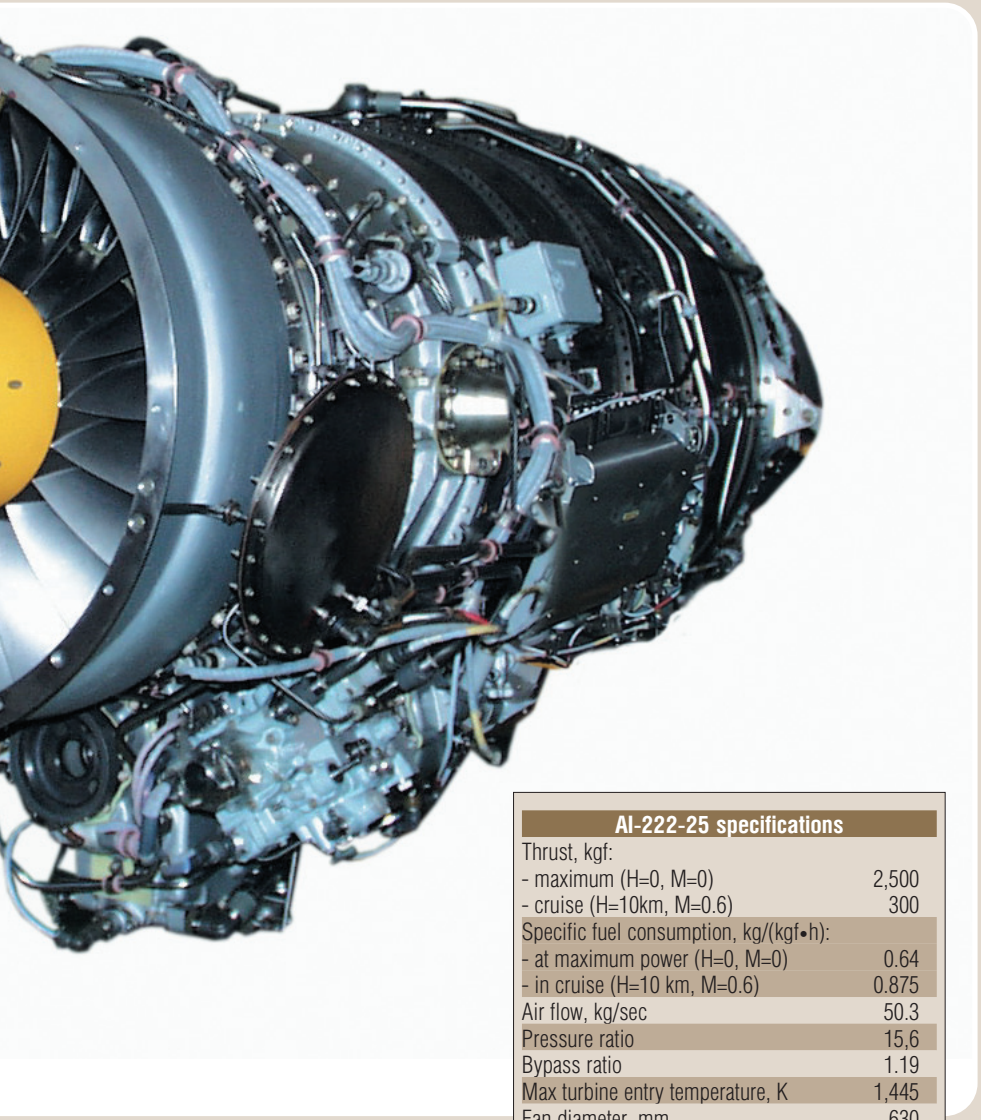
Ivchenko-Progress developed a special engine for production Yak-130s. The 2,500kgf AI-222-25 turbofan offered greater thrust, enhanced efficiency and reliability. The engine was built around a proven gas generator of the new-generation 3,850kgf AI-22 turbofan, which was then under development for the new Tu-324 regional passenger jet. The AI-22's gas generator was first powered up on 28 April 1999; already on 26 September 2000 the first full-scale AI-22 entered ground tests.

The tried gas generator solution sped up the AI-222-25 development programme. The only differences between the new engine and the AI-22 were in the fan, low pressure turbine, gear box and nozzle. Bench tests of the AI-222-25 gas generator began in November 2002; the first full-scale engine was first powered up in June 2003. In December 2003 two AI-222-25s were delivered to the Sokol plant (Nizhny Novgorod) for installing on the first preproduction Yak-130, which had its maiden flight on 30 April 2004 and is currently undergoing certification tests. Two more engines were delivered in December 2004 for the installation on the second flying prototype, which entered the testing programme in early April 2005. Certification tests of the AI-222-25 are scheduled to start in December 2005.

Motor Sich (Zaporozhye) and MMPP Salut (Moscow) are preparing AI-222-25 series production for the Yak-130 trainer. Motor Sich will build gas generators, whereas Salut will produce fans, low pressure turbines and other engine parts, and will also perform final assembly.

The AI-222-25 is a twin-spool turbofan engine comprising a two-stage high-pressure fan, eight-stage high pressure compressor with a variable inlet guide vane, annular combustor, single-stage high pressure/low pressure turbines and a convergent nozzle common to both flows. The blisk fan is made of titanium alloy. The film-cooled low-emission combustor has 16 air blast fuel nozzles. The high-pressure turbine is equipped with an efficient cooling system, and the low-pressure turbine has a cooled inlet guide vane. Directional solidification casting is used to manufacture the blades for both turbines.

The low-pressure rotor is mounted on three supports, and the high-pressure rotor



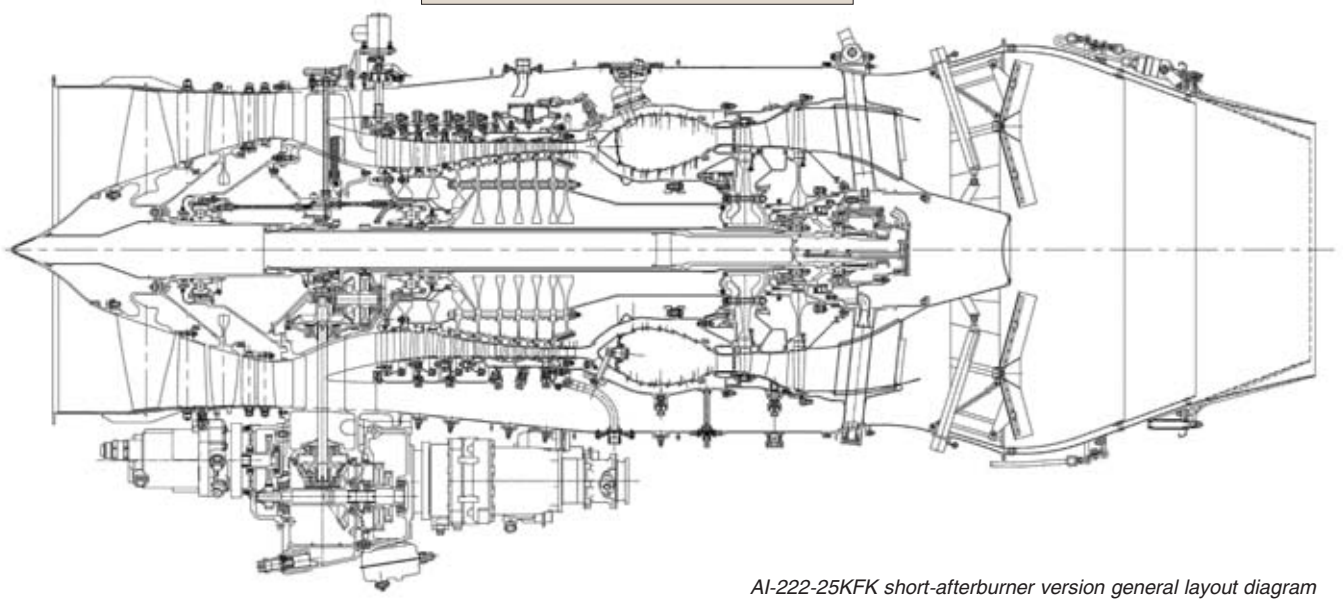
on two supports. The intermediate casing and the rear mount ring provide for engine mounting inside the aircraft. The detachable gear box is developed in several versions to accommodate the unique number of accessories and mounting peculiarities of the particular engine modification.

The engine is fitted with a FADEC system capable of comprehensive testing and health monitoring. The AI-222 includes innovative, miniature and lightweight hydromechanical fuel system components. Its modular design allows for quick line replacement of worn or damaged modules.

The AI-222-25 will be used as the baseline for a family of turbojet engines intended for trainers and light combat aircraft. Requisite parametric and engineering studies have already been run for AI-222 modifications with increased thrust, afterburner and thrust vectoring, namely the 2,830kgf AI-222-28 version; the 4,200kgf reheat thrust AI-222-25F version; and the 3,000kgf thrust AI-222-25KFK version with a so-called short afterburner measuring in length not more than 500mm. All members of the AI-222 family may be fitted with all-aspect thrust vectoring nozzles, which would vector thrust to angles of 20 degrees for increased manoeuvrability and takeoff/landing performance.

Apart from the Yak-130, the AI-222 family may be used with a number of other types, both new-build and modernised. The AI-222's optimum thrust and efficiency parameters, low noise and emissions, long service life and low operating costs will facilitate the development of many highly competitive aircraft.

AI-222-25 specifications	
Thrust, kgf:	
- maximum (H=0, M=0)	2,500
- cruise (H=10km, M=0.6)	300
Specific fuel consumption, kg/(kgf•h):	
- at maximum power (H=0, M=0)	0.64
- in cruise (H=10 km, M=0.6)	0.875
Air flow, kg/sec	50.3
Pressure ratio	15,6
Bypass ratio	1.19
Max turbine entry temperature, K	1,445
Fan diameter, mm	630
Engine length, mm	1,960
Dry weight, kg	440



AI-222-25KFK short-afterburner version general layout diagram

RRJ team gets state funding and secures first firm order

Recent MAKS 2005 air show witnessed several important events concerning Sukhoi RRJ Russian Regional Jet programme. On 16 August Sukhoi Director General Mikhail Pogosyan and Boris Alyoshin, head of the Russia's Federal Agency for Industry, signed a state development contract for the RRJ airliner. The contract envisions state funding worth 7.9bln roubles (about $280mln) until 2009 for the RRJ development work.

The first firm order for the RRJ was signed on 17 August between Sukhoi Civil Aircraft (SCAC) Director General Viktor Subbotin and Finance-Leasing Company (FLC) president Yevgeny Zaritsky. Under the $262mln deal, FLC will take ten RRJ-95 aircraft in the baseline configuration for further leases to Russian carriers. The first four RRJ-95s will be delivered in 2008, and the remaining six in 2009.

On the same day SCAC signed two more RRJ-related agreements at MAKS. Khabarovsk-based Dalavia airline committed to purchasing four aircraft in 2008–2010. SCAC also signed a $21mln contract with the UK company Ipeco for crew seats for the RRJ, with deliveries scheduled to start in 2006.

On 18 August Viktor Subbotin, Boeing president for Russia and CIS Sergey Kravchenko and Progresstech Group president Vladimir Kulchitsky signed an agreement on cooperation, under which the three companies will jointly use the engineering and production infrastructure of Boeing and SCAC for the development of civil aircraft.

Also on 18 August Mikhail Pogosyan, Boris Aleshin and Finmeccanica chief operating officer Giorgio Zappa as well as Alenia Aeronautica vice-chairman Giorgio Brazzelli signed a framework agreement on RRJ cooperation. Alenia intends to acquire a stake in SCAC, and offers its services in RRJ development, marketing and aftersale support. As Boris Aleshin told journalists on 26 September, the Finmeccanica board of directors has approved the acquisition of a 25 per cent interest in SCAC.

Contrary to widespread expectations, Aeroflot did not announce an RRJ order at MAKS 2005. Many experts believed Russia's flag carrier would use the exhibition to declare SCAC the winner in its lingering regional jet tender. However, according to Sukhoi representatives, the parties are still "discussing this issue". Likewise, Siberia has not yet firmed up its July 2004 commitment for 50 RRJs.

Our sources report that Aeroflot is close to ordering 30 RRJ aircraft with an option for a further 30 or so, but several unsolved issues remain. Aeroflot Director General Valery Okulov has recently told a Moscow newspaper: "We view the RRJ as the most promising project. This short-haul aircraft seats 95 passengers and has a range of 2,500km. From the start it was intended for both the Russian and international markets. Besides, we can expect to order a large batch, thus getting a better initial unit price."

In the meantime, it transpired shortly before the MAKS show that SCAC had rescheduled the maiden flight from November 2006 to spring of 2007. Now the RRJ prototype will most likely fly not earlier than in April 2007. Whatever the exact date, Sukhoi is certain that the RRJ will take part in the flying demonstration of MAKS 2007.

At an October meeting with Khabarovsk Governor Viktor Ishayev and KnAAPO Director General Viktor Merkulov Mikhail Pogosyan said: "The first 12 KnAAPO-built RRJ aircraft will be built and delivered to their customers in 2008, and by 2010 we intend to reach a production rate of 60 aircraft a year."

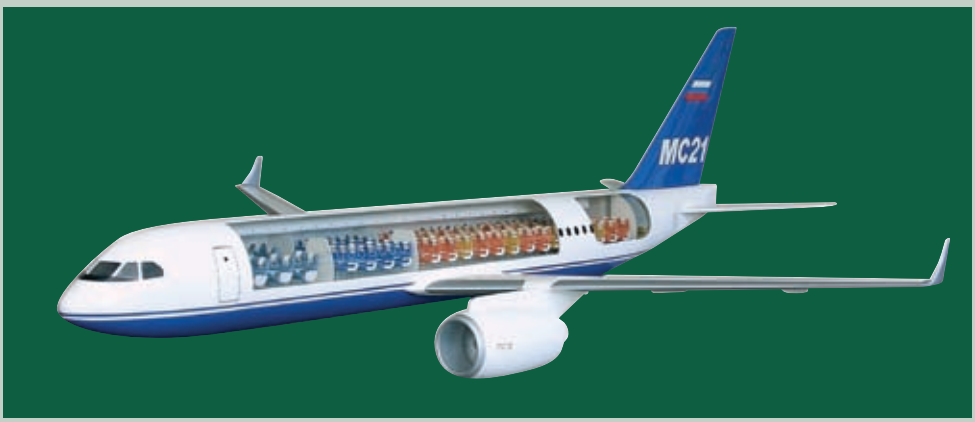
Andrrey Fomin

Tupolev joins MS-21 team

Tupolev announced at MAKS 2005 that it will join the Ilyushin/Yakovlev programme to develop the twin-engined MS-21 prospective medium-haul passenger jet. The aircraft is aimed to replace the Tupolev Tu-154 widely operated by Russian airlines. Also at the MAKS exhibition, Yakovlev contracted Russia's KVAND interior specialist to outfit the MS-21 cabin. Apart from designing the interior, KVAND will supply lighting, in-flight entertainment and other cabin equipment.

The MS-21 team might further expand: during the Aviation Expo China 2005 show this September China Aviation Industries II corporation (AVIC II) was invited to take part in the development and production of the new aircraft. Yakovlev chief designer Andrey Matveyev says the preliminary design is to be completed by mid-2006. The MS-21 could be certified in 2011 and enter service in 2012.

The MS-21 family will consist of three members. The MS-21-100 will carry 132 passengers to 4,600km; the MS-21-200 will have a seating capacity of 150 seats and a range of 5,150km. The MS-21-300, the largest member planned, will seat 168 passengers and fly to 3,800km. The first version will have a take-off weight of 65.6t, and the other two members 70.5t. One of the engines proposed for the MS-21 is the 12,000kgf-thrust AI-436T12 under joint development by Ivchenko Progress and Motor Sich of Ukraine as well as MMPP Salut and UMPO of Russia.



Yakovlev

An-148 gets 39 orders

Sergey Sergeyev

Antonov's new An-148 passenger jet was presented to the general public at the MAKS 2005 air show in Zhukovsky for the first time. Antonov availed of the exhibition to land the first major contracts via its partner, Russian leasing company Ilyushin-Finance (IFC). Of the 56 commitments collected by IFC during the MAKS 2005 show, 39 were for the An-148.

On 16 August the St. Petersburg-based Pulkovo Airlines agreed to take 18 An-148-100Vs on 15-year financial lease from IFC. Deliveries of eight firmly ordered aircraft will commence in 2006. On receiving the third machine Pulkovo might exercise its option on another ten An-148s. Antonov reportedly sells the An-148-100V in the baseline configuration for about $20mln.

On 17 August KrasAir signed an agreement on purchasing the An-148-100 in the VIP configuration that was demonstrated at MAKS 2005 (see picture). The aircraft will be delivered in the second half of 2006, after the completion of the testing programme. Earlier this year KrasAir placed a firm order for 15 An-148-100V passenger airplanes with IFC.

Also on 17 August IFC signed a lease agreement for 20 An-148s (15 An-148-100V passenger airplanes and five An-148T transports) with the Voronezh-based carrier Polyot. The final contract is to be signed until year-end. Polyot will take its first An-148-100V in 2007; the first two transports will be delivered in 2008. The deliveries will run until 2010.

Outsize freight carrier Volga-Dnepr of Ulyanovsk might purchase at least ten An-148T transports in the ramp configuration. President Aleksey Isaykin says the company is awaiting Antonov's conclusion on the possibility of developing a ramp version.

Antonov, IFC and the Voronezh-based VASO production plant signed an agreement at MAKS defining the main terms of An-148 licence production in Voronezh. The lease agreements will be signed by the end of 2005.

The An-148 programme reached another milestone on 18 August, when IFC, Antonov and Rolls-Royce signed an agreement on fitting R-R BR710 engines on the aircraft. A joint workgroup has been set up to carry out a corresponding feasibility study.

Antonov acting Designer General Dmitry Kiva told at MAKS 2005 news conference about the current status of the An-148 certification programme. By the time of the show the two flying prototypes involved in the certification tests had together performed over 200 flights, clocking more than 400 flying hours. About 30 per cent of the flight testing programme had been successfully completed, including high AoA, icing and hot and high trials. The cold soak tests will be held in Yakutia. Antonov expects the certificate to be awarded in the first quarter of 2006.

Six An-148s are to be built in 2006: one by Ukraine's Aviant plant and five by VASO.

Andrey Bystrov

Yakutia to take first Russian-built An-140s

Yevgeny Yerokhin

The Samara-based Aviacor plant flew its first production Antonov An-140 passenger aircraft on 2 August 2005. The 25-minute flight was performed by a mixed Ukraino-Russian crew.

The An-140 production launch in Russia would have been impossible without assistance from Ukrainian and Russian specialists. Several more aircraft of this type are currently under construction at Aviacor.

The Samara plant became the third enterprise to launch An-140 production. The other two are KSAMC in Kharkov, Ukraine, and the Isfahan Iran-based HESA company. The three enterprises have to date built the total of 14 aircraft, which operate passenger services (including international routes) in Azerbaijan, Iran and Ukraine.

The first Russian-built An-140 debuted at this year's MAKS 2005 air show in Zhukovsky (see picture). The aircraft wore the livery of Yakutia Airlines, the launch customer for Aviacor's An-140s. Under a contract signed on 16 August between Yakutia, Aviacor and Finance-Leasing Company, the carrier will take three such airplanes. Aviacor chairman Sergey Likharev says the plant is building five aircraft of the An-140-100 version. He adds that the Khabarovsk-based Dalavia carrier is expected to order An-140-100s. An order for 13 missionised aircraft might also come from Russia's Federal Security Service.

Andrey Fomin

CLIPPER:

Early in the XXI century both Russian and American space exploration programmes keep on exploiting manned spacecraft, designed over a quarter of a century ago, namely the Russian Soyuz expendable spacecraft, which has lived up to its reputation during the 38 years of its operation, and the US Space Shuttle, fielded in 1981. It is worth mentioning that neither of them meets tougher contemporary requirements, facing manned spacecraft, any longer. The Space Shuttle has proved to be too expensive, and has displayed a number of drawbacks, affecting the flight safety. The Soyuz spacecraft no longer meets contemporary requirements either, despite the relative simplicity and high reliability of its design. Contemporary requirements include the necessity to increase the cargo traffic to the International Space Station (ISS), provide for returning results of space exploration back to the Earth, step up the frequency of launches, etc. In addition to that, limited dimensions of the spacecraft cabin complicate long autonomous flights, including space tourism ones. Based on that, the RKK Energia Corporation has been developing a partially reusable new-generation manned spacecraft for several years, taking advantage of its long-term experience in designing manned spacecraft. First information on the Clipper, the name of the new spacecraft (a clipper was a fast seagoing sail boat, featuring a pointed hull configuration, which was used for transporting valuable cargo and passengers at great ranges in the XIX century) was published in February 2004. RKK Energia has designed several versions of the spacecraft and built several models and mock-ups, demonstrating various design solutions, which may be capitalised on in the course of the development of the future reusable spaceship. The first demonstration of the Clipper full-scale mock-up took place at the RKK Energia premises a year ago, last November. The mock-up of the winged version was for the first time demonstrated in public at the MAKS 2005 air show in August 2005.

Layouts and versions

The main objective of the Clipper consists in delivering crews and cargo to the ISS and taking them back to the Earth, and being employed as the Assured Crew Rescue Vehicle (ACRV) for urgent evacuation of astronauts from the orbit in case of emergencies at the ISS or other spacecraft, etc. Unlike the existing expandable Soyuz, designed to accommodate three astronauts, the Clipper will be able to carry six crewmembers and remain in orbit as part of the ISS twice as long for up to a year. Thus, the Clipper is twice as heavy as the Soyuz: it has a launch weight of 13 tons, as compared to about seven tons of the Soyuz. The design of the new spacecraft will enable it to carry out up to 25 flights to the orbit and back. Its service live will amount to a decade.

Various layouts were considered during the design stage. At first, designers worked on the so-called wingless layout of the all-body spacecraft type, designed for a vertical parachute landing. The all-body mock-up was demonstrated to reporters in November 2004. Slightly later designers focused their efforts on developing the winged version, expected to glide in the atmosphere and land at an airfield similar to a fixed-wing aircraft (just like the Buran and the Space Shuttle). The Sukhoi Design Bureau joined the development of the winged Clipper and was tasked with calculating aerodynamic and strength characteristics of an aircraft-type return vehicle, as well as developing its design. Both versions are standardised to the maximum extent possible, and, in fact, differ only in the lack or

the presence of the wing, and corresponding modifications of the return vehicle fuselage.

The spacecraft comprises two main compartments: the return vehicle, weighing 8.8 tons, the large 20 m^3 pressurised cabin of which hosts the crew and cargo, and the assembly compartment, quartering sustainers, the fuel load, food, water, and gas bottles for fuel-tank pressurisation. The payload may amount up to 500kg. It has an endurance of five days with six astronauts onboard, and up to 15 days with two astronauts. The length of the spacecraft with the docking unit is about 10.4m (the return vehicle has a length of 6.4m, and the length with the assembly compartment is about 8.6m), diameter of the assembly compartment is about 3.5m, and the maximum fuselage width is about 3.6m.

The Clipper is expected to be launched into orbit by either the Zenit-2SLB launch vehicle (a modified version of the Zenit-3SL employed in Sea Launch), or a deep-modernisation version of the existing Soyuz, also known as the Soyuz-3, or the Angara-3A new-generation LV. The launch vehicle will take the Clipper, manned by a crew (or in an automatic mode) to a near-earth orbit at an altitude of up to 500km. After that the spacecraft can either dock with the ISS and stay in space for up to 360 days, or carry out an autonomous flight for up to 15 days and return back to the Earth. When deorbited, the return vehicle will disengage from the assembly compartment at retroburn and enter the Earth's atmosphere along a flat trajectory.

In the all-body version the drogue chute ejects at an altitude specified, it is then followed by a decelerating parachute, and three canopies of the primary parachute system. When the surface is only several hundred metres away, the return vehicle turns its aft downwind. Just before the touchdown, when the surface is a metre and a half away, a special altimeter starts solid-state fuel engines, which slow down the vertical and the horizontal speed, and the vehicle touches down. The winged version lands with the help of the extending wheeled landing gear on special airfields, after carrying out an aircraft-type glide and a possible side-step manoeuvre at range of up to 1,500km. Either version of the spacecraft will be ready to be launched back into orbit in half a year, after all necessary checks and preventive maintenance have been completed.

REUSABLE SUCCESSOR TO SOYUZ?

Mikhail ZHERDEV

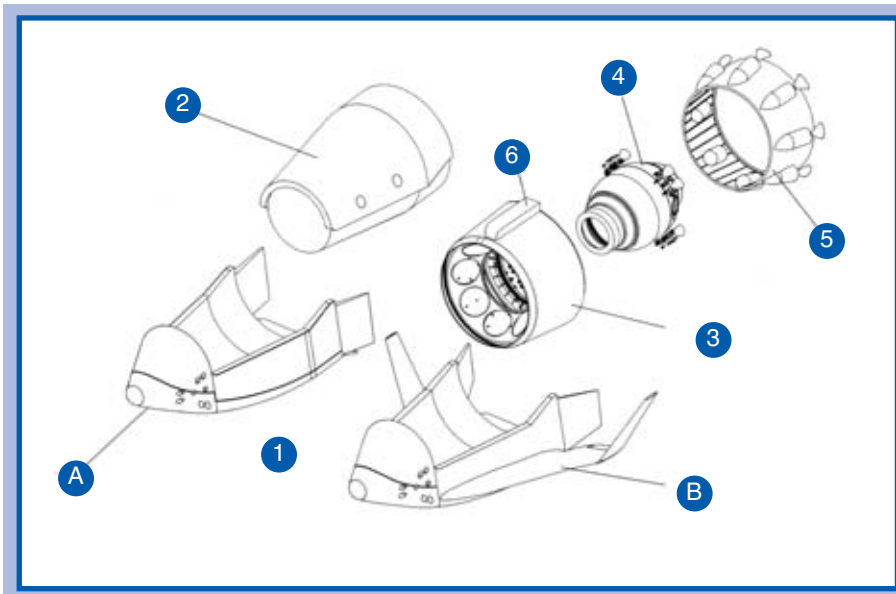
Andrey Fomin

Finance

The Clipper project has until recently been financed by RKK Energia only. According to Vladimir Khodakov, head of the research and development centre of the Central Engineering Research Institute of Machine-building (TsNIIMash), the flagship space exploration institute, overall expenditures on the Clipper development may amount to about US $360mln. Thus, it will be next to impossible to develop a new-generation reusable spacecraft without state funding. It has recently become common knowledge that Clipper has been included in the Russian Federal Space Program for 2006–2015, adopted by the Russian government in late October 2005 (see article in News). Thus, the project may soon be funded by the federal space budget, which will allow the full-scale development of the spaceship to be embarked on.

In addition to that Clipper designers investigate a feasibility of involving foreign partners in the project. With this end in view the results of the Clipper development have already been demonstrated at the following two large international shows this year: the Le Bourget air show, held in France this June, which was the first to see the mock-up of the Clipper winged version, and the EXPO 2005 show, held in Japan from March until September. "I believe that it should be a joint project, involving several countries, since a joint project is easier to fulfil, as far as the timeframe and finances are concerned," Anatoly Perminov, Director of the Russian Federal Space Agency, said. The Federal Space Agency pays special attention to cooperating with Europe, since the European Space Agency (ESA) has remained Russia's major partner in a number of space programs for the past few years. In particular, the ESA's possible participation in the Clipper project was announced at the Le Bourget air show. Russia and Europe, represented by France, are long-term partners working jointly on manned reusable spacecraft. In the late 1980s – the early 1990s the USSR provided technical assistance to France in fulfilling the Hermes project, which was terminated in 1993. "For Europe this project means that it will be able to launch its astronauts into space aboard its own spacecraft," an ESA official said at the French air show, commenting on the feasibility of the ESA's participation in the Clipper programme. The issue will be discussed at the meeting of the ESA Ministerial Council in December 2005.

Japan may become another potential participant in the programme. Russia does not rule out cooperation with NASA, though, the US is currently developing its own new-generation manned spacecraft, named the Crew Exploration Vehicle (CEV). Certain private American companies, planning to secure a niche in the so-called space tourism sector, may express their interest in the Clipper project as well. By the way, NASA plans to spend US $15bln on developing



Mikhail Zherdev

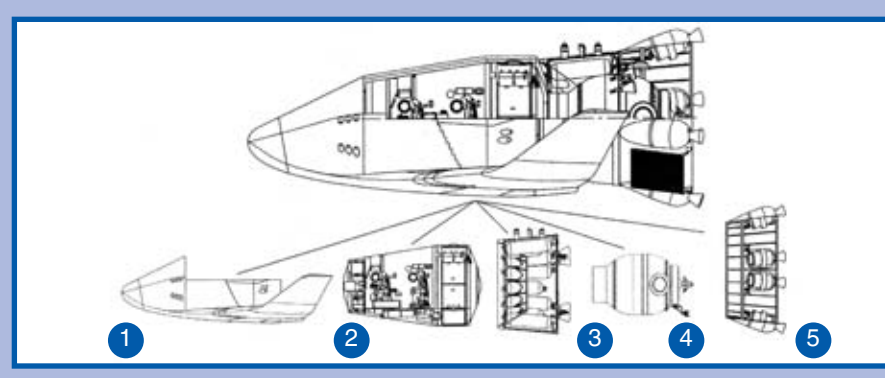
Interior of the Clipper full-scale mock-up demonstrated at MAKS 2005

Mikhail Zherdev

Clipper layout diagram

1. *Fuselage*
2. *Cabin module*
3. *Assembly compartment hull*
4. *Orbital module*
5. *Adapter module with ERS engines*
6. *Jettisonable cover*

A *– All-body version airframe*
B *– Winged version airframe*



CEV, which is 40-fold (!) as much as needed for developing, testing, manufacturing, and launching into space the first Clipper prototype.

According to experts, the Clipper will be able to make its maiden unmanned flight as early as 2011–2012, if sufficient funds are earmarked on time.

Design features

What are the design features of the Clipper spacecraft at the ongoing development stage? The layout of the winged version comprises the following two parts: the reusable return vehicle (a reusability of about 95 per cent) and the expendable assembly compartment.

The return vehicle quarters the crew and crew life support systems for all stages of the flight. The return vehicle includes the pressurised cabin module and the non-pressurised main body. The nose part of the main body quarters reaction control system jets of the nose integrated propulsion unit. The inside of the main body also accommodates fuel tanks, aerodynamic control drives, and the landing gear. The main body is fitted with a nose cone. The wingtips of the slightly extended swept wing are bent upwards. The outside of the main body is covered with heat-resistant panels.

The cabin module is a 20 sq.m pressurised body, made of an aluminium alloy and longitudinal and transverse frames. The cabin module hosts a crew of two to six astronauts. The crew is seated in two rows of coaches, with the spacecraft piloted by the mission commander and the flight engineer. The crew wear pressurised spacesuits during launches, orbital manoeuvres, and landings. The coaches can be reclined at an optimal angle for the comfort of the crew and the best g-tolerance. The cabin module is fitted with an access hatch and four side windows, however, there is no transparent canopy, providing a forward field of view during landing, as it is to be substituted for a TV system. The cabin module also accommodates the onboard control system, life support and temperature control systems, the electric power supply system, and the chute boot. The upper part of the cabin module is covered by heat-resistance panels, while the lower one is inside the main body.

The assembly compartment is designed to accommodate the power plant, the fuel load, food, and gases, used in life support systems. The assembly compartment is made of a hull and an orbital module. The hull is made of an aluminium alloy as a cone shell with a framework. The inside of the hull accommodates fuel tanks, and the stern integrated propulsion unit with four engine packs. The outside of the hull is fitted with antenna feeder systems and the temperature control system heat-exchange assembly.

The orbital module is an 8 sq.m pressurised body, accommodated inside the assembly compartment. One side of the orbital module is docked with the return vehicle with the help of a special docking unit. The other side is equipped with a standard active docking assembly for docking with a space station. The orbital module carries the rendezvous system equipment, and docking antennas and TV camera. The inside of the orbital module quarters crew sleep stations, life support system supplies, and sanitary systems. The life support system provides the spaceship with an endurance of up to 15 days. The orbital module undocks from the return vehicle, when the latter is deorbited, after retroburn. The hull of the orbital module is covered by a blanket on the outside.

The integrated propulsion unit, comprising 32 liquid-propellant rocket engines of two types, is designed to facilitate the spacecraft's rendezvous with the space station, docking, manoeuvres, retroburn signal for deorbiting. The liquid-propellant rocket engines, designed by RKK Energia, use pollution-free fuel, made of ethanol and gas oxygen. The return vehicle is equipped with 16 reaction control system jets, with 12 of them accommodated in the nose – six on each side, and four in the stern – two on each side. The assembly compartment is fitted with 16 engines, integrated into four engine blocks, with each block comprising two sustainers and two reaction control system jets. Each sustainer features a thrust of 50kgf, and each reaction control system jets has a thrust of 24kgf. The return vehicle and the assembly compartment carry a total fuel load of about 2,000kg.

The Clipper is expected to be provided with electric power by electrochemical generators, mounted in the nose part of the return vehicle. An electrochemical generator, weighing 200kg, boasts three independent batteries and tanks for reaction components, hydrogen and oxygen. Each battery has a power of 2.5kW.

The onboard control system comprises onboard computers, the guidance, navigation, and control system, the flight measurement system, the onboard equipment control system, and displays for the crew. The guidance, navigation, and control system controls the Clipper at all stages of the flight from the moment it disengages from the carrier rocket, and facilitates various manoeuvres, such as: rendezvous, docking, undocking, retroburn, descent, and landing. The spacecraft is equipped with the upgraded Kurs-N radio radar for docking with the space station.

The Emergency Recovery System (ERS) is one of the systems to receive special attention during the Clipper development. Uncustomary for Russian spacecraft, it is quartered in the rear on a cone-shaped transfer compartment. The ERS consists of eight solid-fuel rocket engines and discharges two tasks. During the launch abort all eight engines are started simultaneously in order to take the spacecraft to a safe rage from the carrier rocket in distress. Folding ladder-type wings may be used for control at this stage. In the normal mode ERS engines are employed for additional orbiting, with several groups of solid-fuel rocket engines started up repeatedly after the second stage off the carrier rocket separates.

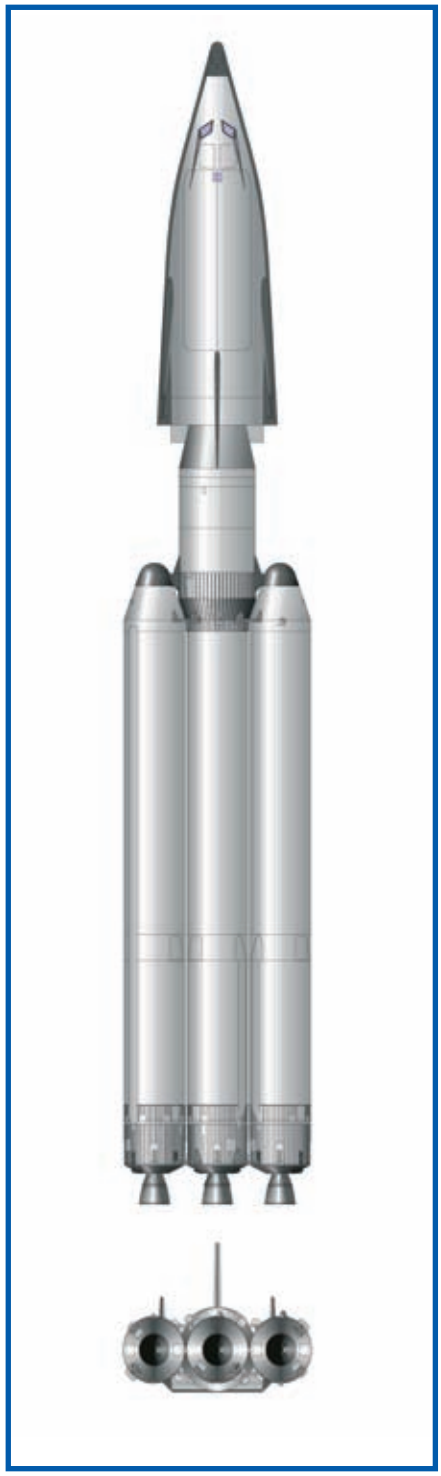
The most crucial problem to be solved in the course of the Clipper development consists in providing the Clipper with thermal protection at the re-entry stage. During the re-entry the nose part of the spacecraft heats up to about 2,000° Centigrade. Existing Soyuz descent vehicles sustain the same temperatures when returning to the Earth, thus, the thermal shield of the Clipper's nose part is made of the same material as that of the Soyuz's front thermal screen. The thermal effect on the rest of the Clipper is considerably lower and amounts to about 1,200° Centigrade. Thus, it may be fitted with the plated thermal protection cover, tested on the Buran shuttle, which is made of 60x60cm reusable plates.

LV for the Clipper

The Zenit-2SLB launch vehicle is a version of the Zenit-2 LV, featuring a number of improvement, copied from the Zenit-3SL LV, employed in the Sea Launch system. The Zenit-2SLB launch vehicle, being developed by the Ukrainian Yuzhnoe Design Bureau for the Land Launch system, will allow payloads weighing up to 13 tons to be launched into low circular orbits from Baikonur. However, manned spacecraft launches may require changing the orbiting programme in order to reduce the maximum g-load.

The Soyuz-3 launch vehicle, being developed by RKK Energia, is the follow-on of the Soyuz LV, succeeding the Yamal (Avrora) and the Onega projects. It features a considerably greater launch weight of 390 tons, as compared with that of existing Soyuz-family carrier rockets, a 600mm greater central block diameter, and new power plants. The central unit (the second stage) is expected to be fitted with a version of the well-known NK-33 liquid-propellant rocket engine. The side units (the first stage) will be equipped with modified RD-120 liquid-propellant rocket engines, currently mounted on the second stage of the Zenit LV. The third stage mounts four RD-0146 engines, designed by the KBKhA Chemical Automatics Design Bureau. The LV will be capable of orbiting up to 15.3t of payload into low circular orbits, and up to 2.6t into the geostationary orbits. The Soyuz-3 launcher system is an improved launch pad of the Soyuz LV. If it is decided to launch the Clipper into space with the help of a Soyuz-family LV, it will enable the new spacecraft to be launched from the Kourou Space Centre in French Guiana, being constructed.

The Khrunichev State Space Scientific Industrial Centre, pursuing the Angara programme, has also proposed a LV for launching manned spacecraft, including the Clipper, into space. The LV modification being developed is known as the Angara-3A.



Khrunichev

Angara-3A prospective LV with a hypothetic reusable spacecraft as a payload

Given a launch weight of 480t, the Angara-3A will be able to orbit a payload of up to 14.6t into low orbits. A launcher system for Angara-family launch vehicles is currently under construction at the Plesetsk Space Centre, but the issue of its funding is yet to be settled. A launch pad for the Angara LV may be constructed at the Baikonur Space Centre in the future under the joint Russian-Kazakh Baiterek project.

Federal Space Programme 2015 adopted

The Russian government has adopted the Federal Space Programme for 2006–2015. Russian Prime Minister Mikhail Fradkov signed a corresponding decree on 22 October. The Russian Federal Space Agency plans to publish part of the programme in the near future, while for the moment only its main provisions have been aired.

First and foremost, the Federal Space Agency plans to replenish its satellite force with another 17 spacecraft by 2008, including seven communications satellites, three meteorological satellites (the Meteor-3M polar orbiting satellite and two Elektro-2 geostationary satellites), two remote probing satellites, three spacecraft for basic space research, and two search-and-rescue ones.

The programme will allow the development of the Soyuz-2 medium-class launch vehicle and the Angara heavy launch vehicle to be completed. In addition to that, it envisions further work on boosters and reusable space systems (the Clipper project), as well as covers funding major international projects, in particular, completing construction of the ISS (Russia will complete a multi-role laboratory module for the space station and launch it into orbit).

Although, the Federal Space Agency has succeeded in persuading the government to increase the funds earmarked to this end (the state is to allocate over $10bln, for fulfilling space programmes over the next decade), given the rate of inflation, the money will be just enough to accomplish the minimum of what is necessary. The Agency will have to attract investments from sources other than budget in order to find the rest of the money for developing Russian cosmonautics.

Next year the Federal Space Agency's budget will amount about $800mln. It is less than what the Agency expected, but more than its 2005 budget (this year the state earmarked less than $650mln, for space exploration). The Federal Space Agency will be able to get additional $50mln for building Soyuz and Progress backup launch vehicles to conduct launches to the ISS, with the exact sum to be defined when the Russian Federal Assembly adopts the 2006 budget.

New expedition at ISS

The Russian Soyuz TMA-7 manned transportation spacecraft, designed and manufactured by the Korolev Energia Rocket and Space Corporation, was launched to the International Space Station (ISS) with the help of the Soyuz-FG launch vehicle from the Baikonur Space Centre at 07.54 Moscow time (03.54 GMT) on 1 October. The objective of the launch consisted in delivering Expedition 12 (ISS-12) to the ISS, replacing Expedition 11 (ISS-11) as planned, and relieving the Soyuz TMA-6 spacecraft, which had been employed as an assured crew rescue vehicle (ACRV) at the ISS since 17 April 2005. The Soyuz TMA-7 spacecraft carried Russian cosmonaut Colonel Valery Tokarev (spaceship commander; ISS-12 flight engineer), NASA astronaut William McArthur, an expert from the Johnson Space Centre (spaceship flight engineer, ISS-12 commander), and US citizen Gregory Olsen, a space tourist.

Expedition ISS-12 is tasked with controlling operation of the ISS for 182 days, carrying out applied-science researches in compliance with the Expedition programme, the Visiting Crew Expedition 9 (VCE-9) programme, and commercial contracts, as well as conducting spacewalks.

The Soyuz TMA-7 docked with the ISS at 05.27 GMT on 3 October. The low earth orbit of the ISS features the following characteristics: a maximum altitude of 367km, a minimal altitude of 347.8km, an orbit time of 91.4 minutes. The ISS hosted a total of five Russian and American astronauts for nine days.

After completing the joint flight programme, Expedition ISS-11, comprising Russian cosmonaut Sergey Krikalev (mission and spaceship commander, Energia's test cosmonaut, who has carried out six space flights) and NASA astronaut John Phillips (flight engineer, two space flights) returned to the Earth aboard the descent vehicle of the Soyuz TMA-6 spaceship on 11 October. Gregory Olsen, a space tourist, who worked onboard the ISS under the VCE-9 programme on 3–10 October, returned to the Earth along with them. It was his first space flight.

The spaceship undocked from the Zarya module of the Russian section of the ISS at 21.49 GMT on 10 October on orders from the Mission Control Centre, based outside Moscow. The descent from the orbit was conducted in an automatically controlled mode as scheduled. The descent vehicle touched down 57km north-east of

RKK Energia

a Kazakh town of Arkalyk at 01.10 GMT. Despite the lack of light in the small hours of the morning, search-and-rescue services quickly detected the descent vehicle, tracked it during the parachute descent and touchdown, and evacuated the crew from the landing area.

The Soyuz TMA-6 spacecraft had operated in space for 179 days, including 177 days as the ISS assured crew rescue vehicle. Mission objectives of Expedition 11 and Visiting Crew Expedition 9 are considered to have been fulfilled. Expedition 11 ensured operation capabilities of the ISS and its systems. It also received the Progress M-53 and the Progress M-54 cargo spacecraft, the US Discovery space shuttle, (STS-114) and the Soyuz TMA-7 spaceship. Expedition 11 carried out a spacewalk from the Pirs module. The Soyuz TMA-6 spacecraft was redocked from the docking unit of the Russian Pirs module to that of the Zarya functional cargo block. The applied-science research and experiments programme was fulfilled. The Russian section of the ISS was fitted with equipment delivered under the mission plan.

Expedition 12, incorporating V. Tokarev and W. McArthur, continues its work at the ISS. At the present time the weight of the ISS amounts to about 186.4 tons.