FAMOUS RUSSIAN AIRCRAFT

MIKOYAN MiG-29

YEFIM GORDON

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Introduction

By the end of the 1960s the air forces of most countries of the world that possessed a well-developed aircraft industry were equipped with second-generation jet fighters – the Mikoyan MiG-21 (NATO reporting name *Fishbed*), the McDonnell (later McDonnell Douglas) F-4 Phantom II, the Northrop F-5 Tiger/Freedom Fighter and the Dassault Mirage III. The principal requirements which these fighters were designed to meet were high performance (a top speed of Mach 2.0 or better and a service ceiling of 19,000-20,000 m [62,335-65,620 ft]), guided air-to-air missile (AAM) armament and the provision of a fire control radar enabling the aircraft to operate day and night in all weather conditions.

At the same time third-generation fighters were about to emerge, such as the MiG-23 (NATO codename *Flogger*) in the Soviet Union, the Dassault Mirage F.1 in France and the SAAB JA/AJ 37 Viggen in Sweden. No quantum leap in speed and altitude performance was needed at this stage. The main requirements were longer range, better manoeuvrability, the ability to operate from semi-prepared tactical airstrips and versatility.

Third-generation fighters were to enter service in the early 1970s, along with upgraded versions of the MiG-21 and the F-4. However, by then the fighter makers on both sides of the Iron Curtain had started working on fourth-generation aircraft which would form the backbone of NATO and Warsaw Pact air forces in the next decade. The USA made the first move by announcing the FX (Fighter Experimental) programme in March 1966. Boeing, Lockheed and North American entered the competition, to be followed by Republic (a division of Fairchild-Hiller Corporation) later on.

Originally the single-seat twin-engined FX was to have a 27-ton (59,520-lb) gross weight and a top speed of Mach 3. However, operational experience gained in Vietnam forced the US Air Force to totally redefine the advanced fighter concept. The powerful radar and heavy missile armament of the F-4 gave it an advantage over the MiG-21 only at long and medium range; in a dogfight the lighter and nimbler MiGs came out on top. Hence the new general operational requirement (GOR) for the FX called for a lightweight fighter armed with only an internal gun and short-range AAMs. Later, however, the USAF thought better of it and revised the GOR to include a fire control radar and medium-range AAMs. The gross weight was set in the 20-ton (44,090-lb) class and top speed at Mach 2.5.

US aircraft manufacturers began designing fighters to meet the new requirements in 1969; McDonnell Douglas won the FX contest with the F-15 Eagle, securing a contract by the end of the year. The prototype YF-15A took off on 27th July 1972 and deliveries of production F-15As commenced in November 1974.

Still, the lightweight tactical fighter idea was not dead and buried. In the early 1970s the USAF General Staff decided it was advisable to complement the costly heavy fighters with much lighter and cheaper aircraft grossing at 9-10 tons (19,840-22,045 lb). Such a fighter would have simpler avionics and a limited weapons range (internal cannon and short-range AAMs only) but high manoeuvrability. The LWF (LightWeight Fighter) programme was announced in January 1972, with the MiG-21 as a reference point for the designers. The USAF was well aware that in a dogfight the *Fishbed* was more than a match for the more sophisticated and better armed but less agile Phantom – and that often the Phantom pulled the short straw.

In February 1972 General Dynamics (ex-Convair), Northrop, Boeing, LTV-Aerospace

Lockheed Martin

The first prototype YF-16A light fighter (serial 72-1567, c/n 60-1) in General Dynamics demonstrator colours. The unusual chin air intake, the blended wings with leading-edge root extensions, the all-round vision canopy and the wingtip missile rails are clearly visible.

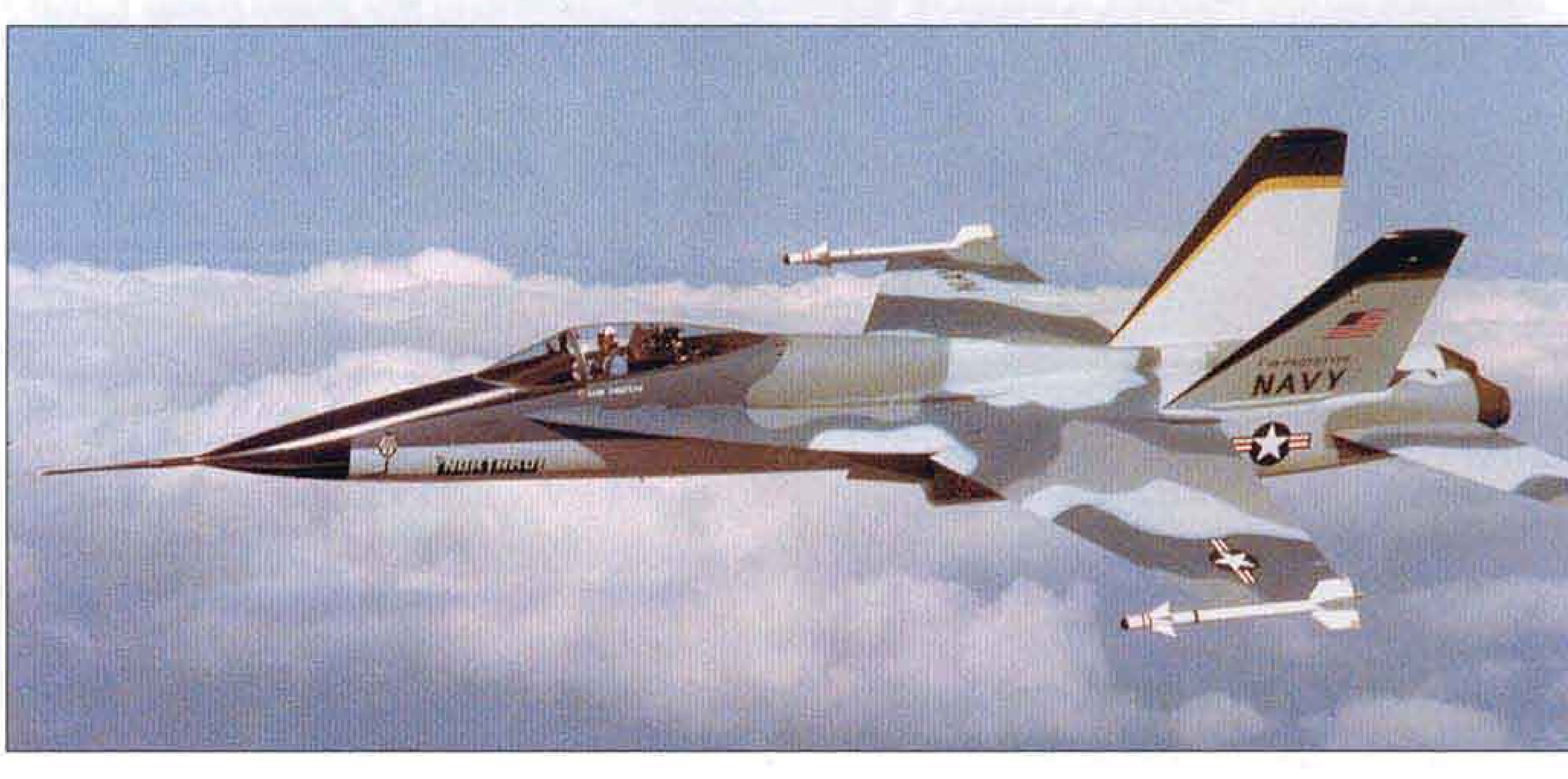
and Lockheed submitted their proposals for the LWF contest. GD's Model 401 and Northrop's P.600 were selected for full-scale development. The former project was based on studies made by Convair for the FX programme, while the latter was an evolution of the P.530 project developed in 1966 as an F-5 replacement. In April GD and Northrop were awarded contracts for the completion and testing of prototypes of the two fighters as the YF-16 and YF-17 respectively.

Both aircraft entered flight test in 1974; the YF-16 won the flyoff in January 1975. The USAF requested that the aircraft be given strike capability under the ACF (Air Combat Fighter) programme. The definitive F-16A Fighting Falcon made its first flight on 8th December 1976 and entered production in August 1978.

However, Northrop's efforts were not lost. McDonnell Douglas decided that the YF-17 could be modified at minimum cost to fit the US Navy's NACF (Naval Air Combat Fighter) requirement. The aircraft then entered full-scale development in January 1976 as the McDD F/A-18 Hornet shipboard air superiority fighter/attack aircraft. The prototype made its first flight on 18th November 1978 and production commenced in 1979.

McDonnell Douglas

The McDonnell Douglas F-15A (exemplified by F-15A-4-MC 71-0287, c/n 10 in high-viz test colours) was the USAF's heavy advanced fighter of the 1970s.



Northrop

The Northrop YF-17A lost out to the YF-16A but became the basis for the naval F/A-18. It resembled a cross between the F-15 and the F-16, having both twin tails and LERXes.

PART ONE

TAKING SHAPE

Early Studies and the PFI/PLMI Programmes

In the late 1960s the Soviet Union was also working on the fourth-generation fighter concept. Analysing operational experience with fighters in regional conflicts, Soviet engineers began considering ways and means of enhancing combat capabilities. The latest know-how and technologies and the entire potential of the Soviet aerospace industry were brought into play. Fourth-generation fighters were to be armed with new air-to-air missiles and feature a sophisticated weapons control system (WCS).

All three of the Soviet Union's leading fighter makers joined the research and development effort. These were the design bureau led by Artyom Ivanovich Mikoyan – aka OKB-155 or MMZ *Ze**nit*** (Zenith), OKB-51 led by Pavel Osipovich Sukhoi, aka MZ *Koo**lon*** (Coulomb, a physical unit), and the bureau led by Aleksandr Sergeyevich Yakovlev, aka OKB-115 or MMZ ***Sko**rost'* (Speed). (Note: OKB = ***op**ytno-kon**strook**torskoye byu**ro*** – experimental design bureau; the numbers are codes allocated for security reasons. MMZ = *Mos**kov**skiy ma**shi**no-stro**i**tel'nyy za**vod*** – Moscow Machinery Plant; MMZ 'Zenit' or MMZ No.155 was the name of Mikoyan's experimental shop, while the Sukhoi OKB's experimental shop was prefixed MZ, not MMZ.)

In 1971 TsNII-30 (*Tsen**trahl'**nyy na**ooch**no-is**sled**ovatel'skiy insti**toot*** – Central Research Institute No.30), a division of the Soviet Ministry of Defence, issued the GOR for a fourth-generation fighter tentatively designated PFI (*perspek**tiv**nyy fronto**voy** istre**bi**tel'* – advanced tactical fighter). The primary roles of the PFI comprised destroying enemy fighters in close-in combat with short-range AAMs and an internal cannon, intercepting aerial targets at long range – either by means of its own radar or with guidance from ground controlled intercept (GCI) centres – and destroying them with medium-range AAMs, providing top cover for friendly troops and point defence of important targets, destroying enemy reconnaissance vehicles, escorting heavy aircraft, performing tactical reconnaissance and destroying small ground targets in daylight conditions with bombs, unguided rockets and gunfire.

The aircraft had to possess 'look-down/shoot-down' capability (that is, the ability to destroy aerial targets flying below its own flight level) and operate in any weather conditions, day and night, in an active and passive electronic countermeasures (ECM) environment. The F-15 and the Northrop P.530 and YF-17 were regarded as the PFI's principal adversaries in air-to-air combat, though the Northrop fighters were replaced by the General Dynamics (now Lockheed Martin) F-16 when the results of the LWF contest became known. Typical aerial targets in the interceptor or 'hunter-killer' role included the F-4E, GD F-111A Aardvark, Panavia MRCA (Tornado) and SEPECAT Jaguar fighter-bombers.

The PFI differed from third-generation fighters mainly in having higher manoeuvrability, a completely new avionics suite and highly effective new weapons. High agility would be attained by utilising new aerodynamic layouts improving the lift/drag ratio and installing lightweight, powerful and fuel-efficient engines to achieve a thrust-to-weight ratio in excess of 1. The integrated weapons control system would feature digital computers, an infrared search and track (IRST) unit complementing the customary radar and be based on semi-conductors rather than vacuum tubes for greater reliability. The armament would comprise a fast-firing gun and new short- and medium-range AAMs.

The Mikoyan OKB started work on a fourth-generation fighter in 1970; at a very early stage the aircraft was designated MiG-29. Initially the MiG-29 programme as a whole was the responsibility of Gleb Ye. Lozino-Lozinskiy who was also the project chief of the MiG-25MP heavy interceptor (the future MiG-31 *Foxhound*). The actual work on the fighter's general arrangement, however, was directed by the preliminary design (PD) section. The chief of this section was Aleksandr A. Choomachenko, a Doctor of Technical Sciences and a prominent aerodynamicist.

Two major research bodies were actively involved in the MiG-29 programme. The Central Aerodynamics & Hydrodynamics Institute named after Nikolay Ye. Zhukovskiy (TsAGI – *Tsen**trahl'**nyy **a**ero- i **ghid**rodina**mich**eskiy insti**toot***) aided with the general arrangement while the State Research Institute of Aircraft Systems (GosNII AS – *Gosoo**dar**stvennyy na**ooch**no-is**sled**ovatel'skiy insti**toot** aviatsi**on**nykh sis**tem***; originally called NIIAS, without the 'state' prefix) worked on the fighter's advanced avionics. Both are located in the town of Zhukovskiy south of Moscow.

Selecting the proper general arrangement and aerodynamic layout was the key issue at the PD stage. The engineers considered both conventional arrangements and the so-called blended wing/body (BWB) layout, or 'integral'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◄◄
Soviet Air Force Commander-in-Chief, Air Marshal P. S. Kutakhov was one of the decision makers at the top level on whom the MiG-29's fate depended.

◄
Pyotr V. Dement'yev, the Soviet Minister of Aircraft Industry in the 1970s, is seen here in his Colonel General's uniform.

layout, when the wings and fuselage form a single lifting body.

Much thought was given to the powerplant. Placing the air intake in the nose *à la* MiG-21 was ruled out immediately because the inlet ducts would occupy a disproportionately large portion of the internal volume; it had to be two lateral intakes. Choosing the number of engines was easy. A version powered by a single large turbojet proposed at first was quickly rejected. Building on operational experience with the best single-engined third-generation fighters (the MiG-21, MiG-23, Mirage III and so on), Mikoyan opted for a twin-engined aircraft. This improved survivability in combat and reduced accident attrition risk in peacetime.

An early configuration of the MiG-29 had shoulder-mounted trapezoidal wings, a low-mounted horizontal tail and a single fin and rudder. The wings featured leading-edge root extensions (LERXes) and full-span leading-edge slats. The sharply raked two-dimensional air intakes with horizontal airflow control ramps were strongly reminiscent of the MiG-25 *Foxbat* interceptor or the F-15. There were six underwing hardpoints: four for medium-range AAMs and two for short-range 'dogfight missiles'.

Another early configuration was a sort of cross-breed between the MiG-29 and the MiG-31 (that is, the way each of them came to look eventually). Likewise it had boxy *Foxbat*-style air intakes; the nose gear unit had twin wheels while the main units featured twin-wheel bogies with the wheels located in tandem *à la* SAAB JA/AJ 37 Viggen, not in the MiG-31's staggered-tandem arrangement. The aircraft was to be armed with four K-25 medium-range AAMs based on the Raytheon AIM-7E Sparrow (a handful of these had been captured in Vietnam and shipped to the USSR for examination), but eventually the work on this missile was discontinued.

A third study utilised the BWB layout with the fuselage, wings and engine nacelles all blended together. Unlike the two previous projects, this was a light fighter with a normal gross weight of some 13.5 tons (29,760 lb). Thus it was not only lighter than other Mikoyan projects but also lighter than Sukhoi's entry for the PFI competition, the T-10 (the future Su-27 *Flanker*) with a normal TOW of 21 tons (46,300 lb) and the production single-engined MiG-23M *Flogger-B* which grossed at 15.7 tons (34,610 lb) fully armed. Another advantage of the BWB layout was that the prominent LERXes provided a convenient location for the internal cannon; finding a good place for it turned into a major problem in the 'conventional' projects. The aircraft was shorter than the actual MiG-29 and had a wing area of only 25 m² (268.8 sq ft).

The blended wing/body layout had its opponents. Some of the engineers claimed a conventional fighter was easier to build; moreover, they were armed with calculations showing that the conventional layout offered a smaller maximum cross-section area. PD section engineer Yakov I. Seletskiy had to reduce the height of the No.3 fuel tank by 50 mm (2 in) and came up with a cross-section area identical to that of the conventional version.

In 1971 several research institutes within the frameworks of the Ministry of Aircraft Industry (MAP – *Mini***ster***stvo aviatsi***on***noy pro***mysh***lennosti*) and the Soviet Air Force (VVS – *Vo***yen***no-voz***doosh***nyye* ***seely***) began developing fighter force re-equipment concepts for the 1980s. Analysis of trends in hardware and tactics development showed that fighters were facing a broader range of missions in contemporary warfare.

Ideally the Air Force should have several kinds of fighters with different weapons systems optimised for the various mission types. For instance, to intercept an enemy strike group over territory held by friendly troops a fighter would have to be 'tied' to GCI centres guiding it to the target. Conversely, maximum independence from ground control was required during 'free chase' missions over enemy-held territory. An interceptor needed good acceleration and rate of climb, heavy armament and capable avionics giving it 'look-down/shoot-down' capability. An escort fighter should have sufficient range to operate 250-300 km (155-186 miles) beyond the frontlines. High manoeuvrability, a high thrust-to-weight ratio, a wide speed range and special short-range air-to-air missiles were a must for close-in combat.

Designing a single aircraft capable of meeting all these contradictory requirements didn't seem possible. Yet the Soviet Union could not afford to have a multitude of specialised fighters in its inventory. A possible compromise solution was to build up the future fighter force with two basic types complementing each other: an advanced tactical fighter (PFI), that is, a 'heavy' fighter capable of operating singly or in groups 250-300 km beyond the frontlines, and an advanced mass-produced light fighter (PLMI – *perspek***tiv***nyy* ***lyoh****kiy* ***ma****ssovyy istre***bi***tel'*; later changed to Lightweight Tactical Fighter, LFI – ***lyoh****kiy fronto***voy** *istre***bi***tel'*) optimised for operations above friendly territory and the tactical battle area – that is, 100-150 km (62-93 miles) beyond the frontlines.

The PFI would be a sophisticated aircraft featuring a sizeable internal fuel load and ordnance load (at least four medium-range AAMs in addition to short-range or 'dogfight AAMs' and a built-in cannon); it would have a comprehensive navigation, communications and electronic support measures (ESM) suite. With a specially configured avionics and weapons fit it could be operated by the PVO (***pro****tivovoz***doosh***naya obo***ro***na* – Air Defence Force). Conversely, the PLMI was to be as easy to build and maintain as possible, use semi-prepared airstrips and be operated by average-skill pilots and ground personnel. Its armament would be limited to two medium-range AAMs and short-range weapons. The PFI and PLMI would account for 30-35% and 65-70% of the fighter force respectively, being the Soviet answer to the F-15 and the F-16 respectively.

This concept was developed jointly by the fighter design bureaux, the Air Force's research

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▶
Deputy General Designer of OKB-155 Gleb Ye. Lozino-Lozinskiy, the MiG-29 programme chief.

▶▶
Aleksandr A. Choomachenko, preliminary design section chief at the Mikoyan OKB. It was he who determined the fighter's general arrangement.

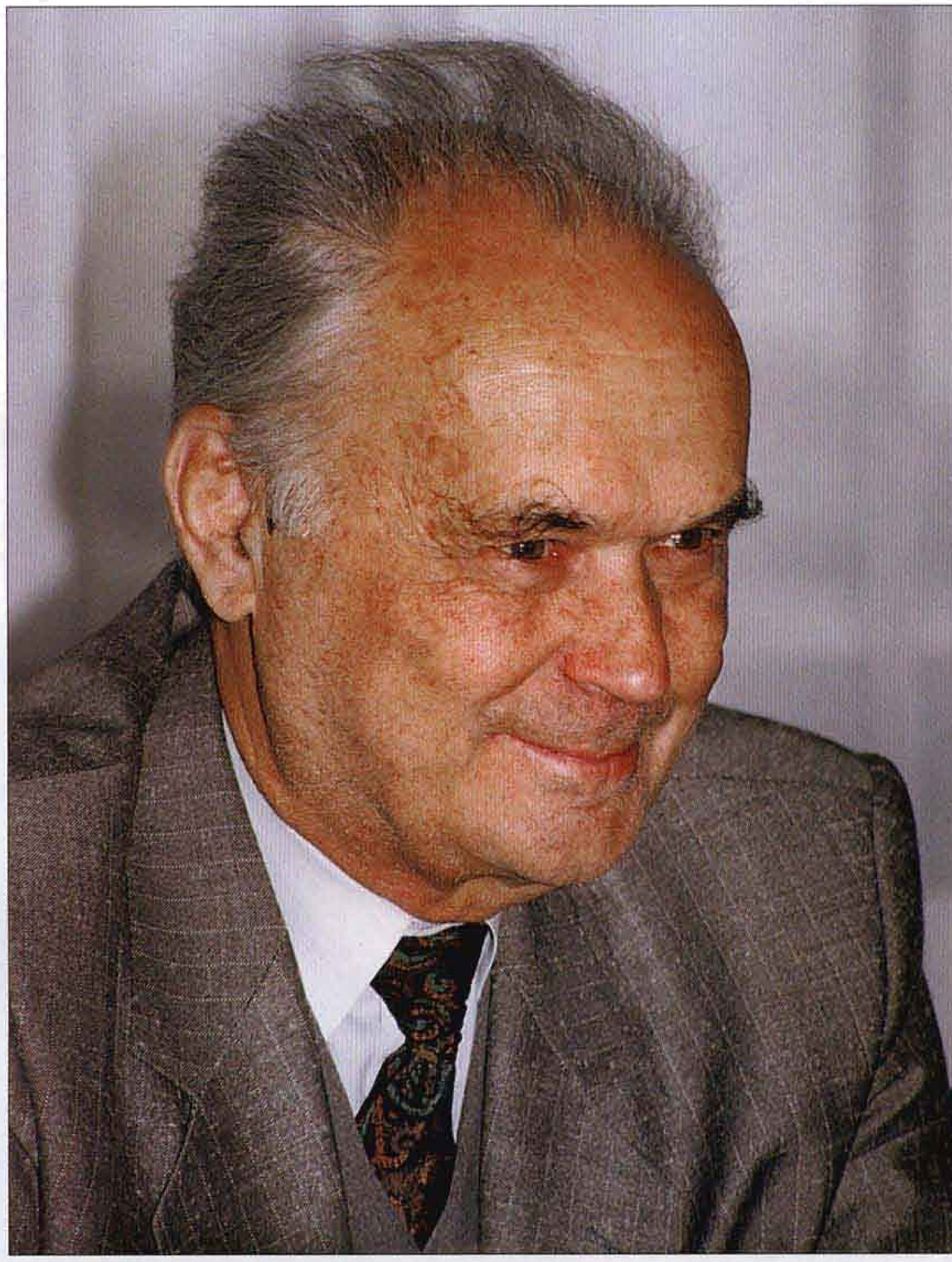
and development (R&D) establishments and the aircraft industry. It was at this stage that specific operational requirements (SORs) for fourth-generation fighters were developed. The key demand was the ability to win in close-in combat by virtue of agility, a high thrust-to-weight ratio and an effective WCS. Col. Sookhankin, Director of TsNII-30, and P. V. Fedosov, Director of NIIAS, played a key role in defining the two-types concept and getting it accepted. This was no easy task; Air Force C-in-C Marshal Pavel S. Kootakhov took a lot of convincing. It got worse when Marshal Dmitriy F. Ustinov was appointed Defence Minister, and worse still when Mikhail S. Gorbachov became head of the Soviet state and defence spending cuts ensued.

As early as the end of May 1971 MAP's Scientific & Technical Council convened to discuss the PFI programme for the first time; the meeting was only for those who 'need to know' and Air Force representatives were not invited at this stage. The session included reports by TsAGI Vice-Director G. S. Büschgens and NIIAS Vice-Director A. M. Batkov who stated the aircraft industry research establishments' perspective of the problem. For the first time NIIAS, which had done a prior analysis of combat aircraft development in the West, floated the idea of creating a fighter fleet composed of two types – a 'light' fighter and a 'heavy' advanced tactical fighter. Representatives of all three Soviet design bureaux participating in the fourth-generation fighter contest joined in the ensuing discussion.

The Mikoyan OKB was the first to make its presentation. (Actually we should call it *the OKB named after A. I. Mikoyan*. Artyom I. Mikoyan passed away on 9th December 1970; his deputy Rostislav Appollosovich Belyakov succeeded him as General Designer and the design bureau was named after its founder – a common practice in the Soviet Union.) Deputy General Designer Gleb Ye. Lozino-Lozinskiy, who headed the PFI programme at the Mikoyan OKB in those days, presented a fighter provisionally designated MiG-29. Such designations allocated at the preliminary design stage were sometimes abandoned and later re-used; the MiG-23 is a case in point. In this case, however, the designation stuck.

PD studies on the advanced tactical fighter subject had been going on at OKB-155 for two years by then, and widely varying layouts had been considered. In fact, the first project to bear the MiG-29 designation had nothing in common with the well-known fighter it eventually evolved into. It was an interceptor with a service ceiling of 23,000 m (75,460 ft); it was designed for a top speed of 3,000 km/h (1,860 mph) at high altitude and 1,500 km/h (931 mph) at sea level, with an effective range of 2,500 km (1,550 miles) in cruise mode. The take-off weight was envisaged as 25,400 kg (56,000 lb), including 7,000 kg (15,430 lb) of fuel. The armament and the powerplant parameters were optimised for the interceptor role. When the military issued their first specific operational requirement, the MiG-29 project was reworked as a smaller machine with a 19,000-kg (41,890-lb) TOW.

The project unveiled at the session was a conventional fighter resembling the MiG-25 with shoulder-mounted low aspect ratio wings featuring moderate sweepback and twin tails. The two afterburning turbojets in the 11,200-kgp (24,700-lbst) thrust class (such as the Lyul'ka AL-21F-3) were located side by side, breathing through lateral variable scoop air intakes. The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▲ **Rostislav A. Belyakov, the new General Designer at the Mikoyan OKB who succeeded Artyom I. Mikoyan after the latter's death.**

RSK MiG

tail surfaces were mounted on lateral booms projecting far beyond the engine nozzles.

The Sukhoi OKB's PD projects section chief Oleg S. Samoylovich was the next to take the floor. He presented the T-10 tactical fighter project which, unlike the MiG-29, utilised the blended wing/body layout. After briefly analysing the development of the McDonnell Douglas F-15 Eagle, which was perceived as the PFI's closest counterpart and potential adversary, he criticised certain items of the Air Force's SOR and outlined the Sukhoi OKB's approach to designing the new fighter. Samoylovich expressed his disagreement with NIIAS's idea of having two basic types of fighters in service at the same time. The Sukhoi OKB believed that in

▲
An artist's impression of the projected MiG-29A – the first project to bear this designation. The aircraft was designed along conventional lines, looking like a cross between the MiG-25 and the SEPECAT Jaguar. Note how the medium-range AAMs are carried low on the fuselage sides. The cannon is located ventrally.

▶
This view shows clearly the shoulder-mounted wings with small LERXes, the bubble canopy, the single fin and rudder and the short landing gear wheelbase. The nose gear unit probably retracts forward.

RSK MiG

This view shows the wide landing gear track and the tall main gear struts.
▼

RSK MiG

modern aerial combat Soviet fighters would mainly be up against the F-15 and the Grumman F-14 Tomcat, both of which had relatively long range and endurance, and the Soviet PFI had to match this performance – which a smaller and lighter aircraft would be unable to do.

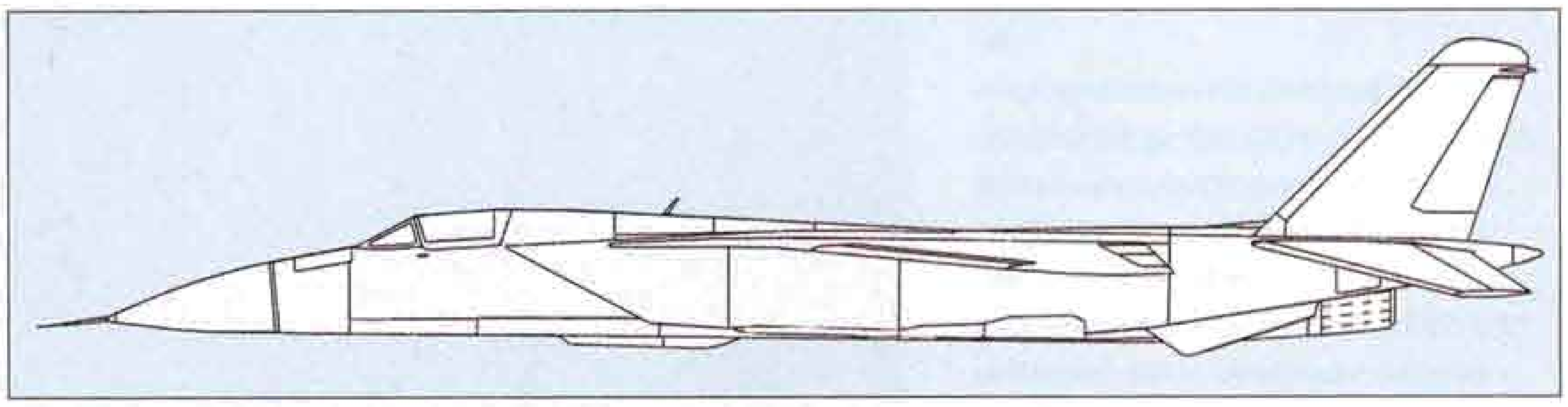
The Yakovlev OKB was represented by General Designer Aleksandr S. Yakovlev himself. He presented the Yak-45I project which had originally been developed in 1970 in two versions – the Yak-45 strike aircraft and the Yak-45I light tactical fighter (*istre**bi**tel'*). The aircraft utilised the layout that had been used in the mid-1960s for the projected Yak-33 supersonic interceptor. The circular-section fuselage with a high fineness ratio was mated to wings featuring compound leading-edge sweep (the inboard portions were more sharply swept than the outer ones); the conventional tail unit featured all-movable stabilisers (stabilators). Two Tumanskiy R53F-300 afterburning turbojets were mounted in cylindrical nacelles at the wing leading-edge kink, breathing through axisymmetrical air intakes with conical centrebodies (shock cones). The Yak-45 was conceived as a 'bantam fighter' with the lowest possible airframe weight and a minimum set of avionics intended for *'protecting the ground forces against enemy strike aircraft and destroying enemy fighters [...] in visual meteorological conditions'*. At a normal TOW of around 10,000 kg (22,045 lb) the aircraft was to have a 2,900-kg (6,390-lb) fuel load. The version which Yakovlev presented at the Scientific & Technical Council session (the Yak-45I) had been updated to meet the 1971 SOR and was intended for 'aerial combat with enemy fighters and destruction of enemy strike aircraft [...] in all weather conditions, day or night'. This caused the mission avionics suite to be expanded and the aircraft's dimensions to grow accordingly; the TOW and the fuel load were now 13,500 kg (29,760 lb) and about 4,000 kg (8,820 lb) respectively.

The second session of the Council dedicated to the PFI programme followed barely a month and a half later, in May 1971. The deadline for PD project submission set for the late summer of 1971 was approaching rapidly. Shortly after-wards an MAP board convened to assess the readiness of the three competing projects for presentation to the Air Force. The board session was chaired by Minister of Aircraft Industry Pyotr V. Dement'yev. Representatives of the Mikoyan, Yakovlev and Sukhoi bureaux presented their projects. By then a new version of the MiG-29 PD project was on the agenda; it looked quite similar to Sukhoi's T-10, utilising the BWB layout, and shared the same design ideology. The Yakovlev OKB, on the other hand, stuck to its original ideas, and the Yak-45I was radically different from the other two contenders.

The board's ruling boiled down to the following: all three PD projects met the SOR and could be submitted to the customer for review.

In 1972, having revised the SORs, the VVS issued a request for proposals concerning fourth-generation fighters. The Mikoyan OKB submitted two versions of the MiG-29 project; Yakovlev entered the Yak-45I light lighter and the Yak-47 heavy fighter (neither project materialised eventually), while Sukhoi's entries were the T10-1 and T10-2 (BWB and conventional versions respectively). Interestingly, the Yakovlev OKB analysed the lay of the land and submitted two versions of the project at once – a light fighter and a 'heavy' fighter. To save time it was decided to use the same layout for the two; the 'heavy' version designated Yak-47 was derived from the Yak-45 strike aircraft, being basically a scaled-up Yak-45I. The fighter version had a TOW around 23 tons (50,700 lb).

After evaluating the projects the Air Force tasked the Sukhoi and Mikoyan bureaux with



▲ **A side view of the second conventionally-built MiG-29 project configuration.**

A model of the same version, showing the wing LE flaps and the 'tailbooms' carrying the twin tails. In this case the fuselage spine aft of the canopy blends into the engine housings. ▼

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This upper view of the same model shows the wing planform with curved LERXes replacing the earlier version's straight ones. It also illustrates how far the tail unit is located aft of the engine nozzles. Note how the fuselage spine widens to blend into the engine housings.

The vertical tails were rather small, so they were augmented by long ventral strakes under the 'tailbooms'. Note the dielectric fin caps.

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Rear view of the same model, showing the engine nozzles. Except for the twin engines, the model has a striking similarity to the much later Yak-41M (Yak-141) naval fighter with vertical take-off and landing (VTOL) capability.

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This view shows the placement of the medium-range AAMs. Again, the short landing gear wheelbase is evident.

Yefim Gordon

◄ Yet another PD project version of the MiG-29. Once again the aircraft is built along conventional lines and looks remarkably similar to the F-15, albeit the proportions and the shape of the wings and tail surfaces are somewhat different. Importantly, the fins are canted outward, whereas those of the F-15 are vertical. The raked stabilator tips are meant to increase flutter resistance.

Unlike previous PD project versions of the MiG-29, the 'F-15 look-alike' carried all six missiles under the wings. ▼

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▲ This rear view shows the greater (and constant) wing trailing-edge sweep and the more widely spaced engines as compared to the F-15, with a brake parachute container between the engine nozzles which the American fighter does not have. Note how the rear ends of the engine housings are sculpted into the flat top of the fuselage.

This version of the MiG-29 project had a high-set cockpit and a noticeably drooped nose ahead of the cockpit in order to maximise the pilot's field of view. ►

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The next approximation to the eventual MiG-29. This model was the first one to utilise the blended wing/body layout with large curved LERXes and underslung air intakes. Note the reverse trailing-edge sweep on the stabilators.

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At this stage the projected MiG-29 still had a high wing aspect ratio; this was reduced later on the real thing.

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Rear view of the first BWB configuration model.

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This view shows the exceptionally long (for a change) wheelbase and the aft-retracting nose gear unit. In its proportions this project version of the MiG-29 was strikingly similar to its competitor – the original version of the Sukhoi T-10 (Su-27).

RSK MiG

◄◄
Preliminary design section engineer Yakov I. Seletskiy, who did a lot to defend the BWB configuration from the conventionalists.

◄
Anatoliy F. Pavlov, one of the 'co-authors' of the MiG-29's BWB layout.

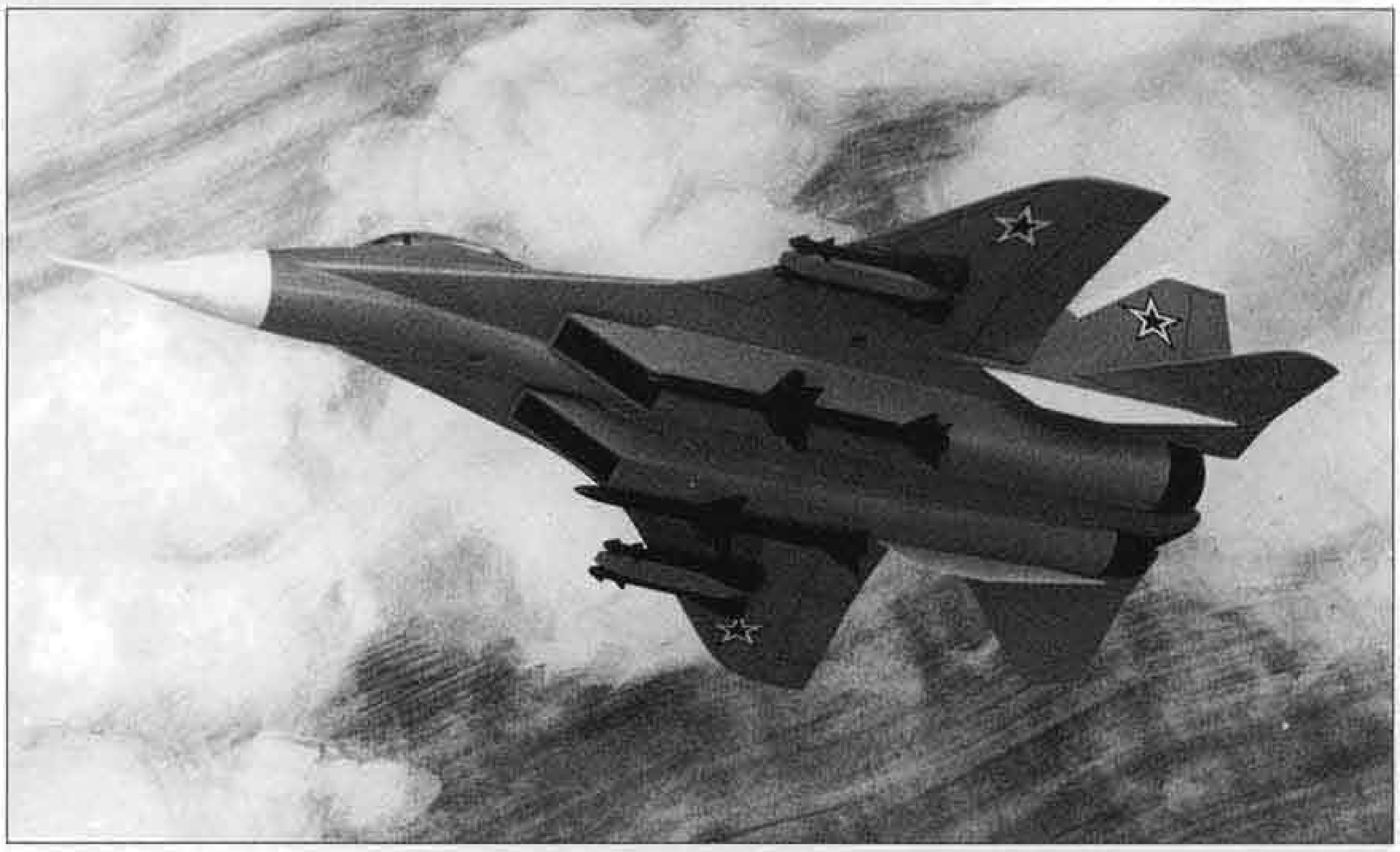
An artist's impressions of the MiG-29 (*izdeliye* 9.11) project. The aircraft is extremely similar to the real thing but looks more stubby and has an ogival wing leading edge; the ventral strakes are longer and positioned far from the engine nacelles, and the medium-range AAMs are still positioned on the air intake trunks. Note the auxiliary air intakes in the LERXes.
▼ ▼▼

building the heavy PFI and LFI respectively; Yakovlev had to walk away empty-handed. The MiG-29 project was then swiftly reassigned to the LFI role to fit the new policy – all the more so because Mikoyan hoped to get (and eventually did get) an order for the MiG-31 heavy interceptor.

MiG-29 (*Izdeliye* 9.11) and MiG-29A (*Izdeliye* 9.11A) Light Tactical Fighter (Advanced Development Projects)

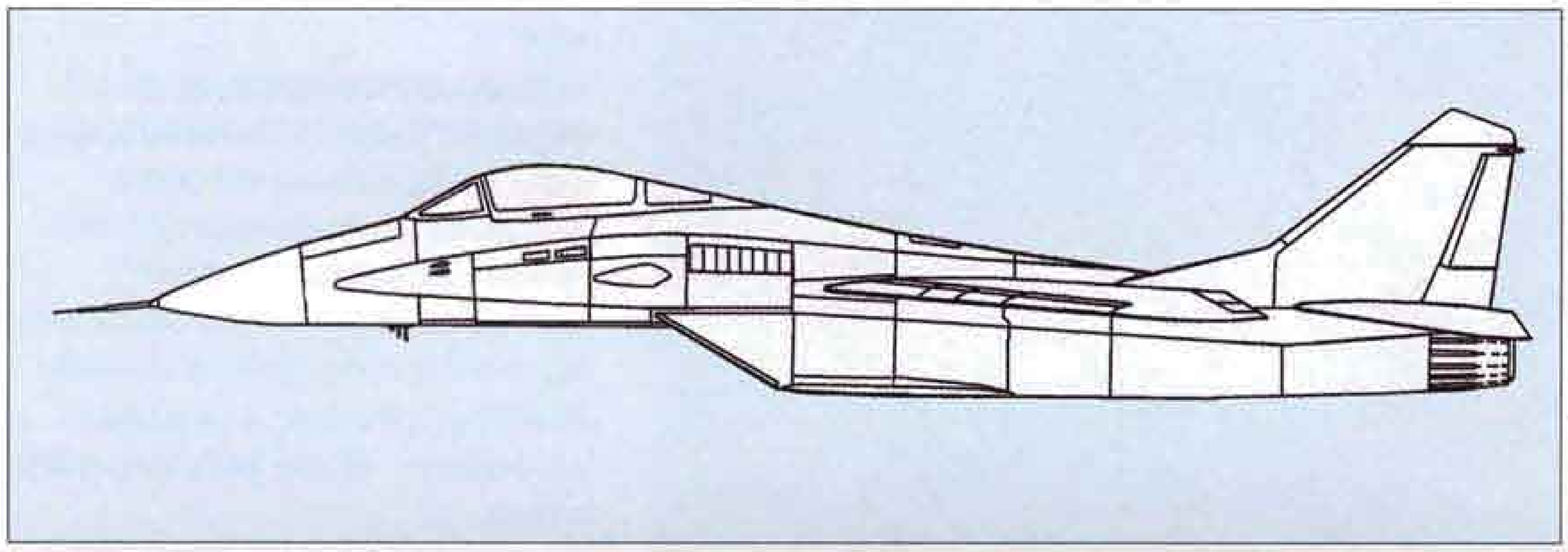
In 1973 the fighter force re-equipment research was largely complete, with the T-10 and MiG-29 selected as the primary types after the PFI/PLMI contest. That year TsNII-30 issued SORs for the two types, with revisions based on the research results. The most stringent demands applied to the avionics, primarily the WCS. The fire control radar was to work in multiple wavebands and be capable of detecting and tracking multiple targets. The avionics were to be based on semiconductors instead of the vacuum tubes used hitherto, be lighter, more compact and more reliable. The aircraft were to be equipped with an optoelectronic targeting system comprising an IRST unit and a laser rangefinder. The cockpit was to feature a head-up display (HUD) and a cathode-ray tube (CRT) indicator.

Originally both the PFI and the LFI were to be armed with a twin-barrel fast-firing automatic cannon – the 23-mm (.90 calibre) Gryazev/Shipoonov GSh-23 or the 30-mm (1.18 calibre) GSh-30, K-27 advanced medium-range AAMs and K-14 or K-73 short-range AAMs (the K stands



RSK MiG

RSK MiG



for **kom**pleks [vo'oroo**zhen**iya] – armament system). However, this had to be changed very soon. Development of the S-29 fire control radar originally planned for the MiG-29 was taking longer than anticipated, and Mikoyan had to undertake a crash redesign programme to speed up development and ensure that the Air Force's requirements were met. The S-29 was substituted by the production *Sap***feer-2**3ML (Sapphire) radar fitted to the MiG-23ML *Flogger-G*, and the K-14 and K-73 AAMs were replaced by the K-23M (K-24) missile (NATO codename AA-7 *Apex*) intended for the same fighter and production R-60/R-60M (AA-8 *Aphid*) 'dogfight missiles'.

The original version equipped with the S-29 radar bore the manufacturer's designation *iz***del***iye* 9.11, while the 'stopgap' version with MiG-23 avionics and armament was designated *izdeliye* 9.11A. *Izdeliye* (product) such and such was a term used for coding Soviet military hardware items. Quite simply, 9 stood for [MiG-2]9 while 11 was probably an allusion for some obscure reason to the manufacturer's designation of the 'true' *Flogger* prototypes (*izdeliye* 23-11). The production costs of the MiG-29 in basic configuration would be little more than half those of the T-10; with the two types making up 70% and 30% of the fighter force respectively, this would ensure maximum cost-effectiveness.

Work on the MiG-29A project proceeded throughout 1973-74, and the proponents of the conventional layout were not about to give up the fight yet. In early 1973 design team chief A. Nazarov approached PD section chief Aleksandr A. Choomachenko, saying that an integral-layout aircraft had a bigger surface area and hence created more drag than a

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▲▲
The second project designated MiG-29A was totally different from the model on page 10. The aircraft looks almost like a caricature of the real MiG-29 with a big 'head' and too small tails

▲
The second MiG-29A was similar to the model on page 14 but the wing shape was different, with a smooth curve at the wing/LERX junction instead of a kink. Note the windshield with a flat windscreen and the four pylons instead of six, with twin launch rails on the outboard ones.
►

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◄
This view of the same model shows the nose gear unit placed well forward and the very short nose ahead of the cockpit. Note the slight kink in the fin leading edges and the starboard-side position of the cannon.

This view shows the MiG-29A's wing planform, which is remarkable similar to that of the rival Sukhoi T-10. As compared to the previous model the fuselage spine is shorter and a fairing is added between the engine nozzles; note the lower wing aspect ratio and the kinked trailing edge
▼

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conventional aircraft. He was backed by Deputy General Designer Z. Ye. Bersoodskiy, fuselage design team head I. V. Lipets and some other OKB employees who claimed the BWB layout could not give adequate structural strength and in general it was a dead duck.

Yakov I. Seletskiy, the main 'author' of the BWB layout, and Anatoliy Pavlov stood up against the traditionalists. Choomachenko himself favoured the new design; however, being a cautious person, he decided to let the two projects proceed in parallel and let the 'innovators' and 'conservatives' fight out the issue. Eventually the 'innovators' won. The conventional version with lateral intakes proved to have poor performance in tight turns during a dogfight when the 'leeward' intake operated in extremely unfavourable conditions; moreover, it could not attain angles of attack (AOAs) in excess of 20°. This was not the case with the blended wing/body layout where the intakes were mounted under the fuselage/wing centre section, continuing into the engine nacelles.

TsAGI participated actively in the development of the fourth-generation fighters from the start, evaluating the competing aerodynamic layouts of the MiG-29 and T-10. Mikoyan engineers recalled that N. K. Lebed', a female TsAGI employee in charge of the fourth-generation fighter research programme, showed them plan views of the 'integral' versions of both aircraft; the similarity was incredible.

However, like the OKB, the institute had its share of traditionalists who insisted that both the MiG-29 and T-10 should be designed along conventional lines, period. G. S. Büschgens, the then director of TsAGI, kept urging Rostislav A. Belyakov to abandon the BWB layout.

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▲ **Mikoyan OKB General Designer Rostislav A. Belyakov in his study with a model of the MiG-29A on his desk. Note the two Gold Star Orders that go with his two Hero of Socialist Labour titles.**

V. Mikeladze, Irodov, Koorochkin and other influential TsAGI engineers also favoured the conventional layout; N. K. Lebed' maintained neutrality. Belyakov, for his part, was unwilling to speak openly on this all-important issue because, unlike Büschgens, he was not yet a fully-fledged member of the USSR Academy of Sciences and thus was not authoritative enough. (The General Designer did not participate directly in developing the MiG-29's general arrangement.)

Choomachenko, who had been appointed project chief and Deputy General Designer on 29th December 1972, was instrumental in the choice of the integral layout over the conventional one. Vano Anastasovich Mikoyan, the nephew of the OKB's founder, was appointed Choomachenko's deputy same day. Zinaida Zhevyrkina, an OKB employee (she helped Choomachenko stand for his doctor's degree), did a lot of work, analysing the strengths and weaknesses of the competing layouts. This analysis was later sent to TsAGI and was one of the reasons that made the institute's leaders change their attitude. Later G. S. Büsch-gens led a major aerodynamics research and wind tunnel test programme (the first wooden models of the 'integral' MiG-29 were tested in TsAGI's wind tunnels in 1973). A lot of structural strength research was made by Academician A. I. Makarevskiy and, later, his successor A. F. Selikhov, both notable TsAGI engineers.

On 15th July 1974 the General Designer formally approved 1/20th scale drawings of the MiG-29A. Anatoliy Pavlov working under project engineer Yakov I. Seletskiy had completed the drawings which illustrated not only the fighter's general arrangement but all main structural elements, even indicating the design structural loads. (The project engineer is the 'next in command' after the chief project engineer. He is a 'workhorse' doing the actual design work while the chief project engineer mostly superintends and coordinates the whole programme, reporting to the General Designer.)

The smoothly blended wings and fuselage minimised drag and maximised lift throughout the speed range while providing ample internal space for fuel and avionics. The wings featured prominent LERXes for better lift at high alpha and powerful high-lift devices (automatic leading-edge flaps, trailing-edge flaps and flaperons). The stabilators were deflected differentially for roll control, augmenting the ailerons and enabling the aircraft to manoeuvre vigorously throughout its flight envelope (speed, altitude and AOA).

The SOR issued by the Air Force for the T-10 did not specify leading-edge flaps; however, the SOR for the MiG-29 did, and this decision was promptly proven correct when wind tunnel tests began. The very first wind tunnel model of the 'integral-layout' MiG-29 lacking LE flaps immediately showed poor directional stability at AOAs in excess of 20° (the flaps had been omitted for purely technological reasons). This was remedied by making saw-cuts at certain angles in the wooden wings to imitate the LE flaps and the maximum AOA immediately increased to 25°. Surprisingly, a wind tunnel model incorporating working LE flaps was not built until the real aircraft was flying!

The axes of the stabilator hinges were slightly inclined downwards to increase stabilator momentum. To maintain a 90° angle between the vertical and horizontal tails the fins were canted slightly outwards. This made the aircraft statically stable (unlike the T-10 which was statically unstable).

The T-10 as originally flown (the aircraft known in the West as *Flanker-A*) had no LE flaps. However, a complete redesign proved necessary before the aircraft entered production as the Su-27 (T-10S or *Flanker-B*), and this aircraft did have LE flaps. Being competitors, Mikoyan and Sukhoi are not exactly the best of friends and some Mikoyan employees have accused Sukhoi of filching the idea, as well as the idea of outward-canted vertical tails. (The latter claim does not hold water. The first two *Flanker-A* prototypes had the fins placed vertically; outward-canted fins were indeed

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▶
This desktop model depicts an early project configuration of the competing T-10 (Su-27). This aircraft utilised the BWB layout from the outset. However, the shape and angle of the vertical tails is nothing like the real T10-1 prototype; nor were the Whitcomb fairings on the wings (at mid-span) and the wingtip 'spikes' present on the real thing.

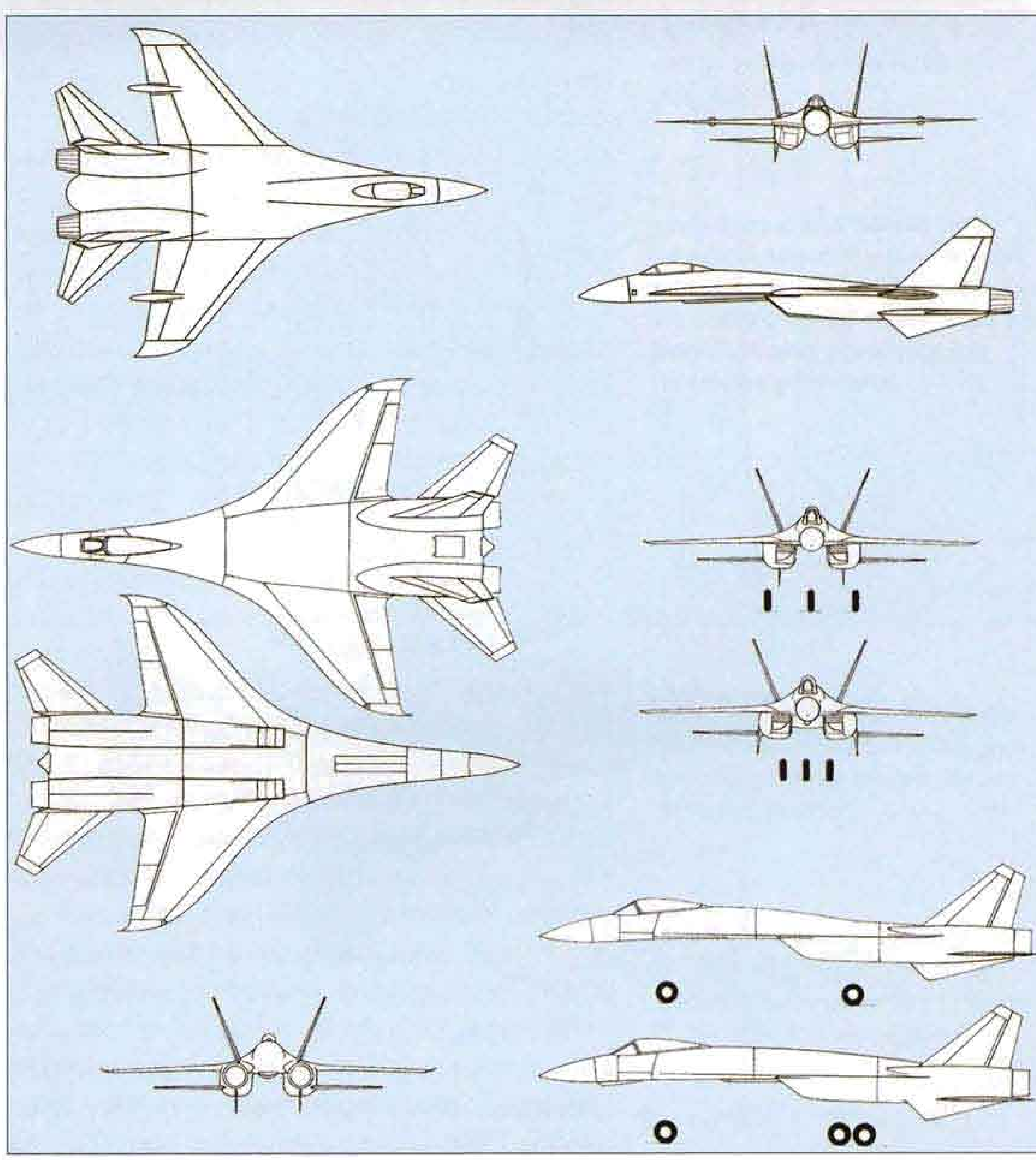
Sukhoi

Another model showing one more PD project configuration preceding the T10-1. Note the outward-canted vertical tails, outward-canted intake trunks, the narrow track of the main gear units retracting into the fuselage between the engine nacelles, the F-16 style frameless canopy and the eight external stores pylons. ▶▼

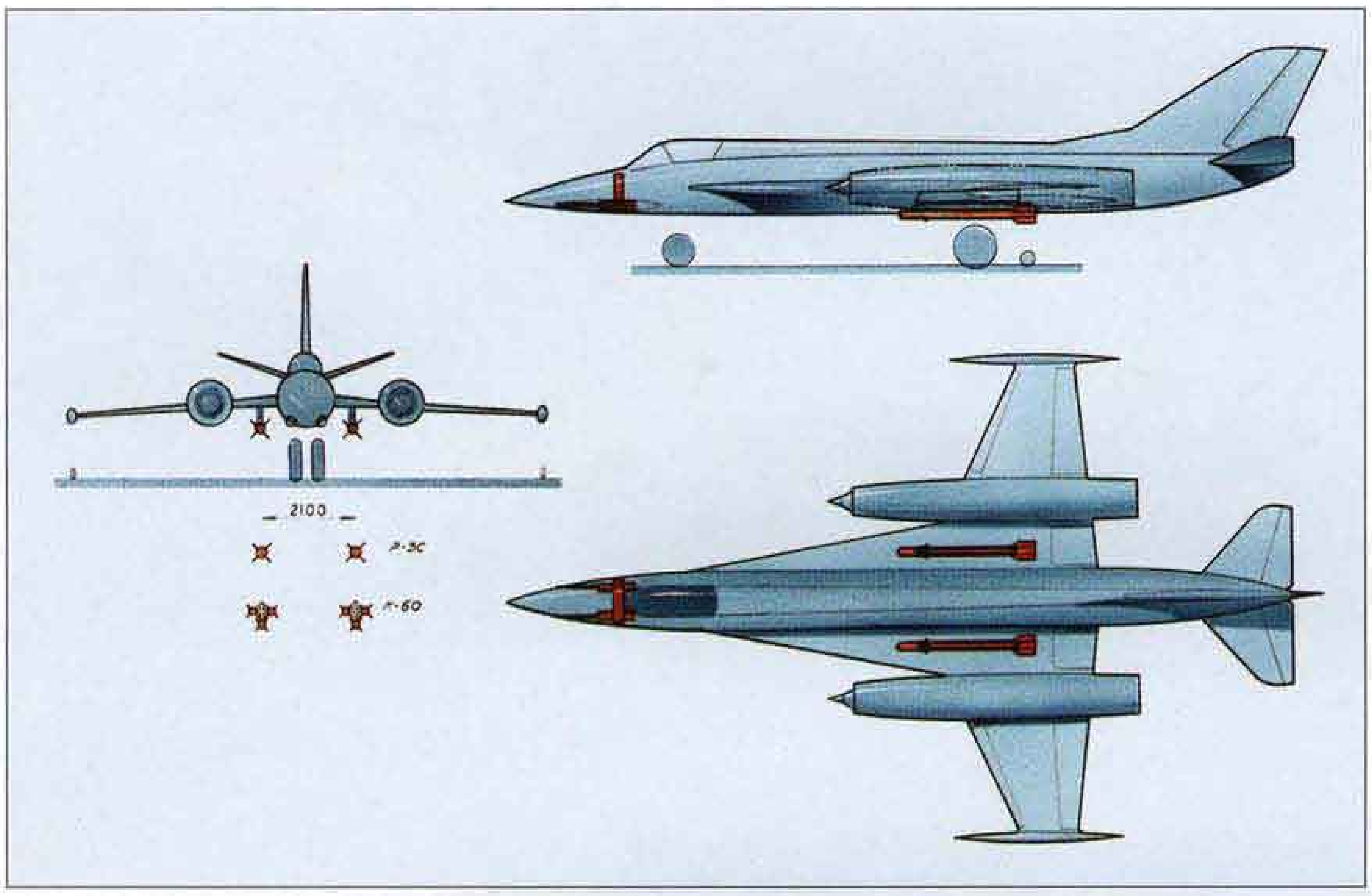
introduced on the next seven *Flanker-A* development aircraft (T10-3 through T10-6 and T10-9 through T10-11) but the T-10S prototype (T10-7) reverted to vertical fins! To paraphrase a popular saying, what is a sauce for a MiG is not always a sauce for the Sukhoi.)

As noted earlier, all Soviet fourth-generation fighter projects were strictly twin-engined aircraft. This improved survivability in combat, reduced accident attrition risk in peacetime and gave the aircraft a thrust-to-weight ratio in excess of 1. However, the advantages of the twin-engined layout could be used to the full on a modern light fighter only by fitting advanced jet engines with a low specific fuel consumption (SFC) and a high specific thrust.

Several Soviet engine design bureaux started working on such engines in the late 1960s. These were the State machinery plant named after Vladimir Yakovlevich Klimov (OKB-117 led by Klimov's successor, Sergey Petrovich Izotov), the '*So**yooz***' (Union) machinery plant in Moscow (OKB-300 led by Sergey Konstantinovich Tumanskiy), the Moscow-based OKB-165 led by Arkhip Mikhailovich Lyul'ka and the OKB-19 design bureau in Perm' led by Pavel Aleksandrovich Solov'yov. They received scientific support from the Central Aero Engine Institute (TsIAM – *Tsen**trahl'**nyy insti**toot** aviatsi**on**novo mo**to**rostro**yen**iya*).



▶
These drawings show the initial project configurations of the T-10. Top: a three-view of the version with the Whitcomb fairings and separate flaps and ailerons pictured at the top of the page. Next come upper, lower, front, rear and side views of a version with 'clean' wings and one-piece flaperons. This comes in two variants differing in landing gear design; the one with tandem-wheel main gear bogies has a very narrow wheel track.



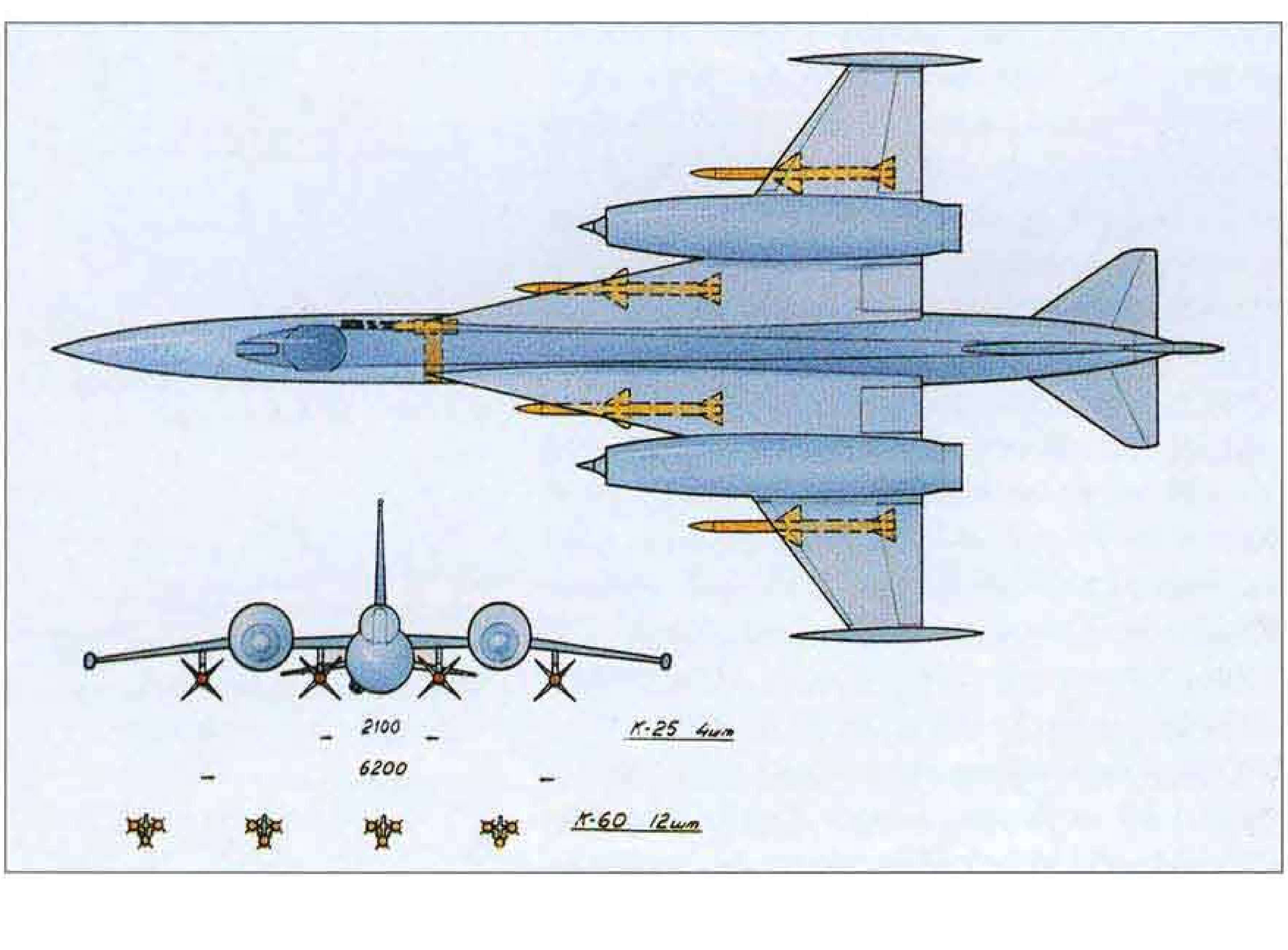
Lyul'ka and Solov'yov came up with the AL-31F and D-30F6 afterburning turbofans (all previous Soviet fighter engines had been strictly turbojets). However, these were rather too large for a light fighter like the MiG-29, being rated at 12,500 kgp (27,560 lbst) and 15,500 kgp (34,170 lbst) respectively in full afterburner. The MiG-29 required an afterburning turbofan in the 7,500-8,500-kgp (16,530-18,740-lbst) thrust class. The Izotov OKB (better known for its turboshaft engines used in Mil' and Kamov helicopters) offered such an engine – the RD-33 rated at 8,300 kgp (18,300 lbst). Before long, however, competition showed up in the form of the Tumanskiy OKB with the R67-300 afterburning turbofan rated at 7,500 kgp, and an unofficial contest began.

▲ **A three-view of the projected Yak-45I light fighter, showing the guided weapons options (two R-3S AAMs or six K-60 AAMs) and the built-in cannons in the nose.**

▶ **An artist's impression of the Yak-45I.**

Yakovlev OKB

The Yak-47 was a scaled-up version of the Yak-45I; it was to carry four K-25 AAMs or 12 K-60s and have a twin-barrel cannon on the starboard side. Note the outer wing anhedral. ▼



Tumanskiy cited his engine's lower dry weight as a strong point; however, Mikoyan engineers were sceptical about this. The point was that the R67-300 was a three-shaft turbofan while the RD-33 was a two-shaft turbofan. How come the R67-300 was lighter when the extra turbine and compressor should weigh some 50 kg (110 lb)? A major design issue was the engine's accessory gearbox driving generators, fuel and oil pumps. Izotov proposed a mechanical drive for the gearbox while Tumanskiy suggested a compressed-air turbine instead; this necessitated air supply lines which again resulted in a weight penalty.

After studying the two projects carefully the Mikoyan OKB selected the RD-33 in 1973. TsIAM also spoke in favour of the Izotov turbofan, proving that the R67-300 would be heavier than

Tumanskiy claimed because of its design shortcomings. Using Izotov's accessory gearbox drive gave an overall weight saving of about 250 kg (551 lb).

By 1974 the MiG-29 powerplant had been finalised. The RD-33 (aka *izdeliye* 88) had a specified thrust of 5,040 kgp (11,110 lbst) dry/ 8,300 kgp (18,300 lbst) reheat and a bypass ratio of 0.475. By comparison, the turbojets powering production tactical fighters of the time – the Tumanskiy R25-300 of the MiG-21*bis Fishbed-L/N* and the Tumanskiy R29-300 of the MiG-23M – had afterburner ratings of 7,100 kgp (15,652 lbst) and 12,500 kgp (27,557 lbst) respectively.

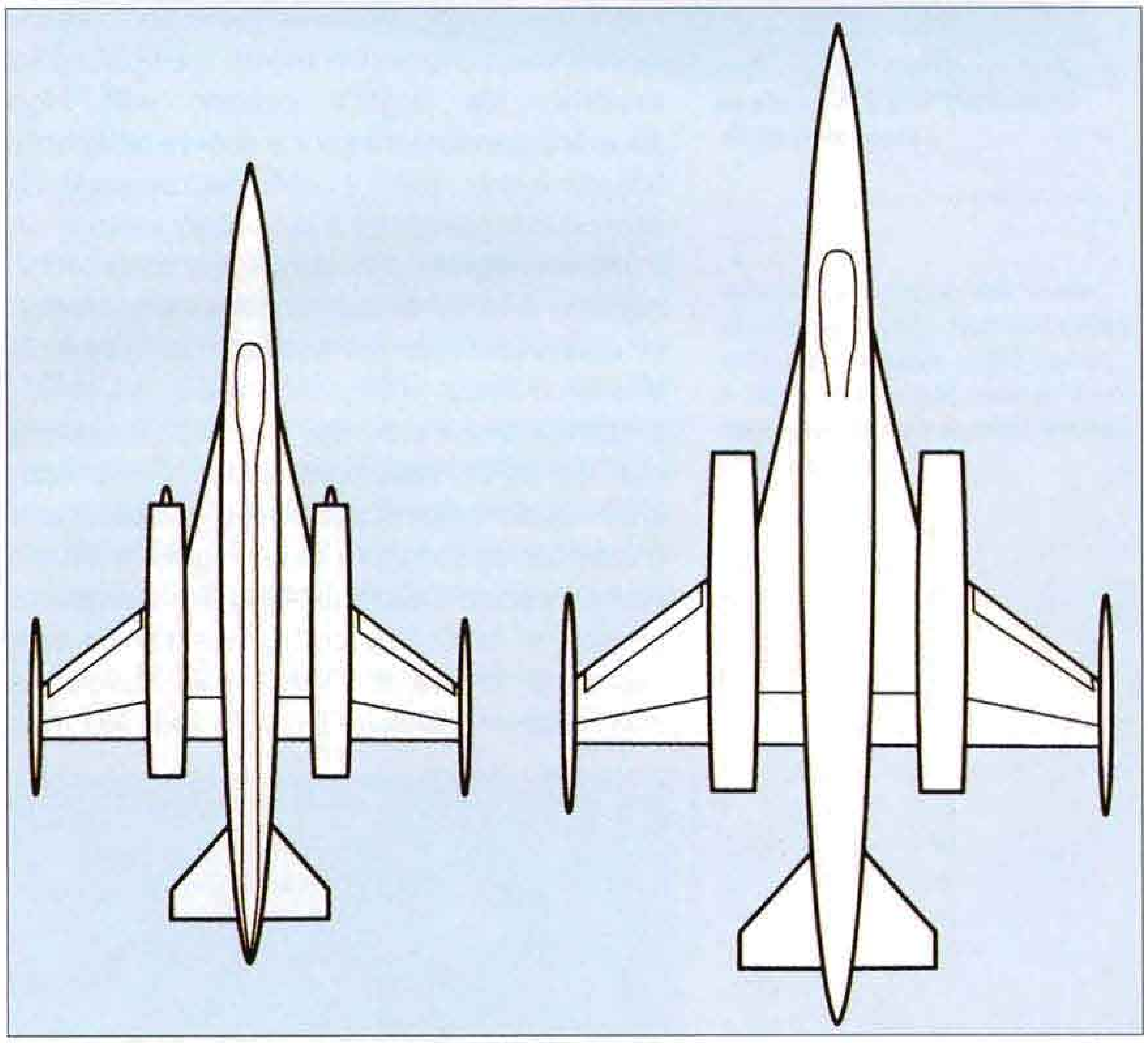
The RD-33's turbine temperature was 1,650°K versus 1,313°K for the R25-300 and 1,443°K for the R29-300. Overall engine pressure ratio (EPR) was 21.5 versus 9.5 for the R25-300 and 13.1 for the R29-300. The turbofan had a 20% lower SFC at full military power than both Tumanskiy turbojets and a weight/thrust ratio 26% and 11% better respectively; with a 1,055-kg (2,325-lb) dry weight, the RD-33 was even 15% lighter than the less powerful R25-300.

Actually the Izotov OKB had been working on the RD-33 since 1968 at its own risk. Bench testing of engine components began in 1972 and the prototype engine ran in late 1974. The advanced development project of the RD-33 was completed same year, along with several pre-production 'batch zero' engines; the design task, however, was not officially issued by MAP until 15th July 1975 when the RD-33 project had been duly approved and Mikoyan had agreed to use the engine in the MiG-29. In 1976 a flight-cleared RD-33 took to the air for the first time, suspended under one of the ten Tupolev Tu-16LL engine testbeds (converted *Badger-A* medium bombers) operated by the Flight Research Institute named after test pilot Mikhail M. Gromov in Zhukovskiy (LII – ***Lyot**no-is**sled**ovatel'skiy insti**toot***). (LL = ***le**ta**yuschchaya labora**to**riya* – lit. 'flying laboratory', that is, either testbed or research aircraft, depending on the aircraft's actual role.)

The engines were located in spaced nacelles and the MiG-29's low-slung intakes attached to the fuselage underside made them extremely vulnerable to foreign object damage (FOD). Mikoyan engineers found a very unconventional and singularly effective solution to the problem not used by any fighter maker before. On the ground the main air intakes were blanked off completely by perforated panels (FOD protection doors) hinged at the top and the engines breathed through a series of spring-loaded blow-in doors on the upper sides of the LERXes. During rotation the FOD protection doors swung up into a horizontal position, triggered by weight off the nose gear, allowing the engines to operate normally, and the dorsal blow-in doors closed automatically.

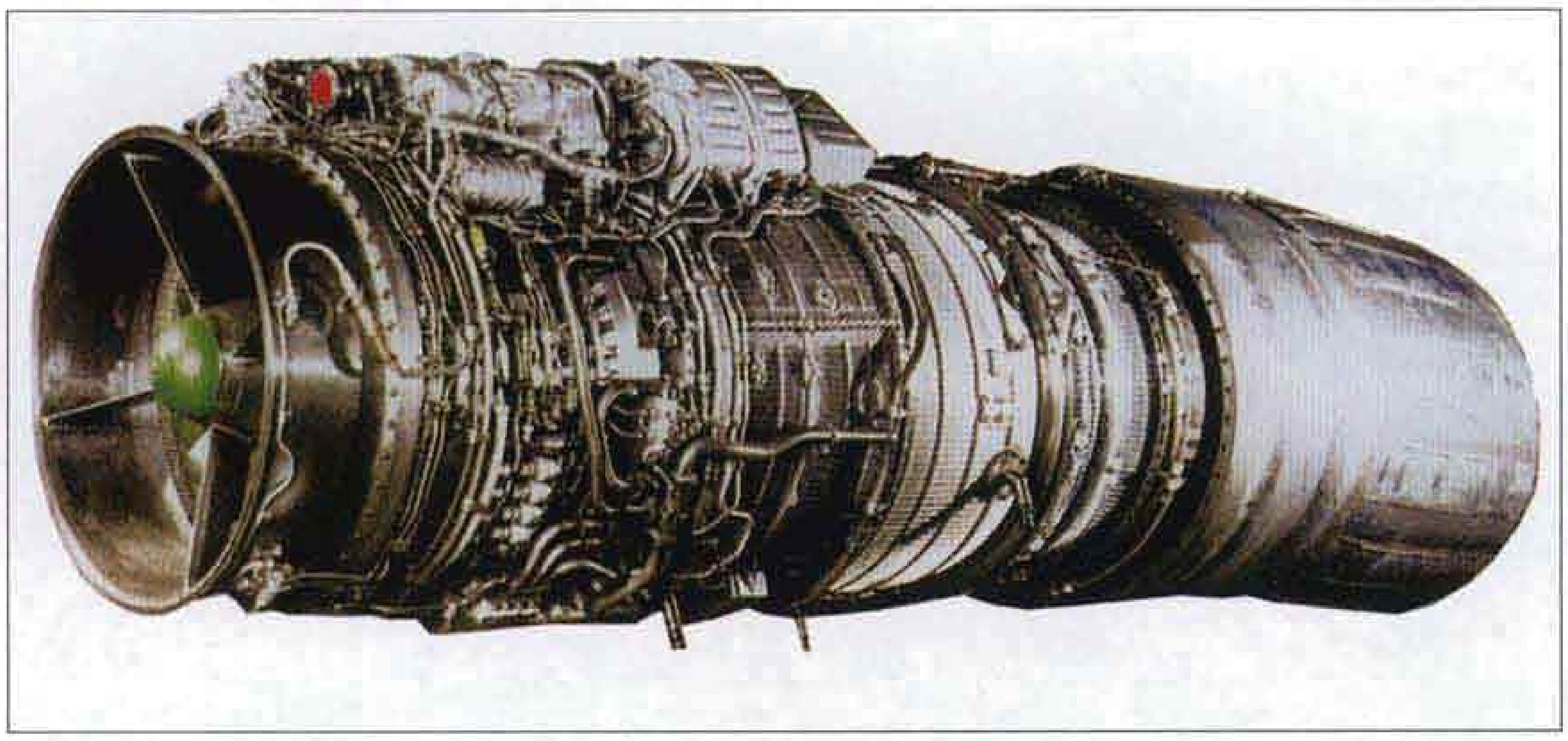
The integrated weapons control system (WCS) developed by NIIAS was one of the fighter's most important systems. The MiG-29 was the world's first fighter to have three targeting systems: a pulse-Doppler fire control radar with 'look-down/shoot-down' capability, an IRST and a helmet-mounted sight (HMS).


Yakovlev OKB



▲▲
Another artist's rendering of the Yak-45I, showing the triplets of K-60 'dogfight missiles' under the wing roots.

▲
The Yak-47 was scaled-up version of the Yak-45I. This drawing shows the two projected fighters to the same scale.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▲ **The Izotov RD-33 (now known under the Klimov brand). Note the slightly downward-angled nozzle and the dorsal accessories; some of the engine accessories are located remotely and driven via an extension shaft.**

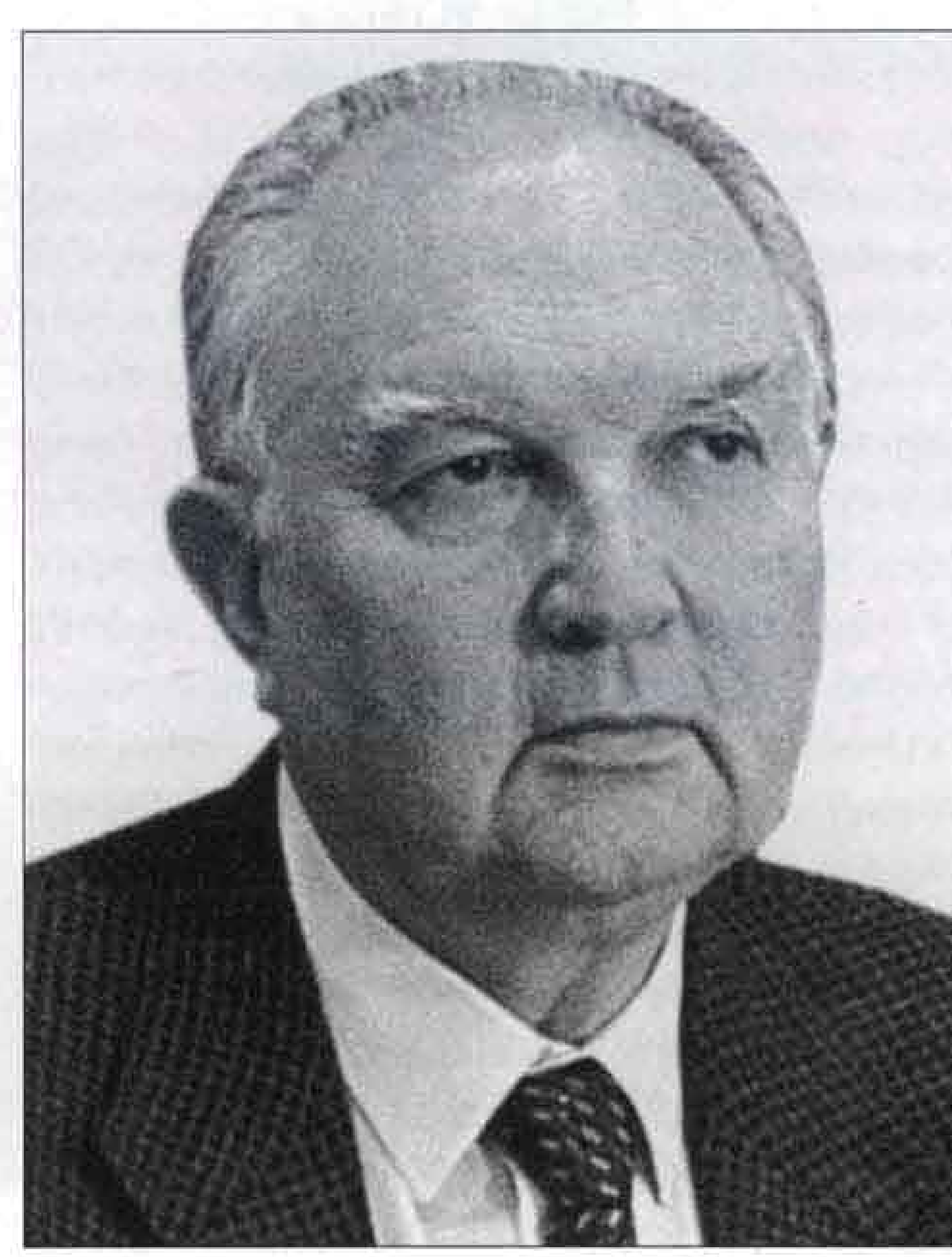
They were to work in concert, exchanging data via computers; this gave a high degree of automation, higher reliability and ECM resistance and the ability to attack covertly. Apart from its stealth feature (the ability to attack without switching on the radar), the IRST could establish the target's position with high accuracy, allowing the pilot to score a hit with the first burst of gunfire – a useful feature since the cannon is regarded as a secondary weapon on a modern fighter and hence the ammunition capacity is rather limited. The IRST was located in a characteristic transparent 'ball' offset to starboard ahead of the windscreen.

Development of the IRST was 'subcontracted out' to NPO *E**lek**troavto**ma**tika* (*na**ooch**no-proiz**vod**stvennoye obyedineniye* – research and production association) in Leningrad while the Radio Research Institute (NIIR) in Moscow, a division of NPO Phazotron, was tasked with designing the radar. NIIAS itself developed mathematical models and software for the unique weapons control system and was responsible for systems integration.

A major issue was the fighter's control system. After considering fly-by-wire (FBW) controls the engineers decided to play safe and opted for a conventional control system with mechanical linkages. Sure enough, FBW controls offered higher manoeuvrability but conventional controls were considered more reliable. The control system featured irreversible hydraulic actuators in all three control circuits and an artificial-feel unit to facilitate flying and reduce pilot fatigue during prolonged high-G manoeuvring.

On 26th June 1974 the Communist Party Central Committee and the Council of Ministers issued a directive ordering the development of the MiG-29 light tactical fighter. Also in 1974, TsNII-30 issued an SOR for the type with still more updates reflecting the results of research made in 1971-74. An interdepartmental plan for advanced development project completion was drawn up. Such a document was necessary because the MiG-29 programme was a major effort involving numerous organisations within the aerospace, electronics and defence industries and their efforts needed a lot of coordinating. Besides, time was running short; the F-15A had already achieved initial operational capability (IOC) with the USAF, the YF-16 had entered flight test, and in France, Avions Marcel Dassault were working on the Mirage 2000 fighter.

As noted earlier, the MiG-29 programme was unusual in that development proceeded in two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► **G. P. Svishchev, Director of the Central Aero- & Hydrodynamics Institute (TsAGI) at the time when the MiG-29 was under development.**

►► **Academician Yevgeniy A. Fedosov, Director of the Aircraft Systems Research Institute (NIIAS) which was responsible for developing the ideology and architecture of the MiG-29's weapons control system.**

parallel lines – the 'pure' MiG-29 with advanced mission avionics and weapons and the downgraded MiG-29A with simplified radar and weapons based on current production models. The MiG-29A was regarded as an 'entry-level' version designed to save time; it could achieve IOC in the late 1970s and do the job until the more sophisticated equipment and weapons was ready to enter service. Besides, the idea of a 'cheap' light tactical fighter was actively supported by the Soviet MoD, whereas the MiG-29 with a new radar and new missiles still had to win acceptance.

Both versions had identical airframes, powerplants and systems, including the flight instrumentation system, navigation and communications equipment; flight performance was also nearly identical. The MiG-29A featured the SUV-23ML-2 (SUV-29A) weapons control system (*sis**tem**a oopravl**en**iya vo'oroozheniyem* – WCS). It included the Phazotron *Yan**tar'*** (Amber) fire control radar (a derivative of the Sapfeer-23ML and Sapfeer-23D-III fitted to the MiG-23ML and MiG-23M respectively) with associated analogue computer and target illumination channel for missiles with semi-active radar homing (SARH), the OEPrNK-29A optoelectronic targeting/nav suite, data transfer equipment for feeding target data to the missiles' guidance units and so on The OEPrNK-29A (***opt**iko-elek**tron**nyy pri**tsel'**no-navigatsi**on**nyy **kom**pleks*) comprised the OEPS-29A optoelectronic targeting system (***opt**iko-elek**tron**naya pri**tsel'**no-navigatsi**on**naya sis**tem**a*), an HUD, a direct-vision CRT display, an *Or**bit**a*-20 digital computer and an SN-29A navigation system.

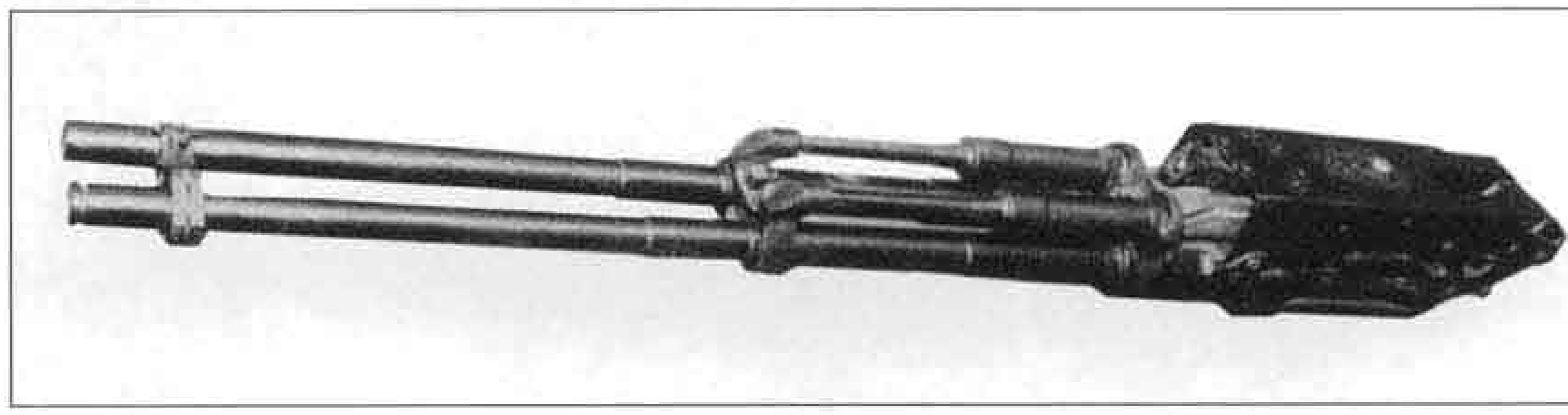
The Yantar' radar (aka Sapfeer-23ML-2) developed by NPO Phazotron under General Designer Yuriy N. Figoorovskiy was to be capable of detecting small aerial targets such as fighters at 55 km (34 miles) in open airspace and 20 km (12.4 miles) in 'look-down/shoot-down' mode. For large targets such as bombers the required detection range was 80 km (49.6 miles) and 25 km (15.5 miles) respectively.

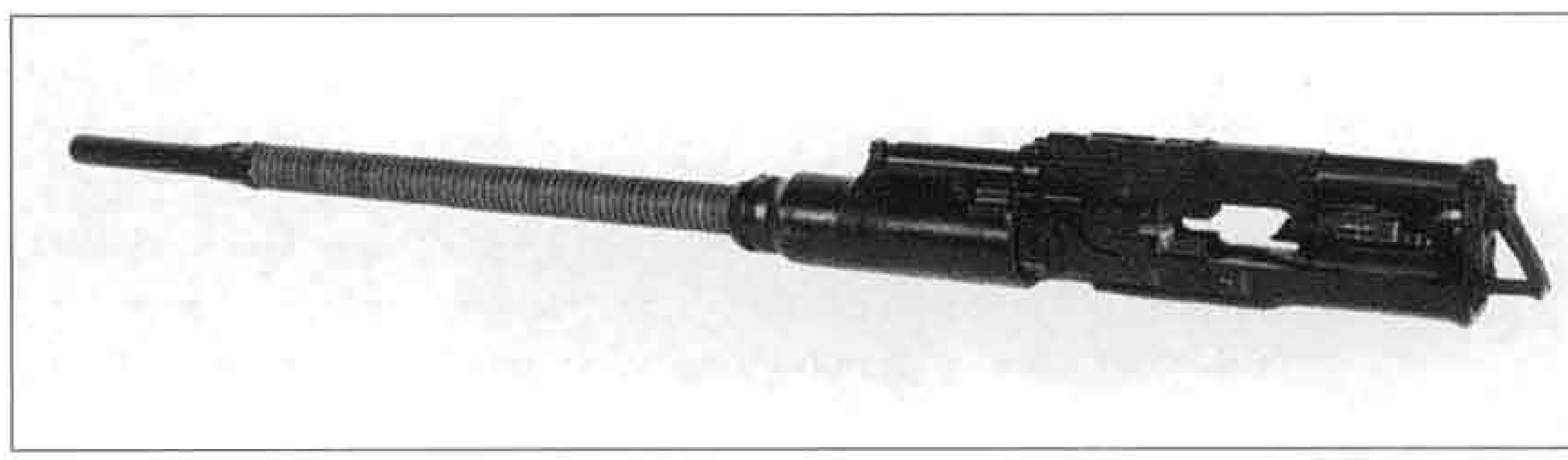
The OEPS-29A optoelectronic targeting system was designed by the Gheofizika (Geophysics) Central Design Bureau in Moscow. It comprised an IRST unit and a laser rangefinder. Its functions included target search, acquisition and tracking, distance measuring to targets and ground, and establishing the targets' angle coordinates and angle speed. The system could operate throughout the aircraft's altitude envelope in visual meteorological conditions (VMC), day or night, and was immune to ECM. In pursuit mode a fighter-type target could be detected at more than 15 km (9.3 miles); target lock-on range was 8-10 km (5-6.2 miles).

In addition to the WCS, the avionics would include an identification friend-or-foe (IFF) transponder, the *Bir**yuza*** (Turquoise) command link system, the SAU-29 automatic control system (*sis**tem**a avtoma**tich**eskovo ooprav**len**iya*, that is, advanced autopilot/ILS), the SO-69 air traffic control (ATC) transponder, the *Ber**yo**za-L* (Birch-L) radar homing and warning system (RHAWS), the Reper-M (Benchmark) radio altimeter, the Olenyok automatic direction finder (ADF), the MRP-56P marker beacon receiver, the *Zhoo**ravl'***-30 (Crane-30) radio set and so on.

The MiG-29A was armed with an AO-17A twin-barrel 30-mm cannon with 150 rounds. The

The AO-17A (alias GSh-30) twin-barrel 30-mm cannon developed by V. P. Gryazev and A. G. Shipoonov at NPO Tochnost' for the MiG-29A. ▼





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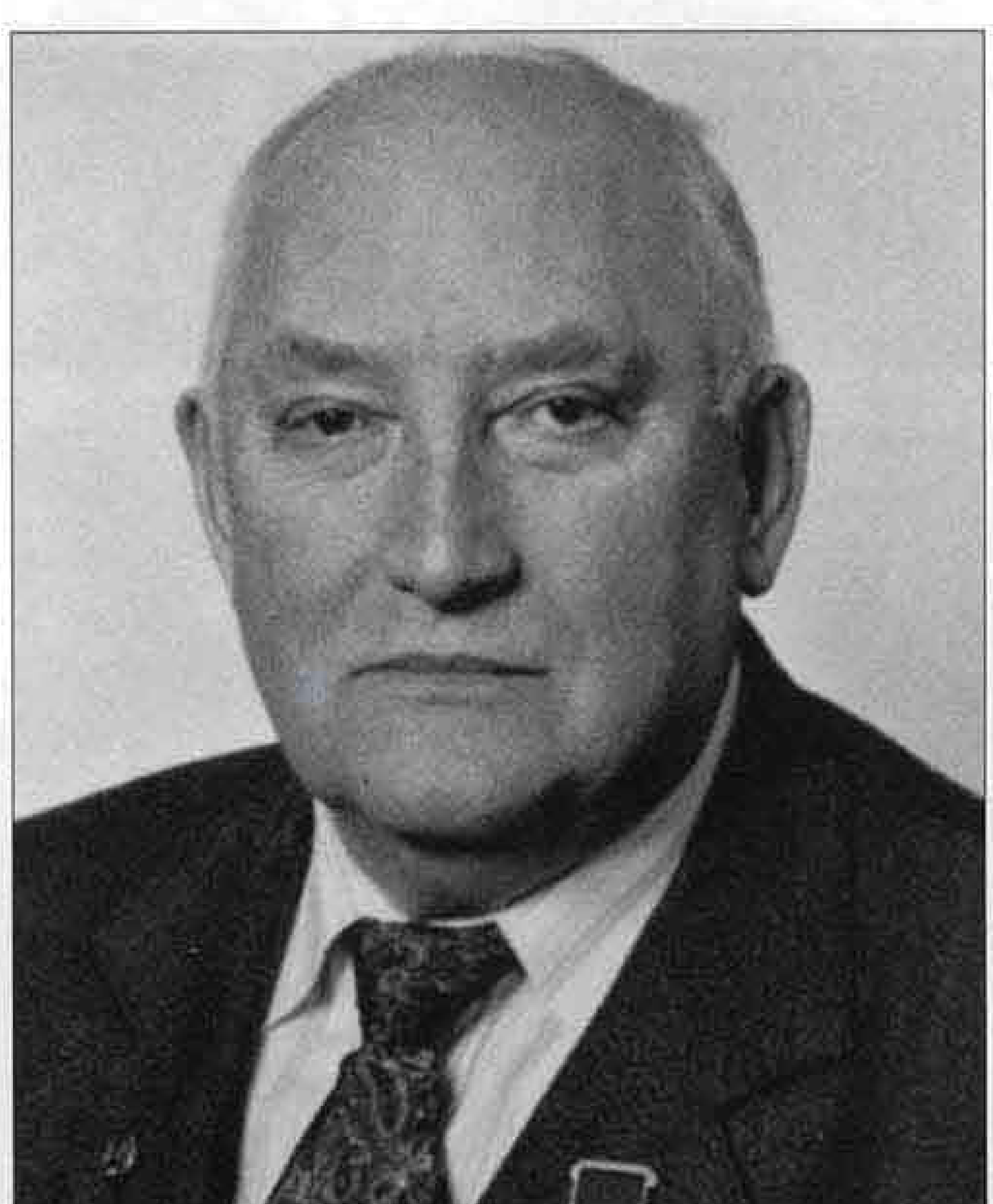
▲ **Another product of the same design team, the TKB-687 (alias GSh-301) cannon of the same calibre. It was this cannon that was eventually selected for the MiG-29.**



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◄ **A. G. Shipoonov, one of the designers of the GSh-301 cannon.**

▶
Matus R. Bisnovat, head of the Molniya weapons design bureau which developed the K-60 (R-60) AAM.

▶▶
A. L. Lyapin, General Designer of the Vympel design bureau responsible for the K-24 AAM.

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▶
V. N. Yelagin, Deputy General Designer at the Molniya OKB and project chief of the K-60.

The K-24 (R-24) medium-range AAM which was to be the MiG-29's principal air-to-air weapon. Note the large cropped-delta fins or 'wings'
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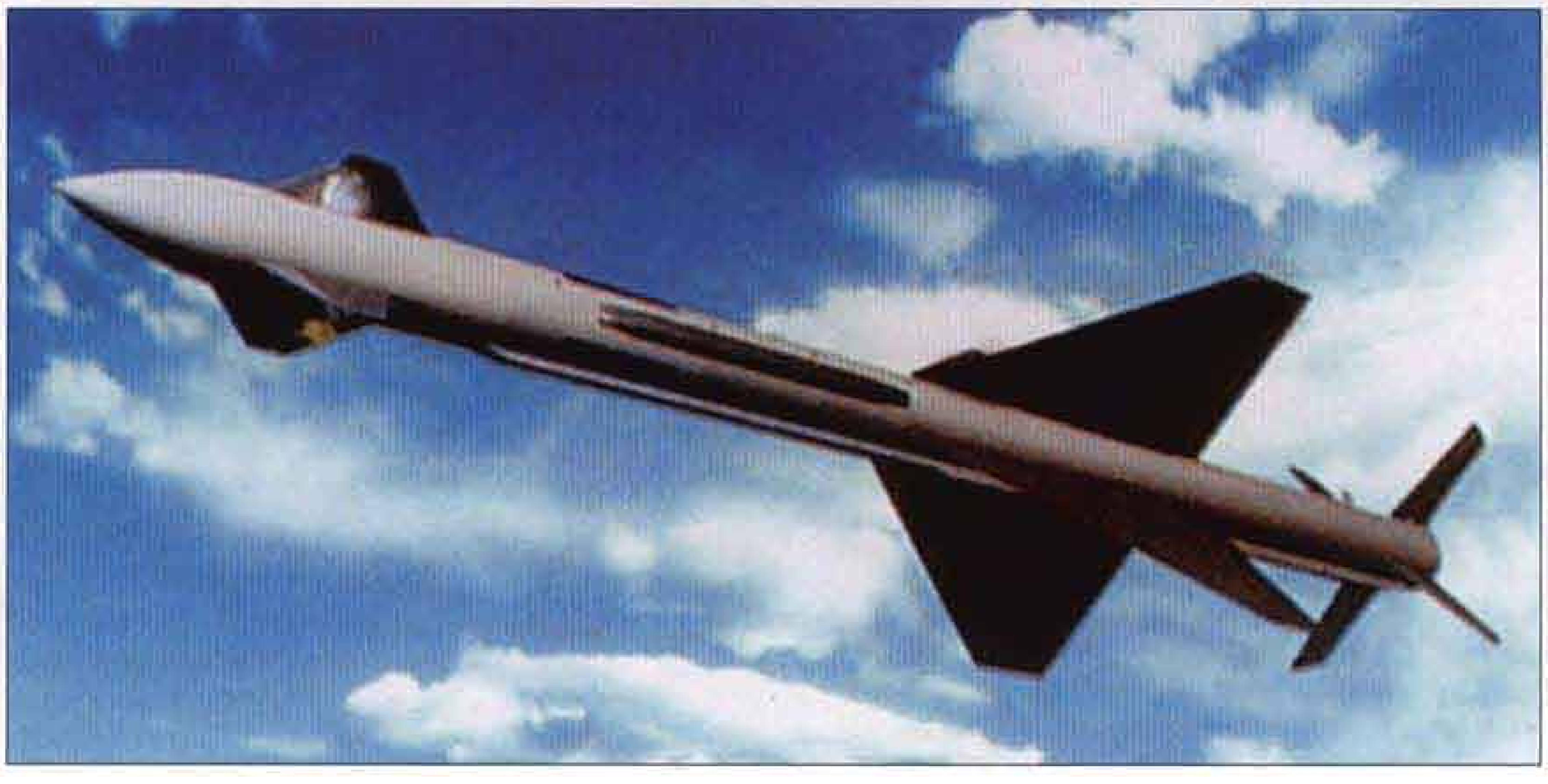

GMKB Vympel

missile armament comprised two K-24 (K-23M) medium-range AAMs then under development (alternatively, two production R-23R SARH missiles, likewise codenamed AA-7 *Apex*) and four K-60/K-60M IR-homing 'dogfight AAMs'. The latter could be substituted by two to four R-13M (AA-2 *Atoll*) short-range AAMs – a Soviet copy of the AIM-9 Sidewinder – or the projected growth version, K-13M1, eventually produced as the R-13M1 (AA-2-2 *Advanced Atoll*).

In the strike/close air support (CAS) role the aircraft could carry 100-kg (220-lb), 250-kg (551-lb) and 500-kg (1,102-lb) free-fall bombs; the total bomb load was 2,000 kg (4,410 lb). Other compatible air-to-ground weapons included UB-32 rocket pods with thirty-two 57-mm (2.24-in) S-5 folding-fin aircraft rockets (FFARs) each, B-8M rocket pods with twenty 80-mm (3.15-in) S-8 FFARs each, S-24 and S-25 heavy unguided rockets, and two UPK-23-250 gun pods (each housing a GSh-23 twin-barrel 23-mm cannon with 250 rounds). The armament was carried on six underwing hardpoints. (B = *blok* – unit or module. This term is used in many contexts – when speaking of avionics and so on: in this case it means 'FFAR pod'. UB = *oonifi**tsee**rovannyy blok* – standardised FFAR pod. UPK = *oonifi**tsee**rovannyy **push**echnyy kon**tey**ner* – standardised gun pod.)

The K-24 AAM was a product of the ***Vym**pel* (Pennant) OKB led by A. L. Lyapin; V. A. Pustovoytov, his deputy, was the missile's project chief. Developed for the MiG-23ML tactical

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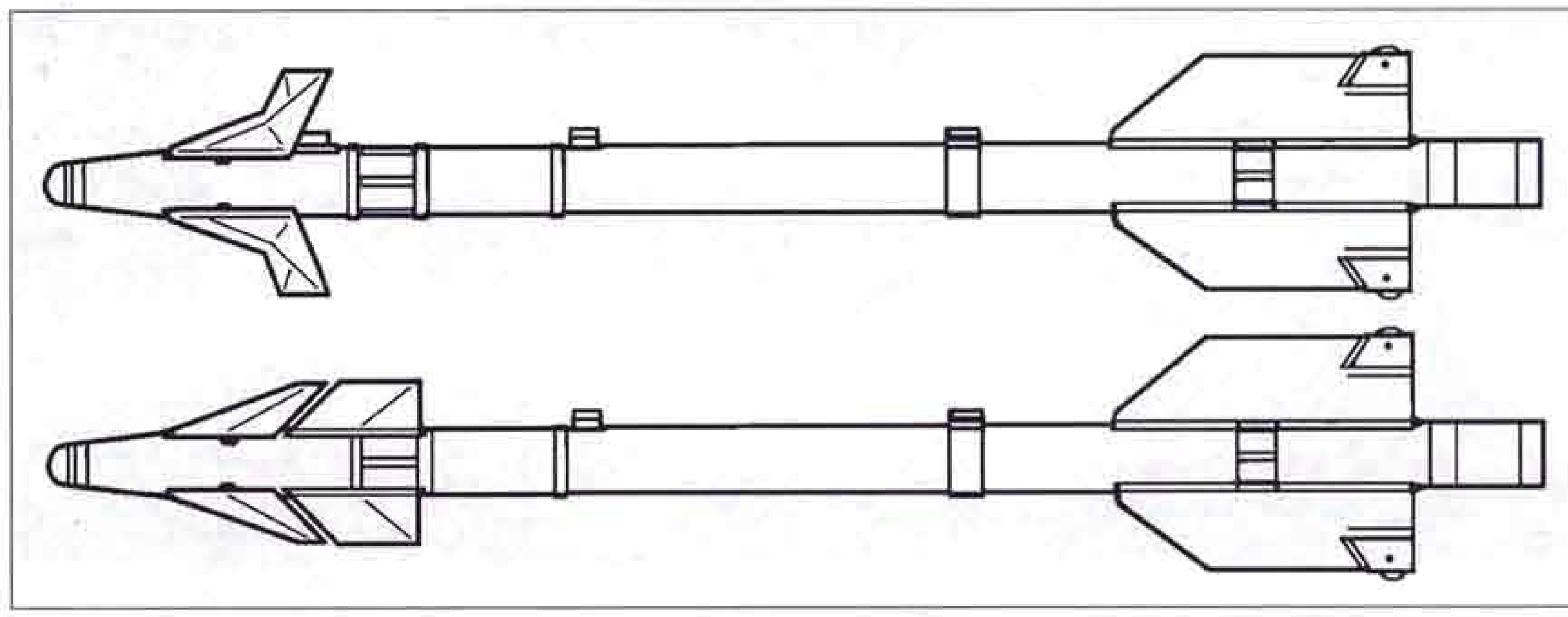
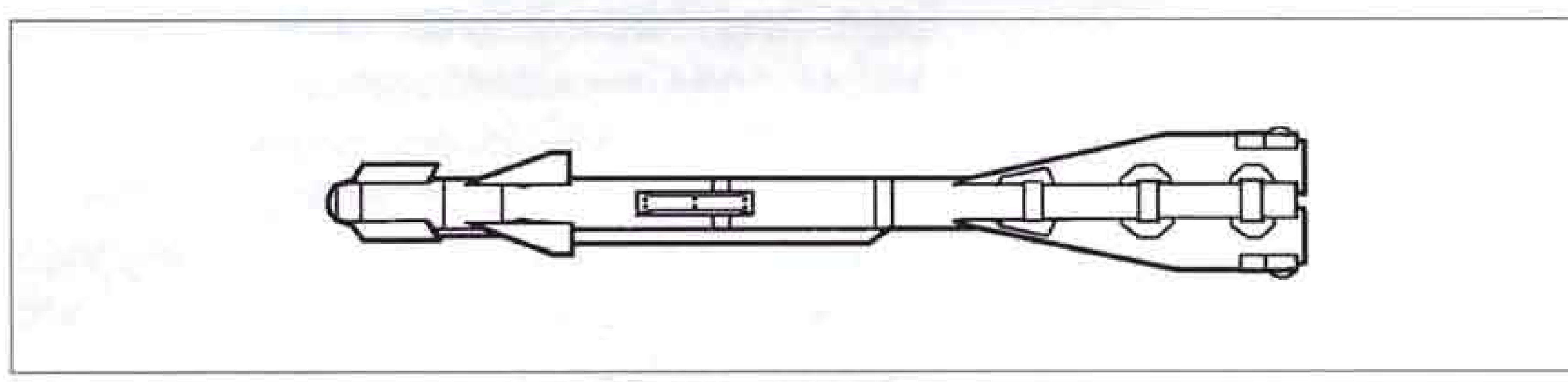
The K-13M1 (above) and K-14 short-range AAMs. Both were Soviet derivatives of the AIM-9 Sidewinder.

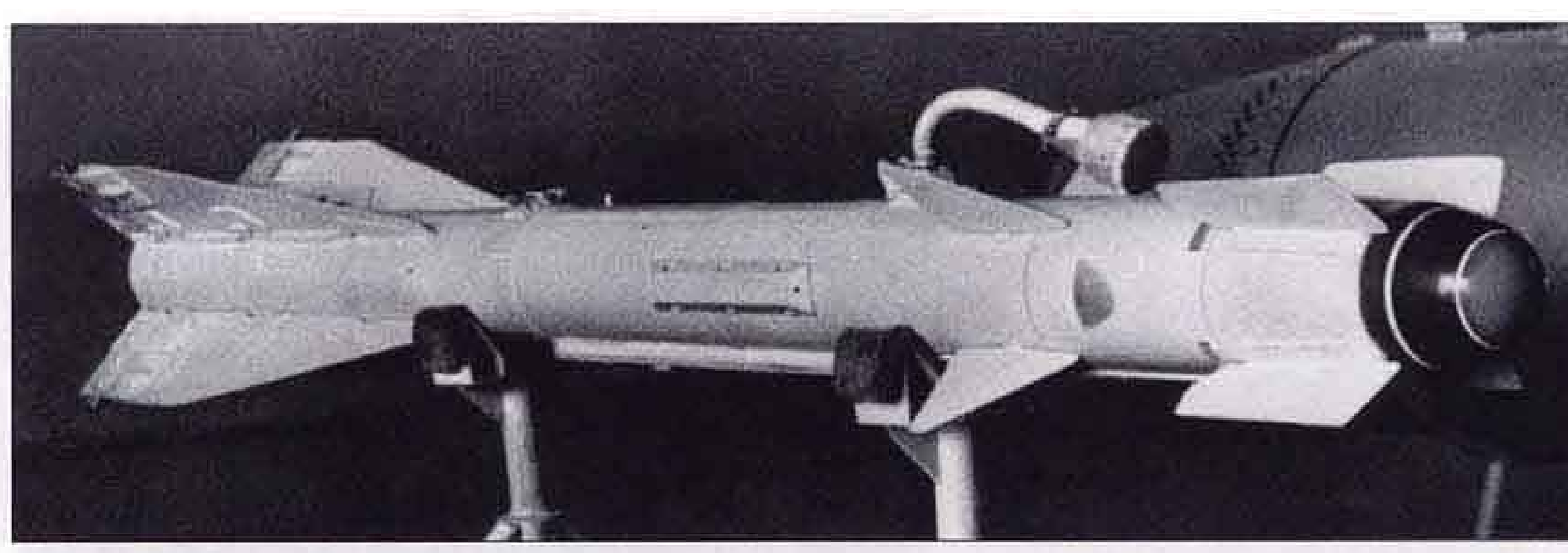


A photo of the R-13M1 from a GMKB Vympel ad.
► ▼

GMKB Vympel

A drawing of the K-60M and a photo of the real R-60M. Note the lateral aerial of the proximity fuse and the connecting cable
► ▼ ▼





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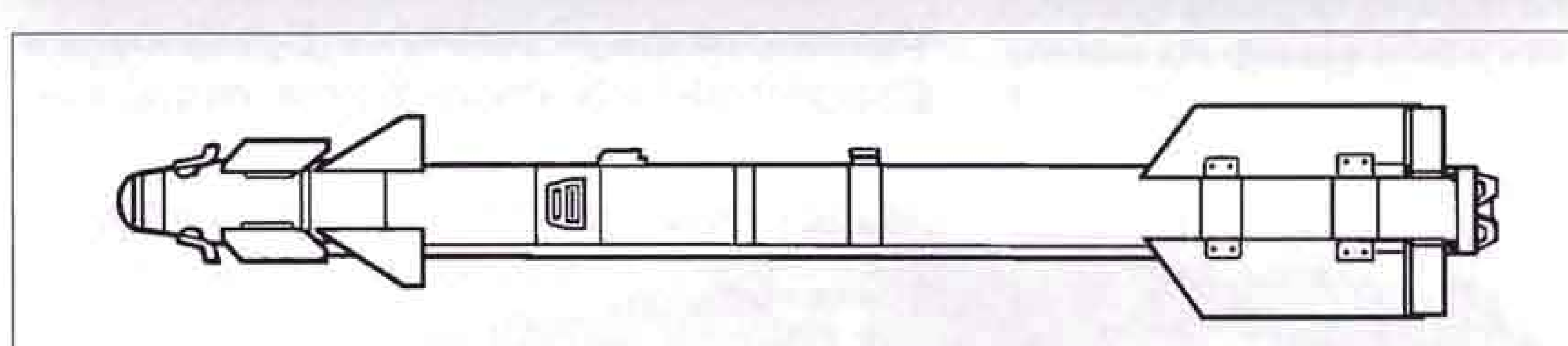
A drawing of the K-73 and a production R-73 missile.
► ▼ ▼ ▼



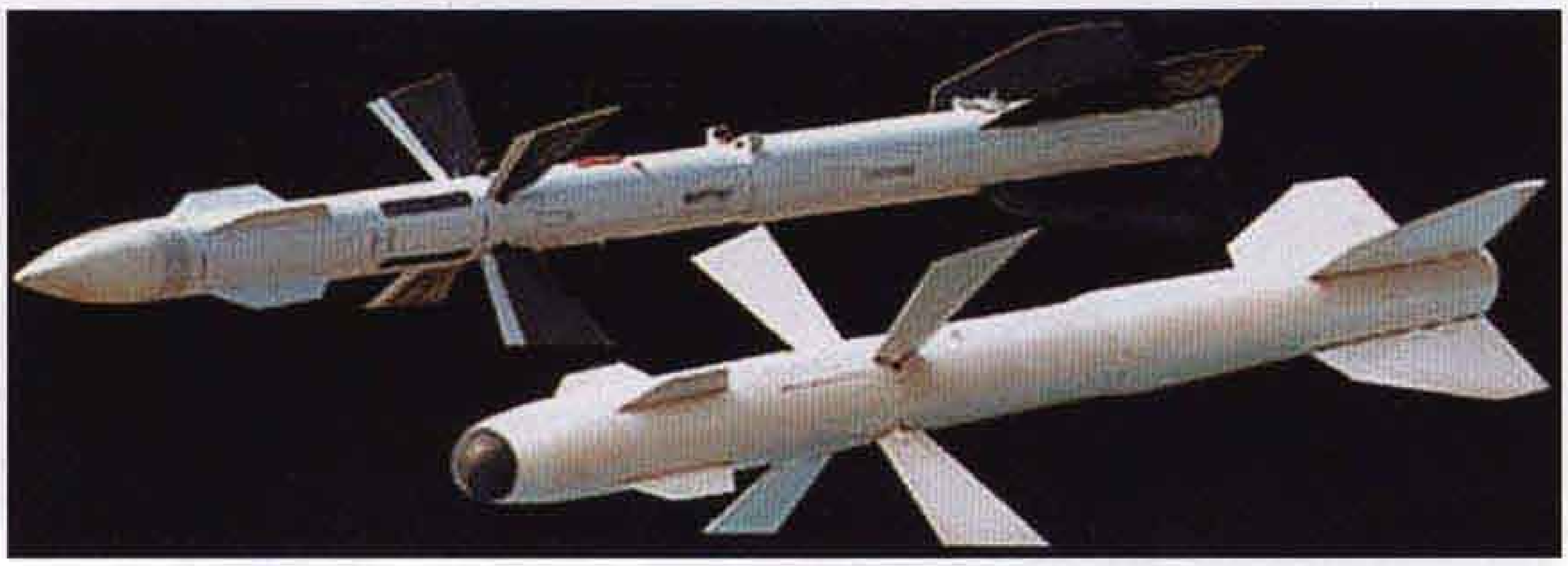
GMKB Vympel

fighter, the K-24 was a major upgrade of the production R-23 medium-range AAM introduced in 1973. It was comparable in performance to the newly-introduced AIM-7F (the latest version of the Sparrow) and had a range increased to 50 km (31 miles) and a more powerful warhead. The missile came in two versions – the K-24R with a monopulse radar seeker head (with enhanced ECM resistance) and the IR-homing K-24T; a passive radar-homing version (anti-radiation missile) and a version with combined IR/radar guidance were to follow later.

The K-13M1 emanating from the same bureau was an improved version of the R-13M missile used by most Soviet tactical aircraft since 1973. It had extended G limits (allowing it to be fired during tighter turns), a shorter minimum safe launch range and an upgraded ***In**ey-M* (Hoar Frost-M) IR tracker head.

The R-60M was developed by the rival ***Mol**niya* (Lightning) OKB under Matus Ruvimovich Bisnovat (his deputy V. N. Yelagin was project chief). Like the K-13M1, the R-60M was an upgrade of an existing missile (the R-60). However, in this case the engineers concentrated on increasing the field of view and IRCM resistance of the *Komar-M* (Mosquito-M) IR seeker head and on improving warhead lethality. The K-13M1 project was completed in 1974, the other two missiles following in 1975.

The AO-17A twin-barrel gun, also designated 9A623, was a product of A. G. Shipoonov's bureau of instrument engineering – a division of NPO ***Toch**nost'* (Accuracy) – in Tula south of Moscow, a town renowned for its gun makers. It used the 30-mm AO-18 round and utilised the same operating principle as the lighter GSh-23 (AO-9), one barrel being loaded by the recoil action of the other and vice versa. The AO-17A had a rate of fire of 3,000 rounds per minute, a muzzle velocity of 850 m/sec (2,788 ft/sec) and weighed about 100 kg (220 lb).



GMKB Vympel

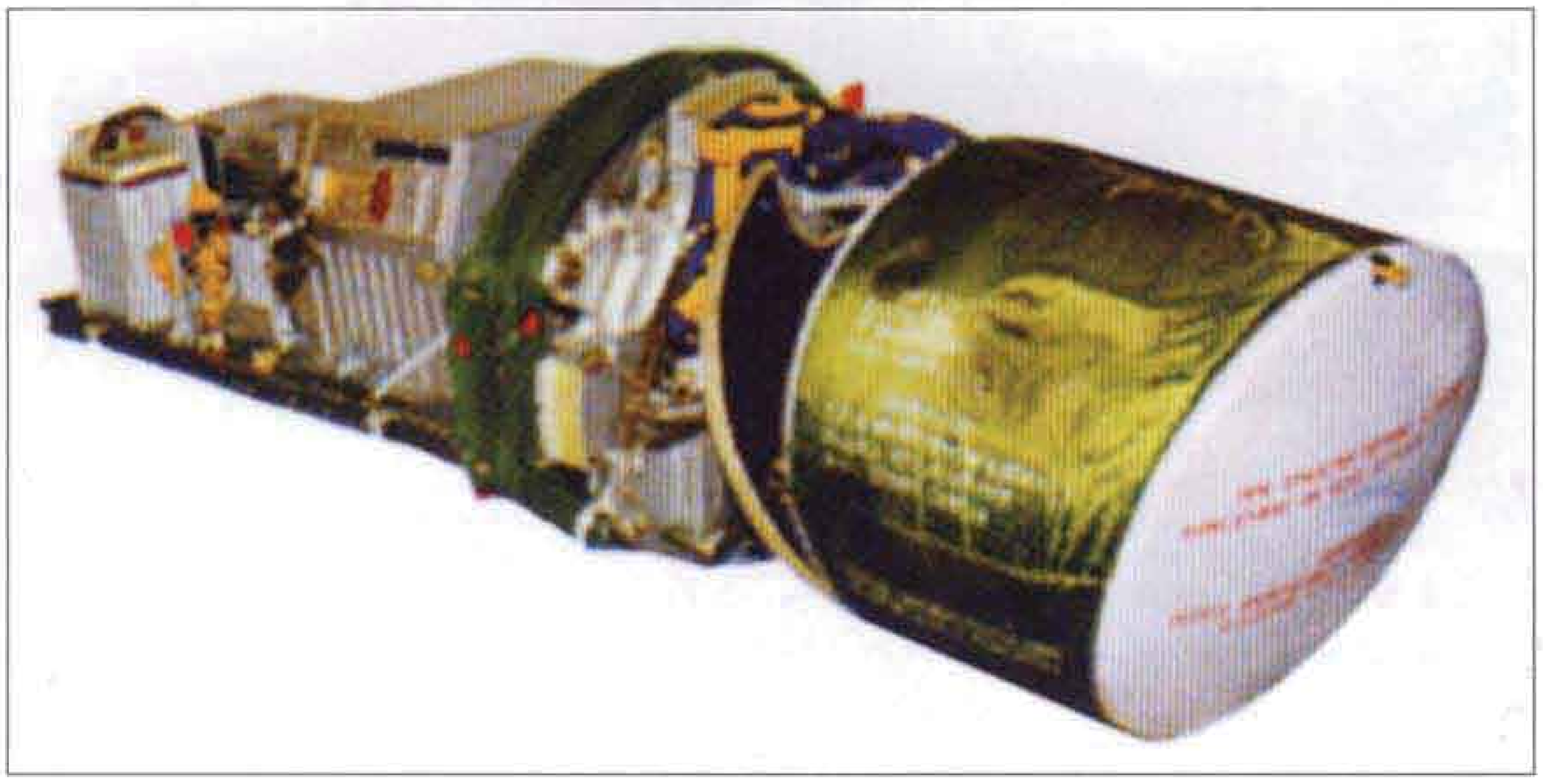
▲ The semi-active radar-homing R-27ER medium-range AAMs (left) and the IR-homing R-27ET

Originally, as mentioned earlier, Mikoyan had intended to equip the MiG-29 with a version of the GSh-23L cannon fitted to 'third-generation' versions of the MiG-21 and the MiG-23. However, the survivability of fighters (including the MiG-29's potential adversaries) had improved considerably since GSh-23 days and a 23-mm (.90 calibre) cannon simply did not pack a punch that was big enough; 30 mm (1.18 in) was the calibre required to really put some holes in the enemy. The AO-17A successfully passed its state acceptance trials in 1976 and was fitted to production Su-25 *Frogfoot* strike aircraft and Mi-24P *Hind-F* assault helicopters as the GSh-30.

The 'proper' MiG-29 differed from the 'entry-level' MiG-29A mainly in having an SUV-29 (S-29) WCS comprising the RLPK-29 (***rah****diolokatsi****on****nyy pri****tsel'****nyy* ***kom****pleks*) and the OEPrNK-29 (S-31) optoelectronic targeting/navigation suite. The latter was almost identical to that of the MiG-29A but featured a helmet-mounted sight enabling the pilot to 'point' the missile tracker heads towards the target and feed target data to the radar and IRST simply by turning his head towards it – a major asset in a dogfight.

The RLPK-29 radar targeting system was built around the Phazotron N019 Rubin radar (Ruby, pronounced *roo****bin***) developed under project chief Yuriy P. Kirpichov (Deputy General Designer at NPO Phazotron). It was a new-generation pulse-Doppler radar which was both lighter and more capable than current models, tracking up to ten targets at a time. A fighter-type target could be detected at 60-70 km (37.2-43.4 miles) in open airspace and 40 km (24.8 miles) in 'look-down/shoot-down' mode. The NATO codename was *Slot Back*. (Curiously, the same name was also used for a very different radar – the RBP-4 ground mapping/bombing radar fitted to the Tu-16 *Badger*, Tu-22A/R *Blinder-A/C* and Tu-95 *Bear-A* bombers; RBP = ***rah****diolokatsi-****on****nyy bombardi****rov****ochnyy pri****tsel*** – lit. 'radar bomb sight'.) The MiG-29 also featured an improved digital computer and changes to the weapons selection system and the SN-29 navigation system.

The Phazotron N019 Rubin fire control radar forming the core of the RLPK-29 targeting system. It has a twist-cassegrain antenna. ▼



Phazotron

The cannon and air-to-ground weapons were identical in both versions but the missile armament was totally new. In standard configuration the MiG-29 was to carry two new K-27 medium-range AAMs and four K-14 or K-73 short-range AAMs. Alternatively, six K-14, K-13M1, K-60M or K-73 AAMs could be carried.

The GOR for air-to-air missiles intended for fourth-generation fighters drawn up in 1973, and a government directive ordering the development of such weapons was issued next year. Specialists from GosNIIAS (notably R. D. Kooz'minskiy and A. N. Davydov) had a hand in making the GOR and closely monitored the missile development work.

At the same time there was a contest going on between the missile makers. The Vympel and Molniya bureaux were vying for the K-27 medium-range AAM. The missile was required to have better performance than the AIM-7F introduced in 1975 and a modular construction allowing it to be configured with different guidance systems and powerplants. The basic K-27A with a range of 70-80 km (43.4-49.6 miles) and a launch weight of 250 kg (550 lb) was intended chiefly for the MiG-29, while a version with a longer-burn rocket motor designated K-27B had a range of 120-130 km (74.5-80.7 miles) and a 350-kg (771-lb) launch weight was destined for the T-10. The A and B versions were intended mainly for the MiG-29 and T-10 respectively. Vympel's entry developed by chief project engineer A. L. Lyapin came out as the winner.

Vympel proposed two configurations of the K-27. One had regular tail surfaces while the other had large forward-swept canards; the latter configuration was selected at the advice of TsAGI. The missile came in four versions: the K-27R with SARH, the IR-homing K-27T (both with regular rocket motors) and the extended-range K-27ER and K-27ET. (R = *rahdiolokatsionnaya golovka samonavedeniya* – that is, radar homing unit; T = *teplovaya golovka samonavedeniya* – IR homing unit. The E means *energheticheskaya* – 'high energy', that is, with a long-burn rocket motor.)

Unlike all AAMs existing in the Soviet Union or elsewhere, the K-27 had an inertial guidance mode. The target was initially illuminated by the fighter's radar and the missile switched to active radar homing at the terminal guidance phase. This considerably increased effective 'kill' range, allowing the pilot to fire his missiles before the 'bad guy' did so, and was expected to give Soviet fighters a considerable advantage over the F-15 and McDD F/A-18 Hornet armed with Sparrows. The modular construction with interchangeable guidance units made the missile easily adaptable to the changing tactical situation and posed countermeasures problems for the enemy. The basic K-27R/T was broadly similar to the AIM-7F while the 'heavy' K-27ER/ET had much better speed and range. (After entering production in 1984-87 the missile was redesignated R-27 for *raketa* and received the NATO codename AA-10 *Alamo*.)

The same two bureaux were working on short-range (12-20 km/7.45-121.4 miles) AAMs, or 'dogfight missiles'. 'Vympel' developed the K-14 – a thorough update of the K-13M and K-13M1 with an omnidirectional IR tracker head and higher G limits. Molniya designed the all-new K-73 high-manoeuvrability wingless missile with a jet control system and an IR seeker head with a limited field of view. It was designed along the same lines as the K-60 (R-60 in production form/AA-8 *Aphid*) which weighed a mere 45 kg (99 lb).

However, aerial combat tactics and experience with foreign missiles showed that an omnidirectional tracker head was a must for a 'dogfight missile'. The VVS urged the company to alter the K-73 project and incorporate the *Mayak* (Beacon) wide-angle seeker head developed by the Arsenal factory in Kiev under project chief A. V. Molodyk. The new tracker head was rather large and heavy, resulting in an increase in the missile's dimensions; still, the basic concept remained unchanged.

In 1976 the K-73 had to be redesigned once again, as the original layout had some serious shortcomings, including poor manoeuvrability and limited flight time. The engineers opted for a mixed jet/aerodynamic control system and added cruciform wings. This decision was

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◄ **Yuriy P. Kirpichov, the chief project engineer of the N019 radar.**

influenced by reports of the US Navy's Agile AAM, a wingless missile with a jet control system which had been terminated for much the same reasons. In its definitive form the K-73 weighed 110 kg (242.5 lb).

The K-73 development programme was originally led by Matus R. Bisnovat until his death in 1977. Later, G. I. Khokhlov was assigned responsibility for guided missiles in the newly formed NPO Molniya with Gleb Yevgen'yevich Lozino-Lozinskiy as General Director. In 1983 NPO Molniya switched to ballistic missiles; the aircraft armament group was transferred to the ex-rival Vympel OKB – which thus got all the credit when the missile entered production two years later as the R-73 (AA-11 *Archer*).

As for Vympel, their competing K-14 project was completed in 1976 and it was immediately apparent that the two missiles were virtually identical in class, performance, weight and dimensions. The K-14 had the advantage of a simpler design, employing a purely aerodynamic control system, and a good deal of commonality with the proven R-3S (AA-3 *Anab*) and R-13M/R-13M1 which meant it could be readily launched from the MiG-21, MiG-23, MiG-27 *Flogger-D*, Yak-28P *Firebar*, Su-17 *Fitter-B* to *Fitter-K* and other fighters and fighter-bombers in service with the VVS.

To expand the G limits at which the missile could be fired the K-14 incorporated an unusual device called a feathering rudder. For a long time work on the two missiles progressed in parallel and the reason why the K-14 was eventually rejected was that its so-called no-autopilot control system dating all the way back to the 1960-vintage R-3S was hopelessly antiquated. GosNII AS engineers urged the OKB to redesign the control system completely but Vympel was not in a position to do so, having a lot of other air-to-air missile programmes on its hands (the K-24, K-27, K-33 and so on)

Combat efficiency analysis in 1974-76 showed that the 'entry-level' MiG-29A was quite capable of filling the role which the more sophisticated MiG-29 had been designed to fill. It could successfully destroy advanced Western fighters at medium and close range, intercept low-flying multi-role tactical aircraft and take out stationary or slow-moving ground targets in VMC conditions. In the air defence role it was capable of intercepting aircraft flying at up to 23,000-24,000 m (75,460-78,740 ft) and 2,500-2,600 km/h (1,552-1,615 mph). In the strike/CAS role the MiG-29A's combat efficiency was two to four times that of the MiG-21PFM *Fishbed-F*.

On 19th January 1976 the Communist Party Central Committee and the Council of Ministers issued a new directive ordering the development of two fourth-generation fighters – the MiG-29 light fighter and the Su-27 heavy fighter. Both types were to pass their state acceptance trials in 1977. This was the official go-ahead – at long last. The two aircraft were to feature an advanced weapons control system and highly effective new-generation weapons matching or even surpassing those of the F-15 and F-16. That took care of the 'two versions issue'; the more basic MiG-29A was cancelled and the OKB concentrated wholly on the MiG-29 *sans suffixe* as originally proposed.

The new-generation WCS proved to be one of the greatest challenges. Data available on the F-15 and F-16 showed that Western fighters were way ahead of Soviet ones in avionics, especially radar and processors. Therefore, the Su-27 and MiG-29 programmes involved a massive and high-priority R&D effort concerning primarily radar, digital aircraft processor, data exchange and data presentation technologies, as well as avionics integration.

An R&D programme codenamed Soyuz aided a lot in the development of radars for the new-generation fighters. The programme was initiated by NIIR's chief G. M. Koonyavskiy. He was the man responsible for the RP-21 *Sap**feer*** (Sapphire/NATO *Jay Bird*) radar of the MiG-21, the ***Oryol*** (Eagle/NATO *Skip Spin*) radar of the initial production Su-15 *sans suffixe* (*Flagon-A*) and the *Tai**foon*** (Typhoon/NATO *Twin Scan*) radar of the Su-15T/TM *Flagon-D/F*. In the late 1970s Koonyavskiy left NPO Phazotron and went on to work at GosNII AS.

The main 'contractor' under the Soyuz programme was NPO *Is**tok*** (Source of a river) under General Designer S. I. Rebrov. This company designed and built three prototypes of a fire control radar which, by coincidence, was also known as Soyuz. One was retained by the manufacturer for debugging, another was turned over to GosNII AS for trials in simulated service conditions and the third was tested by LII on an avionics testbed. The Soyuz was a pulse-Doppler radar broadly similar in design and performance to the Hughes Electronics AN/APG-65 fitted to the F/A-18. It featured semiconductor technology and a high-speed digital signal processor permitting ultra-accurate ground mapping. Ground and flight tests went well and, though the Soyuz was strictly a technology demonstrator, some of its features went into the N001 and N019 radars fitted to the Su-27 and MiG-29 respectively.

Development of digital computers for tactical aircraft and software for these computers had progressed in the Soviet Union since the late 1960s. Aerospace, electronics and defence industry enterprises involved included GosNII AS, LII, NPO Elektroavtomatika, NPO Phazotron, LNPO Leninets (Leninist) in Leningrad, NIITsEVT (*Na**ooch**no-is**sled**ovatel'skiy insti**toot** tsifro**vykh** elek**tron**no-vychis**li**tel'nykh tekhno**lo**giy* – Digital Computing Technologies Research Institute) and MNIIP (*Mos**kov**skiy na**ooch**no-is**sled**ovatel'skiy insti**toot** pri**bo**rostro**yen**iya* – Moscow Research Institute of Instrument Engineering, aka NPO Vega-M). It was not long before this massive effort bore fruit: starting in the early 1970s, digital computers were fitted to Soviet tactical aircraft, including fourth-generation fighters.

In the Su-27 and MiG-29, the first Soviet fighters with digital avionics, the extremely stringent operational requirements (high processing speed and multiple functions) meant the engineers faced a cartload of problems. The Mikoyan OKB had to undertake a special R&D programme named ***Fen**iks* (Phoenix) to tackle them. Under this programme supervised by Yuriy A. Yanyshev, the BTsK-29 digital avionics suite (*borto**voy** tsifro**voy** **kom**pleks* – lit. 'on-board digital complex') would be developed and tested on the purpose-built experimental version of the MiG-29 fighter. Apart from the Mikoyan OKB, which held overall responsibility, 29 other research and development organisations, including NPO Elektroavtomatika, NIIAS, NPO Phazotron, NIITsEVT and so on, participated in the Feniks programme.

The main part of the research under the Feniks programme was undertaken by the Mikoyan OKB's Research Section No.317 (NIO-317 – *na**ooch**no-is**sled**ovatel'skiy ot**del***). The BTsK-29 had a centralised federal architecture with digital data processing throughout, several data processing subsystems and several multiplex databuses. The work proceeded under the direction of V. P. Shkolin and G. V. Filimonov.

NIO-317 developed and built a test rig featuring a real MiG-29 cockpit and a data processing suite built around the SM-4 three-processor computing system which allowed the thing to work in real-time mode. This rig was used for testing and debugging the software of the data processing system, the software of the onboard processor modules and the integration of the latter with the aircraft's other avionics. V. V. Ivashchenko, V. S. Khenkin, I. Yu. Barchenkov, A. S. Fisher and Ye. F. Korolyov made a major contribution to the design process.

Tests revealed that multiplex data exchange channels based on ordinary wires could not furnish the data exchange speed required for advanced fighters and that fibre-optic lines were necessary. Once these had been incorporated, the new digital suite allowed the aircraft's avionics to 'talk' at the required speed, considerably enhancing the fighter's combat potential. Mikoyan OKB engineers N. V. Sementinov and V. Ye. Danovskiy made a major contribution at this stage.

The Feniks programme yielded important results. The main principles of the avionics' hardware structure on board an aircraft and of the cockpit data presentation and controls placement were formulated; the Ts100 series of digital computers was developed by NIITsEVT for the MiG-29 while NPO Elektroavtomatika produced a similar TsVM-80 computer (*tsifro**va**ya vychis**li**tel'naya ma**shi**na*) for the Su-27.

NIIAS led by Academician Yevgeniy A. Fedosov contributed much to designing and refining the MiG-29's avionics suite; P. V. Poznyakov directly supervised all of the institute's research programmes for the MiG-29. A lab managed by Z. A. Kaploon was specially organised at NIIAS for developing and debugging avionics software for fourth-generation fighters. With the cooperation of Mikoyan OKB Chief Designer Rostislav A. Belyakov the institute built a special S-2900 simulation complex for testing the fire control radar, optoelectronic targeting system and weapons control system. Data obtained on the KPM-2300 test rig/combat simulator (***kom**pleks poluna**toor**novo mode**lee**rovaniya*) developed under the guidance of G. A. Bashkov enabled the engineers to estimate how the MiG-29 would fare against the F-15 and F-16 in a dogfight. Later, NIIAS engineers participated in the state acceptance trials of the actual aircraft at GK NII VVS (the Air Force Research Institute).


RSK MiG

Yuriy A. Yanyshev, the man in charge of the Feniks R&D programme held by the Mikoyan OKB to develop the BTsK-29 digital avionics suite for the MiG-29.

The Feniks programme culminated in an advanced development project of the BTsK-29 avionics suite. The MiG-29E never reached the hardware stage.

MiG-29 (*Izdeliye* 9.12) and MiG-29A (*Izdeliye* 9.12A, First Use of Designation) Light Tactical Fighter (Definitive Projects)

The MiG-29 project was finally frozen in 1977. However, preparation of drawings and project documents had gone on steadily for the last four years. When approving the 1/20th scale drawings of the MiG-29A on 15th July 1974, General Designer Rostislav A. Belyakov had deemed it necessary to increase wing area from 34 m² (365.6 sq ft) to 38 m² (408.6 sq ft). The rewinged fighter received a new manufacturer's designation, *izdeliye* 9.12, the 'entry-level' version with MiG-23 avionics and armament becoming *izdeliye* 9.12A. The general arrangement, however, remained unaltered; *izdeliye* 9.12 was blended wing/body mid-wing monoplane with prominent LERXes and powerful high-lift devices, canted

RSK MiG

▲
The full-scale wooden mock-up of the MiG-29 (*izdeliye* 9.12) behind a security fence in the assembly shop of the Mikoyan OKB's experimental plant (MMZ No.155). Note the extra frame member on the hinged portion of the canopy, a detail which was later deleted.

This view shows how the nose gear unit was positioned well aft on the mock-up, in line with the intakes' upper lip. The nose gear unit would be repositioned twice afterwards.
▼

RSK MiG

RSK MiG

◄
This front view shows the twin muzzle ports of the originally envisaged AO-17A cannon, the taxi lights on the nose gear door attached to the oleo and the closed FOD protection door of the port air intake. Note the drop tank and the MiG-31 cockpit section in the background.

The cockpit of the mock-up, showing the large HUD and the Zvezda K-36D ejection seat with twin 'rip yer balls off' actuation handles.
◄▼ ▼

Another view of the MiG-29 mock-up with the canopy open. Note that here the nose gear strut is located further forward.
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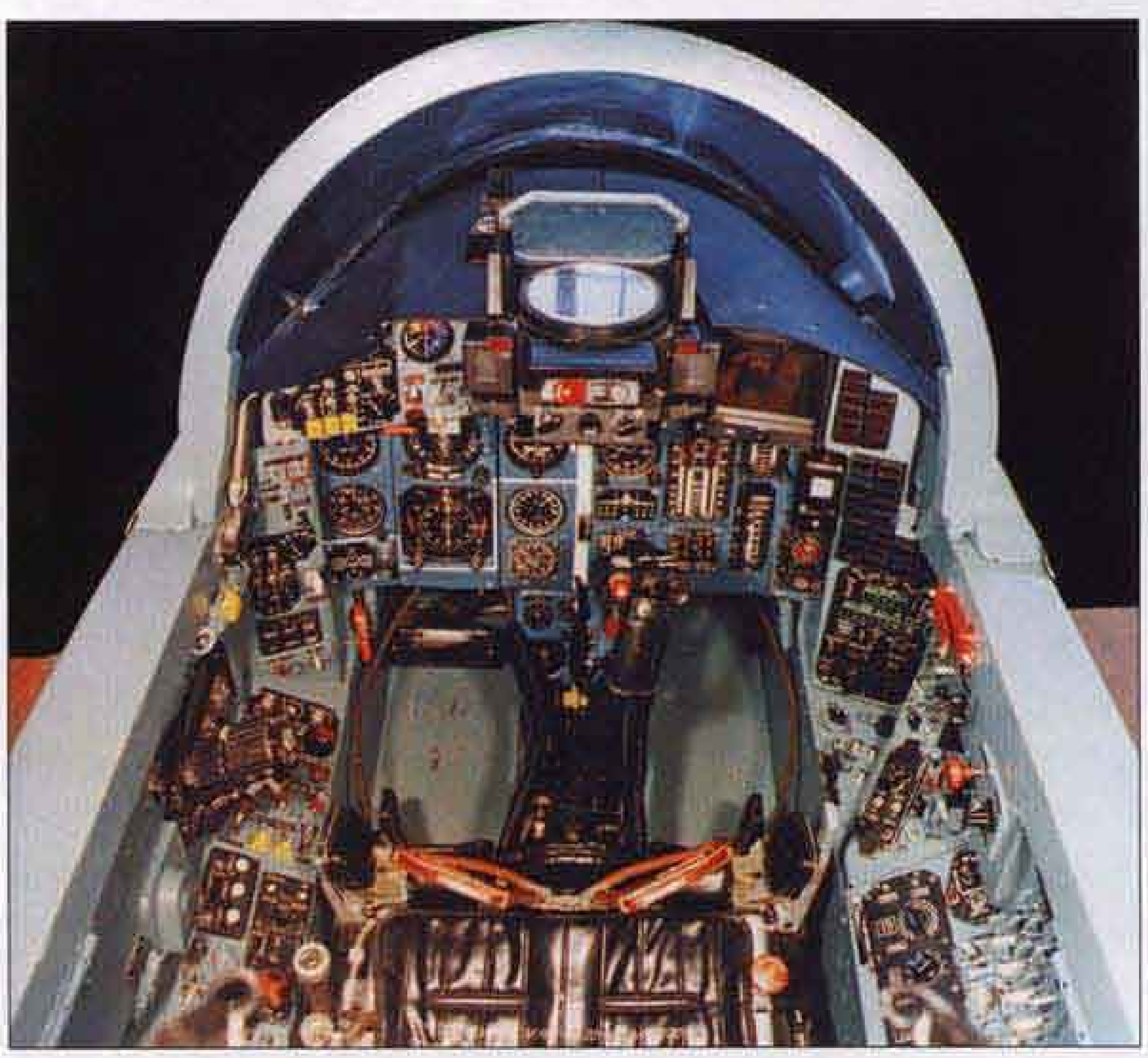

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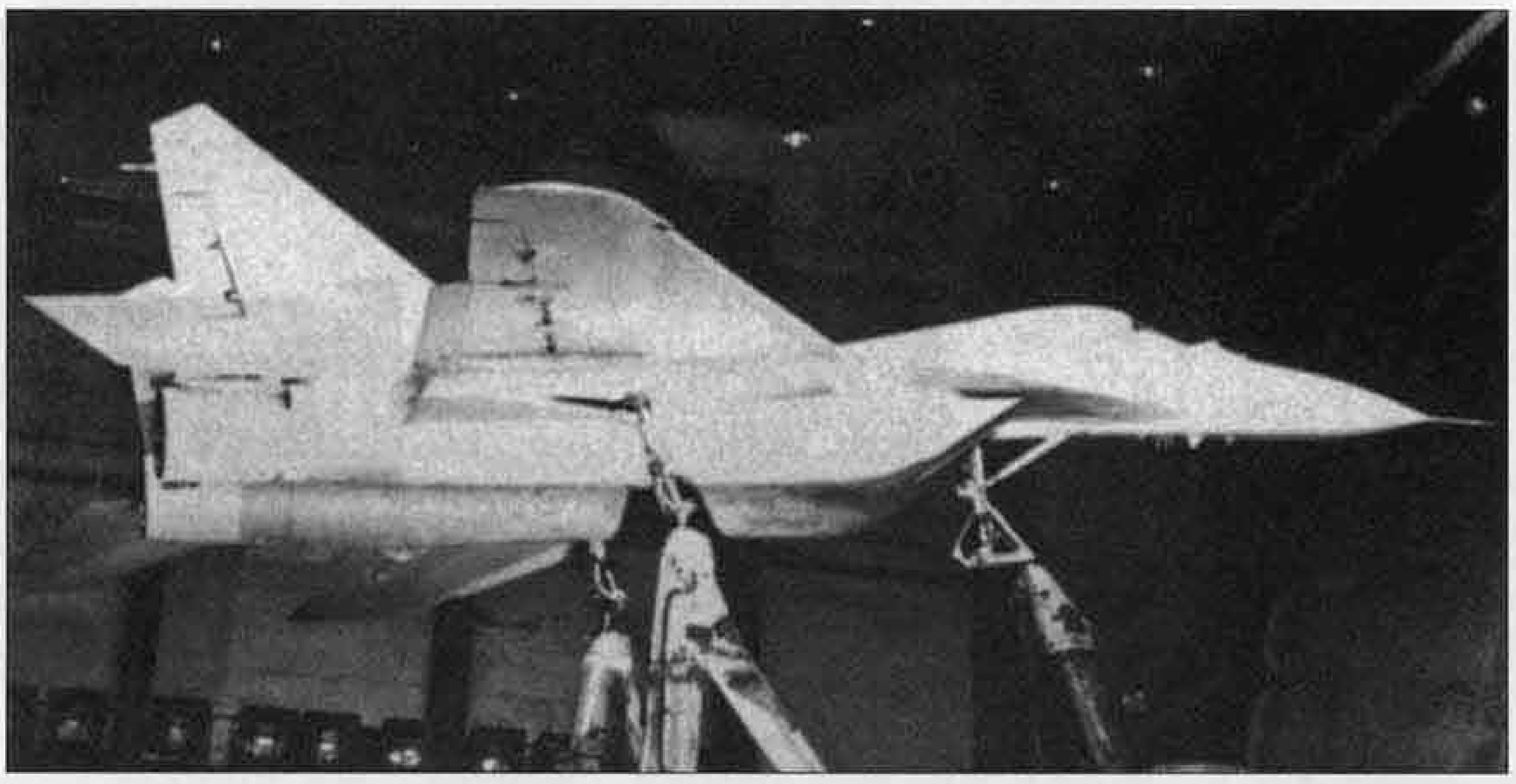
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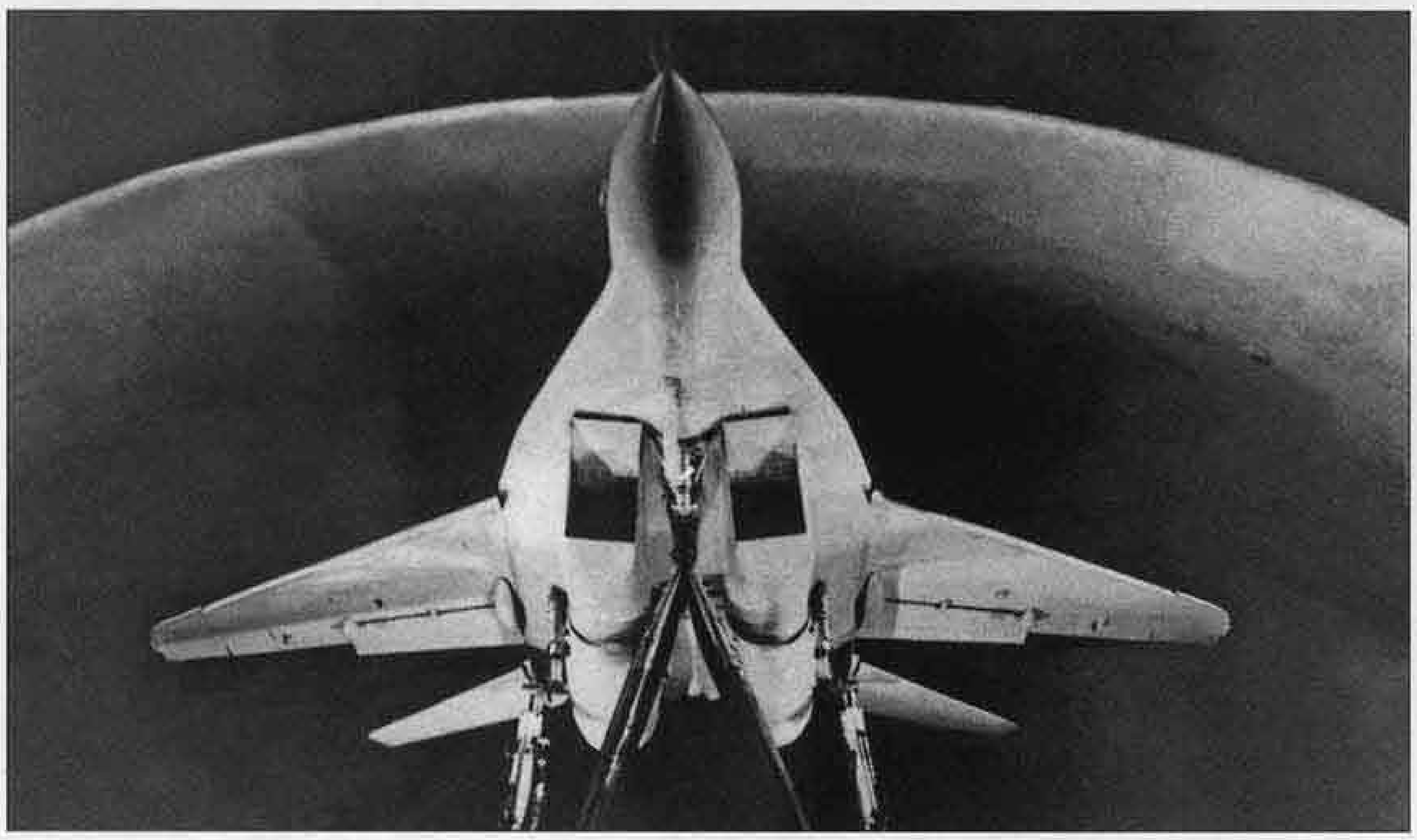
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▲▲
This is not a model – this is a full-scale MiG-29 development aircraft in the TsAGI T-1 wind tunnel in Zhukovskiy. The mounting struts are attached to the landing gear units with the wheels removed and the wheel wells are faired over. Note the area-increasing flaps being tested.

▲
Another view of the MiG-29 in the T-1 wind tunnel.

twin tails and differentially-movable low-set stabilators. It was powered by RD-33 afterburning turbofans in underslung spaced nacelles with inlet FOD protection doors and auxiliary dorsal intakes, and fitted with a heavy-duty tricycle landing gear.

The BWB layout provided a good lift/drag ratio and ample structural strength reserves, enabling the aircraft to pull high G loads and manoeuvre at high AOAs. Wing lift was increased by means of camber, programmable automatic leading-edge flaps, trailing-edge flaps and flaperons. The LERXes increased wing lift at high alpha, reducing the risk of stalling and/or spinning. The multi-mode air intakes were highly efficient at high alpha, rendering the aircraft safe and easy to fly.

The MiG-29 made large-scale use of composites and aluminium-lithium (Al-Li) alloys to cut airframe weight. The elevated position of the cockpit and the bubble canopy with a one-piece curved windscreen offered the pilot excellent all-round visibility; this was helped by the triple rear-view mirrors on the windscreen frame. The pilot sat on a K-36DM zero-zero ejection seat developed by the 'Zvezda' (Star) design bureau under Guy Il'yich Severin; it enabled safe ejection throughout the aircraft's flight envelope.

In definitive form the MiG-29 had a length of 15.0 m (49 ft 2$\frac{35}{64}$ in) less pitot boom, a wingspan of 10.8 m (35 ft 5$\frac{3}{16}$ in), a wing area of 38.0 m^2 (408.6 sq ft) and a height on ground of 4.56 m (14 ft 11$\frac{35}{64}$ in). Empty weight was 9,670 kg (21,320 lb) and normal take-off weight with a 3,650-kg (8,050-lb) internal fuel load was 13,570 kg (29,920 lb; the specific operational requirement stated a 12,800-kg (28,220-lb) TOW). Takeoff thrust-to-weight ratio was 1.23 and specific wing loading was 350 kg/m^2 (1,706 lb/sq ft).

Unlike the Su-27, which was designed to operate up to 400 km (248 miles) beyond the frontlines, the MiG-29 was to operate mostly over friendly territory, venturing only some 100 km (62 miles) beyond the frontlines. It had higher performance and more capable avionics and armament than the MiG-23 then forming the backbone of the Soviet Air Force's tactical fighter element. The higher performance was due to the integral layout increasing speed and manoeuvrability and to the twin engines giving a significantly better thrust-to-weight ratio (compared to the *Flogger*'s single engine). The highly effective K-27, K-73 and K-14 new-generation AAMs and twin-barrel 30-mm cannon enabled the MiG-29 to destroy highly manoeuvrable targets within a broad speed and altitude range.

The SOR stated the MiG-29's roles first of all as counter-air and top cover for ground troops. The CAS/strike role was viewed as very secondary, which, as Mikoyan conceded, was a big mistake. The aircraft was required to have a top speed of 2,500 km/h (1,552 mph) at high altitude, 1,500 km/h (931 mph) at sea level and go from 600 to 1,100 km/h (372 to 683 mph) in 13 seconds and from 1,100 to 1,300 km/h (807 mph) in 7 seconds. Service ceiling with 50% fuel was 19,500 m (63,980 ft); maximum rate of climb at 1,000 m (3,280 ft) was 325 m/sec (63,960 ft/min). Range was 800 km (496 miles) at sea level and 2,750 km (1,708 miles) at high altitude with a single 1,500-litre (330 Imp gal) drop tank on the fuselage centreline.

The aircraft was stressed for 9 Gs. This and the high AOA limit, wide speed and altitude range, high thrust-to-weight ratio and carefully designed aerodynamics enhanced flight safety, allowing prolonged violent manoeuvres in combat.

Combat efficiency estimates showed that the MiG-29 could destroy an F-4E, an F-111A, a

Tornado or a Jaguar flying at 30-23,000 m (100-75,460 ft) and up to 2,500 km/h (1,552 mph) with K-27 missiles in both head-on and pursuit mode. In a dogfight with an F-15 or an F-16 armed with AIM-9L Sidewinder missiles the chances of a kill were 1.4 and 1.5 times better than the respective enemy's. In a long-range 'missile duel' with an incoming F-15 the MiG-29 (aided by GCI centres) was superior to the enemy throughout its flight envelope thanks to the higher agility of the K-27 AAM as compared to the AIM-7F. It was also decidedly superior to the F-16A because the N-019 radar had much longer detection range than the US fighter's Westinghouse AN/APG-66. The probability of scoring a hit on an F-4E pulling 4 Gs with a 0.5-second burst of gunfire at 200-800 m (660-2,620 ft) range was 40-80%; it was estimated that four or six rounds would do the job. Efficiency against ground targets was also deemed to be adequate.

The cannon armament was changed before long. Mikoyan soon decided that the AO-17A (GSh-30) was rather too heavy for a light fighter like the MiG-29. A joint effort of the OKB (notably PD section chief Tyapkin) and NPO Tochnost' resulted in the development of an acceptable weapon brought out in 1976. The new cannon, designated TKB-687 or 9A4071 used the same AO-18 round; it was based on a single barrel borrowed from a naval twin-barrel 30-mm automatic gun and shortened by 500 mm (1 ft 7 11/16 in). This reduced the muzzle velocity to 850-900 m/sec (2,790-2,950 ft/sec) as compared to the naval weapon but even so it was actually higher than that of the AO-17A! At 50 kg (110 lb), the TKB-687 was twice lighter than the AO-17A and had a rate of fire of 1,500-1,800 rpm.

A prototype was built in 1977; six years later the production cannon (redesignated GSh-301) was fitted to the MiG-29 and Su-27. With this weapon, the probability of scoring a hit on an F-4E pulling 4 Gs with a 0.5-second burst at 200-800 m range was 20-70% (one barrel is less than two, after all).

The Mikoyan OKB also had to cope with a few problems while integrating the GSh-301 cannon with the MiG-29. The belt feed mechanism and the ejection of empty cases and belt links had to

One more aspect of the MiG-29 (aircraft 922). This aircraft was transferred to TsAGI for full-scale wind tunnel tests after making a mere four flights. ▼

TsAGI


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As a precaution against NATO surveillance satellites, at a very early stage of the programme the Mikoyan OKB devised an ingenious way of camouflage making the aircraft appear to have lateral air intakes. These were to be fitted to the prototypes whenever these were handled in the open (outside a hangar or an anti-satellite shed).


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Two more views of the MiG-29A model showing how the false air intakes fitted onto the LERXes. The idea was to create the impression of intakes similar to those of the MiG-25.

be optimised; the harmful effect of the blast gases on the airframe and avionics/equipment had to be minimised. The cannon ammunition proved to be too sensitive to heat, which required a special breech cooling system to be created. A. V. Tyurin, A. I. Lyovochkin, Yu. A. Blinnikov, M. A. Proodtsev, S. A. Ovsyannikov and other engineers of the Mikoyan OKB's armament section were involved in developing and testing the MiG-29's cannon installation. Interestingly, its ultimate version passed its in-house project review when the prototype was already under construction.

At this stage it is worth mentioning how the Soviet counter-intelligence service worked to prevent accurate information on the new fighter from leaking out; obviously any titbit of information obtained by the 'potential adversary' could, and would, be used for developing anti-MiG-29 tactics and tricks. Therefore, right from the SOR formulation stage, the security departments of the enterprises and establishments involved in the MiG-29 programme (first and foremost the Mikoyan OKB itself) analysed possible 'leaky joints' in the information pipeline and developed countermeasures; the information was disseminated to 'those who needed to know' at the design offices and production plants. Thus they managed to complicate matters for the NATO's intelligence agencies and delay the leakage of data on what progress had actually been made on fourth-generation fighters in the Soviet Union.

As already mentioned, the blended wing/body layout was one of the main features of the MiG-29's aerodynamics (as was also the case with the T-10 and the Su-27). Hence the Mikoyan OKB developed a special disguise for the MiG-29A; false lateral air intakes were scabbed on to the fighter's sides to lead Western intelligence agencies astray in the event that the MiG-29 prototypes were photographed by surveillance satellites when parked in the open.

As the subsequent analysis of Western aeronautical and defence publications showed, these carefully developed concealment measures proved effective. For a long time the West was unaware of the MiG-29's true aerodynamic layout, conjuring up several 'versions' of the fighter which in reality never existed, and the potential adversary remained under this false impression throughout the MiG-29's test and state acceptance trials programme.

PART TWO

LEARNING TO FLY

▶
Four views of the appropriately coded '01 Blue', 'aircraft 901' was the first flying prototype of the MiG-29 (note the '901' on the dielectric fin caps). This aircraft differed from all subsequent MiG-29s in having a longer wheelbase in an attempt to enhance the aircraft's directional stability on the ground. The nosewheels are located well ahead of the air intakes, hence the large mudguard enclosing the nosewheels. No ventral fins are fitted yet. Note the three-tone camouflage, the one-piece curved windscreen, the original narrow-chord rudders and the 'beaver tail' fairing between the engine nozzles.
▼

MiG-29 Prototypes & Pre-Production Aircraft (901 through 904, 908 and 917 through 925)

Originally the Mikoyan OKB had planned to build no fewer than 25 flying prototypes and a number of static test airframes. The unusually large number of development aircraft was due to the extreme complexity of the flight test programme; performance and handling trials, avionics trials, armament trials and so on would have to be assigned to different aircraft. And so they were; each flight test airframe was allocated a code number (901 through 925 – that is, [MiG-2]9, flight test article Nos. 1-25) and 'a piece of the cake'. For the first time in Soviet aircraft design history the three-digit prototype numbers were included in government directives, so changing them or reallocating them to a different airframe was out of the question.

Each of the prototypes would have mission equipment and flight test equipment (sensors and data recorders) to match the specific part of the trials programme it was built for. For the first time in Mikoyan's design practice a full-scale aircraft was to be tested in the TsAGI wind tunnel and special airframes built for test avionics trials and avionics compatibility testing.

In keeping with the original two-stage development concept some of the prototypes were earmarked for completion to MiG-29A standard with the SUV-23ML-2 weapons control system. However, it soon turned out that the radar set of the Yantar' (Sapfeer-23ML-2) radar did not fit the MiG-29 airframe. In the MiG-23 the bulky cubic radar set fitted nicely into a bay aft of the cockpit but, try as they would, Mikoyan engineers could not squeeze it into the MiG-29A. NPO Phazotron offered to develop a horseshoe-shaped unit that would fit under the cockpit. However, when the engineers tried fitting the restyled radar set to the full-scale mock-up the result was pure frustration: the unit was too large again. The problem was cured by making the LERXes slightly thicker to provide more room in the avionics bay.

However, as was mentioned earlier, the MiG-29A was cancelled in 1976, leaving only the 'full-blooded' MiG-29. Besides, after Lt. Viktor I. Belenko's notorious defection to Japan in a MiG-25P *Foxbat-A* interceptor on 6th September 1976 NPO Phazotron had to concentrate wholly on developing the S-25 (Sapfeer-25) fire control radar for the upgraded MiG-25PD *Foxbat-E*, which meant the Yantar' radar had to be shelved.

As a result, the MiG-29A airframes (aircraft 905 through 907 and 909 through 916) were never built. The code number 908 allocated to a MiG-29A was later reused for a powerplant development aircraft built to replace the third prototype lost during the trials. Thus a total of 14 flight test aircraft was actually completed.

The first four prototypes were built at Mikoyan's experimental shop (MMZ No.155) with assistance from MMZ No.30 '***Zna****mya* ***Tru****da*' (Banner of Labour). This factory (now part

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of MAPO, *Moskovskoye aviatsionnoye proizvodstvennoye obyedineniye* – the Moscow Aviation Production Association named after Pyotr V. Dement'yev) located at Moscow's Central airfield named after Mikhail V. Frunze (better known as the Khodynka airfield) was gearing up to manufacture production MiG-29s and supplied major structural components such as main integral fuel tanks for all prototypes. The aircraft sported a two-digit tactical code in blue on the air intakes and the full prototype code number in white on the dielectric fin caps. For example, the first prototype was '01 Blue/901 White', the second was '02 Blue/902 White' and so on. Unlike Western military aircraft which have *serial numbers* allowing positive identi-

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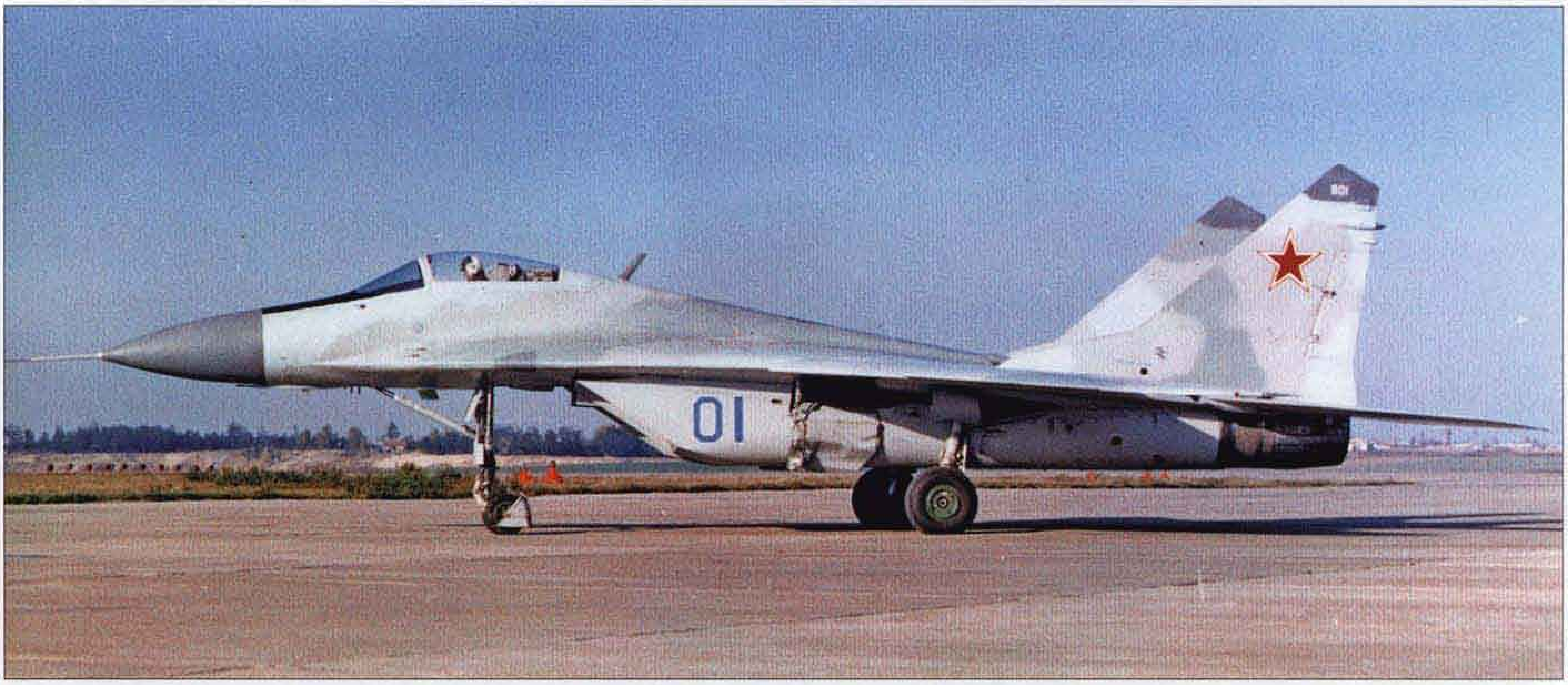

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This front view of 'aircraft 901' with engines running shows the perforated main air intake blocker doors, the cannon muzzles, and the nose gear door segments and taxi light attached to the nose oleo.

◄
Merited Test Pilot Aleksey V. Fedotov, the Mikoyan OKB's chief test pilot who took the MiG-29 up for its maiden flight.

fication, Soviet military aircraft have two-digit *tactical codes* which are usually simply the aircraft's number in the unit which operates it. Three-digit codes are rare and are usually allocated to development aircraft only, often tying in with the aircraft's construction number (manufacturer's serial number) or designation.

All manufacturing drawings released by the OKB had to be duly approved by the factory, the All-Union Institute of Aviation Materials (VIAM – *Vsesoyooznyy institoot aviatsionnykh materiahlov*) and the Research Institute of Aviation Technologies (NIAT – *Naoochno-issledovatel'skiy institoot aviatsionnykh tekhnologiy*). To make sure the prototypes were completed on schedule V. Bykov, a Mikoyan employee, drew up an interdepartmental plan roughly equivalent to a flow chart at a Western enterprise. Representatives of organisations involved in the MiG-29 programme would come to Moscow from all over the country to report on progress and sign the plan, showing what had actually been done. Both MMZ No.30 and the Mikoyan experimental shop had to buy state-of-the-art manufacturing equipment. The experimental shop participated in assembling all prototypes and fitting them out with test instrumentation.

The first prototype was rolled out in 1977 and commenced ground systems tests that year. Having as yet no practical knowledge of the structural strength reserves of an integral-layout aircraft, Mikoyan engineers had incorporated excessive structural strength in the MiG-29, just to be on the safe side, making the aircraft rather overweight. For the first time in Soviet fighter design practice a service life limit had been set, so measures had to be taken to reduce stress build-up in the fighter's structural elements. Both VIAM and TsAGI had expressly recommended the use of composites, and the Mikoyan OKB had high hopes, expecting to save some 400 kg (880 lb) of airframe weight by using them. The real weight saving, however, was only about 200 kg (440 lb). As a result, the first prototype's TOW was 700 kg (1,543 lb) above the specified limit.

Since '01 Blue/901' was intended primarily for handling and performance trials, no cannon was fitted, although the aircraft had provisions for a GSh-30 (AO-17A) gun and featured twin muzzle openings in the port LERX. A mock-up cannon was originally installed but later removed and the gun ports were faired over.

On 6th October 1977 the MiG-29 became airborne for the first time with Mikoyan chief test pilot Aleksandr V. Fedotov at the controls. Valeriy Ye. Menitskiy also flew the first prototype. Later, as more prototypes became available and the scope of the trials programme widened, other test pilots joined in, namely Pyotr M. Ostapenko, Boris A. Orlov, Aviard G. Fastovets, Toktar A.

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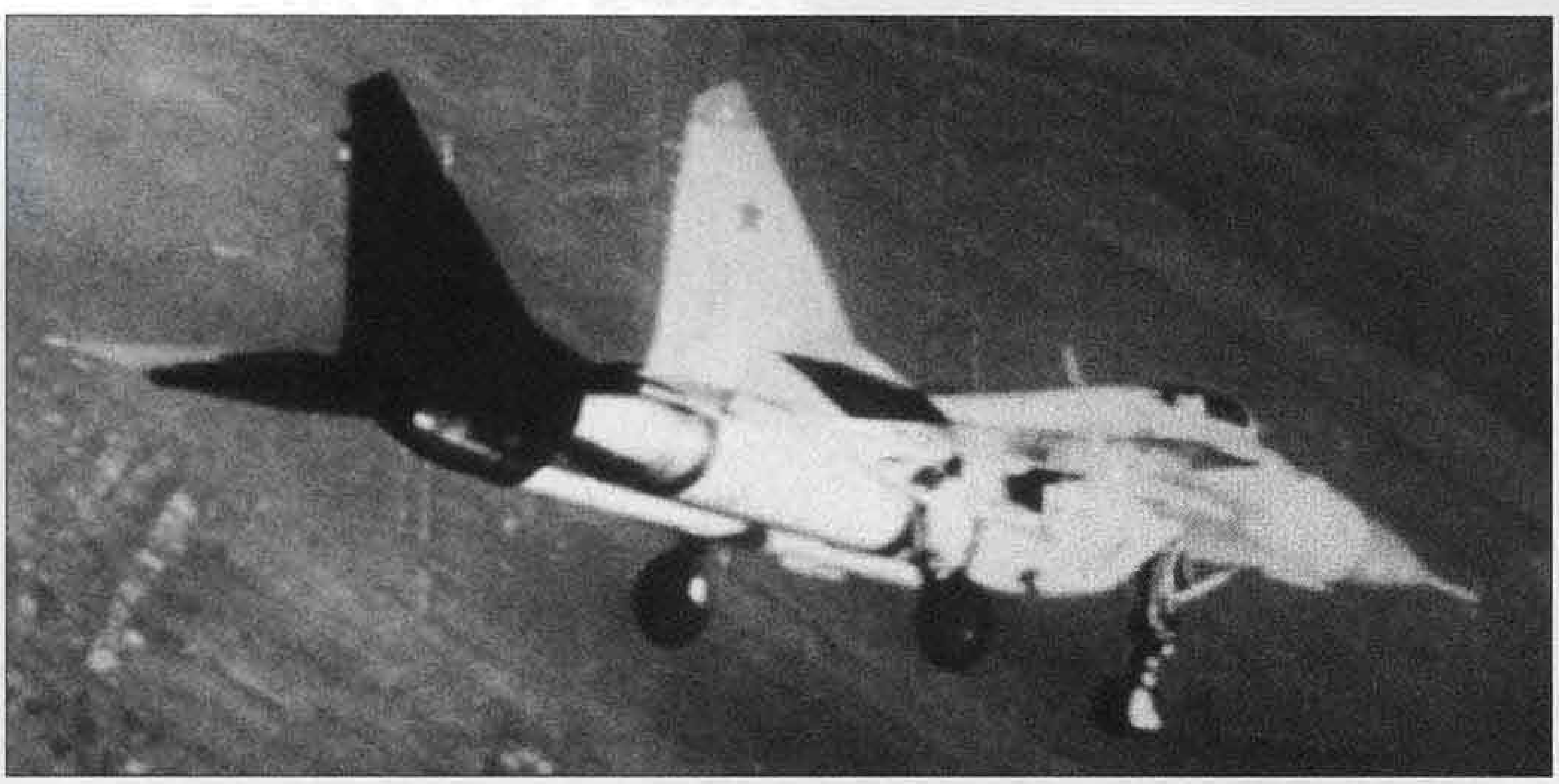
Aleksey Fedotov receives the final instructions before a test flight in MiG-29 '01 Blue'.



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A rare in-flight shot of the first prototype MiG-29 during an early test flight.

Aleksey Fedotov is greeted by overjoyed Mikoyan OKB employees as he climbs out of the first prototype MiG-29 after the maiden flight on 6th October 1977.
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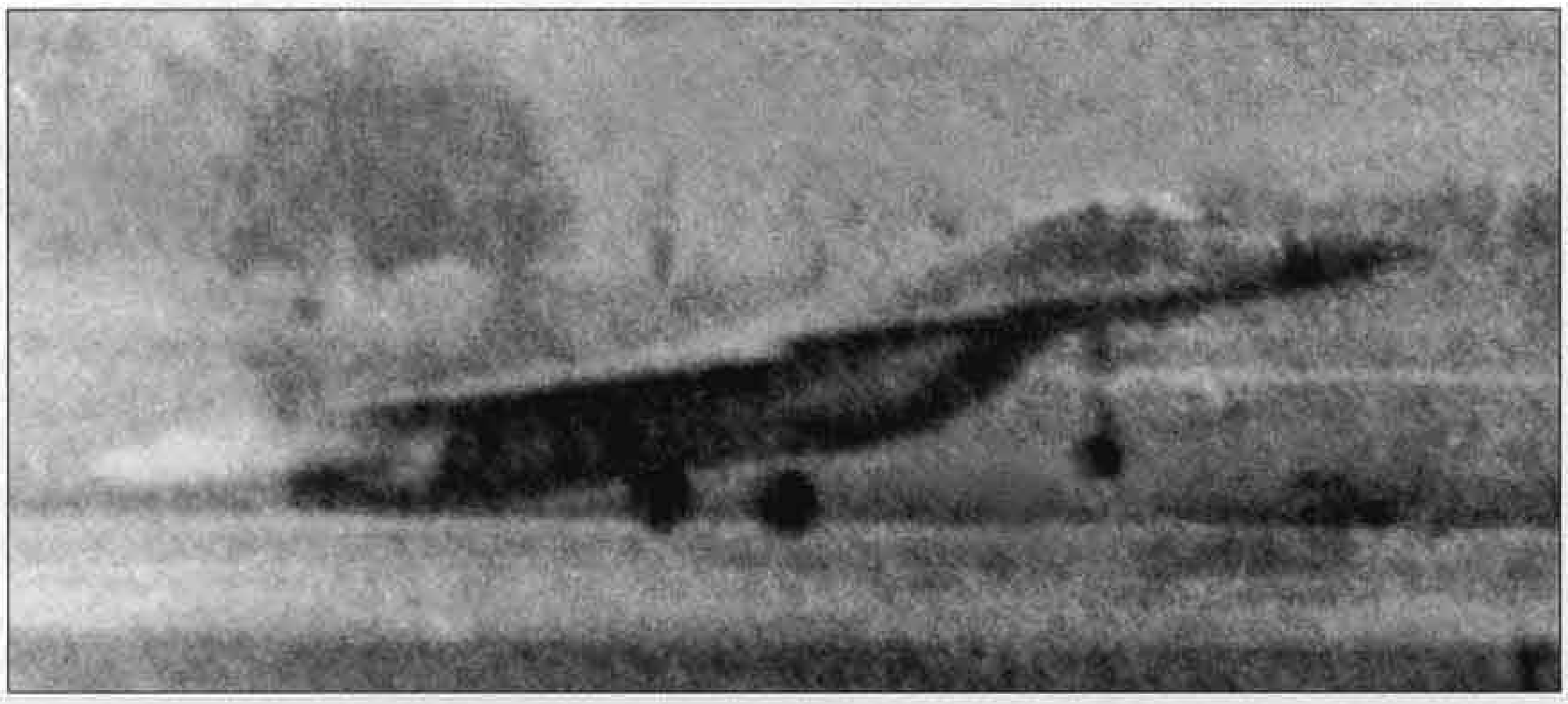

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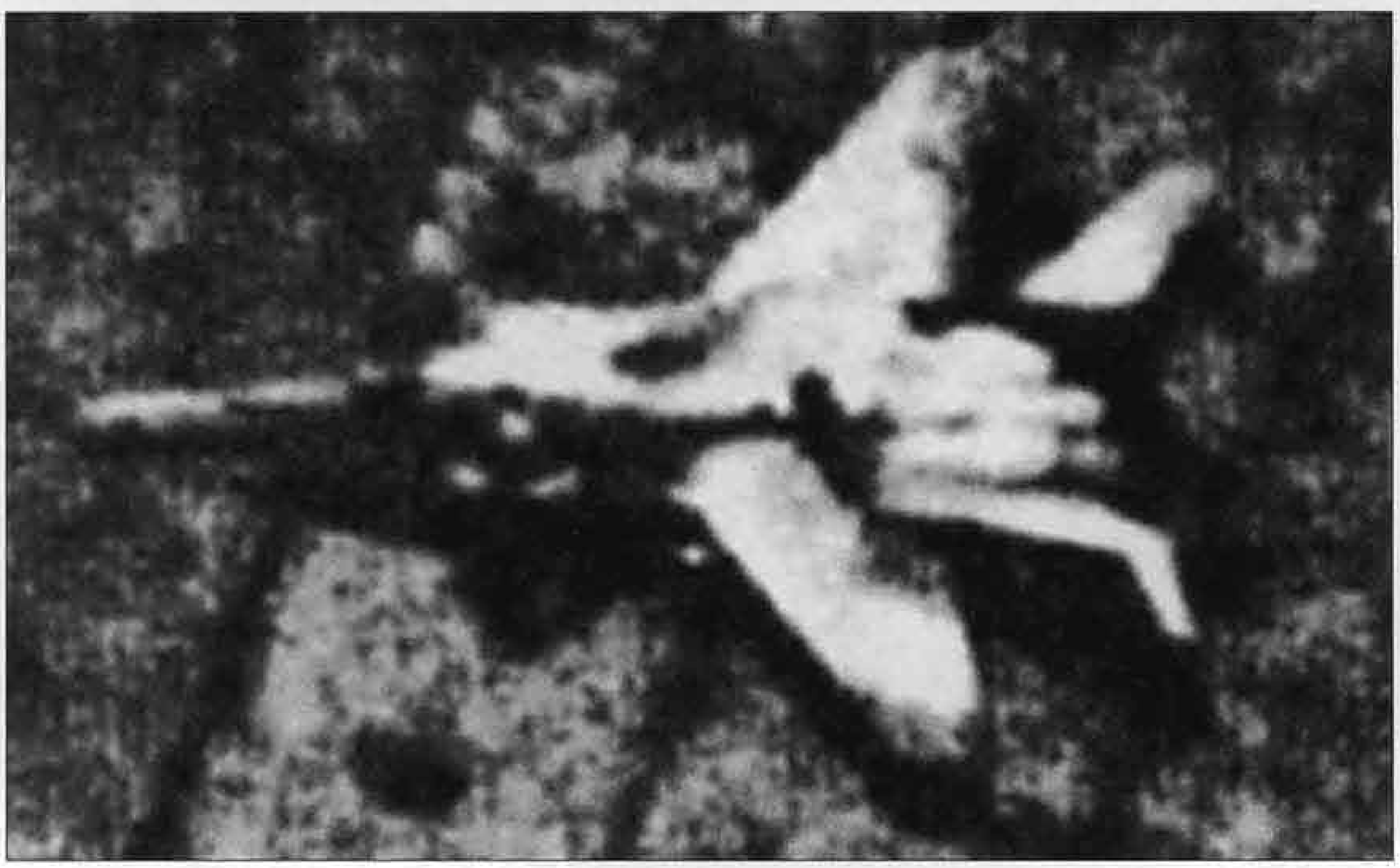

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▲▲ Although of poor quality (which suggests the picture was taken covertly), this shot is interesting in that it shows 'aircraft 901' taking off after the addition of ventral fins to enhance directional stability.

▲ An even more interesting shot! To keep the MiG-29's true configuration secret as long as possible, the prototypes were fitted with special hoods to create the impression of lateral air intakes when parked in the open – and maybe even pass it off as a MiG-25P.

► After completing its flight test career 'aircraft 901' was donated to what was then the Soviet Air Force Museum in Monino. The ventral fins are clearly visible in these three views. Note the addition of the IRST 'ball' ahead of the windshield.

Aubakirov, Viktor V. Ryndin, Anatoliy N. Kvochur and Roman P. Taskayev.

Manufacturer's flight tests with three prototypes made up the greater part of the trials programme until the spring of 1981. The first prototype was used to evaluate performance and handling and measure airframe loads (stress in the main structural elements); engineer Arkadiy B. Slobodskoy was in charge of the test programme. As early as 1978 Fedotov began low-speed handling and stalling/spinning trials. Ventral fins were added in the course of these trials at the insistence of TsAGI to improve directional stability at high alpha and facilitate spin recovery (TsAGI engineers claimed that pitch control in a spin would otherwise be inadequate). All of the 14 prototypes and pre-production aircraft had these ventral fins.

Early test flights revealed that the designers had been so 'lucky' as to pick the only possible location for the nose gear unit where all debris flung up by the nosewheels (despite the mud/snow/slush guard) was projected squarely into the air intakes. Since the MiG-29 had the 'patented' FOD protection doors, this didn't seem to matter much and the nose gear was left as it was. Nevertheless a MiG-23B *Flogger-D* prototype was converted into a 'Test Dirt' aircraft to investigate debris distribution patterns on takeoff and landing, with wire mesh screens protecting the air intakes.

The first prototype was retired in Zhukovskiy after making 230 flights. Several years later it was donated to the VVS Museum (now called the Central Russian Air Force Museum) in Monino southeast of Moscow where it resides in the open-air display.

Construction of the second and third prototypes (aircraft 902 and 903) started almost simultaneously, but the latter aircraft was actually completed first. Initially 'aircraft 902' was identical to the first prototype but even before it was completed the nose gear unit was moved aft 1.5 m (4 ft 11 in) to further reduce the risk of foreign object ingestion – a decision inspired by early flights. The nose gear was also shortened slightly. Thus the MiG-29 reverted to the configuration of the mock-up in this respect.

Coded '02 Blue/'902', the second prototype – which was actually the third flight test article – entered flight tests in November 1979, making seven flights before the year was out; three more flights were made by 15th March 1980. '02 Blue' had no radar and was therefore used to verify the optoelectronic targeting/navigation system. This was the first MiG-29 to have the intended GSh-301 single-barrel cannon; it was also the first aircraft to participate in the state acceptance trials programme at GK NII VVS in Akhtoobinsk in southern Russia (near Saratov on the Volga River). There the fighter was flown by Air Force test pilots V. V. Migoonov, V. N. Kondaoorov, Vladimir M. Gorboonov (who went on to become Mikoyan chief test pilot and Hero of Russia) and S. I. Khraptsov. Anatoliy A. Belosvet was in charge of the flight test programme on the OKB's part and I. G. Kristinov headed the VVS test team.

'Aircraft 902' was first in many respects. The FOD problem was eventually found to be serious enough to cause a relocation of the nose gear unit, intake doors notwithstanding. Therefore, from 02 Blue onwards the nose gear was moved 1.5 m (4 ft 11 in) aft. This aircraft was also the first to have integral wing fuel tanks.

It soon turned out that the aircraft's AOA limit was 5° lower than specified in the project, as violent vibration was encountered at high alpha. The cause of the trouble was traced to sections of the leading-edge flaps which had been eliminated at Belyakov's orders; this gave a weight saving of 15 kg (33 lb) but created turbulence. Since the wings had been

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▶ Arkadiy B. Slobodskoy, the engineer in charge of the MiG-29's manufacturer's flight tests.

▶▶ Anatoliy A. Belosvet, the engineer in charge of the MiG-29's flight test programme during the state acceptance trials.

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redesigned, the original flap configuration could not be restored and the engineers found a different solution, modifying the wingtips to smooth the airflow. After making 229 test flights 'aircraft 902' was relegated to the aircraft systems test facility in Faustovo near Moscow (GosNIPAS – *Gosoo**dar**stvennyy na**ooch**no-ispy**tah**tel'nyy poli**gon** aviatsi**on**nykh sis**tem*** – State Research and Test Range for Aircraft Systems). There it was used at first to test the fire suppression system and later shot up to check if the fuel tanks would explode after taking a hit.

The third prototype, '03 Blue/903', was rolled out ahead of the second one and made its first flight in June 1978; this aircraft was virtually identical to the first one and served for powerplant testing. Unfortunately, its career proved to be extremely short. On 15th June the aircraft crashed on its ninth flight when one of the engines suffered an uncontained compressor failure and fragments severed the control runs. The fighter flicked into a spin from which it could not recover; test pilot Valeriy Menitskiy ejected safely. Flight data recorder readouts showed that the good engine had continued running steadily right to the point of impact, thus proving that the powerplant operated well during a spin with no tendency to flame out.

Interestingly, on the first two flight test aircraft (901 and 903) the No.1 integral fuselage fuel tank was larger than on later aircraft, having two sections projecting forward. In plan view these resembled the legs of a sitting man seen from above and thus were promptly dubbed 'legs' by Mikoyan engineers. When the nose gear unit was moved aft on 'aircraft 902' this necessitated a relocation of the equipment bay, which in turn led to a change in the No.1 tank's shape – as Mikoyan engineers put it, 'the legs were cut off'! Also, the first two flight test aircraft lacked integral wing tanks but did have provision for them – 'in case range proved to be inadequate'.

The fourth prototype, '04 Blue/904', was intended mainly for dynamic load measurement and equipped with numerous stress sensors. It took to the air on 15th May 1979. After making 40 flights within the manufacturer's flight test programme the aircraft was handed over to LII in July 1981; the institute operated it until the type had successfully passed its state acceptance trials. LII representatives, however, tell a different story, claiming that '04 Blue' made only eleven flights with Mikoyan before being transferred to LII and making a further 148 flights there.

This photo presumably shows the second prototype ('aircraft 902'). The altered position of the nose gear unit is evident. The odd colour scheme with the black nose was unique to this aircraft. ▼

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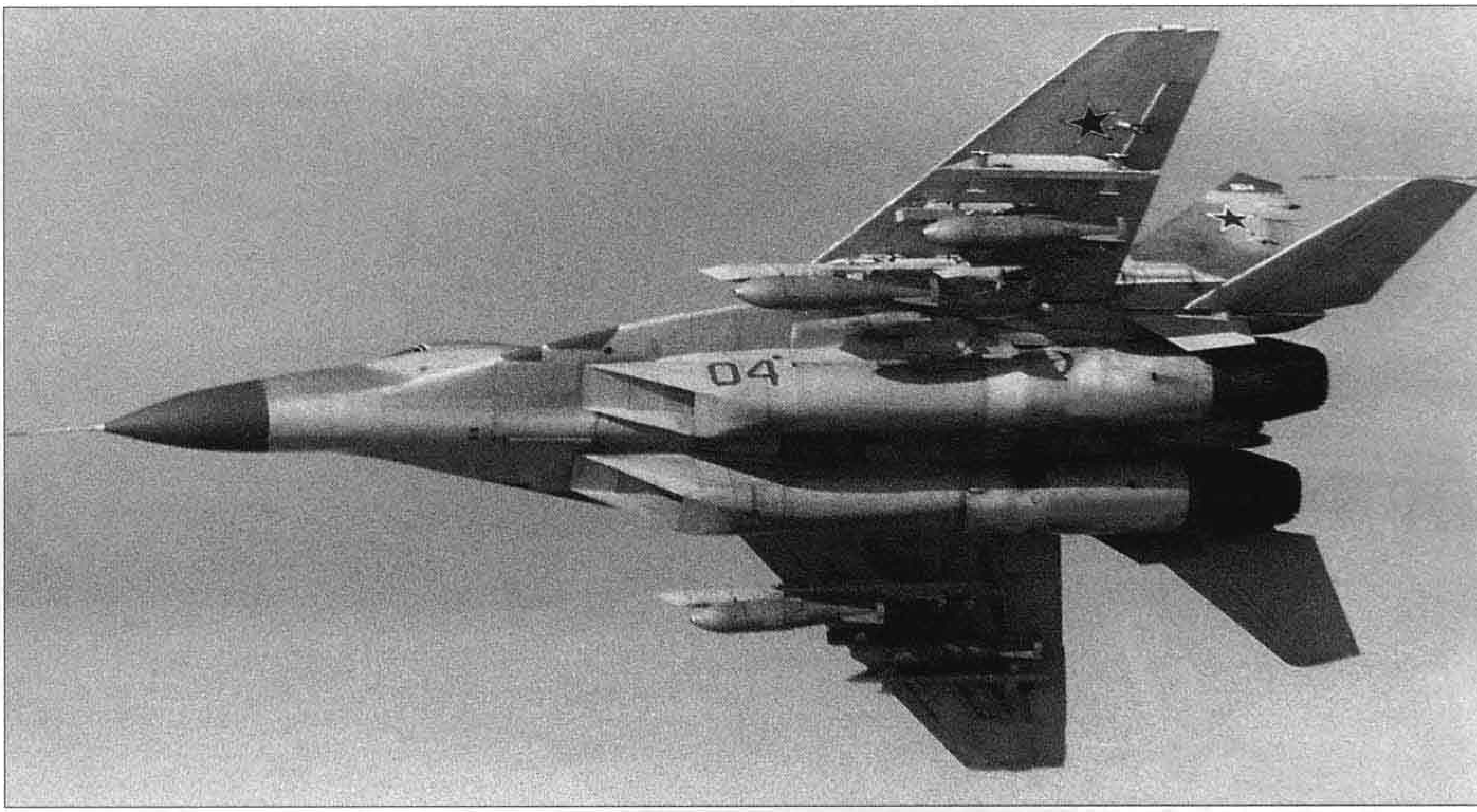

Flight Research Institute

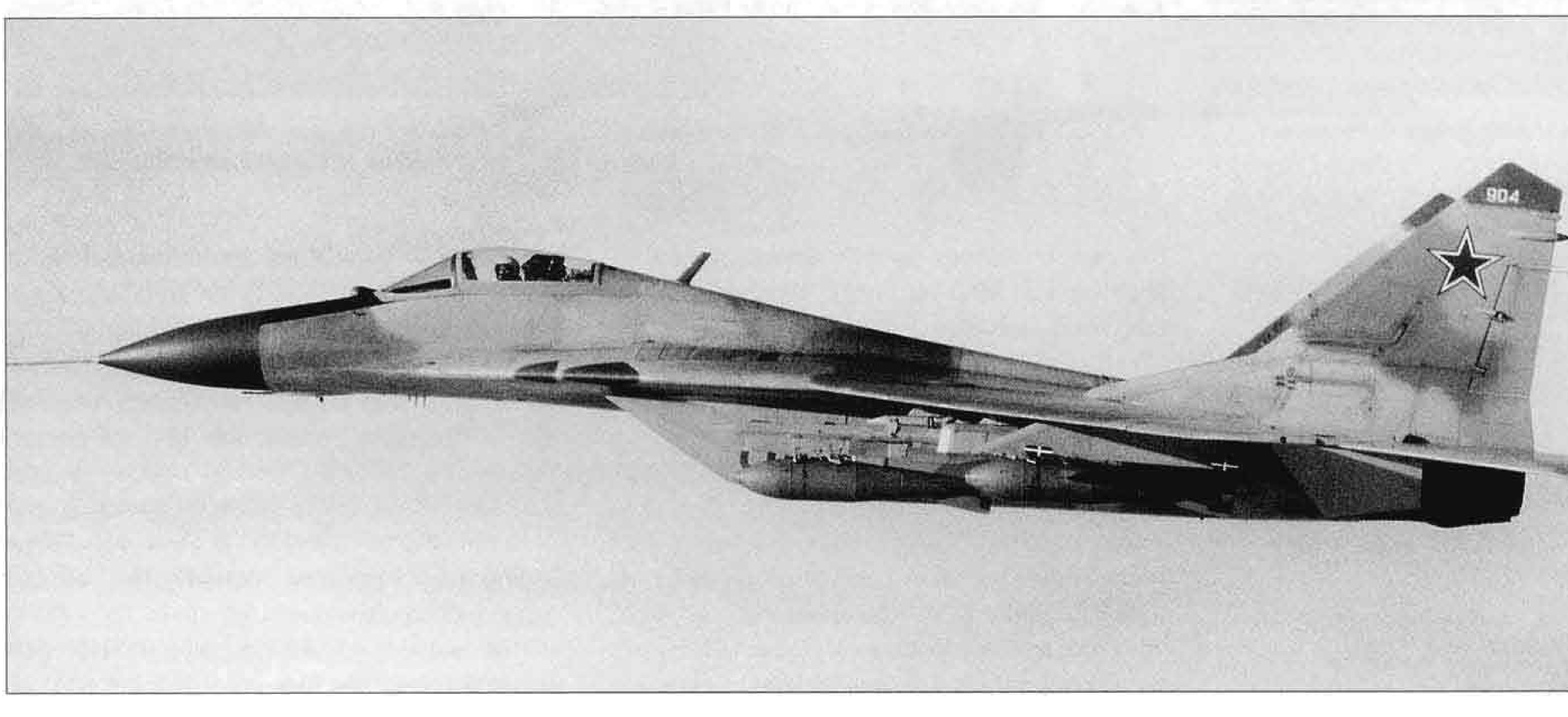
The fourth prototype was used in a comprehensive dynamic load measurement programme at LII; lead engineer A. V. Pochando was responsible for the flight tests. After retiring in July 1991 the aircraft was briefly displayed near Frunzenskaya subway station in downtown Moscow; later it was transferred to the open-air museum at Moscow-Khodynka airfield.

Powerplant testing continued with the fifth prototype ('aircraft 908') which first flew on 5th April 1979. However, this aircraft fared little better than its predecessor. It was lost on its 48th flight on 31st October 1980 when a combustion chamber failed; the resulting fire burned through control runs and the aircraft dived into the ground. A. V. Fedotov ejected while the aircraft was pulling negative G, receiving a spinal injury that kept him in hospital for several months.

Aircraft 901, 903 and 908 took part only in manufacturer's trials; the other prototypes were used in the state acceptance trials as well. In the course of tests the fighter was modified to incorporate the GSh-301 single-barrel 30-mm gun (also designated TKB-687 and 9A4071K).

▲ **The fourth prototype MiG-29, '04 Blue/904', in strike configuration with four FAB-350M62 low-drag bombs on the wing pylons. The inboard ones are carried on MBD3-U2T1 tandem racks.**

Another view of 'aircraft 904'. Note that the number of antenna fairings built into the LERXes had been increased from two to four. ▼



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Test pilot Boris A. Orlov.

Test pilot Pyotr M. Ostapenko.

Test pilot Valeriy Ye. Menitskiy.

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Test pilot Aviard G. Fastovets.

GK NII VVS test pilot V. N. Kandaoorov.

GK NII VVS test pilot Vladimir Gorboonov. He later became RSK MiG's chief test pilot.

This gun, developed by V. P. Gryazev and A. G. Shipoonov at NPO Tochnost', was designed for fixed and movable installations; it used the AO-18 round and had a rate of fire of 1,600 rpm. The new gun necessitated changes to the fittings and ammunition box.

The sixth prototype or 'aircraft 917' ('17 Blue') was the standard-setter for the production MiG-29 and incorporated various improvements made in the course of the test programme. All subassemblies were manufactured at MMZ No.30 but final assembly took place in Mikoyan's experimental shop. This aircraft later became the first MiG-29 to feature the extended-chord rudders protruding beyond the fin trailing edge that were typical of late-production aircraft.

'17 Blue' made its first flight in December 1979. It was used in the aerodynamics research part of the trials programme and for performance and handling testing, making a total of 369 test flights before it was retired. It is now an instructional airframe at the Air Force Engineering Academy named after Nikolay Yegorovich Zhukovskiy in Moscow.

The seventh prototype, 'aircraft 918' ('18 Blue/918'), was the reverse of 'aircraft 902' as

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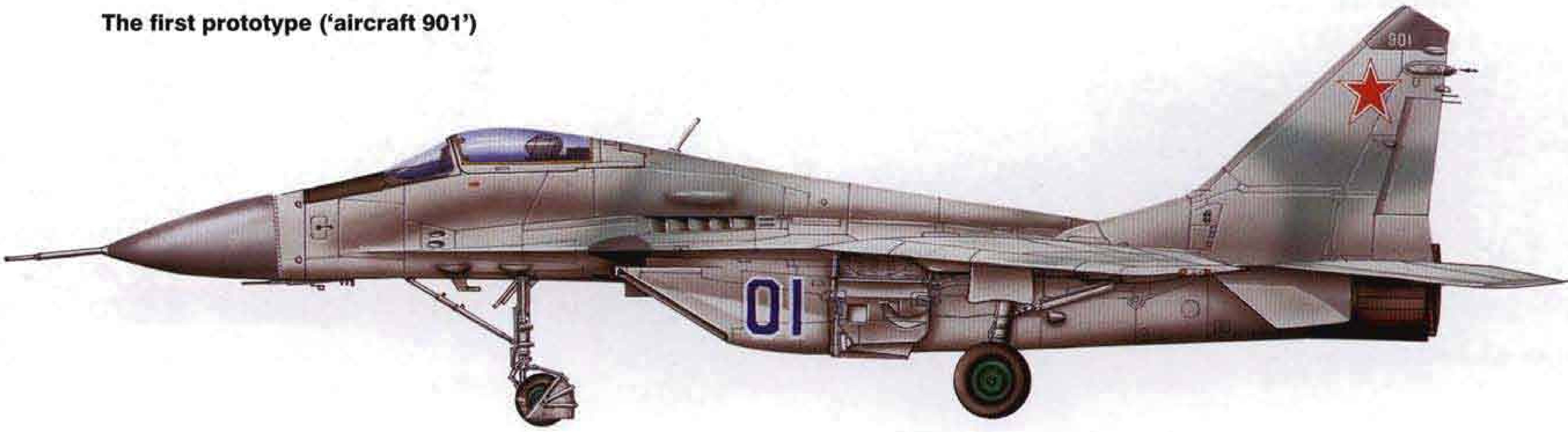
◄ **'Aircraft 904' was briefly displayed at an exhibition near Frunzenskaya tube station in Moscow in the late 1980s; thence it was relegated to the museum at Moscow-Khodynka. Note the angled nose gear door segment attached to the nose gear oleo, a distinctive feature of early-production MiG-29s.**

regards mission avionics: it was the first MiG-29 prototype to have a fire control radar but had no optoelectronic targeting system. It took to the air on 22nd May 1980 and made 265 flights (including 163 flights within the weapons control system test programme), gaining the distinction of the type's first air-to-air 'kill' with a K-27R IR-homing missile. In 1982 'aircraft 918' was modified under the MiG-29K shipboard fighter programme (which see) with an arrester hook under the aft fuselage and unofficially designated MiG-29KVP; this will be described in more detail later.

Between them the prototypes made 331 test flights under the state acceptance trials programme by the end of 1980. The intensity of the trials increased greatly when four more single-seaters ('aircraft 919', '920', '921' and '923') and the MiG-29UB trainer prototype joined the programme. By the end of 1981 the total number of test flights had increased to 700 (647 for the single-seaters and 53 for the two-seater).

The first prototype ('aircraft 901')



Presumably the second prototype ('aircraft 902').

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◄
Front view of the sixth prototype ('aircraft 917'). The aircraft is carrying two inert R-27 medium-range AAMs on the inboard pylons and four dummy R-60M short-range AAMs (note the striped bodies) on the outer pylons.

Two more aspects of 'aircraft 917'. Like the preceding prototypes, it wears a three-tone camouflage.
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RSK MiG


RSK MiG

'Aircraft 919' ('19 Blue'), which first flew on 30th July 1981, was another radar test vehicle. Unlike '18 Blue', however, it featured the new Ts100 digital computer replacing the Orbita-20 analogue computer. This aircraft was the first to score a 'kill' with a K-73 short-range AAM, destroying an M-21 target drone (remote-controlled MiG-21 conversion; M = *mishen'* – target). In July 1985 after making 266 flights with Mikoyan the eighth prototype was transferred to LII, which used it to investigate the effect of vibration and high temperatures on the aircraft's systems at the request of the VVS, as equipment failures were a constant source of annoyance on initial production MiG-29s. It was also used to examine the effect of G loads on gunnery and missile launches.

On 16th August 1988 the eighth prototype was displayed in the city park in Zhukovskiy on Aviation Day which is celebrated on the third Sunday in August. Finally, retiring in 1991 with 364 flights to its credit, it became an instructional airframe at a technical training unit in the town of Elektrougli near Moscow where it is used to demonstrate in-service repair techniques.

The ninth aircraft, '20 Blue/920', was the first to feature a complete set of mission avionics and was used for avionics compatibility testing. It entered flight test on 6th March 1981. After making 373 flights it went to the nuclear test range on the Novaya Zemlya archipelago in the Barents Sea (probably to test its tactical nuclear weapons delivery capability).

Powerplant testing was finally completed on the tenth aircraft ('21 Blue/921') which first flew on 21st August 1981; this included investigating the effect of gunnery and missile launches on engine operation. After making 376 flights under the MiG-29's test programme '21 Blue' served as a testbed for the uprated RD-33K engine developed for the vastly upgraded MiG-29M. After that '21 Blue' was retired, sitting at the OKB's test facility at Zhukovskiy for many years.

'Aircraft 922' joined the programme on 20th May 1982 but was withdrawn from use after making only four flights, including three for WCS testing. It was then handed over to TsAGI for full-scale wind tunnel tests.


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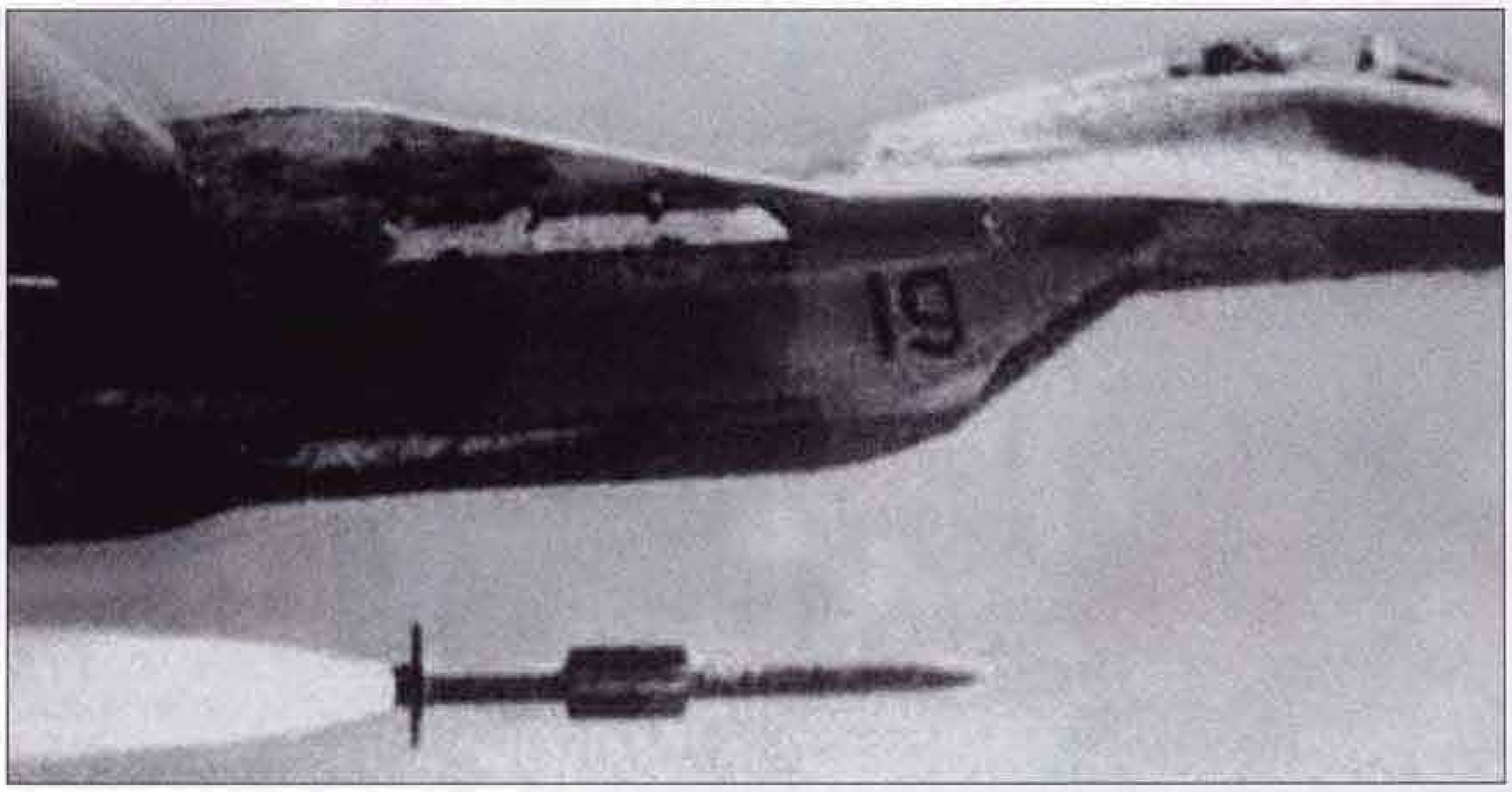
▲ Three aspects of 'aircraft 917' in modified form with increased chord rudders meant to cure the insufficient rudder authority problem. The rudders are the colour of unpainted GRP in the top and centre photos. Note also the modified nose with a smaller radome.



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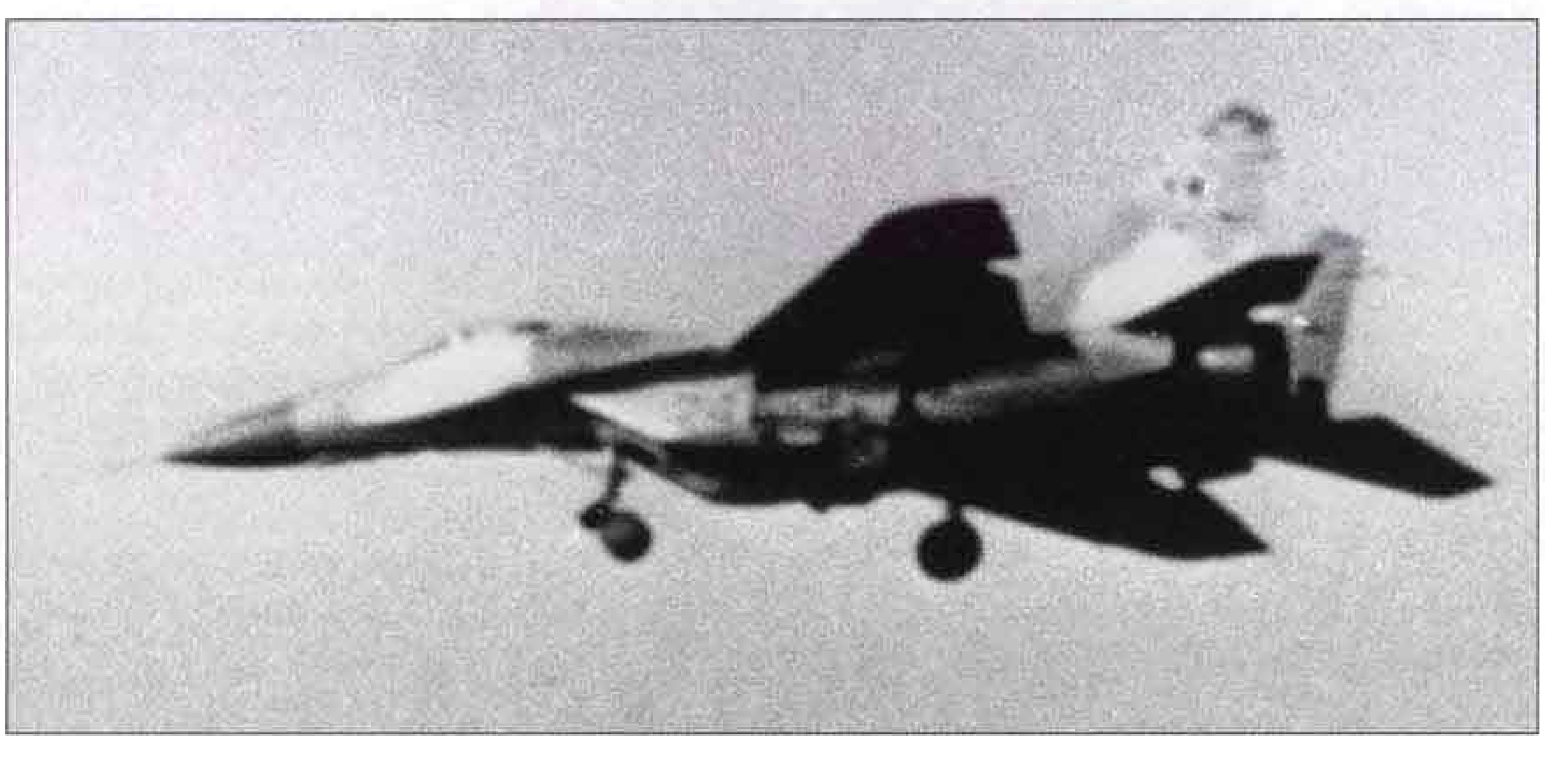
▲
'Aircraft 919' eventually became a weapons testbed. Here it is seen launching an R-77 (RVV-AE) air-to-air missile.

►▲
Close-up of the same aircraft's starboard air intake and nose gear unit with that door segment (dubbed *bahbochka* – butterfly) and high-set taxi light.

Andrey Zhirnov

►
'Aircraft 919' in the city park of Zhukovskiy on 18th August 1988 during the Aviation Day display.

'Aircraft 924' ('24 Blue'), the penultimate prototype, on final approach to Zhukovskiy.
▼



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The next development aircraft, '23 Blue/923', made its first flight in Zhukovskiy on 4th November 1981 and was soon ferried to GK NII VVS in Akhtoobinsk for testing the optoelectronic targeting/nav system and internal gun. This aircraft proved the gun's effectiveness by destroying a Lavochkin La-17 jet-propelled target drone. '23 Blue' introduced redesigned fittings for the landing/taxi lights which had been a pain in the neck on earlier prototypes, turning downwards on their own accord every now and again. Nevertheless, red reference lines were painted on the main gear doors to which the lights were attached; these are present on all production MiG-29s. This aircraft ended its days at GosNIPAS in Faustovo after 281 flights as another fire suppression system test rig.

'24 Blue' ('924', construction number 0390501625) was rolled out by the 'Znamya Truda' factory on 30th September 1981 but did not make its first flight until 9th September 1983 at the hands of OKB test pilot Boris A. Orlov. It was transferred to LII after 22 flights; on 29th December 1983, Rimas A. A. Stankiavicius made the first acceptance flight. (According to LII, Mikoyan test pilots Aleksandr V. Fedotov and Anatoliy N. Kvochur made only eleven flights in '24 Blue' before the aircraft went to LII.)

Note: Single-seat MiG-29s have ten-digit c/ns. The first three digits (in this case, 039; later changed to 296) are a code for the factory (MAPO). 05 is an in-house product code for the MiG-29 (*izdeliye* 5 – see next chapter). The remaining digits, which are stencilled on the fins and under the starboard wing root, are a computer-generated number meaning *nothing at all* so as not to reveal how many have been built; they are known in the West as the 'famous last five', and the first two/last three accrue independently.

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◄ '24 Blue' sits in front of TsAGI's administration building during the Aviation Day display on 18th August 1991, one day before the failed military coup that triggered the break-up of the Soviet Union. The legend on the rooftop reads 'Tsentr aviatsionnoy naooki' (Centre of aviation science).

Another view of '24 Blue' on show at Zhukovskiy on 18th August 1991, with a Su-24 bomber in the background. ▼

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Additionally, there is a parallel system of *fuselage numbers* (f/ns) indicating the batch number/the number of the aircraft in the batch; in this case the f/n is 0101. The fuselage number appears only in OKB documents. Most of the Soviet/CIS aircraft design bureaux use the term *s**ereey**nyy **nom**er* for fuselage numbers; this is derived from the word ***se**riya* in the meaning 'production batch'. The Mikoyan OKB, however, invented its own term, referring to the f/n as ***nom**er kom**plek**ta agre**gah**tov* ('sub-assembly set number') in similar manner to the set numbers of the Hawker Siddeley Andover.

The institute used '24 Blue' for dynamic load measurement and later for evaluating modified engine nozzles and modified air intakes. On 18th August 1991 – a day before the notorious military coup d'état which brought an end to the existence of the Soviet Union – the aircraft was in the Aviation Day static display in front of TsAGI's office building in Zhukovskiy. The aircraft had made 360 flights, logging 233 hours.

The fourteenth and final development aircraft, '25 Blue'/925', was the definitive standard-setter for full-scale production incorporating all the changes made in the course of the trials. It took off for the first time on 30th December 1982, making 235 test flights before it was withdrawn from use at LII. '25 Blue' was used, among other things, to check the interaction between the fire control radar and the IRST. Later it became an instructional airframe at the Moscow Aviation Institute. In 1983 the MiG-29 entered production at MMZ No.30 under the in-house designation *izdeliye* 9.12.

Improvements started coming as soon as the first fighters rolled off the production line at Khodynka. Operational experience in the Afghan War, where the Mujahideen guerrillas were widely using man-portable air defence systems (MANPADS) such as Stinger and Redeye, forced the engineers to devise countermeasures. Thus the MiG-29 received infrared countermeasures (IRCM) flare dispensers; these were initially located on the wings ahead of the fin fillets. The arrangement was tested on the sixth prototype ('17 Blue'). Dorsal strakes of varying length incorporating chaff/flare dispensers were tested during the aerodynamics refining programme which was to continue for a long time yet. Eventually, however, they were found to be unnecessary and on the MiG-29K and MiG-29M (which see) the dispensers were fitted flush with the rear fuselage skin. The final pre-production aircraft also participated in IRCM testing.

Aleksandr V. Fedotov investigated the MiG-29's spinning characteristics. It transpired that if you really wanted the MiG-29 to spin you had to forcibly keep it in that position – the aircraft simply would not spin of its own accord! When the pilot let go of the controls after initiating a spin the fighter recovered automatically.

On the minus side, high-alpha handling did pose problems. The MiG-29 was found to have reverse roll reaction to rudder input at high AOAs – that is, if the pilot applied right rudder the aircraft rolled to the left instead of to the right. Conversely, the fighter behaved normally if bank was countered by rudder input. This 'quirk' initially caused the AOA to be limited to 20°; this was later increased to 22°, then 24° and so on as flight tests progressed and the aircraft's behaviour was studied.

However, both Mikoyan and the VVS were unhappy about having to correct bank at high AOAs by rudder input. The reason was that the MiG-29 was supposed to be the backbone of the Soviet Union's fighter force, superseding not only the MiG-23 but the MiG-21 as well. Now *Fishbed* pilots did not have to work the rudder pedals all that much, and getting them into the habit of vigorous 'footwork' in the MiG-29 would call for a lot of effort. Therefore, Mikoyan introduced an automatic bank corrector into the control system. When the AOA passed certain limits the autopilot automatically deflected the rudders as necessary to eliminate excessive bank. Calculations showed the required rudder deflection was 8°; for safety's sake the bank corrector was adjusted in increments of 2°.

Stage B of the state acceptance trials held by Mikoyan and the VVS was completed successfully on 27th October 1983 with the twelfth prototype ('23 Blue'). All in all the prototypes had made some 2,500 test flights, with the loss of two aircraft due to uncontained engine failure. The aircraft was officially included in the VVS inventory in 1984; full-scale production and initial operational capability (IOC), however, had been achieved two years earlier.

The West got news of the MiG-29's existence in the spring of 1979 when a US surveillance satellite photographed one of the prototypes on LII's airfield in Zhukovskiy. The manufacturer was unknown at the time, so the aircraft received the provisional reporting name Ram-L because Zhukovskiy was then erroneously referred to as Ramenskoye (this is actually a separate town located south of Zhukovskiy). By 1982, when the true designation became known, the MiG-29 was allocated the NATO reporting name *Fulcrum*. However, it was a long time before the West had any idea what the fighter really looked like. Provisional three-view drawings published in 1982 were wildly inaccurate, showing almost a copy of the Northrop YF-17, though in fact the resemblance is purely superficial.

Later, when the MiG-29 was fully operational, the people that created it received high government awards. Mikhail R. Val'denberg, who succeeded Choomachenko as chief project engineer around 1982, was awarded the honorary Hero of Socialist Labour title, many other engineers received decorations. Anatoliy A. Belosvet (Deputy General Designer at Mikoyan), P. V. Pozdnyakov (Deputy Director of GosNII AS), Gen. L. I. Agoorin (head of NII VVS), Mikoyan test pilot Valeriy Menitskiy, Yuriy P. Kirpichov (head of NIIR) and V. G. Stepanov (head of the Klimov engine design bureau) were awarded the prestigious Lenin Prize – a neat sum of money. Twelve Mikoyan employees, including Rostislav A. Belyakov, Vano A. Mikoyan, Anatoliy Pavlov, V. Godoonov, Arkadiy B. Slobodskoy, M. Yakubovich, Stepanov, Bezlyud'ko and four others, received the State Prize.

'25 Blue/925', the final MiG-29 prototype, in high-altitude flight with a load of dummy AAMs. ▼

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PART THREE

THE FAMILY STARTS GROWING

MiG-29 Tactical Fighter (*Izdeliye* 9.12, *Izdeliye* 5) *Fulcrum-A*

The first major production version of the MiG-29 bore the manufacturer's designation *izdeliye* 9.12 and, to confuse things further for hypothetic spies, was referred to in Air Force documents as *izdeliye* 5. (Multiple codes allocated by different organisations to the same equipment item were common practice in the Soviet Union.) As mentioned earlier, the fighter entered full-scale production at MMZ No.30 (MAPO) in 1982, although the initial production fighters rolled off the line in 1979-80. This baseline version featuring the RLPK-29 targeting system (built around the N019 Rubin radar) and the OEPrNK-29 (S-31) optoelectronic targeting/navigation system stayed in production until 1990. It became the main version operated by the Soviet Air Force and several other air arms, serving as the basis for subsequent versions. Mikhail R. Val'denberg became MiG-29 project chief when production started; he was superseded by V. V. Novikov in 1993.

Despite being designed in Leningrad the RD-33 turbofan was built in Moscow. The ***Kras**nyy Ok**tyabr'*** (Red October) plant in Tushino, Moscow (currently known as the Moscow Engine Production Association named after V. V. Chernyshov), assembled the first pre-production engines in 1977. Production of the improved RD-33 Srs 2 began in 1980, initially on a small scale, and really got under way two years later. The co-located 'Soyuz' Tushino Engine Design Bureau (TMKB Soyuz) had a hand in debugging and improving the RD-33. The result was better performance and a greatly increased engine life. RD-33s manufactured in the early 1990s had a 1,400-hour service life and a 700-hour time between overhauls (TBO); by comparison, for early-production engines built in the mid-1980s these were a mere 350 and 800 hrs respectively. Current production engines are even better, with a 2,000-hr service life. The RD-33 is now the bread-and-butter product of the Moscow Engine Production Association named after V. V. Chernyshov.

A lot of enterprises in the aerospace, electronics, defence and other industries supplied components for the MiG-29. For example, the Krasnyy Oktyabr' factory in Leningrad – there were a lot of Red Octobers! – manufactured the Izotov GTDE-117 auxiliary power unit (APU) and the accessory gearbox. The N019 radar was built by the State instrument factory in Ryazan' while the IRST came from the Urals Optical Equipment Factory (UOMZ – *Oo**rahl'**skiy **op**tiko-mekha**nich**eskiy za**vod***) in Sverdlovsk (now renamed back to Yekaterinburg).

On 11th June 1987 the Soviet Council of Ministers issued a directive officially including

The final assembly shop of MMZ No.30 at Moscow-Khodynka, showing at least 12 partially completed MiG-29s. Note the Aviatika MAI-890 biplane at the far end of the line; it is also produced by the same plant. Note also the covers-cum-work platforms over the dorsal air intakes in the LERXes. ▼

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the MiG-29 (*izdeliye* 9.12) into the Soviet Air Force inventory. By then the Air Force had mastered the fighter quite well: the MiG-29 had achieved initial operational capability in 1983.

The production run was split into batches – mostly of fifteen aircraft (though some batches contained 30 aircraft, as you will see). Like most of the prototypes, the first 70 production MiG-29s had small ventral fins outboard of the engine nacelles (these had been fitted at the recommendation of TsAGI to improve spinning characteristics and directional stability at high

▲
The fuselage build-up area at MAPO's Khodynka division, with at least six Batch 49 MiG-29s (left to right: fuselage numbers 4913, 4915, 4917 and 4919); the even-numbered airframes are lined up along the opposite wall. The cockpit transparencies are protected from scratches by covers. Note the dollies and tables on which the radomes and canopies rest.

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◄
Assembly workers install wiring bundles in the centre fuselage of a MiG-29. Note the cutouts for the dorsal air intakes.


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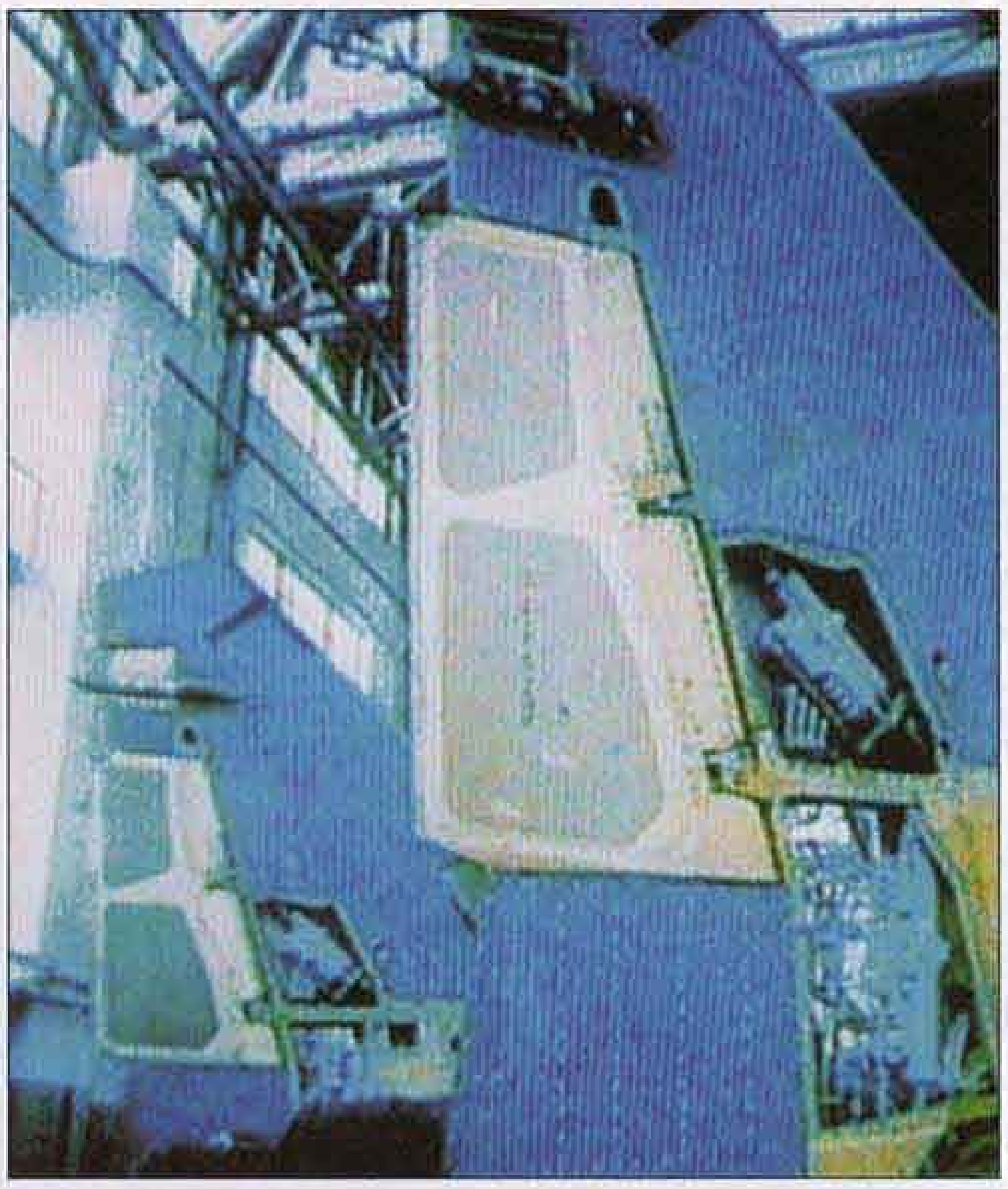
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The wing build-up area, showing a MiG-29 wing panel in the assembly jig.

The vertical tails of a MiG-29, showing how the upper portions made of composites mate with the metal lower portions. Note the rudder actuator access hatches.

Wearing a coat of grey primer, three brand-new MiG-29 *Fulcrum-As* are ready for roll-out at Lookhovitsy. The nearest aircraft is f/n 4025.

Unmarked MiG-29s await delivery at Lookhovitsy-Tret'yakovo. Note the dummy AAMs.


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alpha). By 1984, however, the automatic bank corrector in the rudder control circuit had passed its trials and was introduced on production aircraft, rendering the ventral fins unnecessary; besides, they complicated access to the engine cowlings. Most early-production MiG-29s had the ventral fins removed in service.

The increased-chord rudders tested on the sixth prototype and introduced on late-production aircraft were also associated with high-alpha handling. Large rudder deflection in order to counter bank at high AOAs proved inadvisable, as the pilot had difficulty in bringing the rudders to neutral position manually in the event of an autopilot or actuator failure. The solution was to reduce rudder deflection in this


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▲ A dramatic 'toad's eye view' of an early-production MiG-29 with the 'butterfly' nose gear door.

mode and compensate for this by increasing rudder area. Another change made on late MiG-29s was the ailerons set at 5° upward deflection in the neutral position to improve the spin recovery characteristics further.

The production MiG-29's AOA limit set by the manufacturer was 26°. However, in service the VVS imposed a 24° limit, just to be on the safe side.

Another characteristic feature of initial production MiG-29s (besides the ventral fins) was a nose gear door section attached to the oleo ahead of the nosewheels and doubling as a gravel deflector! The reason for this was that stones would sometimes stick to the nosewheels and then, coming loose, be projected forward by the centrifugal force, whereupon the aircraft 'caught up' with them. This was dangerous because the FOD protection doors retracted on rotation, leaving the intakes wide open to such 'stray bullets'. (Some research on the MiG-29's mudguards had been done but generally the experience accumulated with the MiG-23 was considered to be sufficient.)

Because of its characteristic shape the deflector was promptly dubbed ***bah**bochka* (butterfly). However, it sometimes made contact with the ground during taxying and was soon deleted; the few aircraft fitted with this deflector had it removed. (Alas, poor butterfly!) Instead, a small grid-type mudguard was fitted aft of the nosewheels.

Soon after production entry the MiG-29 was equipped with BVP-30-26M chaff/flare dispensers (*blok **vy**brosa po**mekh*** – lit. 'interference ejector') in shallow strake-like fairings ahead of the fins, as tested on the 'aircraft 917' prototype; each dispenser held thirty 26-mm (1.02-in) infrared countermeasures (IRCM) flares. A triangular vortex generator was added to the pitot boom in a similar fashion to the final version of the *Flogger* – the MiG-23MLD *Flogger-K* – to improve high-alpha handling.

Originally the MiG-29 was to incorporate a good deal of composites. Indeed, on the first thirty production aircraft the inlet ducts, engine cowlings, leading-edge flaps, control surfaces, wingtips, fuselage spine, detachable upper fin sections and numerous access panels were made of composites, not to mention the radome and dielectric fin caps concealing communications aerials. The ailerons, rudders and aft portions of the stabilators had honeycomb construction.

However, the composite panels failed on several occasions during trials and in service, even causing two serious accidents in late 1984. The trouble was traced to microscopic cracks which appeared during riveting. The riveting technology was changed, with prior drilling of holes to preclude crack formation. Still the problem persisted; it turned out that aircraft built by MAPO's division in Lookhovitsy, Moscow Region (LMZ – *Lookho**vits**kiy ma**shi**nostro-**i**tel'nyy za**vod***), suffered from defective riveting. On one occasion test pilot Abramovich had a hair-raising near-accident when an engine inlet duct failed in flight; the aircraft landed with a gaping hole in the engine nacelle – half the duct was gone.

This was the last straw. Minister of Aircraft Industry Pyotr V. Dement'yev raised hell, demanding that composites be excluded from structurally important areas of the aircraft. From

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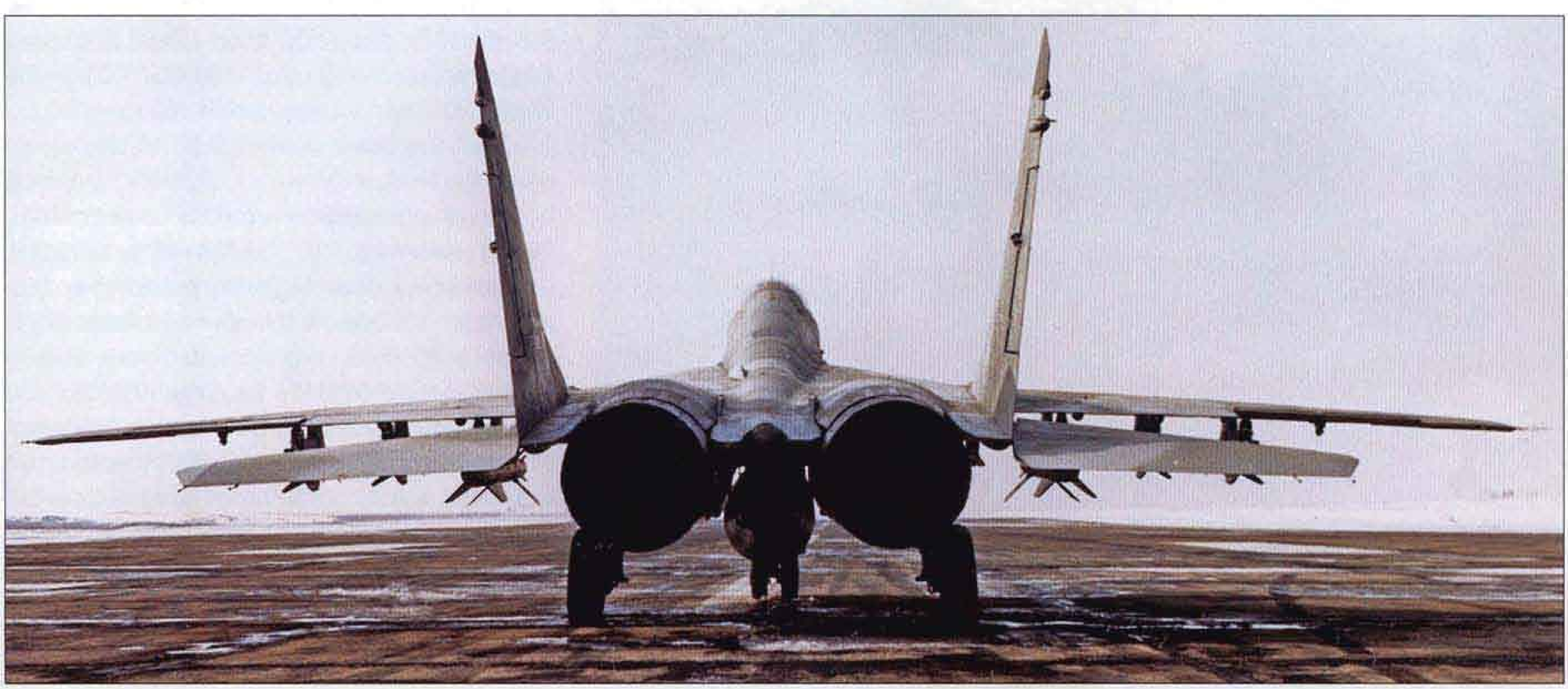
the 31st production aircraft (fuselage number 0301) onwards the inlet ducts, leading-edge flaps and some other components were made of D19 aluminium alloy, which resulted in a 20-kg (44-lb) weight penalty.

Mikoyan stuck to composite cowlings for quite a while. These were 'expendable items' and were replaced by new ones during overhauls; hence the demand was fairly high. However, the aerospace industry was unable to produce enough and started lobbying for a replacement that would last longer. Dement'yev intervened again, demanding that the cowlings be made of metal too; and so they were, adding another 40 kg (88 lb) of airframe weight. In the end only the composite fins, radome and access panels remained (the fins were found to be strong enough).

The MiG-29 (*izdeliye* 9.12) had an internal fuel capacity of 4,300 litres (946 Imp gal); the fuel was carried in four fuselage integral tanks and two wing tanks. For long-range operations and ferry flights a 1,520-litre (334.4 Imp gal) drop tank could be carried on the fuselage centreline. Unlike most Soviet fighters, which used standardised drop tanks, the *Fulcrum*'s tank was tailored to the aircraft. It was semi-conformal to cut drag. The rather bulky drop tank obstructed

▲
A factory-fresh early-production MiG-29 with a load of dummy AAMs. Note the offset position of the IRST 'ball', the single cannon muzzle opening, the centreline drop tank and the brake parachute container sandwiched between the halves of the split airbrake.
▼

Three more views of the same aircraft. Note the lack of ventral fins which were deleted from the 71st production MiG-29 onwards.
◄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► Mikhail R. Val'denberg, the MiG-29's chief project engineer since the beginning of series production.

►► Valeriy V. Novikov succeeded Val'denberg as MiG-29 project chief in 1993.

the APU exhaust located between the engine nacelles, so Mikoyan incorporated a unique feature: the tank had a straight-through vertical duct or 'pipe' at the rear enabling the APU to exhaust right through it!

Flying with the centreline drop tank had its limitations: the airbrake could not be used. It formed the aft extremity of the fuselage and consisted of upper and lower halves, with the brake parachute container in between. If the airbrake were deployed the lower half would strike the drop tank.

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► Vano A. Mikoyan, the OKB founder's nephew, was the MiG-29's deputy project chief.

The SUV-29 (S-29) weapons control system (*sis**tem**a oopravl**en**iya vo'oroo**zhen**iyem*) of the initial production version (*izdeliye* 9.12) included the RPLK-29 radar targeting suite and the OEPrNK-29 targeting/navigation suite. The RLPK-29 comprised the N019 Rubin radar and a Ts100 digital processor. The OEPrNK-29 included the OEPS-29 optoelectronic targeting system comprising the IRST/laser ranger and the Schchel'-3UM helmet-mounted sight, plus another Ts100 processor and the SN-29 navigation system (*sis**tem**a navi**gah**tsii*). The *Fulcrum*'s standard weapons included two R-27R medium-range IR-homing AAMs (*izdeliye* 470), two R-73 IR-homing 'dogfight AAMs' (*izdeliye* 72), two R-60 short-range IR-homing AAMs (*izdeliye* 62) and the GSh-301 (alias 9A4071K) internal cannon with 150 rounds.

Even the basic *izdeliye* 9.12 version could attack ground targets in a dive (by dropping bombs, firing unguided rockets, and strafing), during recovery from a dive (by dropping bombs) and in level flight (by dropping bombs and submunitions). Alternative ordnance loads in the strike/CAS role included four 500-kg (1,102-lb) FAB-500M54 or FAB-500M62 'iron bombs', four 500-kg ZB-500 napalm bombs or six 250-kg (551-lb) FAB-250 bombs on BD3-UMK single bomb racks (that is, one per pylon), up to sixteen 100-kg (220-lb) OFAB-100 or 120-kg (264-lb) OFAB-120 bombs totalling up to 2,000 kg (4,409 lb) on MBD2-67U multiple ejector racks (MERs), two to four 240-mm (9.44-in) S-24 heavy unguided rockets, up to four

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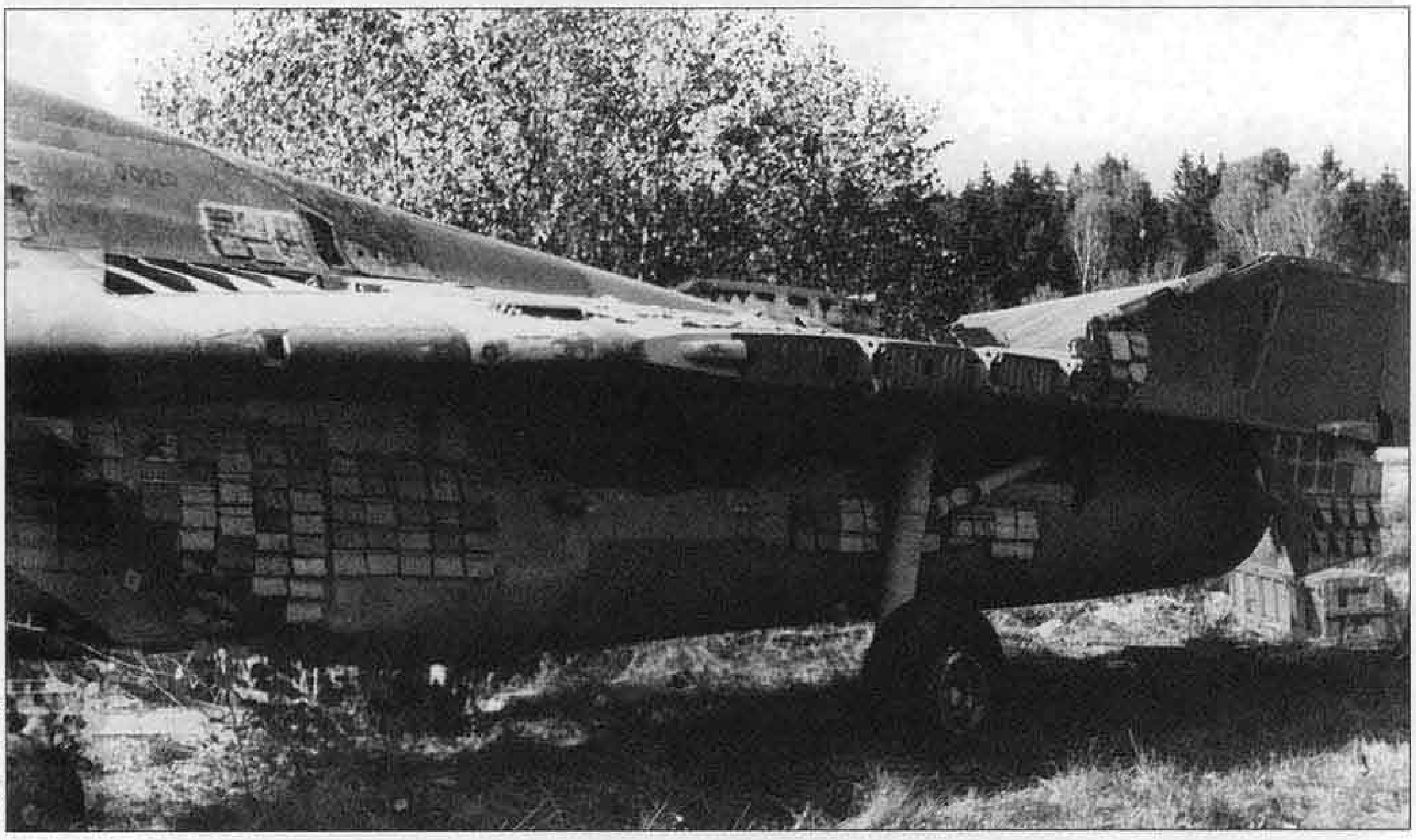
◄ A MiG-29 static test airframe dumped at the OKB's test facility in Zhukovskiy. The numerous rectangular objects on the fuselage sides are attachment points for the load application lines and strain gauges.



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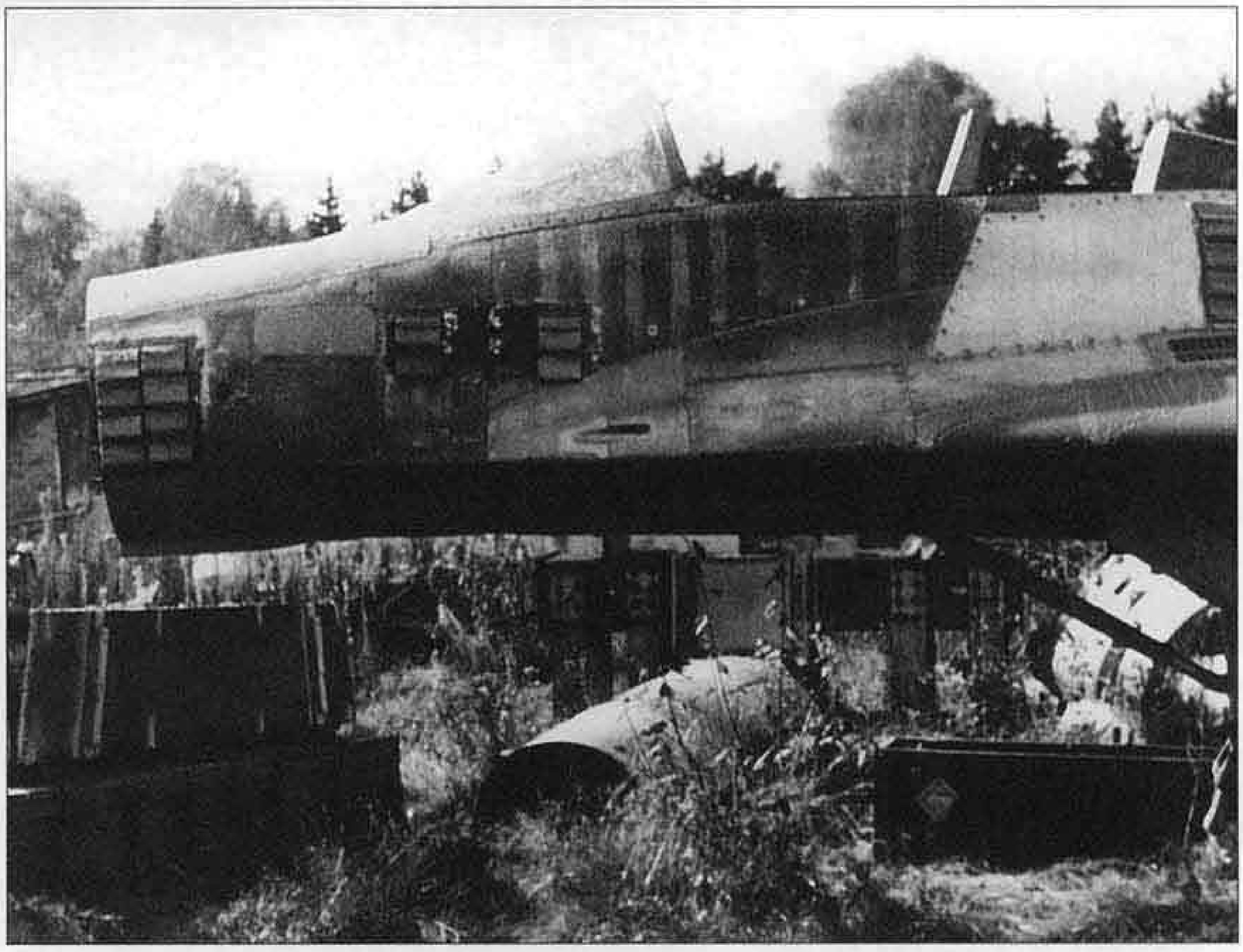
◄ Another view of the static test article. The wing root rib and the three outer wing attachment fittings are visible here. Note the number 00020 hand-painted on the fuselage which may be the aircraft's c/n.

The cockpit section of the static test airframe. ▼



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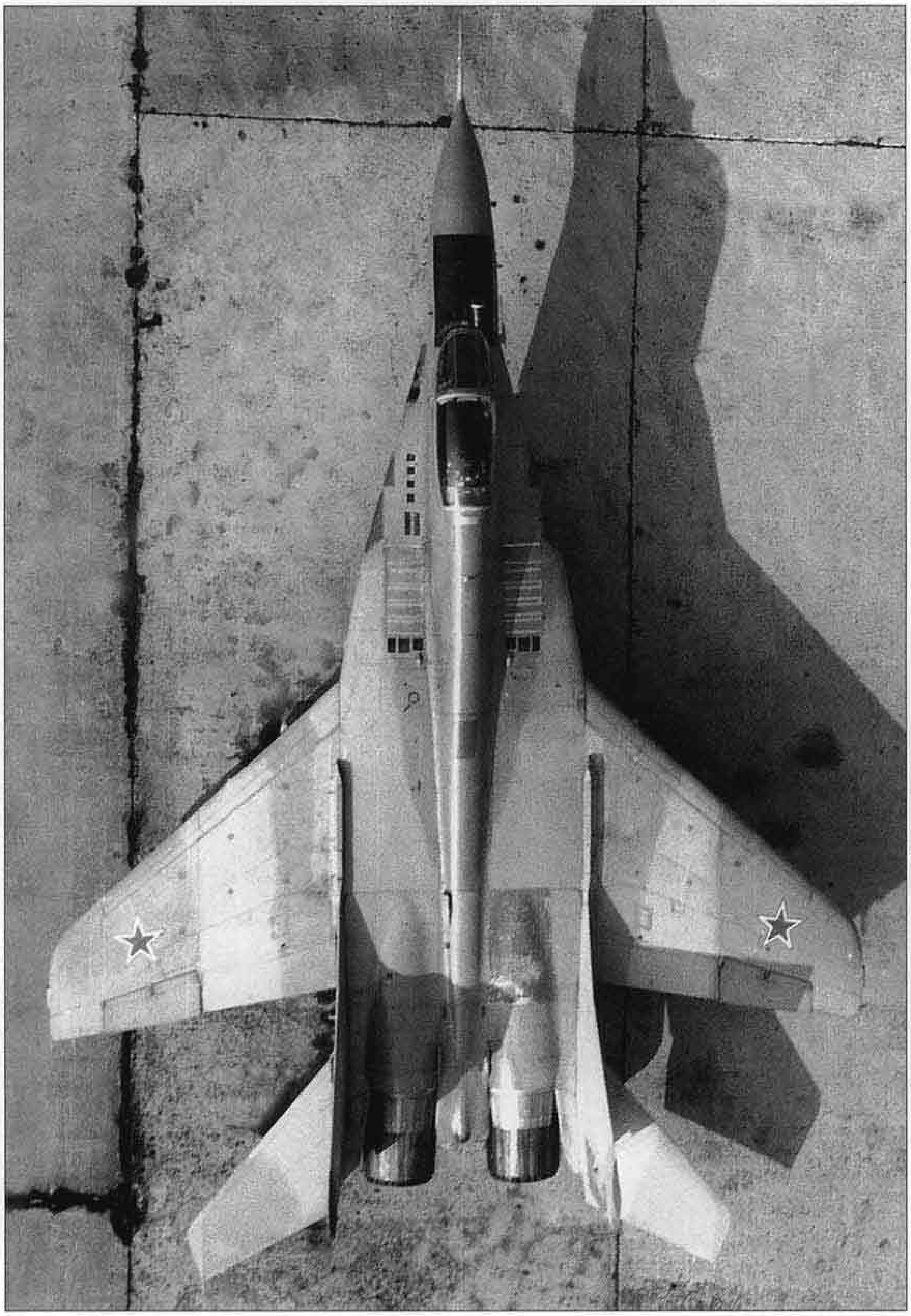
UB-32A-73 rocket pods with a total of 128 S-5K/S-5M 57-mm (2.24-in) folding-fin aircraft rockets or B-8M1 pods with a total of eighty S-8 80-mm (3.14-in) FFARs. A mix of these weapons could be carried, of course. Note: FAB = *foo***gahs***naya* **a***via***bom***ba* – high-explosive bomb; OFAB = *os***kol***ochno-foo***gahs***naya* **a***via***bom***ba* – HE/fragmentation bomb. ZB = *zazhi***gah***tel'nyy bahk* – lit. 'incendiary tank'. MBD = *mnogozam***kov***yy* **bah***lochnyy der***zha***tel'* – 'multi-lock beam-type [weapons] rack' (as distinct from cassette-type racks). B = *blok* – unit or module (used in many contexts – for instance, when speaking of avionics and so on), in this case, FFAR pod; UB = *oonifi***tsee***rovannyy blok* – standardised [FFAR] pod. S = *sna***ryad** – cannon shell or unguided rocket.

The weapons control system switched to the appropriate channel automatically to suit the type of target the fighter was attacking. In strike mode the high-precision laser rangefinder



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◄ **This upper view illustrates well the MiG-29's distinctive dart-like shape. Note the bleed air louvres aft of the dorsal auxiliary air intakes and the cannon bay ventilation ports in the port LERX.**

continuously measured target range; if for some reason the laser ranger could not be used the WCS automatically computed target range, using altitude and attitude (pitch angle) as reference data. This was then used to calculate the weapon impact point and issue signals to the pilot to adjust course, commence and complete the attack. Adjustments for target speed and drift were made semi-automatically by memorising the initial and terminal target sighting lines. A fixed grid in the HUD was used as a backup for 'manual' sighting.

Testing continued both at LII and GK NII VVS even after the fighter entered production (a test pilot's work is never done!). Not all flights ended well. One aircraft was lost at LII when a missile parted company with the aircraft, striking the stabilator and damaging it. The aircraft became uncontrollable and the pilot had to eject.

Like most Soviet fighters, early-production MiG-29s had a dark green/dark earth camouflage scheme. At Le Bourget, however, General Designer Rostislav A. Belyakov noticed that USAF fighters displayed at the airshow sported a two-tone grey colour scheme (the so-called Egypt One camouflage). At his orders the OKB hastily developed a range of new camouflage patterns (including grey ones) and showed them to VVS officials. The Air Force requested

An early-production MiG-29 (with the 'butterfly' nose gear door) coded '10 Blue' taxies at Zhukovskiy. ▼

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▲ **Mikoyan OKB test pilots and engineers pose for a photo with one of the OKB's MiG-29s, '506 Blue'. Valeriy V. Novikov, the then MiG-29 project chief, is standing in the middle of the back row.**

that Mikoyan lend them two MiG-29s for grey camouflage evaluation purposes; the ninth prototype, '20 Blue/920', was the first of these. The results proved encouraging and the Soviet Air Force adopted the two-tone grey colour scheme as standard type; the early dark green/dark earth aircraft were soon repainted.

Hungarian, Polish and Yugoslav MiG-29s, along with a few others, wore the same grey camouflage. Some foreign operators of the *Fulcrum*, however, thought differently. Thus, the East German and Czech aircraft had a dark green/dark earth colour scheme; Syrian and Iraqi MiG-29s sported a desert camouflage, while North Korean aircraft had green upper surfaces and light blue undersurfaces. The standard two-tone grey camouflage was fairly effective, as witnessed by RAF Panavia Tornado F.2 pilots who escorted a pair of MiG-29s in British airspace on the way to the


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◄ **Mikoyan OKB test pilots (left to right): Pavel N. Vlasov, Oleg Antonovich, Vladimir Gorboonov and Marat Alykov.**

A typical Soviet Air Force MiG-29 (*izdeliye* 9.12)

Soviet fighter's debut at the Farnborough International '88 air-show.

MiG-29UB Conversion Trainer (*Izdeliye* 9.51, *Izdeliye* 30) *Fulcrum-B*

To facilitate conversion training of Air Force pilots the Mikoyan OKB developed a combat-capable trainer version of the fighter designated MiG-29UB (*oo**cheb**no-boye**voy*** [*samo**lyot***] – combat-capable trainer). The *sparka*, as the aircraft was informally known, bore the manufacturer's designation *izdeliye* 9.51, eventually entering production under the same product code. *Sparka* (= doublet) is a common Soviet/Russian Air Force slang term for conversion trainer derivatives of fighters and translates loosely as 'Two-Sticks', being derived from ***spah**rennoye oopravl**en**iye* – dual controls. Double Trouble would be more fitting, perhaps?

The trainee and instructor sat in tandem cockpits enclosed by a common aft-hinged canopy giving shorter ejection time in an emergency. To avoid a major redesign and ensure maximum commonality with the single-seater the fire control radar was deleted, leaving only the IRST and HMS; hence the R-27R medium-range AAM with semi-active radar homing was excluded from the MiG-29UB's weapons range. The OEPrNK-29UB optoelectronic targeting/navigation system was modified to include a second set of indicators and controls. The R-73 and R-60 (R-60M) IR-homing AAMs, the air-to-ground armament – all carried on the usual six hardpoints – and the internal cannon were retained.

Despite the lack of radar, the MiG-29UB retained dogfighting and strike capability, as the IRST could engage targets at 25-30 km (15.5-18.6 miles) range, and the ability to deliver strikes against ground targets indirect visibility conditions. Special emulators were fitted to allow pilots to train in intercept techniques, using the radar, firing SARH missiles and dealing with systems failures. The aircraft featured flight and mission data recorders allowing sorties to be analysed quickly and possible pilot errors detected. It was designed to operate in visual and instrument meteorological conditions, day and night, enabling transition to the single-seat MiG-29 within a very short time frame.

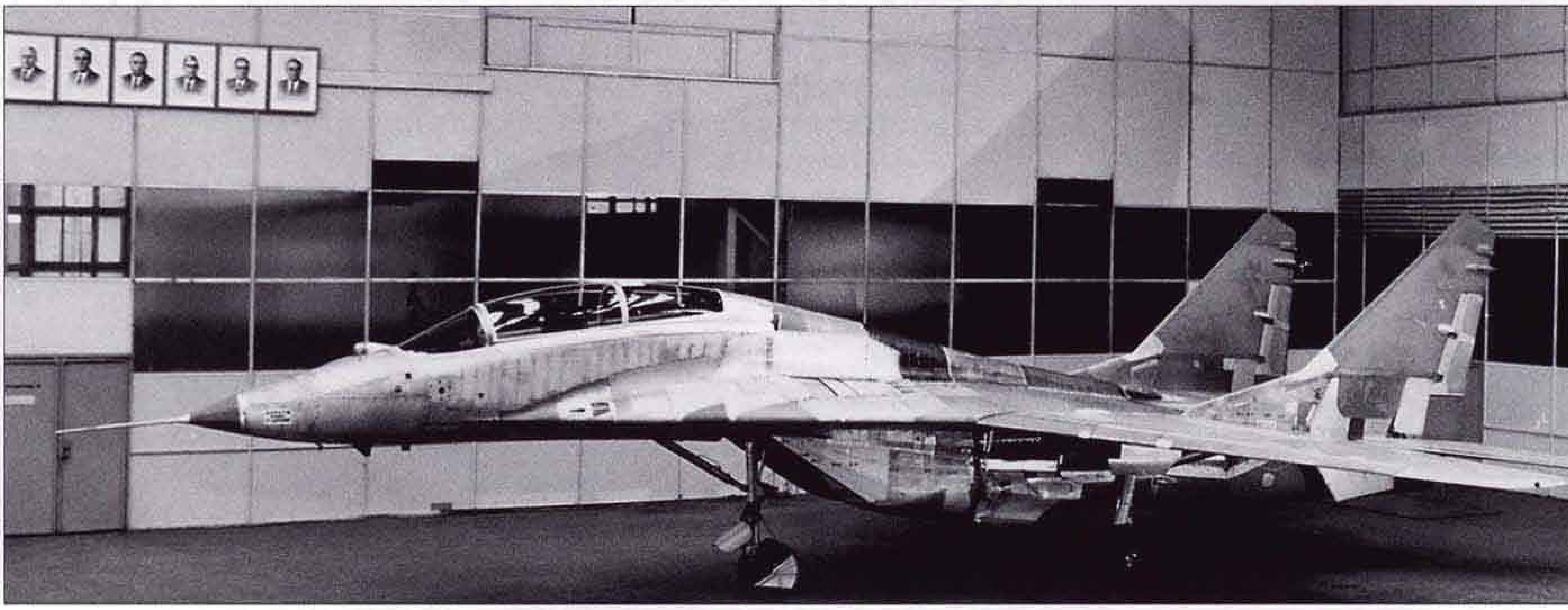
The two cockpits featured identical controls and indicators and K-36DM ejection seats. To give the instructor better forward visibility the rear cockpit was equipped with a large retractable periscope which was raised during landing and taxying. By eliminating the radar the engineers managed to avoid a reduction in internal fuel capacity as compared to the single-seater (*izdeliye* 9.12) – the fuel load was 3,200 kg (7,050 lb) less reserves. At 17.42 m (57 ft 1$\frac{53}{64}$ in), the trainer was only 100 mm (3$\frac{15}{16}$ in) longer than the basic MiG-29. No strakes housing chaff/flare dispensers were fitted ahead of the fins.

Performance, too was almost identical: with a normal takeoff weight of 14,600 kg (32,187 lb) in clean condition (with no external stores) the MiG-29UB had a 1,400-km/h (869-mph) top speed at sea level and a 330-m/sec (64,944-ft/min) rate of climb. Like the single-seater, the *sparka* was stressed for 9 Gs. Top speed at high altitude was slightly lower (2,230 km/h or 1,440 mph); so was the service ceiling (17,500 m/57,410 ft). Range also decreased slightly to 680 km (422 miles) at sea level and 1,410 km (875 miles) at high altitude.

Coded '51 Blue' and marked '951' on the tails, the MiG-29UB prototype (referred to as 'aircraft 951' in OKB documents) took off for the first time on 29th April 1981 with Aviard G. Fastovets at the controls. Like the early single-seaters, it featured ventral fins. By the end of the year the aircraft had made 53 flights. The second prototype ('aircraft 952', coded '52 Blue') was used in the state acceptance trials programme. The third prototype or pre-production aircraft ('53 Blue') had a non-standard c/n, 4029692486; 40 is probably some kind of code, 296 is a code for MAPO (this is the only known MiG-29UB to be manufactured by the production plant in Moscow) and the remaining digits are the 'famous last five'.

After successfully passing the manufacturer's flight tests and state acceptance trials the MiG-29UB entered production at the Gor'kiy Aircraft Production Association named after Sergo Ordzhonikidze (aircraft factory No.21). This long-standing Mikoyan partner is now a joint-stock company called NAZ Sokol (*Nizhego**rod**skiy aviatsi**on**nyy za**vod*** – 'Falcon' Nizhniy Novgorod aircraft factory). 'Assembly' would be more accurate, since the main airframe components – wings, fins, tailplanes and most of the fuselage structure – were manufactured in Moscow by MMZ No.30 and shipped to Gor'kiy (now renamed back to Nizhniy Novgorod) for final assembly, including mating to the new nose, and outfitting. This supports the theory that MiG-29UBs were allocated fuselage numbers in the same sequence as the single-seaters.

In Air Force documents the MiG-29UB was referred to as *izdeliye* 30. The trainer received


RSK MiG

▲ **The still-unpainted first prototype MiG-29UB in the assembly shop of MMZ No.155. Note the nose gear door and mudguard and the ventral fins.**

The same aircraft after painting. ▼

the NATO codename of *Fulcrum-B*, the single-seater (*izdeliye* 9.12) becoming the *Fulcrum-A*. Gor'kiy-built production MiG-29UBs had a separate construction number system – for instance, '84 Blue' is c/n N50903026414. Once again, 509 is a code for the factory, 030 means *izdeliye* 30 (a zero is added at the front to observe the usual three-digit format of such codes), while 26414 is the 'famous last five'. Unlike the single-seaters, the MiG-29UB has the full c/n stencilled on the rear wall of the nosewheel well and on the outer faces of the fixed stabilator root fairings.

MiG-29UB '53 Blue' was retained by the OKB and was much used for demonstration purposes. It was this aircraft that was displayed

RSK MiG

The first prototype MiG-29UB with amended photo calibration markings

at FI'88 along with the single-seater; it subsequently participated in many other airshows, sporting the new tactical code '304 Blue'. Later the aircraft was converted to become the MiG-29UBT upgrade demonstrator (see Chapter 6). As for the first two prototypes, in January 2006 '51 Blue' was still sitting in the repository of inactive prototypes at RSK MiG's flight test facility in Zhukovskiy, while '52 Blue' had become a ground instructional airframe at an aircraft engineer school in Riga, Latvia, after running out of service life.

MiG-29, Export Version A (*Izdeliye* 9.12A, *Izdeliye* 5A) *Fulcrum-A*

Soon after the initial production version became operational with the Soviet Air Force, MMZ No.30 began manufacturing a slightly downgraded export version intended for the Soviet Union's Central European allies (the Warsaw Pact countries). Known as 'version A' or *izdeliye* 9.12A, the aircraft featured an RLPK-29E (*eksportnyy* – export, used attributively) radar targeting system based on the N019EA Rubin radar, a modified OEPrNK-29E (S-31E) opto-electronic targeting/navigation system and different IFF transponders. Performance was identical to Soviet Air Force *Fulcrums*. 'Export version A' stayed in production from 1988 to 1991 and was supplied to Bulgaria, Czechoslovakia, East Germany, Poland and Romania.

MiG-29, Export Version B (*Izdeliye* 9.12B, *Izdeliye* 5B) *Fulcrum-A*

An even more downgraded export version designated *izdeliye* 9.12B was developed for 'friendly' states outside the Warsaw Pact. This aircraft featured a simplified N019EB radar and a simplified OEPrNK-29E2 targeting/navigation system. 'Version B' entered production at MMZ No.30 in 1986 and was supplied to India, Iraq, Syria, Yugoslavia and some other states. (The practice of supplying downgraded equipment to foreign customers was probably a sort of insurance policy in case today's allies would turn enemies tomorrow and use weapons purchased in the Soviet Union against it. In that case having slightly better weapons would give the Soviet Union an advantage.)

Initially the aircraft was armed with R-60 (R-60M) and R-27R missiles, later supplanted by R-27R1 and R-73 AAMs. In the strike role it could carry up to four FAB-250 or FAB-500 HE bombs, ZB-500 napalm bombs or KMGU-2 submunitions dispensers (*kon**tey**ner dlya **ma**lykh **groo**zov ooniver**sahl'**nyy* – 'all-purpose small items container'), four S-24 unguided rockets or four B-8M1 pods with 80 S-8 FFARs.

MiG-29 Tactical Fighter (*Izdeliye* 9.13, *Izdeliye* 7) *Fulcrum-C*

Meeting the specified range requirements was one of the biggest problems facing the designers of Soviet fourth-generation fighters. When the T10-1 (the first prototype of the 'first-generation' Su-27 *Flanker-A*) and the first prototype MiG-29 ('aircraft 901') entered flight test in 1977, both

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▲ **The first prototype MiG-29UB in an early test flight, with a MiG-23UB trainer flying chase. The MiG-23UB is farther from the camera than the *Fulcrum*.**

The first prototype had black and white phototheodolite calibration markings applied to the nose, air intakes and vertical tails. ▼ ▼▼

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were found to suffer from inadequate range. Sukhoi went the hard way, scrapping the original design altogether and coming up eventually with a new aircraft, the T-10S, which entered production as the 'second-generation' Su-27 *Flanker-B*.

Mikoyan did not have to resort to such drastic measures, since the requirements for the light tactical fighter were less stringent. Still, the problem was there and had to be dealt with. The advanced development project specified a range of 800 km (496 miles) at sea level and 2,750 km (1,708 miles) at high altitude with the centreline drop tank. In reality it was 700 km (434 miles) and 2,100 km (1,304 miles) respectively for the production MiG-29 (*izdeliye* 9.12).

Increasing the internal fuel capacity on the MiG-29 was something of a problem since the 'patented' dorsal auxiliary air intakes ate up a lot of space in the LERXes which could otherwise be used for fuel. Only the No.1 fuselage tank in the spine could be readily enlarged; its capacity was increased by 240 litres (52.8 Imp gal), giving an internal fuel volume of 4,540 litres (998.8 Imp gal). As the next-best solution the engineers introduced 'wet' inboard wing pylons permitting the carriage of two 1,150-litre (253 Imp gal) drop tanks. Fitting three drop tanks increased the total fuel volume to 8,340 litres (1,834.8 Imp gal), which gave the fighter a ferry range of 3,000 km (1,863 miles). With the drop tanks in place, speed was limited to 850 km/h (528 mph or Mach 0.8).

Another requirement not met on the initial production model was the provision of a comprehensive built-in electronic countermeasures (ECM) suite. This took longer to develop than anticipated, which is why the initial MiG-29 featured only an SPO-15LM (L006LM) *Beryoza* (Birch) radar homing and warning system (RHAWS) and BVP-30-26M chaff/flare dis-

▲
Engineless but still substantially intact, MiG-29UB '51 Blue' sits at the Mikoyan OKB's flight test facility in Zhukovskiy. Note the MiG logo on the nose and the deletion of the ventral fins.

Marcus Fülber

►
In contrast, the second prototype MiG-29UB ('52 Blue') has been reduced to a stripped-out hulk. It is seen here in the aviation museum at Riga-Skulte.

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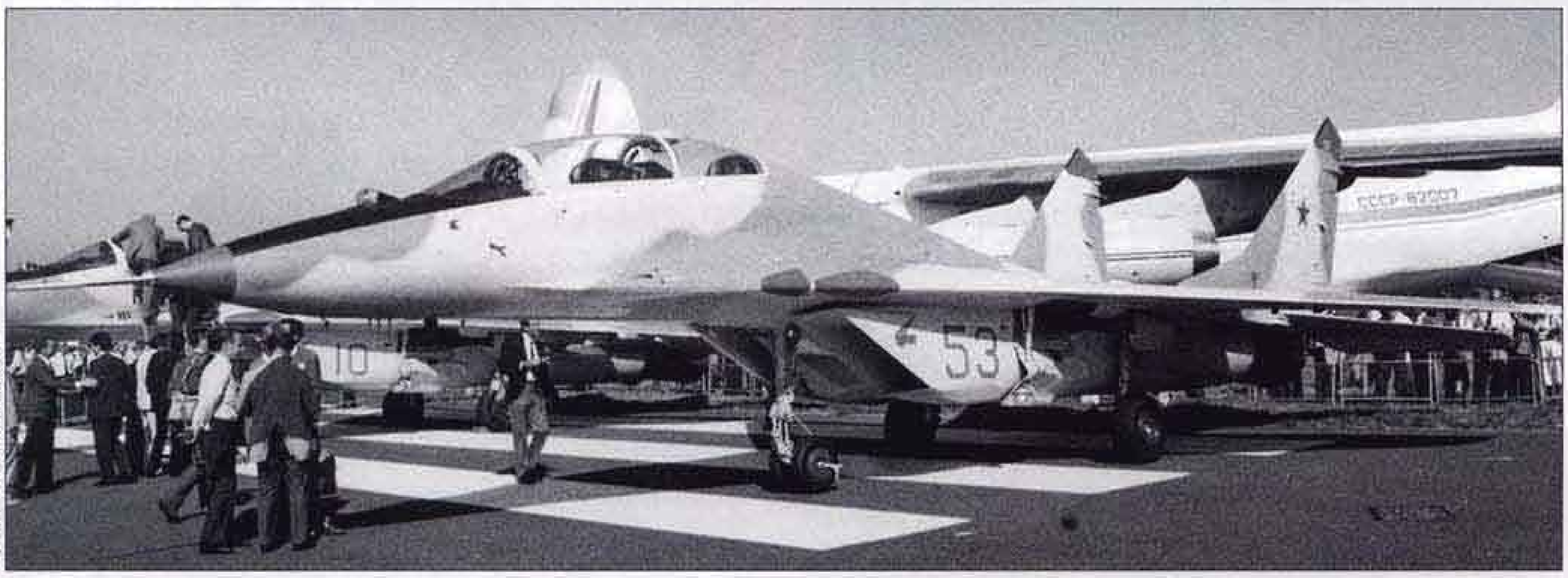

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◄ **Two views of the third prototype MiG-29UB, '53 Blue' (c/n 4029692846), at the Farnborough International '88 airshow.**

▲ **The badge of the Sokol aircraft factory in Nizhniy Novgorod.**

The Sokol plant operates this smartly-painted MiG-29UB, '03 Black', as a company demonstrator. ▼

pensers. In contrast, the Sukhoi engineers designing the Su-27 opted for podded ECM gear from the outset, which meant it could be fitted to all versions of the *Flanker* without requiring modifications.

Late MiG-29s were to have a Gardeniya-1FU (L-203B) jammer installed in the avionics bay aft of the cockpit. This and the enlarged No.1 fuel tank necessitated a change in the shape of the fuselage spine. The upper fuselage contour became convex instead of concave, giving the fighter a distinctive humpbacked appearance

NAZ Sokol

Victor Drushlyakov

The MiG-29UB demonstrator of the NAZ Sokol plant.

'04 Blue/404', one of the 'fatback' MiG-29 (*izdeliye* 9.13) prototypes, is about to be refuelled by a TZ-22 fuel bowser at Zhukovskiy. ▼

The same aircraft in one of the 'anti-satellite' sheds at Zhukovskiy. ▼▼

and earning it the nickname '*gorbahtyy*' – 'hunchback' (though 'fatback' would be more appropriate perhaps). The ECM aerials were located under four prominent dielectric panels at the wingtips to give 360° coverage.

In 1983 the Mikoyan OKB converted three standard Batch 4 aircraft – '04 Blue/404' (f/n 0404), '05 Blue/405' (c/n 2960505533, f/n 0405) and '06 Blue/406' (f/n 0406) into prototypes of the new version. All three had the recontoured fuselage spine but '04 Blue' and '05 Blue' may have been used for aerodynamics research only. '06 Blue' *did* have the enlarged No.1 fuel tank (and the 8,340-litre total internal fuel capacity) and Gardeniya-1FU jammer. '04 Blue' is a real mystery, sporting the c/n 25975!


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Trials began in April 1984, and '06 Blue' was the first to take to the air on 4th May; all in all, the three prototypes made more than 400 flights between them. Upon completion of the manufacturer's tests and the state acceptance trials '06 Blue' was retained by the 929th State Flight Test Centre (GLITs – *Gosoo**darstvennyy** **lyot**no-ispy**tah**tel'nyy tsentr*; formerly GNIKI VVS) in Akhtoobinsk and used in various research programmes. For example, the radar was tested for ECM resistance on this aircraft.

The aircraft entered production at MAPO (Moscow-Khodynka) in 1986 as *izdeliye* 9.13; the Air Force's code was *izdeliye* 7 (which was duly reflected in the c/n) and the NATO codename was *Fulcrum-C*. Production of the 'hunchback' ended in 1991 when the VVS completed its acquisition programme. Even so, *Fulcrum-A* production continued in parallel on a small scale, mainly for export.

The first production *izdeliye* 9.13 ('26 Blue', c/n 2960705560, f/n 1616) was the standard-setter for the production *Fulcrum-C*, incorporating all the refinements made in the course of the tests. This aircraft made more than 500 test flights at GNIKI VVS. When the programme was completed in November 1988 the fighter was donated to the Great Patriotic War Museum in Moscow. (Curiously, the first 15 aircraft of Batch 16 were *Fulcrum-As*; for some reason the first *Fulcrum-C* batch began with f/n 1616 instead of 1701, continuing to f/n 1630!) The new version had a separate 'famous last five' sequence but the f/n sequence continued uninterrupted, blocks of *Fulcrum-As* and *-Cs* being interspersed.

Basically the production MiG-29 (*izdeliye* 9.13) differs from the production *izdeliye* 9.12 as follows. The upper fuselage is recontoured; the forward and rear fuselage structure is revised, and changes are made to the wing and fin structure. The Nos. 1, 2 and 3 fuselage fuel tanks are redesigned; alterations are made to the upper cover of the engine accessory gearbox and the access cover above it between fuselage frames 7 and 8, and the No.1 fuselage longeron is altered between these two frames. The cockpit canopy features a revised rear portion (for better integration with the new spine) and longer-stroke emergency jettison rams. Changes are made to the layout of the control system, the fuel system, the fire suppression system, the engines' oxygen feed system enhancing start-up reliability, and the hydraulic and pneumatic systems.

Apart from the fuel system and ECM suite, the MiG-29 (*izdeliye* 9.13) has an ordnance load increased to 3,200 kg (7,050 lb) and can carry a wider range of air-to-ground weapons. These include KMGU-2 submunitions containers with BKF cassettes containing anti-personnel and anti-tank bomblets and mines weighing 0.5-2.5 kg (1.1-5.5 lb). Six FAB-500M54 high-drag bombs can be carried, instead of four, by fitting MBD3-U2T-1 MERs to the inboard pylons, each with two bombs in tandem. A typical load for a strike mission is four FAB-500s plus two R-73 or R-60M AAMs for self-defence. The *Fulcrum-C*'s maximum TOW is 18,480 kg (40,740 lb).

The first production 'fatbacks' were deployed in East Germany and operated by the 16th VA (*vozdooshnaya armiya* – Air Army, = air force).

More than 400 'fatbacks' were built. 233 of them remained in Russia after the collapse of the Soviet Union; 155 were retained by the Ukraine, seven more by Moldavia and a handful by the Central Asian republics. 30 aircraft unclaimed by the Russian Air Force and not yet fitted with the Gardeniya-1FU jammer sat at the LMZ factory airfield (Lookhovitsy-Tret'yakovo).

Aviatsiya i vremya

▲ GK NII VVS test pilot Valeriy V. Migoonov in the cockpit of *Fulcrum-C* '04 Blue/404'.

MiG-29 Export Tactical Fighter (*Izdeliye* 9.13B) *Fulcrum-C*

Five or six examples of the MiG-29 (*izdeliye* 9.13) were supplied to North Korea. Known as *izdeliye* 9.13B, this version lacked the Gardeniya-1FU jammer and featured other differences in the avionics (primarily the IFF system).

MiG-29 Experimental Fighter (*Izdeliye* 9.14) *Fulcrum-C*

In 1984 the Mikoyan OKB developed a version of the MiG-29 (*izdeliye* 9.13) with enhanced strike capability known in-house as *izdeliye* 9.14. It differed from the standard *Fulcrum-C* in having a new weapons control system which included a *Ryabina* (Rowan) low light level TV/laser designator pod. This had been developed for the upgraded MiG-27M *Flogger-J* attack aircraft and projected light strike/counter-insurgency (COIN)

A spectacular formation take-off by three unmarked brand-new 'fatback' MiG-29s at Lookhovitsy-Tret'yakovo. ▼

RSK MiG

A production Soviet Air Force MiG-29 (*izdeliye* 9.13) coded '47 Blue' and carrying four R-60Ms. These views show well the strongly convex spine.

versions of the MiG-101 twin-turboprop utility aircraft (which remained a 'paper aeroplane') and the Yak-58 piston-engined light aircraft.

The weapons range was expanded to include Zvezda Kh-25M (AS-10 *Karen*) laser-guided air-to-ground missiles, Spetstekhnika Kh-29T/Kh-29L (AS-14 *Kedge*) TV-guided or laser-guided AGMs and KAB-500 'smart bombs' (*korrek***tee***ruyemaya* ***avia*****bom***ba* – guided bomb). The maximum bomb load was 4,500 kg (9,920 lb) with eight 500-kg bombs on MERs under the wings and one on the fuselage centreline. (Note: The Zvezda weapons design bureau is not to be confused with Guy I. Severin's OKB-918 of the same name responsible for the K-36DM ejection seat.)

The *izdeliye* 9.14, '07 Blue' (c/n 2960507682, f/n 0407), was a heavily modified *Fulcrum-A* (the tactical code was later amended to '407 Blue'). Defying superstition, it flew for the first time on 13th February 1985 with Toktar O. Aubakirov at the controls.

The Ryabina LLTV/laser designator was still under development then, so in the summer of 1985 a dummy version was fitted for the initial flight tests. At this stage the aircraft made several flights with the maximum ordnance load of nine FAB-500s. However, live weapons tests with *izdeliye* 9.14 never began because in the mid-1980s the Mikoyan OKB was already working on the radically refined MiG-29M which could deliver pinpoint strikes with precision-guided munitions. The *izdeliye* 9.14 programme was terminated and the one-off prototype became a 'dogship', serving for bomb armament tests, as well as for control system tests, aerodynamics

Two 'textbook' views of the MiG-29 (*izdeliye* 9.13). In the upper view it is virtually indistinguishable from the *Fulcrum-A*.

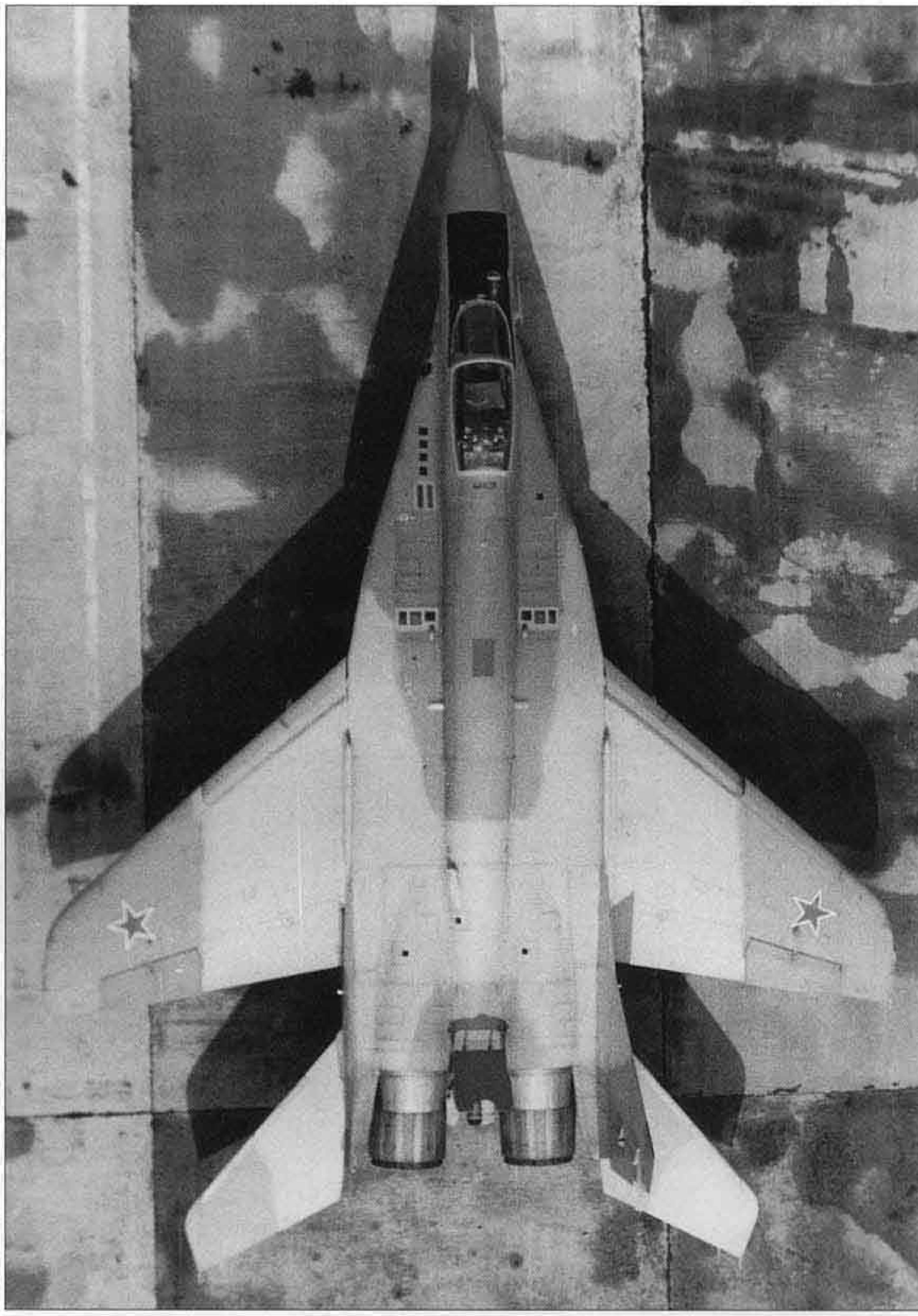
research and performance testing within the *Fulcrum-C*'s state acceptance trials.

Later, when the *Fulcrum-C* had completed its trials programme, '407 Blue' was used in the MiG-29S (*izdeliye* 9.13S) upgrade programme described below. In 1991-92 it participated in several international airshows. In the mid-1990s the fighter was still operational at the 929th GLITs; in late 1997 it was transferred to LII for use in a short take-off research programme involving a mobile ski jump (see below). By then '407 Blue' had more than 800 flights to its credit.

Testbeds and Research Aircraft
a) 'Aircraft 970' and 'Aircraft 971' Weapons Testbeds

Two production *Fulcrum-As* known in-house as 'aircraft 970' and 'aircraft 971' had a modified WCS, serving as weapons testbeds in the interests of the Vympel weapons design bureau. They were used to test the R-27T/TE, R-27RE and K-77 (RVV-AE/AA-12 Adder) medium-range air-to-air missiles. Both fighters ('70 Blue/970' and '71 Blue/971' were very early examples; 'aircraft 970', which had been first flown on 24th December 1984, even retained the ventral fins. This machine made its first post-modification flight in May 1985, followed by the second aircraft in January 1986.

The test programme was completed in August 1989. It included missile separation safety trials in all flight modes, verification of the changes to the N019 radar (as introduced on the later N019M Topaz capable of attacking two priority threats at once) and live firing trials against Lavochkin La-17M, Mikoyan M-21 (MiG-21) and Tupolev M-16 (Tu-16M) *Badger* remote-controlled target drones.



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▲
The one-off *izdeliye* 9.14 (c/n 2960507682) in its original guise as '07 Blue'.

('10 Blue', c/n 2960516767) borrowed from the Air Force's 4th Combat & Conversion Training Centre in Lipetsk. This aircraft later became Mikoyan's demonstrator workhorse (apparently because the OKB had no aircraft of its own available for this purpose), eventually crashing spectacularly at the 1989 Paris airshow (see Chapter 9).

c) MiG-29 Stealth Technology Testbed

To investigate ways of reducing the aircraft's radar signature the Mikoyan OKB applied a coat of radar-absorbent material (RAM) to a standard production MiG-29 coded '22' (the tactical code was later removed). Similar experiments were conducted concurrently with the Su-25 *Frogfoot* attack aircraft. Trials showed that the RAM significantly reduced the fighter's radar cross-section (RCS), thus reducing radar detection range, the accuracy of the enemy missiles' target

Flight Research Institute

▶
The same aircraft in a later guise as '407 Blue'. Note the drop tanks on the wing pylons.

b) Equipment Reliability Research Aircraft

After completing a special test programme with 'aircraft 919' in order to ascertain the causes of the all-too-frequent equipment malfunctions, LII began further research in order to deal with the MiG-29's teething troubles. This time the 'dogship' was a standard production *Fulcrum-A*

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▶
Later still, '407 Blue' had Russian flag stripes added to the vertical tails.

lock-on and radar proximity fuse detonation. However, for some reason the experiment was not taken further.

d) Uprated RD-33 (*Izdeliye* 21) Engine Testbed

After completing its state acceptance trials programme the tenth MiG-29 prototype, '21 Blue' ('aircraft 921'), was converted into a testbed for a version of the RD-33K engine (*izdeliye* 21) uprated to 8,800 kgp (19,400 lbst) in full afterburner. This version had been developed for the MiG-29M (*izdeliye* 9.15). The prototype engine supplanted the fighter's port RD-33 (the standard engine in the starboard nacelle was retained). The air intakes were converted to MiG-29M standard with downward-hinging FOD protection grilles some way downstream instead of solid blocker doors at the mouth and no auxiliary dorsal intakes. The testbed first flew in this configuration on 27th September 1985.

e) N010 Radar Testbed (*Izdeliye* 9.16)

A production 'fatback' MiG-29 coded '16 Blue' was converted into an avionics testbed for the Phazotron N010 Zhuk (Beetle) radar developed for the MiG-29M (see next chapter). Quite simply, the nose ahead of the windshield was severed and replaced by a new MiG-29M-style nose incorporating the experimental radar. '16 Blue' made the first post-conversion flight on 12th January 1987; V. F. Babin was the engineer in charge of the flight tests.

The trials, which took place at GNIKI VVS in Akhtoobinsk, had to be suspended for an extended period because the experimental radar went unserviceable; finding out and eliminating the cause took a lot time. Once the problem had been fixed, the aircraft returned to Akhtoobinsk where it remained operational until approximately 1990, flying quite actively. However, the MiG-29M had entered flight tests by then and further trials of the new radar proceeded on the 'the real thing' at the insistence of the Soviet MoD.

Robert Ruffle archive

▲ **Landing gear tucking away, '407 Blue' pulls up into a spectacular climb in full afterburner.**

f) MiG-29E Skif Avionics Testbed ('Aircraft 211', *Izdeliye* 9.21)

In the late 1980s GosNIIAS began practical research on digital avionics for fourth-generation fighters. The programme was codenamed *Skif* (Scythian; the Scythians were one of the ancient pagan peoples inhabiting pre-Christian Russia). The BTsK-29 digital avionics suite included a

RSK MiG

▲ **The weapons testbed known as 'aircraft 970' had no external recognition features. Note the open airbrake and the absence of the tactical code, which was added later.**

A. Yu. Oblamskiy

◄ **The same aircraft, now coded '70 Blue'; note the ventral fins. Also of note is the 1/4th-scale gliding model of a *Fulcrum-C* in the foreground.**

RSK MiG

RSK MiG

RSK MiG

▲ **Three views of the 'aircraft 971' weapons testbed. Here it is depicted with ordinary dummy R-27Rs and R-60Ms.**

new speed and altitude data system (with self-contained pitot/static sensors), new navigation systems and multiplex fibre-optic data exchange channels; all of this enhanced the fighter's combat potential significantly.

To verify the new digital suite an early production *Fulcrum-A* coded '11 Blue' (f/n 1601) was converted into an avionics testbed known in-house as *izdeliye* 9.21 in late 1987. Since it was also known as 'aircraft 211', the code '211' was applied to the dielectric fin caps; the testbed also had the unofficial designation MiG-29E (*eksperimen**tahl'**nyy* – experimental). Outwardly the MiG-29E could be identified by the additional pitot heads on the nose pitot and on the fuselage underside immediately aft of the radome.

The first flight took place on 1st August 1986, but the actual tests under the Skif programme did not begin until April 1988. Shortly afterwards the programme was suspended. Yet the effort

Yefim Gordon

◄ This MiG-29 (*izdeliye* 9.13) seen at Zhukovskiy during a Mikoyan presentation in February 2000 is a development aircraft for testing a radar-absorbing material coating.

was not in vain; the recommendations of GosNII AS concerning the structure and hardware of the digital avionics were incorporated in later upgrades of the MiG-29.

g) MiG-29KVP Development Aircraft

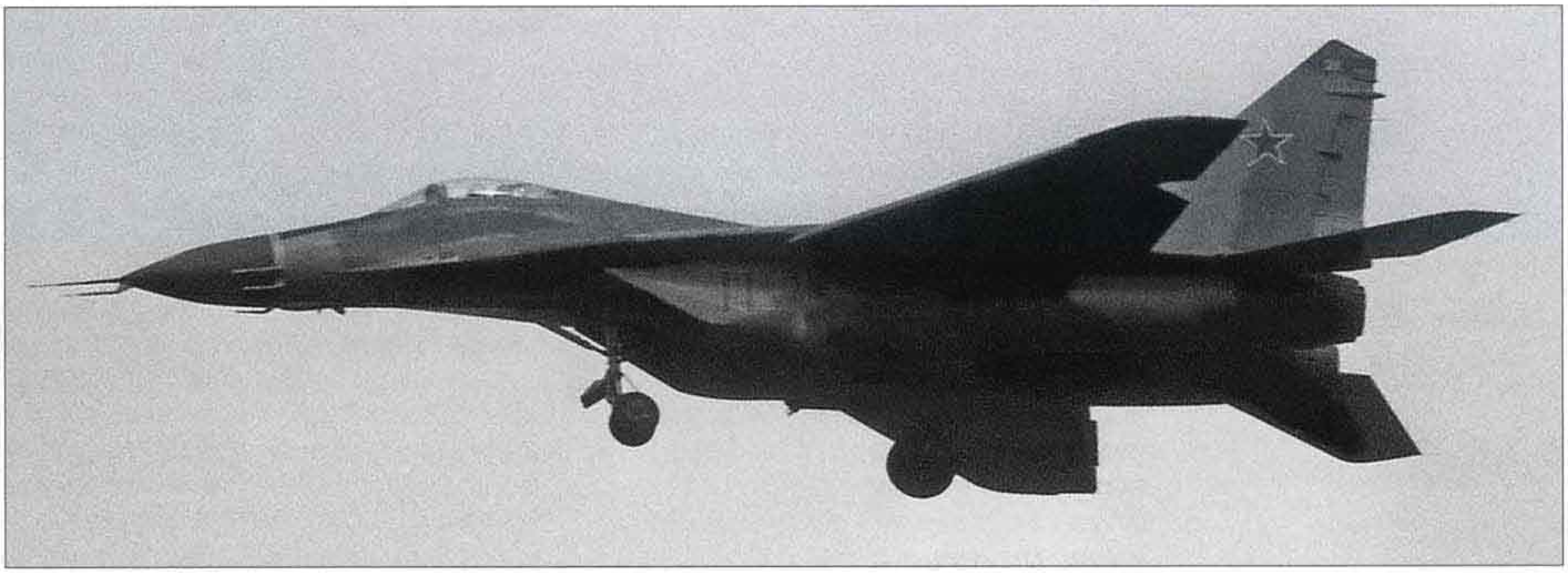
In 1982 the eighth prototype *Fulcrum-A* ('18 Blue', or 'aircraft 918') was converted under the MiG-29K shipboard fighter programme. The objective was to test the type's compatibility with a conventional take-off and landing (CTOL) aircraft carrier and perfect carrier operations techniques. All unnecessary equipment was removed, resulting in a gross weight of only 12 tons (26,455 lb), and an arrester hook fitted under the aft fuselage. This required the airframe to be reinforced to withstand the augmented loads. In this guise the aircraft was unofficially designated MiG-29KVP (*ko**rot**kiy vzlyot i po**sahd**ka* – STOL).

Carrier operations trials proceeded at Novofyodorovka AB near the city of Saki on the Crimea peninsula, which hosted the Soviet Naval Aviation's Flight Test Centre. A special 'unsinkable carrier' had been built there, featuring a ski jump and an arrester wire system. On 21st August 1982 Mikoyan OKB test pilot Aviard G. Fastovets made the first take-off in the MiG-29KVP from the provisional T-1 ski jump (T = *tram**plin***). The aircraft became airborne at 240 km/h (149 mph) after a 250-m (820-ft) take-off run. Between 1st and 25th October 1984 the MiG-29KVP made a number of take-offs from the restyled T-2 ski jump.

Two other Mikoyan test pilots, Toktar O. Aubakirov and A. Krootov, also participated in the ski jump take-off and automatic carrier approach trials. Air Force test pilots had to wait their turn, using breaks in the OKB's flight test programme while the results were analysed. For example, GNIKI VVS test pilot V. M. Kandaoorov made 200 flights at Novofyodorovka in 1988, including 65 wire engagements; some of these were made in the MiG-29KVP.

Initially the aircraft was repainted in a greenish-blue naval colour scheme. However, this was a bad idea: the naval scheme turned out to be an 'anti-camouflage' (as Toktar

'11 Blue/211' (f/n 1601), the MiG-29E ('aircraft 211') testbed for the BTsK-29 digital avionics suite. Note the numerous additional pitot heads on the nose. ▼



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▲ The starboard fin of the MiG-29E ('aircraft 211').

Aubakirov put it, the aircraft was 'as eye-catching as a butterfly'). Therefore, the MiG-29KVP soon reverted to its original grey colour scheme.

'18 Blue' was in the static display at MosAeroShow-92 in Zhukovskiy (11th-16th August 1992), Russia's first major airshow. Later the aircraft was briefly used as an instructional airframe by the Moscow Energy Institute before being donated to the VVS Museum in Monino. For some obscure reason the MiG-29KVP had 'Mikron' written on both stabilators after being transferred to the museum.

MiG-29 Short Take-Off Research Aircraft (Mobile Ski Jump Tests)

As mentioned earlier, the *izdeliye* 9.14 prototype ('407 Blue') was used to assess the possibility of improving the MiG-29's field performance by means of a mobile ramp (ski jump).

The idea of using mobile ski jumps for land-based tactical aircraft first occurred in the late 1980s. Experience shows that when an airfield is attacked with runway-cratering bombs, the distance between bomb craters on a disabled runway does not exceed 300 m (980 ft). No combat jets except vertical short take-off and landing (V/STOL) types can operate from such short runways; by comparison, the MiG-29's normal take-off run is 600-700 m (1,970-2,300 ft). The only possible solution, according to LII specialists, is a mobile ski jump reducing the take-off run. Such a structure can be transported piecemeal and quickly erected at the end of an undamaged section of runway, allowing aircraft to be flown out.

Theoretical research in this field began at LII in 1988. The institute devised an algorithm for determining the optimum ramp profile for a given aircraft (this is important, as each type of aircraft has its own optimum profile due to its design peculiarities and weight) and proved the possibility of creating a versatile mobile ski jump suitable for several aircraft types. To verify the idea, the MT-1 mobile ski jump (*mo**bil'**nyy tram**plin***) was built and tested; it permitted safe operation of aircraft grossing up to 7.5 tons (16,530 lb). First, a preliminary research programme using a MiG-21UM *Mongol* trainer was undertaken in 1989-93; on 7th April 1994 LII test pilot Sergey Tresvyatskiy made the first take-off from the MT-1 ski jump in the same aircraft.

A new stage began on 24th December 1997 when Tresvyatskiy performed the first take-off from the MT-1 in the MiG-29. Due to the weight limitations imposed by the ski jump the aircraft

The *izdeliye* 9.14 development aircraft ('407 Blue') takes off from the MT-1 mobile ski jump at Zhukovskiy in December 1997. ▼

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was flown with the fuel tanks only half full, grossing at 12.8 tons (28,220 lb). The fighter became airborne at a speed of 218 km/h (135 mph); the structural loads applied to the landing gear were not measured. Commencing the take-off run on a slippery snow-covered runway, the MiG-29 started slithering even before the engines had reached full military power, never mind afterburner rating.

The test programme included four flights in MiG-29 '407 Blue'. The best results were obtained when the fighter left the ski jump at 192 km/h (119 mph) – the take-off run was shortened by a factor of 1.7. The AOA reached a maximum of 16°30' (the MiG-29's authorised limit is 19°); the aircraft showed no tendency to 'fall through' after clearing the ski jump. The take-off run was 200 m (660 ft); LII and Mikoyan specialists hoped to reduce it to 130-150 m (430-490 ft) with a partial fuel load. With a full fuel load and four missiles (two R-27s and two R-73s), which corresponds to a 15,400-kg (33,950-lb) take-off weight, the MiG-29 was expected to become airborne from the MT-1 with a take-off run of 230-250 m (750-820 ft); this was sufficient to enable evacuation from a cratered runway.

The tests confirmed the viability of the mathematical analysis methods used to calculate the MiG-29's dynamics during take-off from the MT-1. No further tests were conducted, however, due a singular lack of interest on the part of the Russian MoD and foreign customers alike. A line from a song by the well-known Soviet singer/songwriter Vladimir Vysotskiy comes to mind (no attempts at a poetic translation): *There are no prophets in one's homeland, // but there ain't too many of them abroad either*.

MiG-29S Tactical Fighter (*Izdeliye* 9.13S) *Fulcrum-C*

Two of the *izdeliye* 9.13 prototypes were further modified ('04 Blue' in 1989 and '05 Blue' in 1988) for additional research in order to put the new K-77 medium-range AAM (later known as the R-77 or RVV-AE) through its paces. The result was an upgraded version of the *Fulcrum-C* designated MiG-29S or *izdeliye* 9.13S.

Unlike *izdeliye* 9.14, this upgrade centred on enhancing the aircraft's counter-air capability. The main new feature of the MiG-29S was the improved RLPK-29M targeting system; this was based on the N019M Topaz fire control radar having better ECM resistance. It could guide missiles to two priority threats at a time and was integrated with the R-27T infrared-homing AAM, the longer-range R-27TE/R-27RE and the R-77 AAM. The radar had probably been tested on a Tupolev Tu-134UBL *Crusty-C* bomber crew trainer converted by NPO Phazotron into an avionics testbed (no tactical code, ex-'21 Red', c/n (33)64740).

Other improvements included a new Ts101 digital processor, an upgraded OEPrNK-29-1 optoelectronic targeting/navigation suite, new software and better built-in test equipment. The OEPrNK-29-1 had a combined control mode facilitating gunnery attacks on aerial targets.

Modifications to the automatic flight control system increased the fighter's maximum AOA to 28°, improving high-alpha handling at the same time. The airframe was reinforced, permitting an increase in maximum TOW to 20,000 kg (44,090 lb). The ordnance load in the strike role was increased to 4,000 kg (8,820 lb) of bombs on four MERs under the wings (two 500-kg/1,102-lb bombs in tandem per pylon). Like the standard *Fulcrum-C*, the MiG-29S had provisions for three drop tanks.

According to the designers' estimates, the new missiles, especially the R-77 (which out-performed the American AIM-120 AMRAAM), increased the fighter's combat efficiency 2.5 to 3 times. The R-77 featured a unique combined guidance system with inertial guidance initially and active radar homing at the terminal guidance

▲ **Two more views of '407 Blue' as it clears the ramp during one of the subsequent MAKS airshows at Zhukovskiy.**

RSK MiG

RSK MiG

▲► **'05 Blue', the first prototype MiG-29S (*izdeliye* 9.13S) in three-tone tactical camouflage, with six inert R-77 (RVV-AE) missiles on the pylons.**

This shot of '05 Blue' at Vladimirovka AB, Akhtoobinsk (the main facility of GNIKI VVS), gives a better idea of the MiG-29S prototype's camouflage scheme. Note the mission markers on the nose. ▼

phase. In a long-range 'missile duel' the MiG-29S was estimated to have 10% better chances than the Lockheed Martin F-16C and the Dassault Rafale, and 25% better chances than the SAAB JAS39 Gripen and the Dassault Mirage 2000-5.

'05 Blue' entered flight test on 20th January 1989, with '04 Blue' following on 20th June. These aircraft served to verify the RLPK-29M radar targeting system and the upgraded SUV-29S weapons control system as a whole; they were also used for live trials of the R-77

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AAM. In particular, '05 Blue' became the first aircraft to make a successful simultaneous launch of two AAMs at two different targets. The first fully equipped 'real' prototype MiG-29S entered flight test on 23rd December 1990.

The trials programme continued until September 1991, whereupon the MiG-29S was recommended for Russian Air Force service in 1993. By then MAPO had manufactured close to fifty MiG-29Ss; in fact, however, only 16 of them were actually delivered to the Russian Air Force, the remainder being converted to MiG-29SE export configuration (see below). On the other hand, VVS aircraft overhaul plant No.121 at Kubinka AB began upgrading early-production *Fulcrum-A/Cs* to MiG-29S standard in the mid-1990s. The new version attained IOC with the fighter regiment at Shaykovka AB.

Later, when testing of the R-77 had been completed, '05 Blue' served on as a testbed for new TV-guided air-to-ground weapons intended to further boost the capabilities of the MiG-29S.

MiG-29S Tactical Fighter (*Izdeliye* 9.12S) *Fulcrum-A*

A similar upgrade of the original production version, *Fulcrum-A*, bore the same service designation, MiG-29S; quite logically, however, the manufacturer's designation was different – *izdeliye* 9.12S. Outwardly the aircraft differed from the version described above in having the original concave fuselage spine; thus, it had less internal fuel and lacked the Gardeniya-1FU (L203B) jammer.

Four MiG-29S (*izdeliye* 9.12S) fighters were retained by MAPO-MiG for demonstration purposes. The aircraft, which were painted in a rather bizarre metallic green/blue/silver camouflage and coded '333 Silver' (c/n 2960536093), '555 Silver' (c/n 2960535400, f/n 4710), '777 Silver' (c/n 2960535403, f/n 4711) and '999 Silver' (c/n 2960536501), participated in several international airshows in the 1990s.

MiG-29 IFR System Testbed

A standard production MiG-29 (*izdeliye* 9.12) was converted into a testbed for the optional in-flight refuelling (IFR) probe which was to be fitted to the MiG-29SD, MiG-29SE and MiG-29SM export versions (see below) at the customer's request. Unlike the MiG-29K and MiG-29M, both of which had a fully retractable L-shaped IFR probe offset to port ahead of the windscreen, this probe was semi-retractable and removable. The largish elongated fairing, rather like that of the Panavia Tornado IDS, was located on the port side of the forward fuselage (starboard-side installation was impossible because the No.2 pitot was located there). The probe itself weighed 65 kg (143 lb); the additional fuel lines, valves and other fuel system components increased the aircraft's weight by another 30 kg (66 lb). The system made it possible to fill both internal tanks and drop tanks. A contract with Malaysia signed on 7th June 1994 stated that 14 of the 16 *Fulcrums* ordered by the Royal Malaysian Air Force (the single-seaters) were to be retrofitted with refuelling probes upon completion of deliveries.

In developing the system Mikoyan built on experience with the retractable probe tested on the MiG-25PDZ *Foxbat-E*, MiG-25RBVDZ and MiG-25RBShDZ *Foxbat-B* IFR system testbeds (and later fitted to production MiG-31B *Foxhound* interceptors). The MiG-29's probe was adapted for working both with the Russian Ilyushin IL-78 (IL-78M) *Midas* three-point tanker and with Western hose-and-drogue tankers, such as the Lockheed C-130K Hercules and McDonnell Douglas KC-10A Extender (the latter with an adapter on the 'flying boom').

The only problem was how to squeeze the new components into the very limited space available. Originally the engineers wanted to place the probe immediately below the cockpit canopy but later moved it downward a little. The fuel line could not be stowed completely in the fuselage, and part of it adjacent to the probe had to be covered by a fairing. The probe, complete with the mounting frame and the protruding part of the fuel line, could be removed or reinstalled within an hour if need arose. The system could be retrofitted to any version of the *Fulcrum* with minimum modifications and at minimum cost.

In-flight refuelling is a complex procedure demanding great concentration and skill, so

Still in standard grey colours, '333 Silver' (c/n 2960536093), one of the MiG-29S (*izdeliye* 9.12S) demonstrators, is seen at the Krasnaya Presnya Exhibition Centre in Moscow during the MAKS-93 airshow. Note the Bell 206L-3 Long Ranger III (N980BC) which was on loan to the Moscow City Police Department.
▼

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One of MAPO's MiG-29S (*izdeliye* 9.12S) demonstrators at Lookhovitsy-Tret'yakovo with a representative weapons array, including B-8M1 FFAR pods, KMGU-1 submunitions dispensers, high- and low-drag bombs, ZB-500 napalm tanks and AAMs.

Four views of MiG-29S (*izdeliye* 9.12S) '999 Silver' (c/n 2960536501), illustrating its bizarre camouflage.

changes were made to the semi-automatic control system to facilitate approach to and contact with the tanker. A short-range radio navigation (SHORAN) system was fitted to ensure rendezvous with the tanker. After extending the IFR probe the pilot switched the control system to 'refuelling stabilisation' mode.

The modified MiG-29 (c/n 2960536034, f/n 4808) originally flew in grey primer finish without markings; in this guise it was used for refuelling trials. On 16th November 1995 MAPO-MiG chief test pilot Roman P. Taskayev made the first successful refuelling from an IL-78 registered CCCP-78782. (Many Soviet Air Force transport aircraft wore ostensibly civil registrations and the colours of the national airline Aeroflot, and a few retained the old CCCP-country prefix and the Soviet flag as late as 1997.) Mikoyan OKB test pilot Marat A. Alykov and Air Force test pilots V. D. Shooshoonov and A. A. Goncharov also flew the aircraft. Mikoyan engineers and test pilots claimed that the improved flight control/stabilisation system was better than all others used on Russian combat aircraft with IFR capability. Refilling one fuselage tank and three drop tanks extended the MiG-29's ferry range to 6,000 km (3,726 miles). The IFR probe had no adverse effect on the fighter's performance and handling.

Contact with the IL-78 was made at altitudes up to 8,000 m (26,250 ft) and speeds between 400 and 600 km/h (248-372 mph). Refuelling was also performed at 350-500 km/h (217-310 mph) to simulate working with the slower KC-130 turboprop tanker. This was because the Malaysian Air Force had acquired six C-130 transports which could be readily converted into tankers.

The trials programme was completed in January 1996. The fighter was then painted in the standard two-tone grey camouflage and coded '357 Blue'. That year it was displayed at two major airshows – ILA'96 at Berlin-Schönefeld and Farnborough International '96. In June 1997 '357 Blue' participated in the 42nd Paris Air Show with the exhibit code 353; two months later it appeared in the static park of the MAKS-97 airshow in Zhukovskiy (19th-24th August).

After ILA'96 Western aviation specialists tended to refer to '357 Blue' as a 'MiG-29SM'

The MAPO logo as carried by '333 Silver', '555 Silver', '777 Silver' and '999 Silver'.

The starboard fin of MiG-29S (*izdeliye* 9.12S) '999 Silver'.

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RSK MiG / Artur Sarkisyan

RSK MiG / Artur Sarkisyan

RSK MiG / Artur Sarkisyan

RSK MiG / Artur Sarkisyan

▲
The as-yet uncoded MiG-29 IFR system testbed (c/n 2960536034, f/n 4808) approaches the drogue deployed from the centre PAZ-1 hose drum unit of an IL-78 tanker; the IFR probe is still retracted. Note that no pylons are fitted.

◄
MiG-29 c/n 2960536034 makes contact with the drogue. In this case four pylons carrying two missiles and two drop tanks are fitted. Note the semi-conical fairing protecting the IRST transparency.

►
This sequence shows the MiG-29 IFR system testbed topping up its tanks from the underwing UPAZ-1A HDUs of IL-78 CCCP-78782 (c/n 0083489678, f/n 6710). Despite the fact that the trials took place in November 1995, the tanker still wears the old Soviet flag and country prefix – which was not altogether uncommon for the Russian Air Force's quasi-civil transports.

RSK MiG / Artur Sarkisyan

RSK MiG / Artur Sarkisyan

RSK MiG / Artur Sarkisyan

RSK MiG / Artur Sarkisyan

(although the data placard at MAKS-97 read 'MiG-29SD'!). However, both designations are hardly applicable to this particular aircraft, since it was merely a testbed. Curiously, a stencil on the nose immediately aft of the radome reads 'N019EM' – which is probably a 'misprint' as the radar is designated N019ME. Indeed, there is no positive proof that '357 Blue' is really equipped with this radar!

MiG-29SD Export Version (*Izdeliye* 9.12SD) *Fulcrum-A*

Predictably, an export version of the 'concave' MiG-29S (*izdeliye* 9.12S) intended for third-world customers appeared before long. The aircraft was designated MiG-29SD or *izdeliye* 9.12SD, the D standing for *doza**prahv**ka* – [in-flight] refuelling.

As compared to the existing 'third-world' version (the *izdeliye* 9.12B), the MiG-29SD differed in having the removable semi-retractable IFR probe described above, with appropriate changes to the fuel metering system. The probe had been specially created for the MiG-29SD. The aircraft could carry a centreline drop tank and two 1,150-litre (253 Imp gal) underwing drop tanks increasing the total fuel capacity to 8,100 litres (1,782 Imp gal). Appropriate radio navigation and lighting equipment was provided to ensure rendezvous and safe contact with the tanker.

Furthermore, the fighter had an RLPK-29ME (export) radar targeting system (based on the N019ME Topaz radar compatible with the R-77/RVV-AE missile) and an OEPrNK-29-1E opto-electronic targeting/navigation system. This afforded a major improvement in combat capabilities over the standard export *Fulcrum*. Western communications, navigation and IFF systems were integrated in conformity with the customer's standards. The ordnance load was increased to 4,000 kg (8,820 lb). The MiG-29SD entered production in 1995.

The upgraded radar enabled the MiG-29SD to engage two aerial targets at a time, firing two missiles consecutively or simultaneously. This was possible if the target azimuths differed by more than 8° or if the targets were on a common azimuth but more than 10 km (6.2 miles) apart. The radar consecutively engaged the two targets as they came within 'kill' range; target lock-on occurred automatically or was effected manually. As both targets came within range, the common indication display showed 'fire when ready' symbols. The port side missile was then fired at the left-hand target and the starboard-side missile at the right-hand target. If only one target came within 'kill' range, the system fired on it first and then waited for the other target to come within range.

MiG-29N Tactical Fighter

The 16 MiG-29SDs delivered to the Royal Malaysian Air Force's Nos. 17 and 19 Squadrons and pertaining to batches 52 and 53 are referred to by the operator as MiG-29Ns. The Russian-made flight instruments are calibrated in feet, knots, feet/minute and nautical miles in conformity with Western standards, and all cockpit placards are in English.

During the maintenance check performed upon accumulating 800 hours' total time all 16 aircraft were upgraded to 'full MiG-29N standard' – that is, retrofitted with IFR probes

The MiG-29 IFR system testbed, now in full camouflage colours and coded '357 Blue', in the static park of the ILA'96 airshow. Note the Kh-31P anti-radiation missile on the port inboard pylon and the exhibit code 244 on the fin. ▼

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▲ **Partly stripped down for transportation, Royal Malaysian Air Force MiG-29N M43-04 (c/n 2960536590, f/n 5215) is about to be loaded into a Russian Air Force Antonov An-124 Ruslan for delivery.**

and associated equipment as tested on MiG-29 '357 Blue'. The upgrade also included installation of American avionics, including the AN/ARN-139 tactical area navigation (TACAN) system, a global positioning system (GPS) receiver, VOR/ILS, Raytheon IFF and ATC transponders, additional HF and UHF radios and so on. The work was performed by Aerospace Technologies Systems Corporation at Kuantan between January 1998 and late 1999. The first aircraft to be thus upgraded, M43-12 (c/n 2960538310, f/n 5308) took off on 13th April 1998 and returned to service on 2nd May.

The MiG-29N can carry R-27R1, R-77 (RVV-AE) and R-73E1 missiles. Additionally, the Malaysian *Fulcrums* are powered by RD-33 engines with an increased service life.

MiG-29NUB (MiG-29UBN) Combat Trainer

Similarly, the two MiG-29UB combat trainers delivered to Malaysia in 1995 have the Russian flight instruments marked in Imperial units and have been retrofitted with semi-retractable IFR probes; these aircraft are known locally as MiG-29NUBs (though some sources state the designation as MiG-29UBN, which does sound more logical).

MiG-29SE Export Version (*Izdeliye* 9.13SE) *Fulcrum-C*

A similar export version of the 'fatback' MiG-29S (*izdeliye* 9.13S) was designated MiG-29SE or *izdeliye* 9.13SE (E for export). It differed from the MiG-29SD mainly in having a bigger internal fuel capacity; the bulged spine housed a No.1 fuel tank holding 240 litres (52.8 Imp gal) of extra fuel. The WCS was identical to that of the MiG-29SD, featuring the RLPK-29ME radar targeting system and the OEPrNK-29-1E optoelectronic targeting/navigation system. There was also provision for installing the L-203BE export version of the Gardeniya-1FU active jammer. The maximum bomb load was 4,000 kg and the maximum TOW approached 20 tons (44,090 lb).

In 1992 MAPO manufactured 30 examples of the MiG-29SE (*izdeliye* 9.13SE).

MiG-29SM Multi-Role Fighter

To enhance the *Fulcrum's* strike capability the MiG-29S was developed into the MiG-29SM (*moderni**zee**rovannyy* – upgraded). It could carry two Kh-29T TV-guided AGMs or four KAB-500Kr TV-guided bombs. Engineers O. V. Korotkov and V. V. Bakaleyev working in ANPK MiG's Team 2091 under the guidance of V. I. Mokryakov developed the BD3-21I versatile bomb rack allowing KAB-500Kr bombs to be carried under the wings and on the fuselage centreline. The Kh-29T and the KAB-500Kr had passed integration tests on the aforementioned MiG-29s '05 Blue' (c/n 2960505533), '777 Silver' and c/n 2960536038 (the future '357 Blue'). (ANPK MiG was the Mikoyan OKB's new official name; ANPK = *Aviatsi**on**nyy naoochno-proiz**vod**stvennyy **kom**pleks* – Aviation Scientific & Production Complex.)

The precision-guided munition transmitted a 'bomb's eye view' to a display in the cockpit,

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▲ **MiG-29SM '777 Blue' (ex-MiG-29S '777 Silver', c/n 2960535403, f/n 4711) at the MAKS-97 airshow. Note the 'RSK MiG' titles.**

enabling the pilot to hit targets with pinpoint accuracy; this required several new modules to be added to the WCS. The ordnance load was 4,000 kg (8,820 lb). In production form the MiG-29SM was to have IFR capability. Mikoyan estimated the modification to have tripled the aircraft's combat potential as compared to *izdeliye* 9.12.

The MiG-29SM was presented at the 41st Paris Air Show in 1995. In reality, however, the aircraft in the static park at Le Bourget was a perfectly standard *Fulcrum-A* with an impressive array of weapons in front of it – which it could not carry.

MiG-29MF Multi-Role Fighter (Proposal)

In 1997 Russia began negotiations with the Philippines, offering the MiG-29 to the Philippine Air Force (*Hukbong Himpapawid ng Pilipinas*). The Philippine version is referred to by Mikoyan as MiG-29MF (that is, *modifi**kah**tsiya dlya Filip**pin*** – Philippine version). It seems that Russian manufacturers are adopting the Western practice of incorporating the customer's name into the aircraft's designation – as is the case with, for example, the McDD CF-18A (C for Canada), McDD EAV-8C Matador (E for España) and so on! (Incidentally, in the Russian press the aircraft has been referred to as MiG-29FM, for *Filip**pin**skaya modifi**kah**tsiya*.)

No technical details of the MiG-29MF have been published so far, since the negotiators were mainly concerned with range, avionics fit and armament. However, the aircraft is quite probably based on the MiG-29SD or SM. What is certain is that the MiG-29MF is to be equipped with a semi-retractable IFR probe and that the usable fuel load is 3,300 kg (7,275 lb).

As of 1st January 1995 MAPO had manufactured a total of 1,216 single-seat MiG-29s. Additionally, more than 200 MiG-29UB two-seaters had been produced by the 'Sokol' Nizhniy Novgorod aircraft factory. At that point the Russian Air Force and the Russian Navy operated 443 and 35 *Fulcrums* respectively; most of the existing MiG-29s were in service with foreign operators. Now, mention must be made of the MiG-29 upgrades undertaken abroad – with or without the consent of the manufacturer.

The MiG-29SM's Weapons Options

Weapons	Launchers/racks
6 x R-77 (RVV-AE)	6 x AKU-170
2 x R-27RE + 4 x R-73E	2 x APU-470 + 4 x APU-73-1D
2 x R-27TE1 + 4 x R-77 (RVV-AE)	2 x APU-470 + 4 x AKU-170
2 x R-27R1 + 4 x R-73E	2 x APU-470 + 4 x APU-73-1D
4 x R-77 (RVV-AE) + 2 x R-73E	4 x AKU-170 + 2 x APU-73-1D
2 x R-77 (RVV-AE) + 4 x R-73E	2 x AKU-170 + 4 x APU-73-1D
4 x KAB-500Kr + 2 x R-77 (RVV-AE)	4 x BD3-UMK2-B + 2 x AKU-170
2 x Kh-29T + 2 x R-77 (RVV-AE)	2 x AKU-58M + 2 x AKU-170
2 x Kh-31A/Kh-31P + 2 x R-77 (RVV-AE)	2 x AKU-58M + 2 x AKU-170
8 x FAB-500 + 2 x R-73E	8 x MBD3-U2T-1 + 2 x APU-73-1D

MiG-29G Fighter Upgrade

After the reunification of Germany on 3rd October 1990 the MiG-29 fleet of the former East German Air Force (LSK/LV) was taken over by the unified Luftwaffe. Soon afterwards the fighters were upgraded in conformity with NATO and International Civil Aviation Organisation (ICAO) standards, receiving the unofficial designation MiG-29G ('German').

The upgrade was developed by MiG Aircraft Product Support GmbH (MAPS), a joint venture between the ***Ros**vo'oroo**zhen**iye* arms export agency, MAPO MiG and what was then Daimler-Benz Aerospace. MAPS had been founded on 27th July 1993 for heavy maintenance and modernisation of Luftwaffe's MiG-29s. (Daimler-Benz Aerospace later became Daimler-Chrysler Aerospace (DASA) and is now EADS Deutschland – the German branch of the European Aviation, Defence & Space consortium.) For starters, Western IFF transponders, VHF/UHF radios and emergency radios and TACAN receivers conforming to NATO standards were fitted, and red anti-collision lights were installed halfway along the fuselage spine and under the port engine nacelle. Next, Global Positioning System (GPS) receivers were fitted to seven aircraft. These two modernisations (ICAO I and ICAO II) together formed Level One of the planned upgrade. This was followed by Level Two: the installation of 'wet' wing pylons and an extended airframe TBO (from 800 flying hours or 9 years to 1,300 hours or 15 years) and engine TBO and service life.

Martin Baumann

◄ **Still retaining the original tactical camouflage and the East German 'winged Q' maintenance award badge, Luftwaffe MiG-29G 29+09 (ex-EGAF '670 Red', c/n 2960525121, f/n 3506) is seen after the Level One upgrade.**

Similar upgrade were offered to other MiG-29 users, especially in Europe.

The upgrade work was undertaken by the MAPS facility at Manching AB near Ingolstadt. The sixth upgraded aircraft was redelivered to the Luftwaffe's MiG-29 unit, JG 73 'Steinhoff', on 22nd September 1999.

In 2004 the Luftwaffe withdrew the MiG-29G, transferring the surviving examples to the Polish Air Force as JG 73 transitioned to the Eurofighter EF2000 Typhoon.

MiG-29GT Combat Trainer Upgrade

The Luftwaffe's MiG-29UB trainers also underwent a similar upgrade to make them compatible with NATO standards and extend their service life. The upgraded aircraft bore the unofficial designation MiG-29GT ('German trainer').

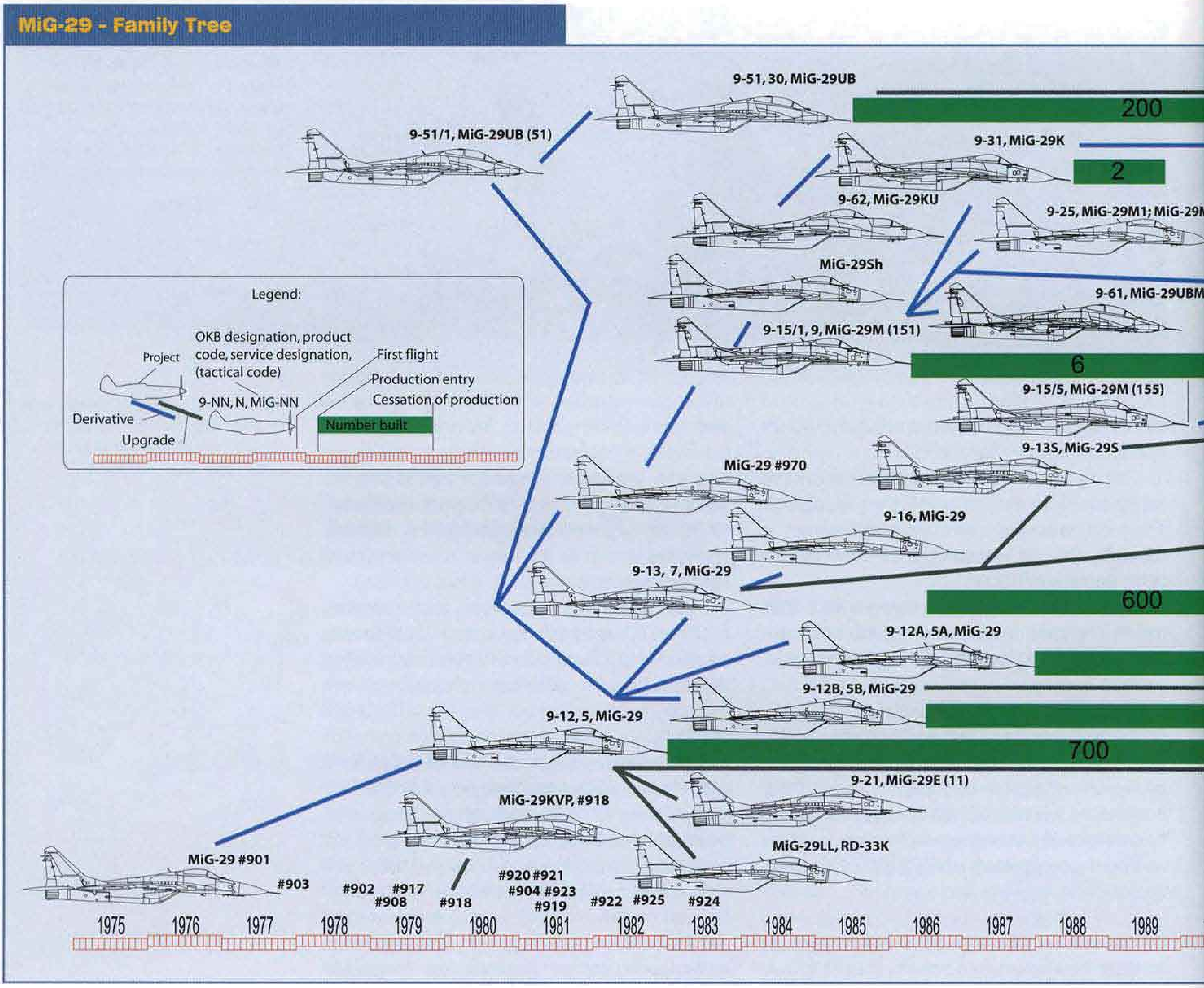
EADS/Aerostar/IAI MiG-29 Sniper Upgrade

In 1997 the Romanian company Aerostar S. A. launched a programme to upgrade the Romanian Air Force's MiG-29s to a new standard called Sniper. In June 1999 Aerostar signed a deal with EADS (DASA) and Israel Aircraft Industries (IAI) in order to undertake the upgrade. The Sniper shared most of the avionics items introduced on Romania's upgraded MiG-21MF fighters and MiG-21UM trainers, which are known as the Lancer A/Lancer C and Lancer B respectively.

The programme capitalised on the existing EADS NATO compatibility upgrade/SLEP, using an avionics package supplied and integrated by IAI's Elbit division, including a modular multi-role mission computer linked to a MIL-STD-1553B digital databus, full hands on throttle and stick (HOTAS) functionality, a second stripped-down Litton Italiana INS integrated with Trimble GPS and a new air data computer. The cockpit featured a new El-Op wide-angle HUD, two 6 x 4" digital colour multi-function displays (MFDs) with a choice of metric or Imperial units, and an Elbit DASH-3 helmet-mounted sight. Centimetre- and decimetre-waveband frequency-hopping communications radios supplied by Honeywell were installed. A new Elisra SPS-20 RHAWS and compatibility with Western weapons were envisaged.

Carlo Kuit

◄ **MiG-29GT 29+23 (c/n N50903006256) shows off its new colour scheme, including the 'false canopy' under the forward fuselage.**



▲
A diagram showing the development and production of the MiG-29 family.

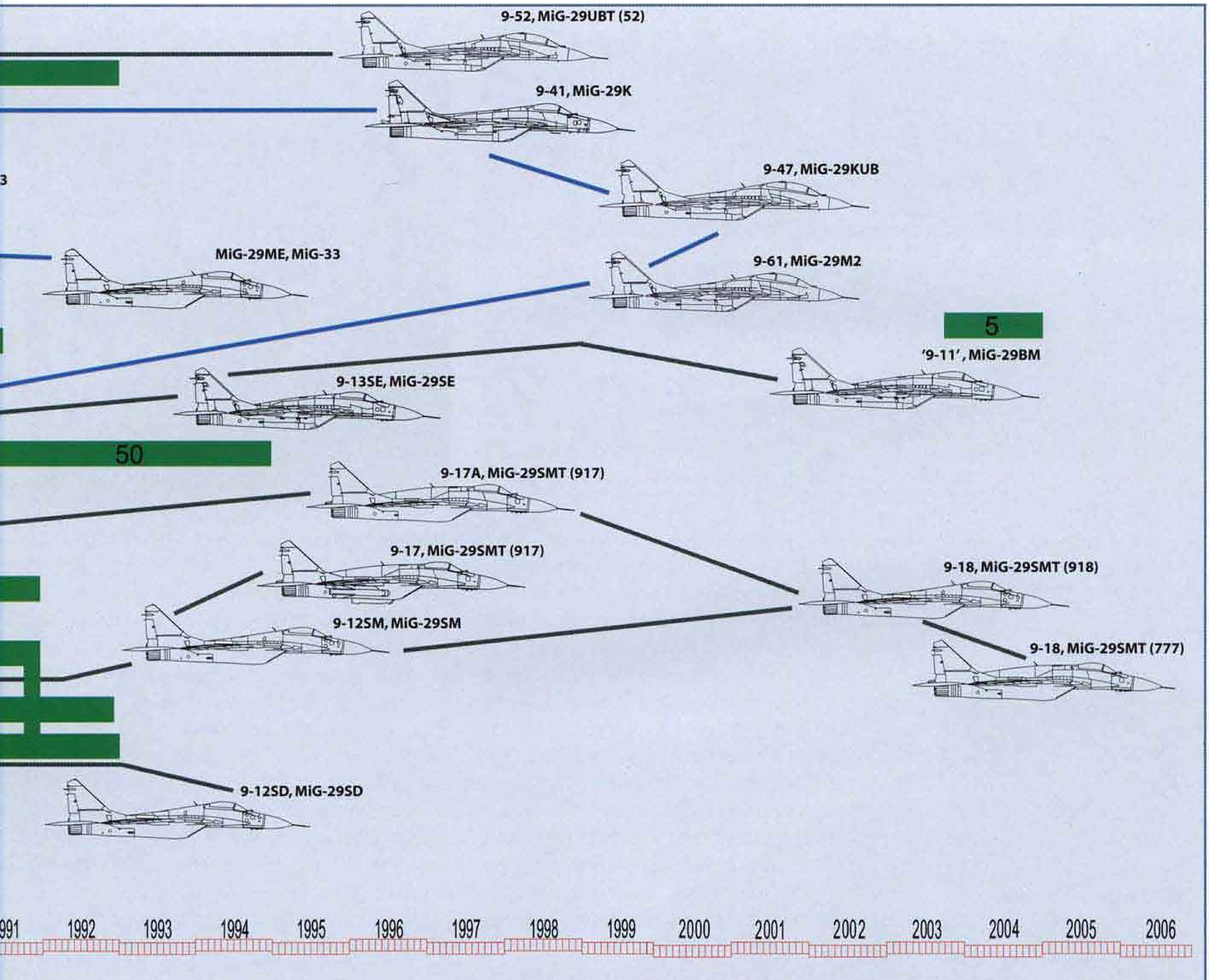
First, a cockpit mock-up of the Sniper upgrade was displayed at a defence trade fair in Bucharest. The real demonstrator, a Romanian Air Force MiG-29 serialled '67 White' (c/n 2960532367, f/n 4305) which had been donated to Aerostar and completely overhauled at the company's Bacău facility, first flew on 5th May 2000 at the hands of EADS test pilot Wolfgang Schindermann; later it was also flown by IAI test pilot Yahuda Shafrir.

After completing a 15-flight test programme the aircraft was flown to Berlin-Schönefeld on 26th May for static display at the ILA 2000 airshow. Later the Sniper upgrade was offered to other MiG-29 operators and advertised at other international airshows. Moreover, it was announced that the upgrade could be expanded to include the same Elta EL/M-2032 pulse-Doppler radar as used by the MiG-21 Lancer C. Understandably, this seriously miffed the Russians who pointed out that DASA and Aerostar had no right to undertake and market such an upgrade without authorisation from the original equipment manufacturer (OEM) – that is, RSK MiG.

The Romanian Air Force had provisionally given the go-ahead to upgrade its 18 MiG-29s to Sniper standard. However, integration problems soon arose. Then, in March 2003 the Romanian Air Force grounded its entire MiG-29 fleet and announced its intention to phase out the type, scrapping any upgrade plans – apparently for financial reasons.

EADS/MAPS Polish MiG-29 Upgrade

In December 1998, when Russian Deputy Defence Minister Nikolay Mikhaïlov visited



Warsaw, an agreement was signed concerning the upgrading of Soviet-built military aircraft operated by the Polish Air Force. These included the 22 MiG-29s which were on strength with the Polish Air Force before the transfer of the German machines. The agreement envisaged the transfer of technical documents on the aircraft's avionics, which would facilitate the integration of Western avionics items in the course of an upgrade, and the delivery of spares for the aircraft and its RD-33 engines.

In due course eight Polish MiG-29s ('67', '70', '89', '105', '108', '111', '114' and '115') were upgraded by the Air Force's WZL-2 repair plant (*Wojskowe zakłady lotnicze*) at Bydgoszcz in association with the MAPS joint venture. WZL-2 had won the right to upgrade the Polish MiG-29s in fierce competition with WZL-3 in Dęblin.

The upgrade included installation of a Honeywell KLU-709 or surplus Luftwaffe AN/ARN-118 TACAN receiver, ILS/VOR equipment, a Trimble 2101 I/O Plus GPS kit, a Russian R-865 VHF radio and anti-collision lights. A Suprasl SC-10 IFF transponder manufactured in Poland under licence from Thomson-CSF was fitted, together with the associated Suprasl SB-14 IFF aerials ahead of the windscreen *à la* F-16. The upgraded aircraft received a new, darker two-tone grey camou-flage.

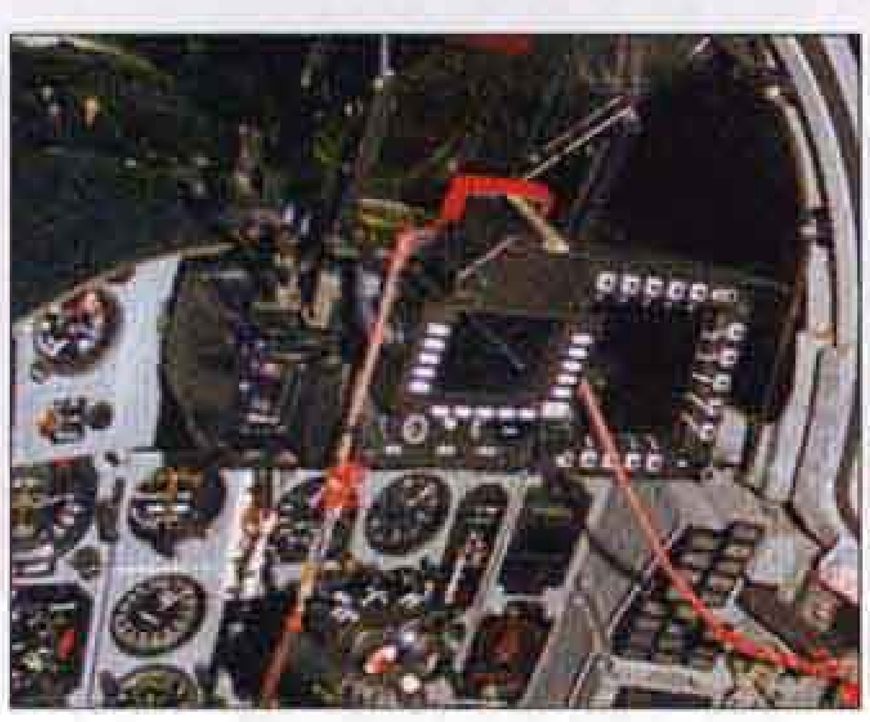
The remaining Polish aircraft were to follow, and these became the subject of a controversy. On 8th February 1999 the DASA concern announced that it had signed a preliminary agreement with WZL-2 for further upgrade work on the Polish MiGs. Immediately, the Ros-vo'oroozheniye arms company protested the


Elbit systems


Elbit systems


Elbit systems

▲
The Romanian MiG-29 Sniper upgrade demonstrator and a mock-up of its cockpit, showing the two MFDs and the I/O module below the HUD.


Miroslav Gyurosi

▲
The cockpit of the upgraded Slovak MiG-29 with a Russian MFD and I/O module.

'6728 Black', the first upgraded single-seat MiG-29 for Slovakia, shows off the dorsal VOR/ILS aerials aft of the cockpit.
▼

deal. 'Polish MiG-29 planes are to be adapted to NATO standards by Rosvo'oroozheniye, not by the DASA concern,' said the Russian company's spokesman Ivan Skryl'nik in an interview to the Polish newspaper *Rzeczpospolita*, referring to the 'relevant agreement' on the modernisation of the Polish MiGs signed in 1998. Captain Andrzej Adamczyk, a spokesman for Deputy Defence Minister Romuald Szeremietiew, confirmed this.

A representative of the Polish MoD confirmed that talks were under way between the WZL-2 and DASA. He added that the issue had been discussed at the government level with the Germans and Americans, but no agreement had been signed. Rosvo'oroozheniye warned that an international scandal would result if Poland unilaterally terminated the agreement. 'The agreement with the Russians is being implemented, and the talks with DASA have no influence whatsoever on the contracts we have signed with them', Capt. Adamczyk said.

Originally Poland intended to phase out the MiG-29 in 2008-2010, replacing it with a modern Western multi-role fighter type. However, a recent revision of Poland's armed forces modernisation policy and military hardware procurement planning will see the Polish *Fulcrums* continuing in service up to 2013-2015 – admittedly due to the lack of funding which makes the prompt purchase of new Western fighters unrealistic. This, in turn, will necessitate a much more extensive upgrade if the fighters are to cope with the challenges of the day. Current plans envisage equipping the Polish MiGs with full-colour MFDs and a new wide-angle HUD, installing an IFR probe and enhancing the aircraft's air-to-air and air-to-ground capability (which presupposes integration of a MIL-STD-1553B databus).

Slovak MiG-29 Upgrade

When Slovakia attained NATO membership in 2004, the issue of upgrading its MiG-29s arose. In 2005 work began on outfitting 18 *Fulcrum-As* and two MiG-29UBs with new avionics. The fighter received an AN/ARC-210 radio, an AN/ARN-147 VOR/ILS and an AN/ARN-153 TACAN receiver (all Rockwell Collins products), BAe Systems AN/APX-113 IFF, a single MFI-54 MFD and a PUS-29 input/output module under the HUD (both produced by Roosskaya Avionika). The new avionics communicated via a MIL-STD-1553B databus.

The upgrade was performed by the aircraft overhaul facility in Trenčín (LOT – *Letecké Opravne Trenčín*). Outwardly the upgraded MiGs were identifiable by the large extra VOR/ILS blade aerials aft of and below the cockpit and the quadruple IFF aerials on the nose.


Miroslav Gyurosi

PART FOUR

THE NEW GENERATION

MiG-29M Multi-Role Fighter (*Izdeliye* 9.15, *Izdeliye* 9) *Fulcrum-E*

As far back as the late 1970s Mikoyan started looking for ways of enhancing the MiG-29's combat potential. The obvious way was to incorporate the latest technologies, new hard-hitting weapons and more capable avionics. Another area open for improvement was the RD-33 engine, which needed uprating. Thus began a new development stage which resulted in what could be called the second-generation *Fulcrum* – the MiG-29M (*moderni***zee***rovannyy* – upgraded) known around the OKB as *izdeliye* 9.15 and in the Air Force as *izdeliye* 9.

The main objectives of the upgrade programme were higher versatility, longer range, better working conditions for the pilot and lower losses in action. This could be accomplished by installing a new-generation weapons control system and an electronic support measures (ESM) suite, integrating new precision-guided air-to-air and air-to-ground weapons, increasing internal fuel capacity (and possibly providing flight refuelling capability), uprating the engines and fitting advanced flight instrumentation and cockpit indication systems. While being basically similar in layout and structure to the production *Fulcrum*, the MiG-29M would feature aerodynamic refinements, changes improving stability and handling, and technological changes making the aircraft easier to build.

The result was, in effect, a new aircraft so different from the basic MiG-29 as to be placed in a new category – the so-called 'generation 4+' multi-role fighters.

To power the MiG-29M the Klimov OKB developed a 'landlubber' version of the RD-33K engine (*izdeliye* 21) designed for the MiG-29K shipboard fighter (see Chapter 5). Modifications to the engine core, including improved turbine first stage cooling, increased thrust to 5,500 kgp (12,125 lbst) at full military power and 8,800 kgp (19,400 lbst) in full afterburner. The RD-33K had a 6-7% lower SFC in full afterburner and a higher weight/thrust ratio. Unlike the naval engine, the version fitted to the MiG-29M lacked the 9,400-kgp (20,720-lbst) contingency rating used for ski-jump take-offs from the aircraft carrier because the field performance requirements for land-based fighters were not so stringent.

The new engine had a duplex full authority digital engine control (FADEC) system replacing the traditional analogue engine controls of the basic RD-33, a duplex automatic fuel flow management system and a new KSA-3 accessory gearbox. Besides having greater reliability, the FADEC gave the engine better acceleration.

The MiG-29M featured redesigned air intakes which, like the engines, had been tested on the tenth MiG-29 prototype ('21 Blue'). The solid FOD protection doors and dorsal auxiliary intakes of the *Fulcrum-A/B/C* were deleted and replaced by downward-hinging grids further downstream. The walls of the mainwheel wells were perforated to admit additional air when the grids were raised. Unlike the basic MiG-29, the intakes had a lower lip that could be deflected 20° down to improve engine operation at high alpha; the FADEC controlled these and the intake ramps.

Major changes were made to the airframe. Most of it, especially the forward fuselage, was made of 01420 aluminium-lithium (Al-Li) alloy. Unlike production *Fulcrums*, the structure was welded, not riveted. This saved structural weight because there was no need to seal rivet joints or leave margins for riveting and the new alloy had a lower specific gravity. Besides, more internal volume could be used for fuel (on the basic MiG-29 fuel tank capacity was limited by the impossibility of sealing all rivet joints. The share of composites was increased; besides the fins and various dielectric and access panels, composites were used for the airbrake, engine cowlings and inlet ducts. The use of radar-absorbent materials (RAM) reduced the aircraft's RCS ten times!

The pilot's seat was raised to improve visibility (the pilot's downward field of view was 15°); this necessitated a change in the shape of the canopy, which was more convex than the *Fulcrum-A/C*'s. The LERXes received a sharper leading edge to generate more powerful vortices at high alpha; this and the increased-span ailerons substantially improved the aircraft's low-speed handling. Stabilator area was increased for the same reason by extending the leading edge, resulting in a characteristic dogtooth which also energised the airflow over the stabilators at maximum deflection. The fin chord was increased below the rudders.

The upper fuselage was reshaped; its contour was a straight line – something in between the slightly concave spine of the *Fulcrum-A* and the strongly convex back of the *Fulcrum-C*. The APU air intake was relocated to starboard. The split airbrake of the standard MiG-29 was replaced by a Su-27 style one-piece dorsal airbrake located further forward (between the fins); this, however, was rather smaller than the *Flanker*'s, having an area of approximately

1 m² (10.75 sq ft). The control system automatically compensated for pitch-up force generated by the airbrake when deployed.

The engineers had met insistent requests from Air Force pilots to increase the MiG-29's combat radius. Deletion of the dorsal auxiliary air intakes and other airframe changes made room for more than 1,000 litres (220 Imp gal) of additional fuel, increasing the internal fuel capacity to 5,720 litres (1,258.4 Imp gal) or 4,460 kg (9,830 lb) of usable fuel and extending range by 30-40%. With three drop tanks the fuel load increased to 9,200 litres (2,024 Imp gal).

The landing gear was beefed up to absorb the higher gross weight. The single cruciform brake parachute of the *Fulcrum-A/B/C* with an area of 17 m² (182.79 sq ft) gave way to twin chutes with an area of 13 m² (139.78 sq ft) each and more powerful wheel brakes were fitted for more effective deceleration on landing.

The MiG-29M had an unusual combined control system featuring a quadruplex analogue fly-by-wire (FBW) pitch control channel with no mechanical backup and triplex FBW roll and yaw control channels with mechanical backup enabling 50% control surface deflection. Making the fighter statically unstable in the pitch control channel reduced drag caused by pitch trim in cruise mode and hence improved fuel economy, contributing to the increase in range.

The S-29M weapons control system was completely new, comprising an RLPK-29M radar targeting system and an OEPrNK-29M targeting/navigation suite. The former was built around the brand-new Phazotron N010 Zhuk (Beetle) fire control radar. The WCS incorporated more effective Ts101 series digital processors and old Ts100 series processors with new software.

The N010 pulse-Doppler radar developed under Phazotron's General Designer A. I. Kanaschchenkov could track ten aerial targets while guiding AAMs to four priority threats. Detection range for a fighter-type target with an RCS of 3 m² (32.25 sq ft) in head-on mode was 80 km

RSK MiG

◄ **A MiG-29M fuselage in the assembly jig at the Mikoyan OKB's experimental plant. The composite vertical tails have been fitted already.**

Yefim Gordon

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▲ **The dismantled MiG-29M static test article at the RSK MiG's flight test facility.**

(49.6 miles) versus 70 km (43.4 miles) for the N019. The radar had a flat-plate slotted array with mechanical scanning in azimuth (90° versus 70° in the N019) and electronic scanning in elevation. It could work in ground mapping mode with low, medium or high resolution (in standard beam, Doppler beam compression and synthetic aperture radar modes respectively), determining target coordinates, 'freezing' or enlarging the picture if necessary, measuring the aircraft's ground speed (for navigation or making corrections during missile firing) and enabling automatic terrain following.

At 220 kg (485 lb), the N010 was 60% lighter than the N019, which weighed 350 kg (771 lb). Outwardly it could be recognised by a reprofiled radome with simple curvature instead of the N019's double curvature. This was due to the fact that the N010 had a much smaller and neater scanner instead of the N019's bulky twist-cassegrain 'bin', allowing the radome to be made aerodynamically cleaner. The radar was probably tested on a modified Tu-134AK airliner (CCCP-65907, c/n (33)63996, f/n 6333), one of Phazotron's avionics testbeds. (This ex-VIP aircraft was spotted at Zhukovskiy in August 1992 with the experimental radar supplanting the navigator's glazing.)

The updated OEPrNK-29M optoelectronic targeting/navigation suite comprised an OLS-M (***op**tiko-lokatsi**on**naya **stahn**tsiya, moderni**zee**rovannaya*) combined IR/TV search and track/laser ranger unit and a helmet-mounted sight. In addition to having increased detection range, it not only detected aerial targets and measured their coordinates but also designated ground targets for laser-guided and TV-guided weapons and tracked them in real time. Unlike first-generation MiG-29s, the characteristic IRST 'ball' was opaque, looking like an 'eyeball' with the TV lens in the middle as the pupil, and was mounted atop an elongated fairing.

The new high-sensitivity IRST unit had a deep-cooling system increasing detection range several times. The TV camera could identify aerial and ground targets at long range, thus having the same function as the Northrop AN/ASX-1 electro-optical target identification system (TISEO) fitted to the McDD F-4E+. The higher-power laser ranger/designator improved the chances of target acquisition in the forward hemisphere and accurate guidance of missiles.

The HMS supplied target data to other targeting systems and IR-homing missiles. For more efficient aiming at ground targets (especially at night) the aircraft could be fitted with a podded laser designator combined with a low light level TV or thermal imaging system.

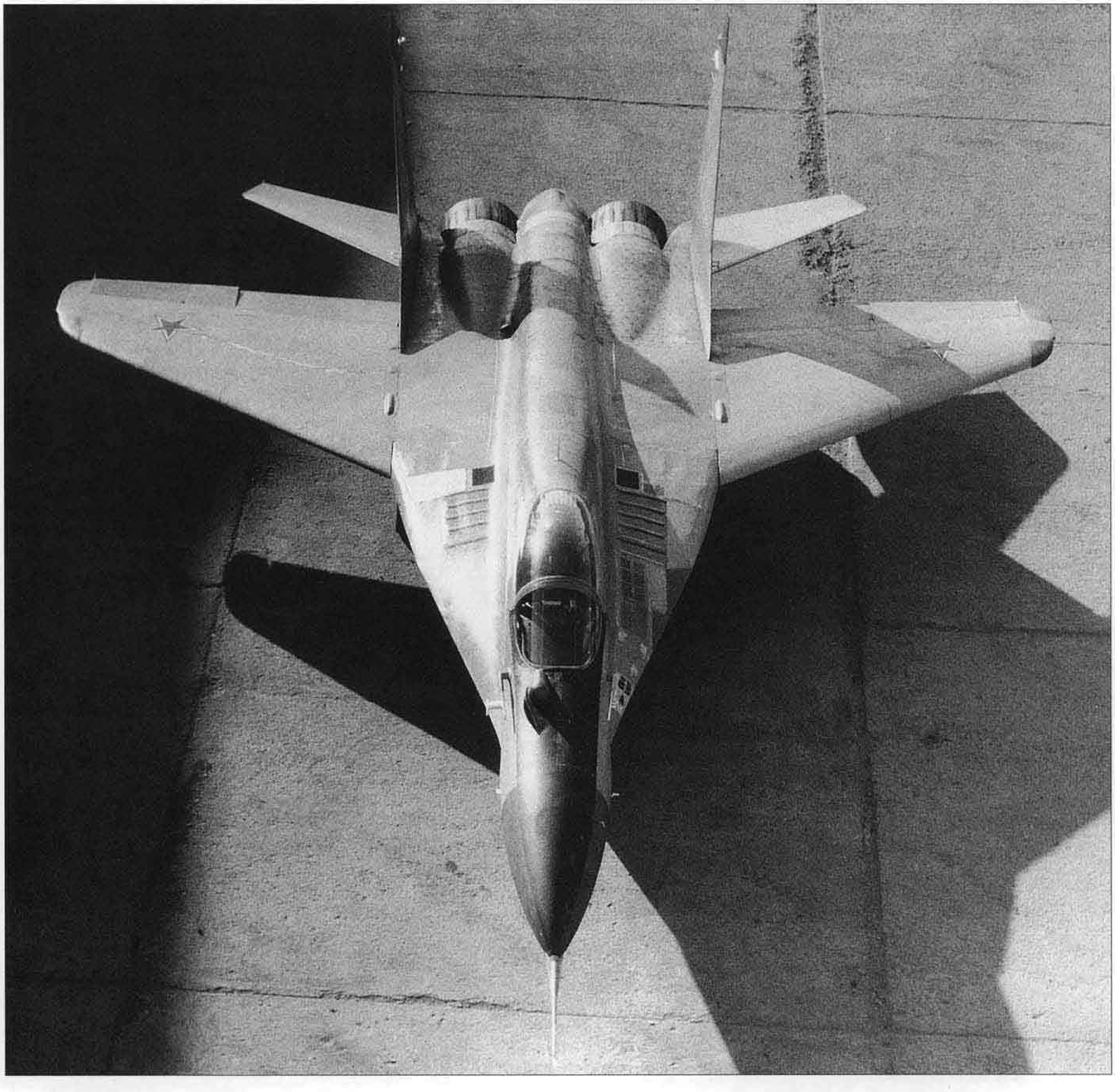
The MiG-29M had a completely new electronic flight instrumentation system (EFIS) with an improved HUD and two multi-function monochrome cathode-ray tube (CRT) displays for flight and target/weapons data; colour CRT displays could be integrated later on. Backup electro-mechanical instruments were retained in the centre of the instrument panel. The cockpit utilised the HOTAS concept. The aircraft also featured a new inertial navigation system (INS), secure data link for interaction with automated GCI centres, a new communications suite and IFF transponders.

The maximum ordnance load carried on eight underwing hardpoints and one centreline station was 4,500 kg (9,920 lb). The weapons range included the latest product of the Vympel design bureau, the R-77 (RVV-AE) AAM under development since 1982 with the bureau's leader G. A. Sokolovskiy as project chief. It was conceived as the Soviet answer to the GM-Hughes AIM-120A advanced medium-range air-to-air missile (AMRAAM) and therefore promptly nicknamed 'AMRAAMski' in the West.

The R-77 was the first Soviet AAM with active radar homing. At the initial guidance phase it had inertial guidance with mid-course correction using signals from the fighter's radar, switching to active radar homing at the terminal guidance phase; this made it an effective weapon at up to 90 km (55 miles) range, and several targets could be attacked at once. The R-77 was a 'fire and forget' weapon – a term previously applicable only to IR-homing AAMs. Novel design features, such as the lattice-like rudders (a world first), gave the missile unparalleled manoeuvrability, enabling it to score a 'kill' against a target taking violent evasive action with up to 12 Gs.

The R-77 had been tested on the two MiG-29s which had been converted into

Efforts to deceive the enemy via satellite imagery continued with the MiG-29M. The early prototypes had false auxiliary intakes painted on the LERXes to make them look like ordinary MiG-29s. Note that '151 Blue' is shown here with the original horizontal tail lacking a leading-edge dogtooth. ▼



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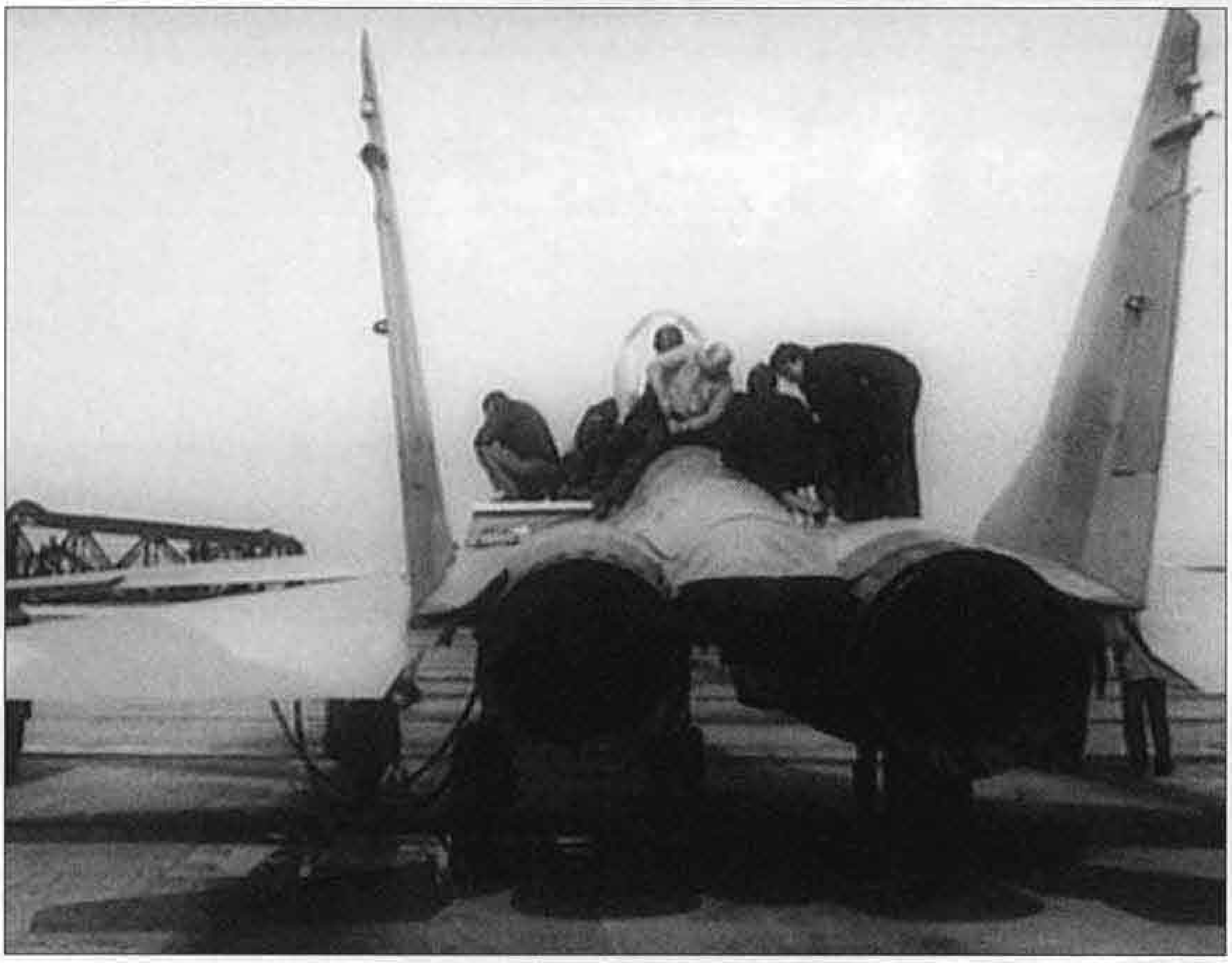

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weapons testbeds by Mikoyan ('aircraft 970' and 'aircraft 971' – see previous chapter) even before construction of the first prototype MiG-29M began. So were various systems and equipment; for example, the powerplant had been put through its paces on the tenth prototype *Fulcrum-A* ('21 Blue'), as mentioned above.

The MiG-29M could carry up to eight R-77s or R-73 IR-homing short-range AAMs, up to four R-27R1/R-27T1 IR-homing/SARH medium-range AAMs, two R-27RE1/R-27TE1 extended-range AAMs, up to six Kh-29T TV-guided air-to-ground missiles, Kh-29L or Kh-25ML laser-guided AGMs, Kh-31A active radar homing anti-shipping missiles, Kh-31P or Kh-25MP (AS-12 *Kegler*) anti-radiation missiles, KAB-500KR TV-guided bombs, up to four B-13L rocket pods with twenty S-13 FFARs or B-8M1 rocket pods with eighty S-8 FFARs, and various free-fall bombs. The GSh-301 internal cannon was retained but the ammunition supply was reduced to 100 rounds. The 'smart bombs' could be dropped singly or simultaneously.

The ESM suite included a Gardeniya-1FU (L203B) active jammer and two BVP-60-26 chaff/flare dispensers with sixty 26-mm rounds each – twice the capacity of the *Fulcrum-A*. The dispensers were buried in the aft fuselage, the characteristic dorsal fin extensions of the *Fulcrum-A/C* housing 30-round BVP-30-26 chaff/flare dispensers being deleted. The ECM aerials were ideally positioned at the wingtips under dielectric housings fore and aft, giving complete 360° coverage.

Normal take-off weight was 15,800 kg (34,830 lb) and MTOW 18,00 kg (39,680 lb). The MiG-29M had better combat efficiency than the F-16C, F/A-18C, Eurofighter Typhoon, Rafale and other Western fighters in the same class. Serviceability was much improved as compared to earlier versions; seven technicians needed 30

▲ **Technicians crawl all over the first prototype MiG-29M, '151 Blue' (c/n 05551). The 'beaver tail' fairing between the engine nozzles is clearly visible**

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► **Another view of '151 Blue', showing the single-curvature radome. Note how the anti-glare panel continues all the way to the tip of the radome.**

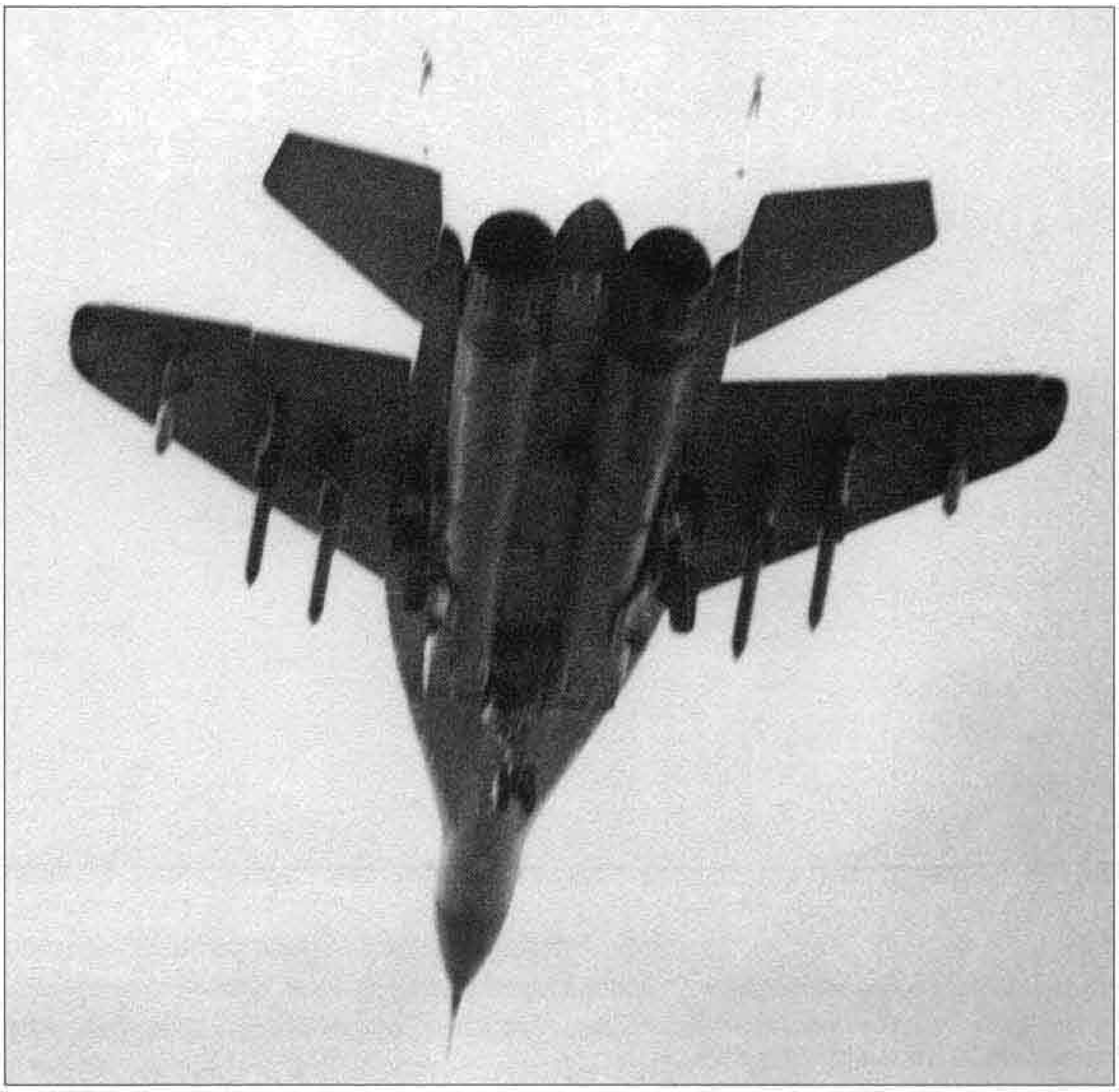
minutes to perform pre-flight checks and 15-25 minutes for a post-flight check. The airframe's service life was increased to 2,500 hours and could be extended to 4,000 hours. Mean time between failures (MTBF) was at least 8 hours; overall maintenance labour intensity was 11.5 man-hours and mean repair time 1.2 hours. Maintenance was done at 200-hour intervals.

Six flying prototypes and a static test airframe were built. The first prototype, '151 Blue' (that is, *izdeliye* 9.15 No.1), took to the air on 25th April 1986, piloted by Valeriy Ye. Menitskiy who succeeded Aleksandr V. Fedotov as Mikoyan's CTP. (Fedotov lost his life in the crash of the third production MiG-31 interceptor ['201 Blue', f/n 0201] on 4th April 1984.) Unlike subsequent prototypes, it sported prominent T-shaped black and white phototheodolite calibration markings on the tail.

The aircraft (c/n 05551) was powered by standard RD-33s because the uprated RD-33K had not yet completed its trials programme. No radar was fitted, since '151 Blue' was intended mainly for verifying the new structural components and for control system, handling and performance testing. According to Milhail R. Val'denberg the aircraft originally flew with the FBW control system disengaged, using only the backup mechanical controls; FBW testing did not begin until November 1989. However, other sources in the Mikoyan OKB discount this, stating that the first prototype used FBW controls throughout.

The second prototype, '152 Blue' (c/n 05552), also entered flight test with RD-33 engines but was retrofitted with RD-33Ks in 1989. It was also the first to be fitted with the N010 radar, a collimator HUD and two CRT displays, thus becoming the first MiG-29M in representative production configuration; conventional electromechanical flight instruments were retained as a backup. The aircraft was used for FBW testing, radar trials, handling, performance and field performance testing with and without external stores, powerplant and fuel system testing.

The third aircraft, '153 Blue' (c/n 05553), was demonstrated to top-ranking industry and military officials at Kubinka AB on 23rd June 1989 along with the other latest Soviet combat aircraft. This aircraft and the fourth and fifth prototypes, '154 Blue' and '155 Blue' (c/ns 05554 and 05555), were used for comprehensive powerplant, avionics and systems testing, live air-to-air and air-to-ground firing trials and cockpit ergonomics trials. These aircraft were mostly tested at GNIKI VVS, later known as the 929th GLITs, at Vladimirovka AB, Akhtoobinsk. The fourth aircraft was especially used to verify the new IRST/LR and the fifth prototype for performance and field performance testing.

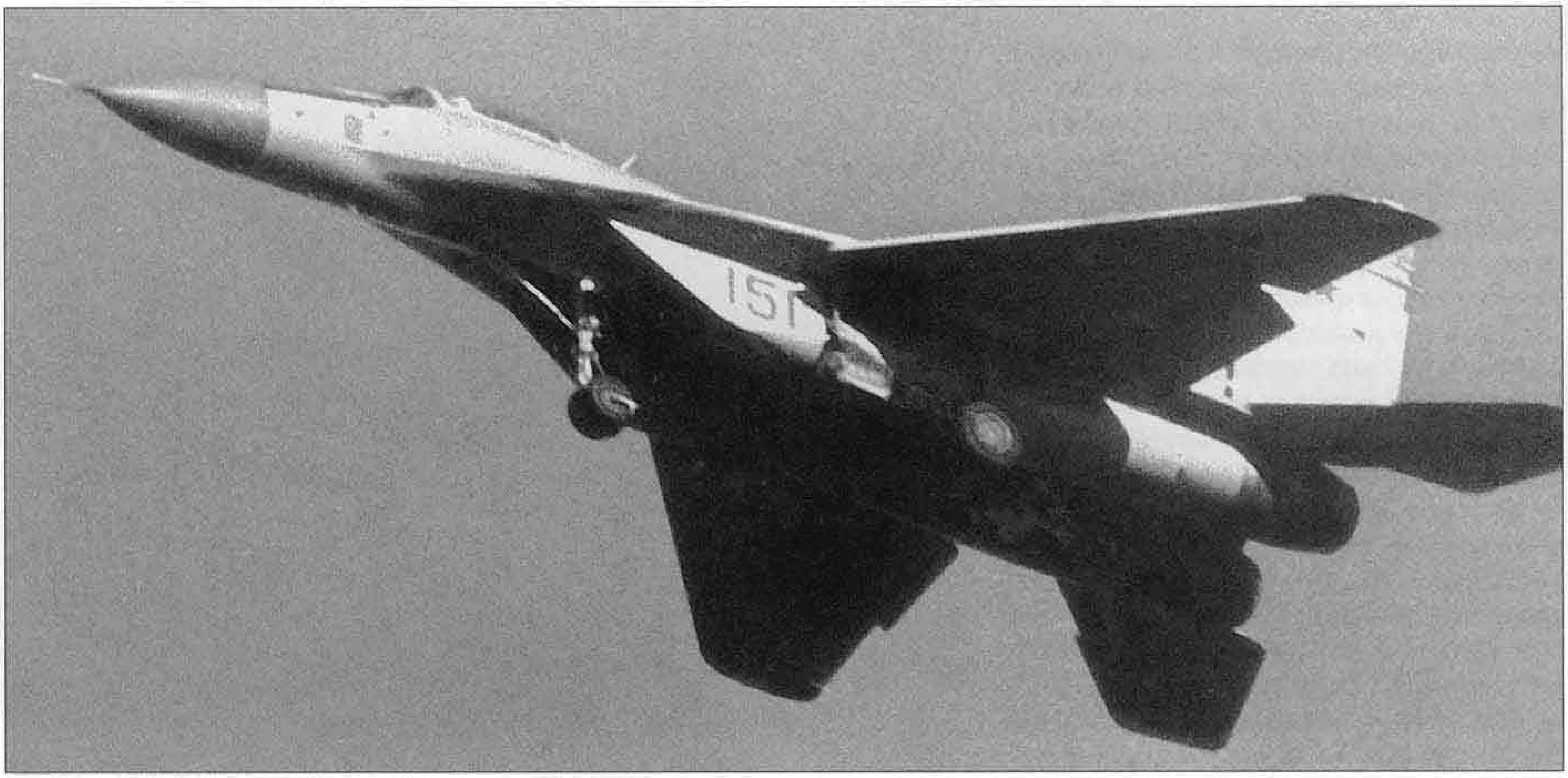


Victor Drushlyakov

▲ **MiG-29M '151 Blue', still with the plain ('toothless') stabilators, on final approach to runway 30 at Zhukovskiy displays its six weapons pylons and the shape of the fairing between the engine nozzles.**

Like '155 Blue', the final prototype, '156 Blue' (c/n 05556), was built by MAPO at Moscow-Khodynka in the early 1990s. (Since the MiG-29M's Air Force product code is *izdeliye* 9, the full c/ns of the six prototypes could be 2960905551 through 2960905556 but this is unconfirmed. The c/n of '156 Blue' has also been quoted as 27585.) This aircraft did not participate in the state acceptance trials since it came after Stage 1 of the trials had been completed in September 1991.

The fifth and sixth aircraft were used for avionics trials, including electromagnetic compatibility (EMC) tests, and live weapons firing trials against both aerial and ground targets, featuring a complete avionics suite with modifications introduced after the third prototype's tests. The final prototype had a redesigned instrument panel with larger CRTs which meant some of the mechanical instruments had to be omitted and their functions transferred to the EFIS. In this guise the MiG-29M was recommended for production upon elimination of the shortcomings detected during the trials.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▲ The first prototype MiG-29M in landing configuration. Note the new stabilators with a leading-edge dogtooth.

'151 Blue' had T-shaped photo calibration markings applied to the fins in the course of the tests. ▼

Painting on airframe parts that aren't there to confuse the enemy is nothing new; for example, some Western fighters have false canopies painted on the underside of the nose, making them harder to engage in a dogfight. Mikoyan, however, gave the idea a new twist. The MiG-29M prototypes, except the last one, had phoney dorsal air intakes painted on the LERXes which would show up on satellite imagery. The idea was to fool Western intelligence agencies into thinking these were ordinary *Fulcrum-As* or *-Cs*. '156 Blue' did not have this 'camouflage' because in 1992 the MiG-29M began participating in Western airshows, giving observers a chance to examine it closely, and this elaborate deception became pointless.

Separate leading engineers were assigned to each of the MiG-29M prototypes for the


Victor Drushlyakov

▲
An interesting formation of two 'next-generation' *Fulcrums* – the first prototypes of the MiG-29M ('151 Blue') and the MiG-29K ('311 Blue'). Both aircraft sport photo calibration markings and show off their rectilinear fuselage spine.

duration of the flight test programme: Boris M. Chak to '151 Blue', Vasiliy F. Shtykalo to '152 Blue' and '155 Blue', Pavel G. Orlov to '153 Blue', Vladimir N. Trooshkov to '154 Blue' and Sergey A. Revnov to '156 Blue'.

Early test flights showed a marked improvement in manoeuvrability; pilots praised the MiG-29M's handling. The fighter had a maximum true airspeed (TAS) of 2,450 km/h (1,451 mph) or Mach 2.3, a maximum indicated airspeed (IAS) of 1,480 km/h (919 mph) and a 310 m/sec (61,000 ft/min) rate of climb at 1,000 m (3,280 ft). Service ceiling was 17,000 m (55,770 ft), range on internal fuel 2,000-2,200 km (1, 240-1,366 miles) and maximum ferry range with three drop tanks 3,200 km (1,987 miles). With a 3,500-kg (7,720-lb) ordnance load the aircraft had a 20-minute on-station loiter time within 520 km (323 miles) from base.

Combat radius was 1,250 km (776 miles) in dogfight mode (involving five 360° turns) with 2+2 short/medium-range AAMs and three drop tanks, 1,440 km (894 miles) in Mach 0.85 subsonic intercept mode with two medium-range AAMs and three drop tanks, and 1,190 km (739 miles) in strike mode with two AGMs, two short-range AAMs and three drop tanks.

Normal and maximum TOW rose to 16,800 kg (37,040 lb) and 22,300 kg (49,160 lb) respectively. Still, this had almost no adverse effect on field performance. Take-off run was 250-500 m (820-1,640 ft), depending on gross weight, and landing run with brake parachutes was 500-600 m (1,640-1,970 ft).

The MiG-29M's G limits, rate of climb and acceleration were roughly the same as in the production MiG-29/MiG-29UB. The maximum AOA, however, was much higher, enabling the fighter to make brief 9-G manoeuvres with a full fuel load, which was a major improvement over production aircraft. The MiG-29M had an electronic alpha limiter; initially the AOA limit was set at 30° but chief project engineer Mikhail R. Val'denberg stated this would be increased when the aircraft completed flight tests.

The new FOD protection screens were put to the test when one of the prototypes collided with a duck on take-off. The bird went into an air intake and made a dent in the screen but the engine suffered no damage.

General Designer Rostislav A. Belyakov asserted that the MiG-29M was 'the world's finest aircraft as regards stall and spin recovery. Even the [basic] MiG-29 was perfect in this respect; with the MiG-29M we took it even further.'

According to the Soviet aerospace industry development plan, the MiG-29M was to gradually supersede the *Fulcrum-A/C* on the MAPO production lines in the early 1990s. The first 60 production aircraft would be built in parallel with 'first-generation' *Fulcrum* before the beginning of 1990; within the next decade the number of production MiG-29Ms would reach 300 or even 400.

Still, these hopes were dashed to the ground. The trials programme was making slow progress; only the manufacturer's flight tests had been completed by the early 1990s. These were

RSK MiG

▲ '155 Blue' banks away from the camera ship, toting a load of four inert Kh-31 ASMs and four R-77 AAMs. Note the undernose pitot.

Head-on view of the same machine with a mixed ordnance load comprising Kh-31s and R-77s to port, plus R-73s and finless Kh-29Ts to starboard. ▼

deemed to be successful, even though the first (and later the second) aircraft had to be grounded because of fatigue cracks. The state acceptance trials, however, were suspended after Stage 1 because of funding shortages.

Nevertheless, the State commission recommended that the MiG-29M be put into production upon elimination of certain shortcomings, mostly associated with the radar. The broad weapons range was not completely integrated with the WCS during Stage 1, and the minimum safe range for air-to-air missile launch was not determined.

The collapse of the Soviet Union and ensuing political and economic chaos certainly did not help; state funding, which had been a mere trickle until then, all but dried up completely. Besides, the Russian Air Force stopped MiG-29 purchases in 1991, as it could not afford to buy both the Su-27 and the MiG-29 when Russia was in the throes of a financial crisis. As a result, the factory airfield in Lookhovitsy (Tret'yakovo) soon became crammed with row upon row of new but unwanted *Fulcrums* – a sorry sight indeed.

The final flight under the state acceptance trials programme was made in May 1993. Between them the five prototypes participating in the programme made 1,068 flights.

On 13th February 1992 the fifth prototype was demonstrated to top-ranking military officials and the leaders of the CIS republics at Machoolishchi AB near Minsk. A few weeks later the same aircraft was demonstrated to Russian Air Force C-in-C Col. Gen. Pyotr S. Deynekin in Akhtoobinsk during his visit to GNIKI VVS. Later '155 Blue' participated in the Kubinka-93 'open house' (29th May 1993), the MAKS-93 (31st August – 5th September 1993) and Farnborough International '94 airshows. Logically, the

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MiG-29M would be *Fulcrum-E* but, since the true designation was known, no NATO codename was allocated (although some Western publications do call it *Fulcrum-E*).

The sixth prototype was also displayed at major airshows – FI'92, Le Bourget '93 and MAKS-95 (22nd-27th August 1995). For the latter occasion the aircraft was recoded '301 Blue' and sported the Russian flag on the rudders but the original tactical code '156' on the dielectric fin caps (which no one had taken the trouble to change or remove) gave it away.

According to MAPO MiG estimates, the MiG-29M could match the performance of the

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▲
Close-up of the finless Kh-29T AGMs and dummy R-73s under the starboard wing wing of '155 Blue'.

◄
The same aircraft armed with four Kh-31s and four R-77s at Kubinka AB on 29th May 1993.

'155 Blue' is just about to touch down at Kubinka, arriving from Zhukovskiy for the 1993 'open house'. Note the blue colour of the IRST 'eyeball'.
▼

Victor Drushlyakov

Yefim Gordon

▲
Three 'textbook' view of the fifth prototype, showing the false auxiliary air intakes, dogtooth stabilators and starboard-side APU air intake. ►
▼

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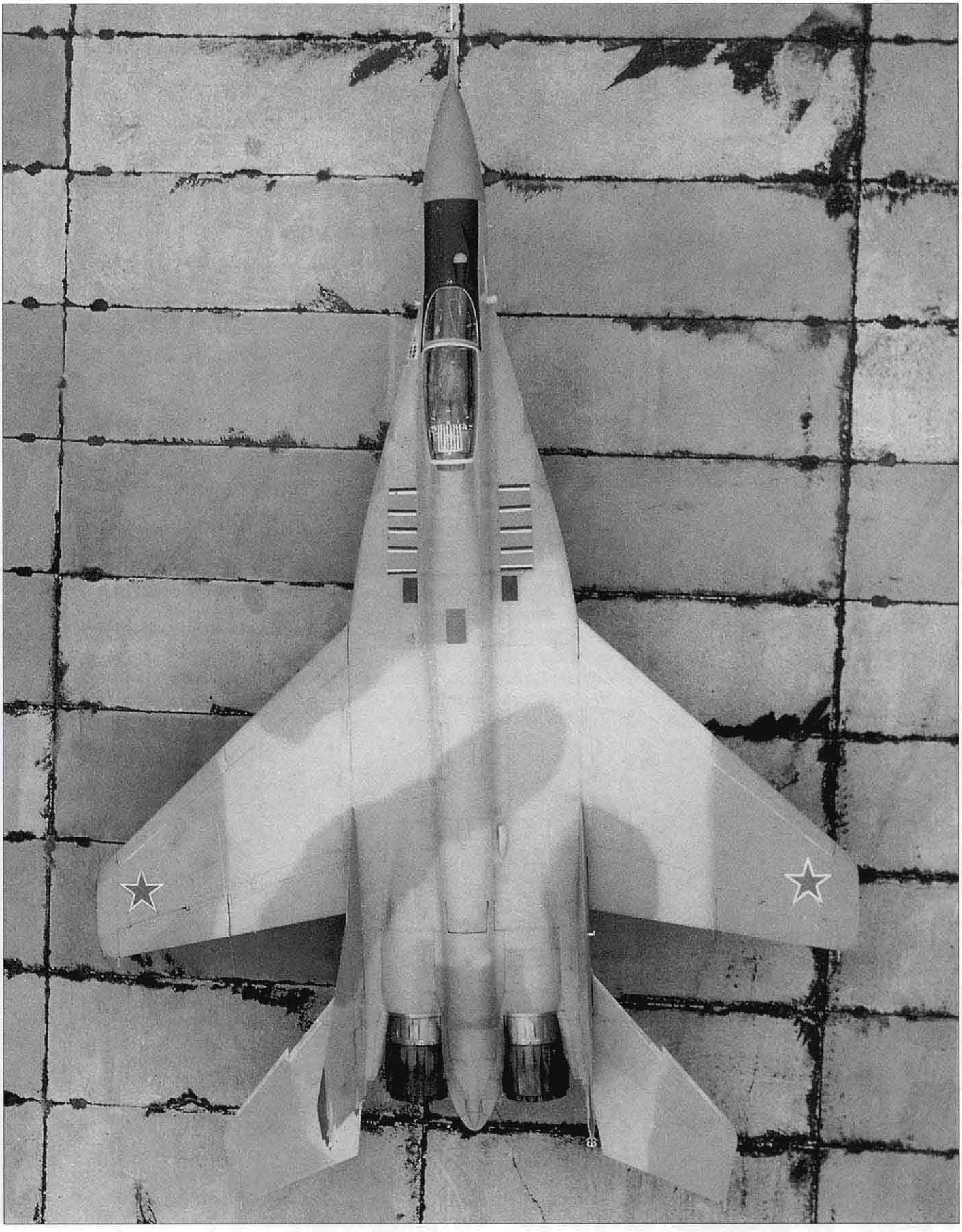

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Sergey Sergeyev

▲ The fifth prototype MiG-29M at Vladimirovka AB, Akhtoobinsk, prior to a military aircraft display at the 929th GLITs. Note how the tactical code is carried on the fins in a new italic style and augmented by Russian flag stripes.

Boeing/Lockheed Martin F-22A Raptor fifth-generation fighter. Its combat potential was 1.5 times that of the *Fulcrum-A/C* in the counter-air role and 3.4 times better in the strike role. The MiG-29 has evolved into a true multi-role combat aircraft.

The Russian popular press reported that the VVS intended to acquire 30 MiG-29Ms in 1996. However, the plan had to be shelved because the MoD had no money to fund the order.

Anatoliy A. Belosvet, former Deputy General Director of ANPK MiG, stated that virtually all technical problems associated with the fighter's weapons control system had been eliminated by 1997 and the state acceptance trials could be completed quickly, providing state funding was made available. The second, third, fourth and fifth prototypes were then operated by the 929th GLITs at Vladimirovka AB in Akhtoobinsk while the sixth aircraft was retained by LII for demonstration purposes.

ANPK MiG considered further upgrading the MiG-29M, namely enhancing its agility (by using canard foreplanes or thrust vectoring) and extending the fighter's range.

In early 1997 several of the MiG-29M prototypes operated by the 929th GLITs were still airworthy. On 21st January that year test pilot Pavel Vlasov flew a sortie in '155 Blue' as part of the air-to-surface guided weapons test programme. However, the possibility of further using these aircraft was not considered until the beginning of the 21st century and the launch of several upgrade programmes, as described in Chapter 6.

The same aircraft in company with MiG-29S (*izdeliye* 9.12S) '999 Silver' at the MAKS-93 airshow a while earlier. ▼

Robert Ruffle archive

MiG-29ME (MiG-33) Export Multi-Role Fighter

ANPK 'MiG' also worked on a downgraded export version of the MiG-29M designated MiG-29ME or MiG-33. This was to have a less capable WCS borrowed from the MiG-29SD/SE based on the N019ME radar.

MiG-29UBM Combat Trainer Project (*Izdeliye* 9.61)

A trainer version of the MiG-29M similar to the MiG-29UB was under consideration for some time. To stress the similarity and 'generation change' from the MiG-29UB (*izdeliye* 9.51) the aircraft was designated MiG-29UBM or *izdeliye* 9.61. However, this remained a 'very paper aeroplane' because of the suspension of the MiG-29M programme.

MiG-29Sh Attack Aircraft (Proposal)

After evaluating the MiG-29 in the strike role MAPO MiG proposed a specialised attack version of the *Fulcrum* designated MiG-29Sh (*shtoormovik* – attack aircraft) and based on the *izdeliye* 9.51. The aircraft featured enhanced survivability (more than 1,000 kg/2,204 lb of armour plate), a 5,000-kg (11,020-lb) ordnance load and a wider weapons range which could include advanced air-to-surface missiles (such as anti-tank guided missiles) as they came along. Gross weight was 25,500 kg (56,220 lb). To ensure adequate performance in spite of the increased weight the MiG-29Sh was powered by new RD-43 engines rated at 9,900 kgp (21,825 lbst) in full afterburner.

The proposal, operational requirements for the attack version and possible project configurations were examined by TsNII-30. However, the project was shelved due to lack of customer interest and lack of funding.

Sergey Skrynnikov

▲ MiG-29M '301 Blue' makes a flypast with a full load of four Kh-31s and four R-77s.

MiG-29M1, MiG-29M2 and MiG-29M3 (*Izdeliye* 9.25) Multi-Role Fighters (Projects)

The MiG-29M's lengthy trials programme and funding shortfalls led Mikoyan leaders to believe that the fighter would be obsolete by the time it finally completed its trials. This, and the Russian Air Force's decision not to spend the limited money there was on two different fighters, led ANPK MiG to develop an upgraded version of the MiG-29M at its own risk. (The VVS suspended further purchases of the MiG-29 in the early 1990s, opting for the Su-27, even though these were fighters of different classes filling different roles. This effectively brought MiG-29 production to a standstill.) Development work had proceeded since the late 1980s; the main objectives were to extend range, improve agility and integrate additional weapons.

Later, '156 Blue' also had the tactical code applied on the fins in the new graphic style. ▼

Sergey Skrynnikov

Robert Ruffle archive

The new fighter was designated *izdeliye* 9.25. It featured engines uprated to 10,000 kgp (22,045 lbst). The fuselage was stretched by moving the engines 910 mm (2 ft $11\frac{53}{64}$ in) aft to make room for an additional integral fuel tank. Canard foreplanes were introduced to increase agility, and wing area was enlarged. A new weapons control system built around a new radar was fitted and the ordnance load was increased to 5,000 kg (11,020 lb); the weapons range included anti-tank guided missiles.

Mikoyan planned to proceed with the upgrade programme in three stages; the aircraft was designated MiG-29M1, MiG-29M2 and

▲ **MiG-29M '156 Blue' in the static park of the ILA'96 airshow. Note the bold Russian flags on the rudders.**

▶ **Later '301 Blue' (seen here at Zhukovskiy) had identical flags applied instead of the narrow stripes worn hitherto. Note the MAPO and MiG logos below the cockpit.**

'301 Blue' streams its twin brake parachutes immediately after touching down at Zhukovskiy. ▼

Yefim Gordon

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MiG-29M3 at the respective stages. Stage 1 introduced the fuselage stretch which allowed fuel tank No.3 to be enlarged and tank No.4 to be added, increasing internal fuel volume 20% to 7,000 litres (1,540 Imp gal). During Stage 2 the canards and increased-area wings were introduced, and fuel capacity was increased once again thanks to wing tanks of nearly twice the usual size.

Finally, Stage 3 was the installation of the new engines and new avionics suite, which would turn the MiG-29 into a fifth-generation fighter. The No.2 fuel tank was enlarged and a further tank (No.5) added, bringing the total to more than 8,000 litres (1,760 Imp gal) – 40% more that the MiG-29M's and a whopping 90% more than the *Fulcrum-A*'s. An IFR probe was also introduced. Thus the lightweight MiG-29M3 would match the range of the much heavier Su-27 and Su-27M (Su-35) if drop tanks were carried.

The initial reactions on the part of the Air Force were positive. Later, however, the interest waned and the programme was shelved along with the MiG-29M as funding dried up.

MiG-29 (*Izdeliye* 9.35) Multi-Role Fighter (Project)

At a MAPO press conference held on 21st August 1997 during the MAKS-97 airshow Mikoyan announced that an even more comprehensive upgrade of the *Fulcrum* referred to by the press as the 'MiG-35' was in the making. This statement was not very far from the truth. Since it had become clear by the late 1990s that no more funding would be forthcoming for the MiG-29M programme, ANPK MiG decided to cheat the money from the stingy government by proposing an allegedly new-generation fighter.

Thus a new upgrade proposal was drawn up in 1997. The aircraft was based on the stillborn *izdeliye* 9.25 project and thus designated *izdeliye* 9.35; the 'MiG-35' designation which appeared in the popular press was pure fiction. The fighter incorporated the improvements proposed for *izdeliye* 9.25, albeit on a more modern technical level, and some ideas from the MFI programme – the famous fifth-generation multi-role fighter known as Project 1.42.

Like its precursor, *izdeliye* 9.35 had uprated engines with revised air intakes and inlet ducts, a 910-mm fuselage stretch, a new radar and an increased ordnance load. Internal fuel capacity was increased to approximately that of the MiG-29SMT, giving an extra 1,500 kg (3,306 lb) of fuel. In addition to the extra integral tank ahead of the engines and larger wing tanks, two strap-on fuselage tanks (Nos. 4 and 4-A) and integral tanks in the fin roots were added. To further extend range *izdeliye* 9.35 had IFR capability.

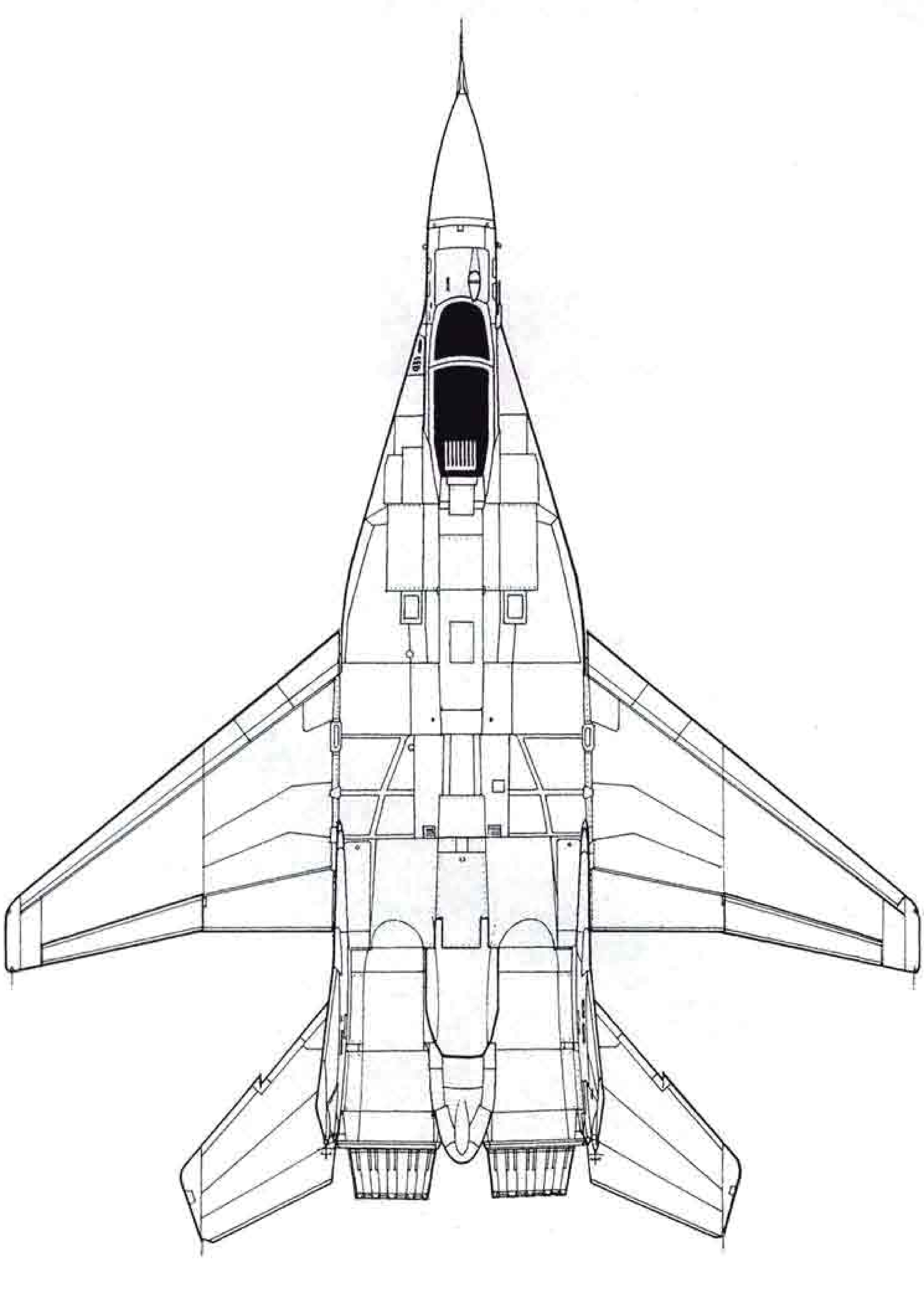
Because the overall length and take-off weight had grown, wing area was increased by increasing the span and root chord; the result was quite similar to the MiG-25 *Foxbat* in planform, with lopped-off wingtips and a straight trailing edge (the kinked trailing edge à la F-15 depicted in Western drawings of the 'MiG-35' is totally incorrect). The landing gear was beefed up to absorb the extra weight, and 01420 Al-Li alloy gave way to more conventional D16 duralumin at some locations.

MiG-29M '301 Blue' under tow at Zhukovskiy during the MAKS-95 airshow. The code '156' on the fin caps reveals the aircraft's previous identity.
▼

Yefim Gordon

The sixth prototype MiG-29M in intermediate guise.

This is how the 'MiG-35' was rendered in the Western press. ▼



Mikoyan claimed that structurally the new *Fulcrum* had virtually nothing in common with the basic MiG-29. The increased internal fuel capacity doubled the new fighter's range as compared to the *Fulcrum-A*. Contrary to Western allegations, no canards were planned (unlike *izdeliye* 9.25) but thrust-vectoring engines with axisymmetrical two-plane nozzles could be incorporated at a later stage.

Some ANPK MiG representatives claimed that *izdeliye* 9.35 had a combat potential approaching that of the heavier and more costly Su-35 multi-role fighter. The type of radar was still to be decided but it could possibly be the Phazotron Zhuk-F phased-array radar capable of tracking 24 targets at a time while guiding missiles to eight priority threats. The aircraft had ten weapons hardpoints (possibly with two wingtip missile rails) and could carry a wide range of air-to-air weapons, including R-77 'fire and forget' AAMs.

Yet this project suffered the same fate as previous MiG-29 upgrade programmes – the Russian MoD didn't want it because it couldn't afford to buy it. ANPK MiG decided that attracting Western investors (that is, possible customers) was a must if the project were to materialise. Some Western analysts believed the 'lightweight' 'MiG-35' was nothing less than Mikoyan's attempt to compensate for the delays with the 'heavy' 1.42/1.44 fifth-generation fighter.

Trainer Derivative of *Izdeliye* 9.35 (Proposal)
Concurrently with *izdeliye* 9.35 ANPK MiG submitted a proposal for a two-seat trainer version. The aircraft differed mainly in having a new forward fuselage (frames 1 through 7), retaining the improvements introduced on the single-seater; unlike the MiG-29UB, the new trainer retained the fire control radar. The instructor's seat was raised to improve visibility, creating a distinctive humpbacked silhouette strikingly similar to the Su-27UB *Flanker-C*.

Like the single-seater, the trainer version of *izdeliye* 9.35 has been put on hold indefinitely.

PART FIVE

PUSHING FOR THE NAVY

MiG-29K Shipboard Fighter (*Izdeliye* 9.31) *Fulcrum-D*

As early as the 1950s, when the US and its NATO allies began bolstering their naval power, especially aircraft carriers, the Soviet military leaders realised that the Soviet Navy needed aircraft carriers to deter potential adversaries at sea. However, creating a 'real' aircraft carrier equipped with conventional take-off and landing (CTOL) jet fighters within a short time frame was impossible because, unlike the US and Great Britain, the Soviet Union had no prior experience with such ships. Therefore, as a first step in this direction, the Soviet Ministry of Defence initiated development of anti-submarine warfare (ASW) carriers or 'large ASW ships', as they were officially called (BPK – *bol'**shoy** protivo**lod**ochnyy ko**rah**bl'*). For starters these would carry helicopters and then vertical/short take-off and landing (V/STOL) attack aircraft.

The first of these ships, the *Moskva* class (Project 1123) ASW carrier SNS (Soviet Navy ship) *Moskva* was commissioned in 1967, followed by sister ship SNS *Leningrad* in 1969. They had a carrier wing of 14 Kamov Ka-25 helicopters, mostly in the Ka-25PL *Hormone-A* version (PL = *protivo**lod**ochnyy* – ASW, used attributively) augmented by a couple of Ka-25PS (*pois**kov**o-spa**sah**tel'nyy* – search and rescue, used attributively) *Hormone-C* SAR choppers and Ka-25Ts (***tse**leooka**zah**tel'*) *Hormone-B* over-the-horizon (OTH) targeting helicopters.

The Soviet Navy's capability was further increased by the addition in 1975 and 1978 of the first true aircraft carriers – *Kiev* class (Project 1143) cruisers SNS *Kiev* and SNS *Minsk*. These featured an angled flightdeck, rather like HMS *Invincible,* and had a carrier wing comprising 16 Yakovlev Yak-38 *Forger-A* V/STOL strike aircraft and 16 Ka-25 or Ka-27 *Helix* helicopters.

It should be noted here that the Soviet (Russian) carriers were, and still are, referred to as 'heavy aircraft-carrying cruisers'. The term was coined to circumvent the Montreux Convention of 1936 prohibiting the passage of aircraft carriers through the straits of Bosporus and Dardanelles. Since the Soviet carriers were built at the Black Sea shipyards, calling them by their proper name would mean they would be locked in the Black Sea, which of course was totally unacceptable.

However, while being the Soviet Navy's only operational V/STOL jet the Yak-38 was, putting it mildly, not a very capable combat aircraft. Its unusual combined powerplant comprising a Tumanskiy R-27V-300 lift/cruise engine and two Kolesov (RKBM) RD36-35FVR lift-jets was extremely thirsty in VTOL mode, meaning the *Forger*'s combat radius even in clean condition was little more than 500 km (310 miles). With external stores it shrank to only 90-160 km (56-99 miles) – even choppers could do better than that. Besides, the subsonic Yak-38 was virtually no good in the air defence role because it lacked an internal cannon, missile armament and radar and had inadequate speed, service ceiling and range.

The obvious necessity to enhance the Soviet Navy's potential with a CTOL carrier led the Ministry of Shipbuilding (MSP – *Mini**ster**stvo soodostro**i**tel'noy pro**mysh**lennosti*) to task one of its divisions, the Neva Design Bureau in Leningrad (NPKB – ***Nev**skoye pro**yekt**no-kon-**strook**torskoye byu**ro***), with developing such a ship. Initial research and feasibility studies were made as early as 1968; however, the project was not included in the military shipbuilding plan for the 1971-1980 decade because CTOL shipboard aircraft projects on hand were still at a very early development stage.

Yet the SOR for the carrier was beginning to take shape. The 40,000-45,000-ton displacement and the carrier wing consisting of 28 fighters and four helicopters outlined in the original project of 1968 were deemed to be insufficient; therefore, in 1972 the NPKB submitted a revised project. The carrier wing now consisted of navalised MiG-23ML *Flogger-G* 'swing-wing' fighters with an arrester hook, a beefed-up landing gear and an uprated R-100 turbojet, navalised Su-25 *Frogfoot-A* ground-attack aircraft and Beriyev P-42 *Gar**poon*** (Harpoon) ASW aircraft. The latter was a chubby straight-wing aircraft powered by two Lotarev D-36 turbofans which bore a striking resemblance to the Lockheed S-3 Viking. This was the first time the Mikoyan, Sukhoi and Beriyev bureaux established direct links with MSP in order to prepare SORs for the shipboard aircraft. Of the three, only the second aircraft was to see production and service as the Su-25UTG (*oo**cheb**no-treni**rov**ochnyy [samo-**lyot**] s **ga**kom* – arrester hook-equipped trainer), a spin-off of the Su-25UB *Frogfoot-B*. The Mikoyan and Beriyev projects were terminated at the advanced design stage.

Having reviewed the project, the Minister of Aircraft Industry, the Minister of Shipbuilding, the Air Force C-in-C and the Navy C-in-C submitted a joint report to the Communist Party Central Committee and the MoD in mid-1973, recommending that a nuclear-powered multi-role carrier displacing 80,000 tons be proceeded with. In addition to missiles, the carrier was to be equipped with P-42 ASW aircraft and Sukhoi T10-K fighters. The latter was the manufacturer's designation of the future naval Su-27K *Flanker-D* (K = *kora**bel**'nyy* – shipboard). However, a go-ahead at the highest level was needed to build the three carriers envisaged by the programme, and the Soviet leaders had said no.

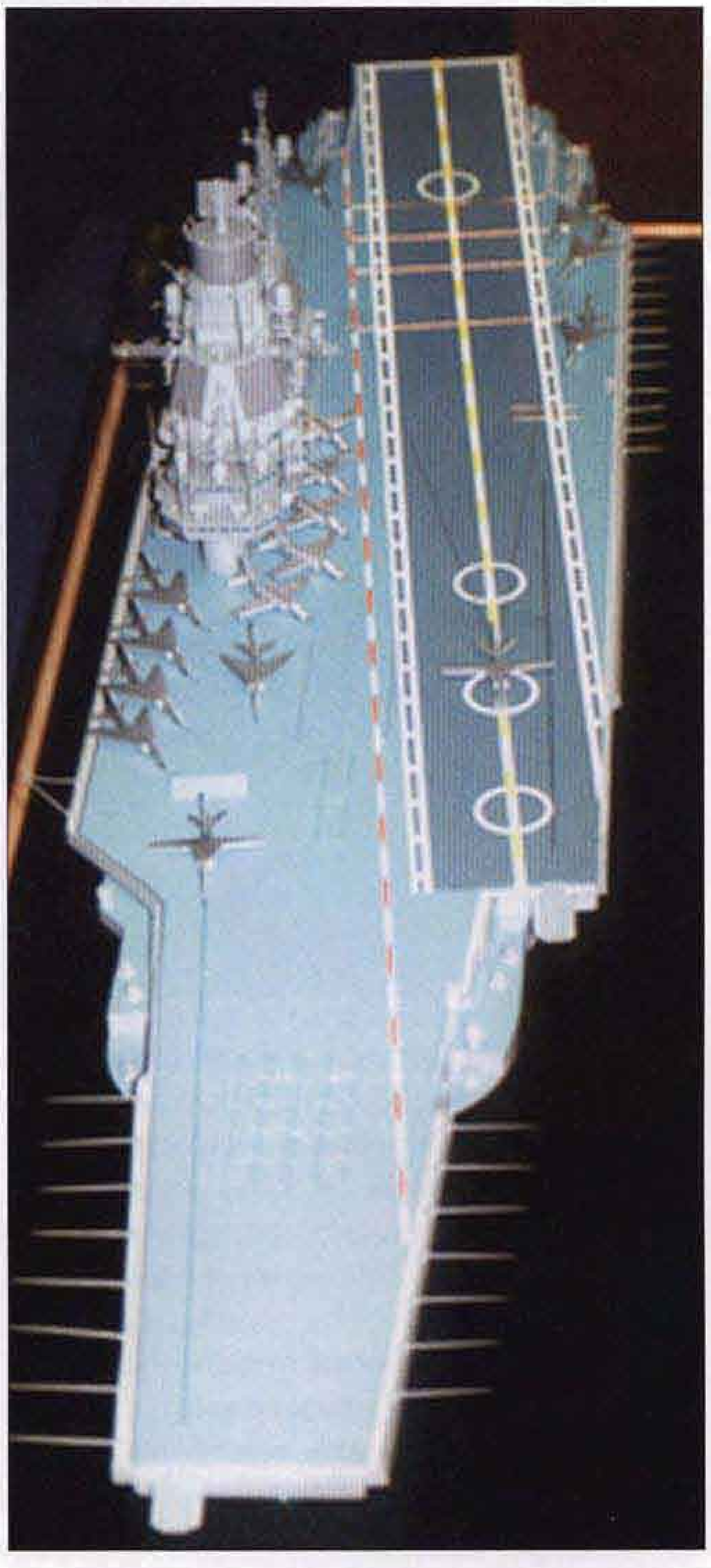
As the next-best solution, Marshal Dmitriy F. Ustinov (then holding the office of Defence Secretary with the Communist Party's Central Committee) proposed modifying Project 1123 carriers. (Note: Defence Secretary is *not* used here in the meaning attached to this phrase in the US. Ustinov was not yet Minister of Defence then but, speaking in US terms, chairman of a standing committee handling defence matters.) Rather than upgrade the two existing Project 1123 ships (SNS *Moskva* and SNS *Leningrad*), it was decided to build a third ship with increased displacement and a carrier wing comprising V/STOL fighters and helicopters. The two carriers that followed would be even more extensively modified, featuring steam catapults for launching the projected MiG-23K fighters and Su-25K attack aircraft. This designation was later reused for the export version of the single-seat *Frogfoot-A*. In the *real* Su-25K the suffix means *kom**mehr**cheskiy* ('commercial', that is, downgraded 'customer version'), not *kora**bel'nyy***. This project (Project 1153) was designated, somewhat enigmatically, 'large aircraft-armed cruiser' and MSP began finalising it with a view to commissioning two nuclear-powered carriers by 1985.

Since CTOL carriers were absolutely new to the Soviet Navy, the deck catapult, arrester wire installation and emergency barrier, optical and electronic landing aids and other things peculiar to carrier operation had to be perfected and mastered. To this end a special Research, Development and Training Complex (RDTC) was to be constructed at Novofyodorovka AB near Saki on the Crimea Peninsula. However, building the 'large cruisers' called for an upgrade of the existing shipyards; Gosplan (the Soviet Union's economic planning and budget management organisation) did not authorise extra funds for this, and the 'large cruisers' were abandoned in favour of the Project 1143 carriers. These would carry V/STOL aircraft, but the fifth Project 1143 carrier would be suitably modified for operating CTOL aircraft.

As the Soviet aircraft carrier programme got under way the aircraft designers were immediately faced with the task of selecting the best take-off mode; they had to choose between a deck catapult and a ski jump. The catapult launch technique is certainly more common. The aircraft is hooked up to the catapult shoe, and as the catapult fires it accelerates to some 300 km/h (186 mph) as it clears the flightdeck. Then it dips below deck level, pitching up to normal take-off angle of attack, and begins climbing normally.

The high launch speed is required because the aircraft's AOA on deck is close to zero and the launch trajectory is almost horizontal. Since the catapult track is only about 90 m (295 ft) long, the acceleration to 300 km/h is a violent experience. During a catapult launch the pilot is subjected to 4.5 Gs, which often causes *G-loc* (G-induced loss of consciousness), impairing his ability to fly the aircraft.

Another peculiarity of catapult-launched aircraft is the necessity to increase the AOA (and



NPKB

◄ **A model of the Project 1153 aircraft carrier ('large aircraft-armed cruiser') with MiG-23K fighters and Su-25K attack aircraft on the deck; note the two steam catapults. The parked MiGs have the wings at 72° maximum sweep to save space; the example preparing to launch from the bow catapult and the one that has just landed have the wings at 16° minimum sweep.**

'18 Blue', the MiG-29KVP development aircraft used in the shipboard fighter programme. Note the black/white photo calibration markings on the air intakes and the radome.

Yefim Gordon archive

The MiG-29KVP in front of a vane-type jet blast deflector.

A. Aksyonov

thus lift) after disengagement from the catapult shoe in order to permit take-off with a full fuel and ordnance load. Therefore, catapult-launched aircraft are fitted with a so-called jump strut – a nose gear unit with an extra-extensible oleo which is extended forcibly to its full length. However, this requires the strut and forward fuselage to be reinforced, incurring a weight penalty and impairing performance.

Conversely, on a carrier equipped with a ski jump the aircraft is restrained by pop-up detents, allowing it to engage full afterburner before the detents are retracted. After leaving the ski jump the aircraft has a positive AOA and pitch rate; these increase as the aircraft accelerates, assisting climb. Thus, the pilot stays in control at all times, which enhances flight safety. The ski jump technique obviates the need for additional reinforcement of the nose gear and forward fuselage to absorb the extra loads generated by the catapult, saving weight and improving performance. On the other hand, the speed at which the aircraft clears the ski jump (120-140 km/h or 74.5-87 mph) is approximately 50%

lower than during catapult launch, which means especially stringent requirements apply to the aircraft's stability and handling.

After carefully studying the catapult launch and ski jump options and analysing operational experience with shipboard fighters abroad, the Sukhoi and Mikoyan bureaux proposed that the future carrier should be equipped with a ski jump. This opinion was supported by LII, TsAGI, GosNII AS and TsNII-30. In mid-1981 Marshal D. F. Ustinov, who had become Defence Minister by then, approved the proposal put forth by MAP and the Air Force. This concerned ski jump take-off research with the MiG-29 and Su-27 fourth-generation fighters, which implied the new carrier would be equipped with a ski jump. However, the carrier wing was to consist mainly of Yak-41 (Yak-141) *Freestyle* supersonic V/STOL fighters, the CTOL MiG-29 and Su-27 being regarded as a 'second choice' in case the Yak-41 programme failed. Beriyev P-42 ASW aircraft and Antonov An-71 *Madcap* airborne early warning (AEW) aircraft – a much-modified An-72 *Coaler* twin-turbofan tactical transport that did not progress beyond the prototype stage – could also be included in the carrier wing.

By mid-1982 the RDTC at Novofyodorovka AB in Saki was fully operational. The pompous and tongue-twisting official appellation NIUTK (*Na**ooch**no-is**sled**ovatel'skiy i **oo**che**b**no-treni-**ro**vochnyy **kom**pleks* – RDTC) soon gave way to the easily pronounceable nickname ***Nit**ka* (Thread) which soon found its way into official documents as well. The complex comprised the T-1 ski jump (T = ***t**ramplin*), a rather provisional deck catapult and the BS-P-1 arrester complex with two arrester systems (one with a cable, the other with a chain). The catapult, arrester hook, Svetlana-2 (S-2) arrester wire installation and S-23N emergency barrier could be tested simultaneously; MSP representatives tested all of this thoroughly before flight tests commenced. (The most improbable codenames were sometimes used for military hardware; Svetlana is a Russian woman's name.) A weighted trolley fitted with an arrester hook was fired by the catapult, engaging the arrester wire immediately after. If the arrester wire and the barrier failed, there was the chain arrester as a last resort.

Carrier compatibility trials began next. Since the navalised *Flanker* and *Fulcrum* prototypes were not yet available, LII experimentally fitted a MiG-27 *Flogger-D* ground-attack aircraft coded '03 Blue' with an arrester hook (the folding ventral fin had to be removed). This testbed flown by LII test pilots A. V. Krootov and Sergey N. Tresvyatskiy was used to study the influence of the aircraft's weight and speed on arrester wire engagement (both normal and offset) and the effect of G loads on the pilot's system.

Practical work to adapt fourth-generation fighters to CTOL carriers began on 21st August 1982 when the MiG-29KVP research aircraft ('18 Blue') made the first take-off from the provisional T-1 ski jump, flown by Mikoyan test pilot Aviard G. Fastovets.

From 1983 onwards the carrier (Project 1143.5) and the aircraft that were to operate from it were developed almost in parallel, the two ministries responsible for the programme (MSP and MAP) working in close cooperation. Yakovlev, Sukhoi and Mikoyan were all busy with naval fighter projects.

It should be noted that initial studies of carrier-based versions of the MiG-29 and T-10 dated back to 1973. Originally it was intended that the MiG-29K, as the naval version was designated, would fill the counter-air role for the carrier group, and it was with this fighter in mind that the carrier was designed.

Meanwhile, stage 1 of the trials at the Nitka RDTC necessitated a drastic redesign of the ski jump. The new T-2 ski jump completed in 1984 was 5.6 m (18 ft 4$\frac{31}{64}$ in) high, 53.5 m (175 ft 6$\frac{19}{64}$ in) long and 17.5 m (57 ft 5 in) wide; it had a 14.3° incline and was an exact copy of the future carrier's bows. Sukhoi test pilot Nikolay F. Sadovnikov made the first take-off from the restyled ski jump on 25th September 1984 in the T10-25 ('25 Blue'), an early-production *Flanker-B* fitted with an arrester hook under the Su-27K programme. The Mikoyan OKB joined in with the MiG-29KVP on 1st October and the trials continued until 25th October.

Trials conducted from 1982 to 1984 showed that building a CTOL carrier-borne fighter using a ski jump for take-off and an arrester wire system for landing was indeed feasible. Hence in 1984 the Communist Party Central Committee and the Council of Ministers issued a directive ordering the Sukhoi and Mikoyan bureaux to develop such aircraft. Sukhoi were to design the T10-K (Su-27K) heavy fighter while Mikoyan were to work on the lighter multi-role MiG-29K, an air defence fighter with a secondary anti-shipping strike and ground-attack capability.

The carrier wing of the Soviet Union's first CTOL carrier would be structured in a similar fashion to US Navy carriers which had Grumman F-14A Tomcat heavy fighters and lighter McDD F/A-18 fighter/attack aircraft. The composition was finalised in 1978; the Project 1143.5 carrier

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▲ **The arrester hook of the MiG-29KVP. Note the absence of the usual airbrake and brake parachute.**

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▲ **This sequence of stills from a Mikoyan OKB video shows the MiG-29KVP taking off from the T-1 ski jump at Novofyodorovka AB.**

would be armed with 18 Su-27Ks, 28 MiG-29Ks and 14 Ka-252s – eight Ka-252PL ASW helicopters, two Ka-252PS SAR helicopters and four Ka-252RLD AEW/OTH targeting helicopters. (Ka-252 was the manufacturer's designation of the Ka-27, reflecting its *Hormone* heritage – that is, 'Ka-25 Mk2'. In production form the helicopters were designated Ka-27PL *Helix-A*, Ka-27PS *Helix-C* and Ka-31 respectively; RLD means ***rah**diolokatsi**on**nyy do**zor*** – radar picket.)

The carrier's fixed-wing element was now tasked solely with the counter-air role and thus not intended to carry air-to-surface weapons. The Su-25K attack aircraft and the P-42 ASW aircraft were abandoned. No bets were as yet placed on the Yak-41 because of the major engineering challenges associated with designing a supersonic V/STOL aircraft, but if everything worked the fighter could complement the Su-27K and MiG-29K aboard Project 1143.5 carriers, besides supplanting the Yak-38 on the Soviet Navy's three operational VTOL carriers – SNS *Kiev*, SNS *Minsk* and SNS *Novorossiysk*.

Full-scale development of the navalised *Fulcrum* began in 1984 pursuant to the said directive. Actually two upgraded versions of the MiG-29 were being developed in parallel under General Designer Rostislav A. Belyakov and chief project engineer Mikhail R. Val'denberg – the MiG-29M (*izdeliye* 9.15) for the VVS and the MiG-29K (*izdeliye* 9.31) for the Naval Aviation (AVMF – *Avi**a**h**tsiya **V**oyenno-mors**ko**vo* ***f**lota*). The MiG-29K was to provide air defence for the carrier group in the daytime and at night in any weather at altitudes between 30 and 27,000 m (100-88,580 ft). Apart from air defence, it was to act as a 'hunter', destroying enemy ASW, transport and AWACS aircraft, fly anti-shipping strike missions, support marine landings, escort shore-based aircraft, set up minefields and perform reconnaissance tasks. (The apparent contradiction as to the aircraft's role is explained by the constantly changing requirements. *Dozens* of directives appeared while development was in progress, and each one contained new requirements! It was much the same story in the US.)

The MiG-29K was based on its land-based counterpart, the MiG-29M, and the airframe was likewise largely welded of 01420 Al-Li alloy. However, the MiG-29K was tailored to carrier operations and thus differed considerably from the MiG-29M. Special attention was given to corrosion protection to enable operation in the salty ocean environment. More stringent requirements applied to structural materials, coatings, seals and gaskets. The fuselage (primarily the main fuel tank) was beefed up considerably to absorb the augmented loads during no-flare landings and arrester wire braking.

The sole Soviet CTOL aircraft carrier, shown here under her original name SNS *Tbilisi* and with her original hull number 113. The ski jump is clearly visible. ▼

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▲ **The MiG-29KVP makes a low pass over the Nitka 'unsinkable carrier' at Novofyodorovka AB with the arrester hook retracted.**

The aircraft was powered by RD-33K engines rated at 5,500 kgp (12,125 lbst) dry and 8,800 kgp (19,400 lbst) reheat, with duplex FADEC and automatic fuel flow management systems. Unlike the MiG-29M, however, the engines had a 9,400-kgp (20,723 lbst) take-off contingency rating. The latter guaranteed the aircraft could take off from either of the two forward take-off stations (105 m/345 ft from the bows) with a 17,700-kg (39,020-lb) TOW and from take-off station 3 (195 m/640 ft from the bows) with a 22,400-kg (49,380-lb) maximum TOW. The added thrust enabled a safe go-around if the aircraft missed the arrester wires. The air intakes were borrowed straight from the MiG-29M, featuring FOD protection grilles, auxiliary intakes in the mainwheel wells and movable lower lips.

To reduce approach speed wingspan was increased to 12.0 m (39 ft $4\frac{7}{16}$ in) and wing area to 43 m^2 (462.36 sq ft). The wings featured a modified TsAGI P-177M airfoil instead of the basic P-177, double-slotted flaps inboard and flaperons outboard. The dorsal fin extensions housing the chaff/flare dispensers were deleted and the dispensers incorporated in the aft fuselage. As on the MiG-29M, stabilator chord was increased to improve pitch control at low speed, resulting in a characteristic dogtooth.

The outer wings folded hydraulically to a vertical position for hangar stowage, reducing span to 7.8 m (25 ft 7 in). For better fatigue resistance the wings were of welded steel construction. The radome could also be folded upwards to decrease overall length from 17.27 m (56 ft $7\frac{59}{64}$ in) to 15.1 m (49 ft $6\frac{31}{64}$ in).

The landing gear struts were lengthened, featuring heavy-duty increased-stroke shock absorbers and tiedown shackles. Special links shortened the oleo struts during retraction to make sure they would fit into standard wheel wells. The nose gear unit featured a modified steering mechanism allowing the nosewheels to turn through ±90° for deck handling. It also mounted approach lights resembling traffic lights in miniature to inform the landing signals officer (LSO) of the aircraft's position and speed on final approach. All wheels were fitted with new higher-pressure (19.95 kg/cm^2; 285 psi) tyres.

The brake parachute was deleted; a quick-release flight data recorder (FDR) and the arrester hook attachment and rebound damper were installed where the brake 'chute canister had been. Like the MiG-29M, the naval version had a one-piece dorsal airbrake which was used to reduce approach speed.

The deletion of the dorsal auxiliary intakes made room for additional fuel in the LERXes, increasing the internal fuel capacity to 5,720 litres (1,258.4 Imp gal) or 4,460 kg (9,830 lb) of usable fuel. The MiG-29K had single-point refuelling for both internal tanks and three drop tanks: 1,520 litres/334.4 Imp gal on the

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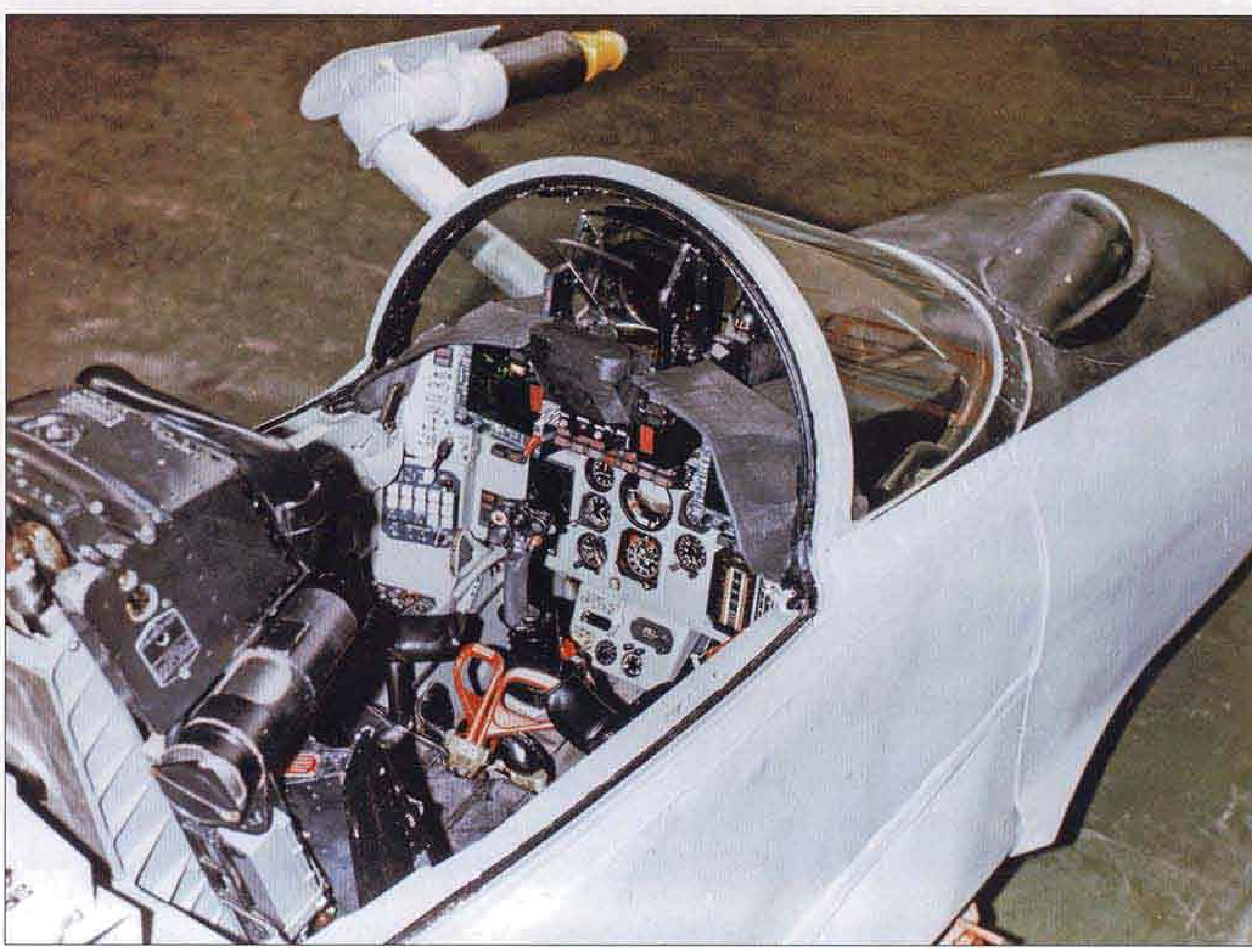
▲
The forward fuselage mock-up of the MiG-29K, showing the fully retractable L-shaped IFR probe and the single-curvature radome.



RSK MiG

►
This view shows the all-new instrument panel featuring an SOI-29K data presentation system with two small multi-function displays. Note the door segment attached to the IFR probe.

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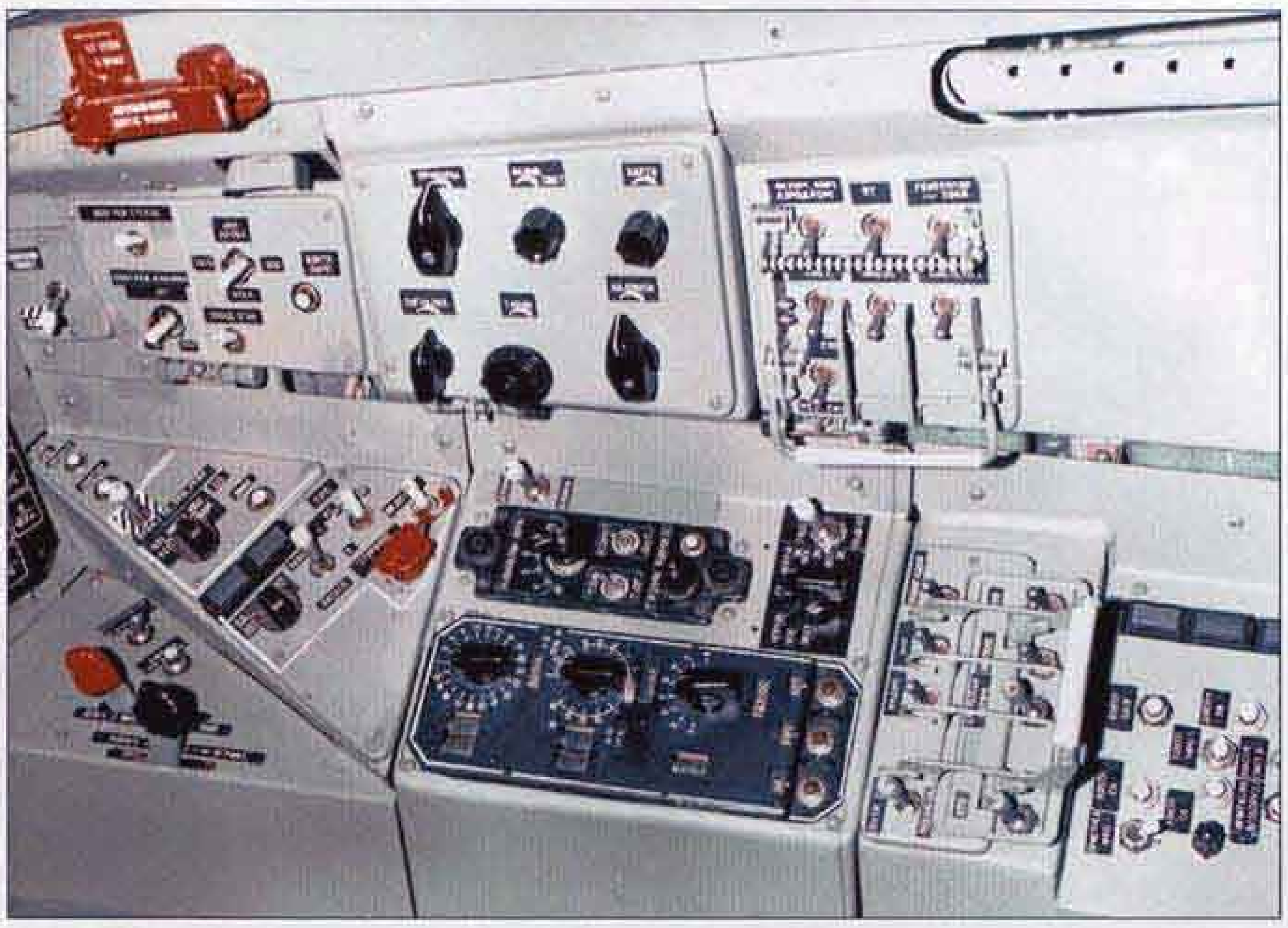
◄ **Close-up of the instrument panel, showing the monochrome MFDs in operation; the left-hand MFD shows flap, landing gear and arrester hook position (all deployed). Note the missile selector panel low on the left side. The MiG-29K's collimator HUD is also new.**



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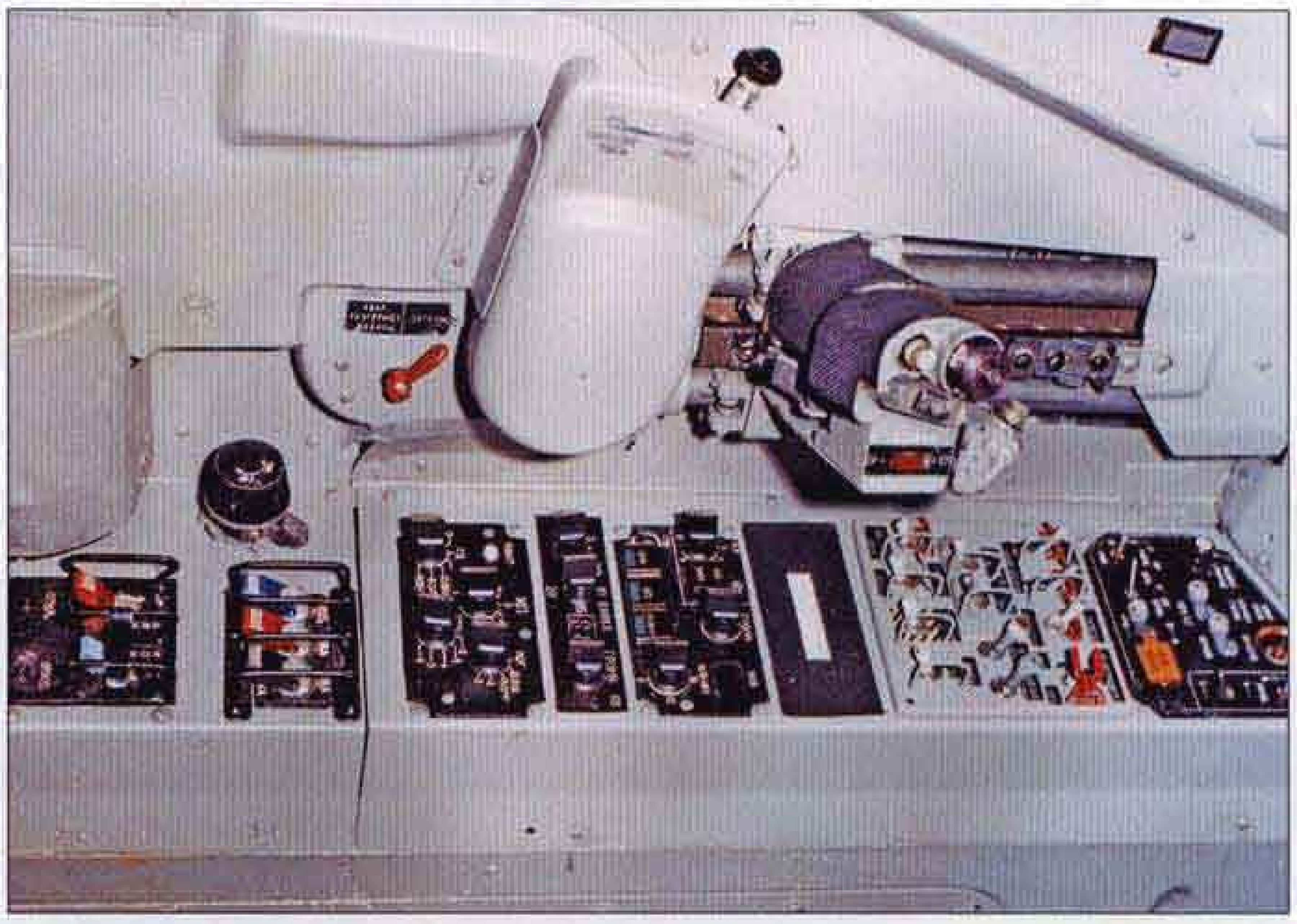

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The port and starboard consoles of the MiG-29K cockpit mock-up. ▼◄ ▼

centreline and 1,150 litres/253 Imp gal on each inner wing station. The total fuel load with three drop tanks exceeded 6,500 kg (14,330 lb). A fuel jettison system was provided to lighten the aircraft to the 15,300-kg (33,730-lb) maximum landing weight in the event of an emergency landing.

To increase range further the MiG-29K was fitted with a fully retractable L-shaped refuelling probe offset to port ahead of the windscreen. This allowed the fighter to receive fuel from any aircraft equipped with an UPAZ-1A podded hose drum unit (HDU). (UPAZ = *oonifi***tsee***rovannyy podves***noy** *agre***gaht** *za***prah***vki* – standardised

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suspended (= external) refuelling unit like, for example, those of the VC-10 K. Mk 1/Mk 2. The 'standardised' part of the name means it is fitted to Ilyushin IL-78/IL-78M *Midas* tankers but can also be used by fighters as a 'buddy' refuelling pack.) For night refuelling the tanker's drogue was illuminated by a special retractable light. The arrester hook was also illuminated during night landings.

The MiG-29M's WCS was almost identical to that of the MiG-29M, comprising an RLPK-29UM radar targeting system and an OEPrNK-29M targeting/navigation suite. The version of the N010 Zhuk radar fitted to the naval *Fulcrum* incorporated modifications for better target definition over water.

The SUV-29K WCS enabled the MiG-29K to seek, detect, identify and destroy single and group targets above and below its own flight level, day and night, in any kind of weather and in an ECM environment. The dual targeting systems allowed it to attack covertly (without revealing itself by switching on the radar) and to use several kinds of weapons in a single pass. The radar could track ten targets while guiding missiles to four of them designated as priority threats. Close formations of enemy aircraft could also be attacked. An important feature of the WCS was automatic evasive action so as to avoid being hit by debris or fragments of the aircraft's own missiles.

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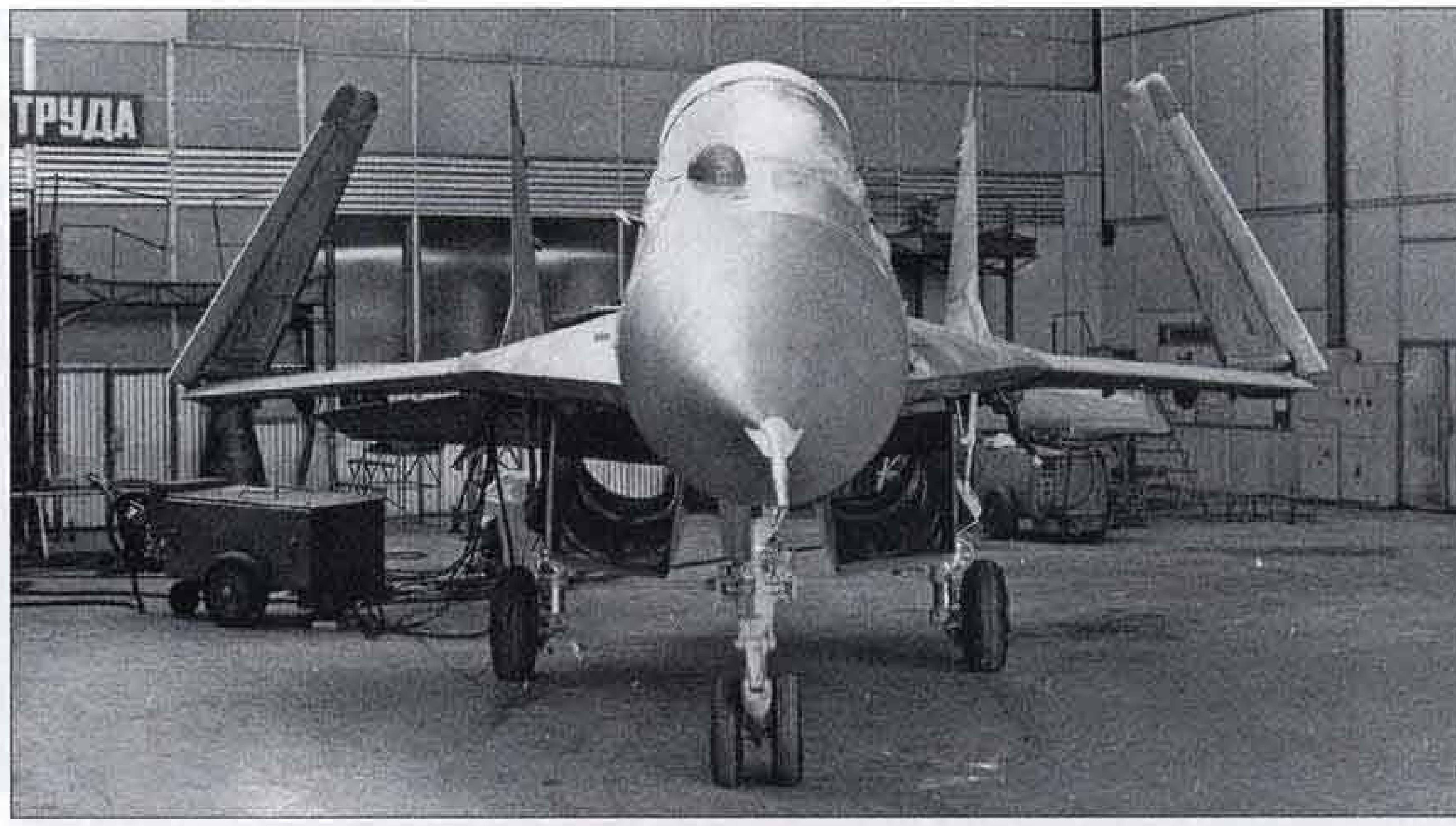
◄
The almost completed first prototype MiG-29K sits in the assembly shop of MMZ No.155 with the wings folded (centre) and deployed. Note the deployed dorsal airbrake in the upper photo and the posters on the wall exhorting the employees to work conscientiously ('The economic plan is the law', 'This is a communist labour shop' and so on).

►
Front view of the MiG-29K prototype; you can see right through the still-empty engine nacelles.



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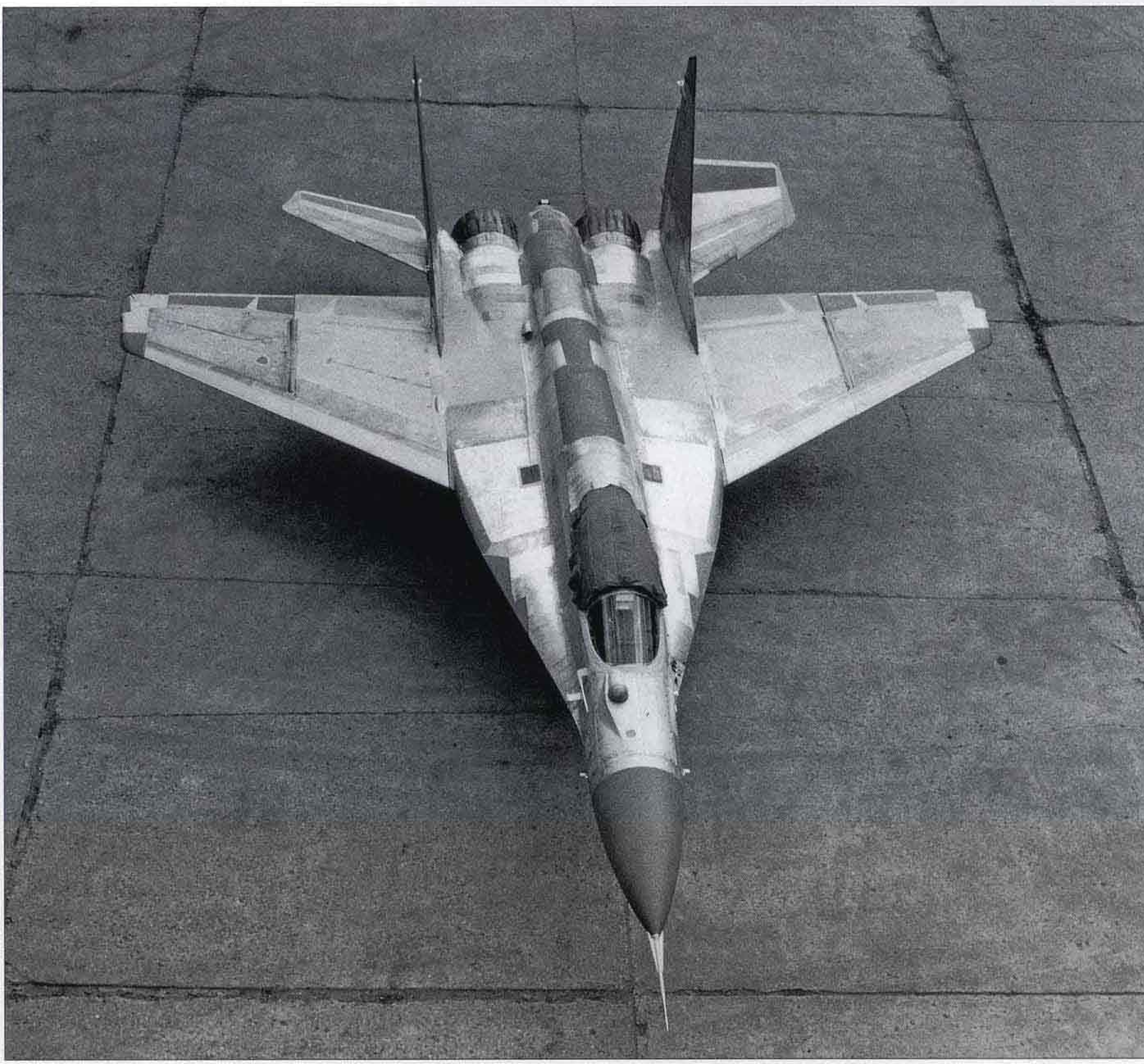
The complete but still unpainted first prototype on the factory apron. Note the ECM antennas at the wingtips and the odd angle of the tailerons.
▼



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◄
The first prototype, now painted light grey and coded '311 Blue', at the OKB's flight test facility in Zhukovskiy. Note the straight upper fuselage contour and the arrester hook. The retracted IFR probe is barely visible above the dielectric panel on the nose.

►
Front view of the MiG-29K.

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This view shows the fuselage spine continuing all the way to the rear 'beaver tail' fairing, the absence of dorsal auxiliary air intakes, the square excess air outlets, the wing folding hinges and the APU air intake offset to starboard.
▼

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▲ This view of '311 Blue' at Zhukovskiy with the IFR probe extended shows the sharp-edged LERXes, the TE flap track fairings and the stabilator leading edge dogtooth. No pylons are fitted yet.

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► The MiG-29K's outer wings go past the vertical when folded. Note the low position of the taxi light on the nose gear strut and the approach lights immediately above it.

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► Rear view of the MiG-29K with wings folded; the port and starboard panels are at different angles, as are the port and starboard stabilators.

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◄▲
The first prototype soon received T-shaped black/white photo calibration markings on the nose and tails for the initial flight tests. Note the additional pitot below the cockpit.

The MiG-29K has a heavy-duty landing gear optimised for n o-flare landings, with oleo shortening linkages on the main units.
▼

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▲▶ **MiG-29K '311 Blue' shows its eight wing hardpoints, four of which are on the folding outer wings. Here the aircraft is in air defence configuration with two R-27Rs inboard, two R-73s outboard and two pairs of R-77s in between. A drop tank is also carried in the picture on the right.**

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Another view of the first prototype MiG-29K configured for an air defence mission. Note the deployed arrester hook and the opaque blue IRST 'ball' rotated back to front. ▼

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◄▲
The MiG-29K in anti-shipping strike configuration with four Kh-31A ASMs on AKU-58 ejector racks under the inner wings. For MTOW reasons the defensive missile armament is limited to two R-77s under the outer wings. Note the drop tank in the upper and lower photos.
▼

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This view shows how the photo calibration markings of the first prototype MiG-29K almost converged on top of the nose.

The cockpit data presentation and weapons selection systems of the shipboard version received a major upgrade. A single multi-function missile control panel allowed additional air-to-surface missile types to be integrated. The SOI-29K data presentation system (*sis**tem**a otobra**zhen**iya infor**mah**tsii*) included a new collimator HUD and two monochrome CRTs on the instrument panel.

The cockpit of the naval version was virtually identical to that of the MiG-29M, differing largely in the navigation equipment. The MiG-29K was equipped with an SN-K ***Oo**zel* (Knot) navigation suite for overwater flights and carrier approach. It included an INS-84 new-generation inertial navigation system, satellite navigation equipment, a 'Resistor' SHORAN/ILS, an air data system and a digital processor. The SN-K navigation suite worked in concert with the carrier's VOR/localiser and glideslope beacons; it featured a jam-proof secure data link and automatic built-in test equipment (BITE). It was more accurate and had a higher navigation data feed rate than systems used hitherto.

Like the MiG-29M, the naval *Fulcrum* was to have an ESM suite comprising a signals intelligence (SIGINT) pack, a Mak-F (Poppy-F) infrared missile warning system (MWS), a Gardeniya-1FU (L-203B) jammer and two BVP-60-26 chaff/flare dispensers. In common with its land-based equivalent the MiG-29K featured ECM aerials at the wingtips; however, the wingtips were characteristically bulged to accommodate the ECM gear, probably because the longer-span wings were thinner at the tips.

The MiG-29K had eight underwing weapons pylons and a centreline pylon. The ordnance load was increased to 4,500 kg (9,920 lbs) and included eight combinations of AAMs and no fewer than 25 air-to-surface weapons options. Air-to-air weapons included up to four R-27R (R-27RE) or R-27T (R-27TE) medium-range IR-homing/SARH missiles, up to eight R-73 short-range missiles and up to eight R-77 (RVV-AE) medium-range active radar homing AAMs. Typical external stores in counter-air mode were four R-27s (or two R-27s plus drop tanks) and four R-73s.

In strike mode the aircraft could carry up to six Kh-25ML or Kh-29L (Kh-29T) AGMs, up to four Kh-31A or Kh-35 ASMs, up to four Kh-31P or six Kh-25MP ARMs, up to four KAB-500KR TV-guided bombs. Unguided weapons included up to nine 500-kg (1,102-lb) or up to sixteen 250-kg (551-lb) 'dumb bombs', KMGU submunitions pods, two S-25 heavy rockets, four B-13L rocket pods with 20 S-13 FFARs or four B-8M1 rocket pods with 80 S-8 FFARs. Like the MiG-29M, the naval fighter had the GSh-301 cannon with 100 rounds.

Specified combat radius was 850 km (528 miles) on internal fuel, increasing to 1,050 km (652 miles) with one drop tank and 1,300 km (807 miles) with three drop tanks. On-station time during combat air patrol (CAP) missions within 250 km (155 miles) from the carrier was 1.6-2.3 hours.

The naval fighter shared the MiG-29M's combined digital/analogue FBW control system with multiple electronic backup in all three control channels and mechanical backup in the yaw and roll channels. The crew escape system had a feature unique to the naval version: the ejection seat trajectory was inclined 30° sideways so that the seat would go overboard instead of falling on the deck and give the pilot a few extra dozen feet of altitude for his parachute to open fully.

Of course, the structural changes added to the aircraft's empty weight. In normal take-off configuration with four missiles and internal fuel only the MiG-29K weighed 15,570 kg (34,325 lb); MTOW with four missiles and three drop tanks was 18,210 kg (40,145 lb).

The design effort led by Mikhail R. Val'denberg took four years to accomplish. In early 1988 the OKB's experimental shop and the MMZ No.30 'Znamya truda' factory began jointly manufacturing two MiG-29K prototypes. The first prototype completed its ground systems tests by early June. Its c/n has been reported as 27578


RSK MiG

◄ **Toktar O. Aubakirov was the MiG-29K's project test pilot. He was also the first Soviet pilot to perform a conventional carrier landing.**


RSK MiG

MiG-29K '311 Blue' in an early test flight. ▼

The first prototype MiG-29K on the deck of the aircraft carrier SNS *Tbilisi*; the retracted jet blast deflector is visible in the background. The wingtip ECM bulges are clearly visible. Note that the IRST 'ball' is now rotated to reveal the 'pupil' of the optical sensor.

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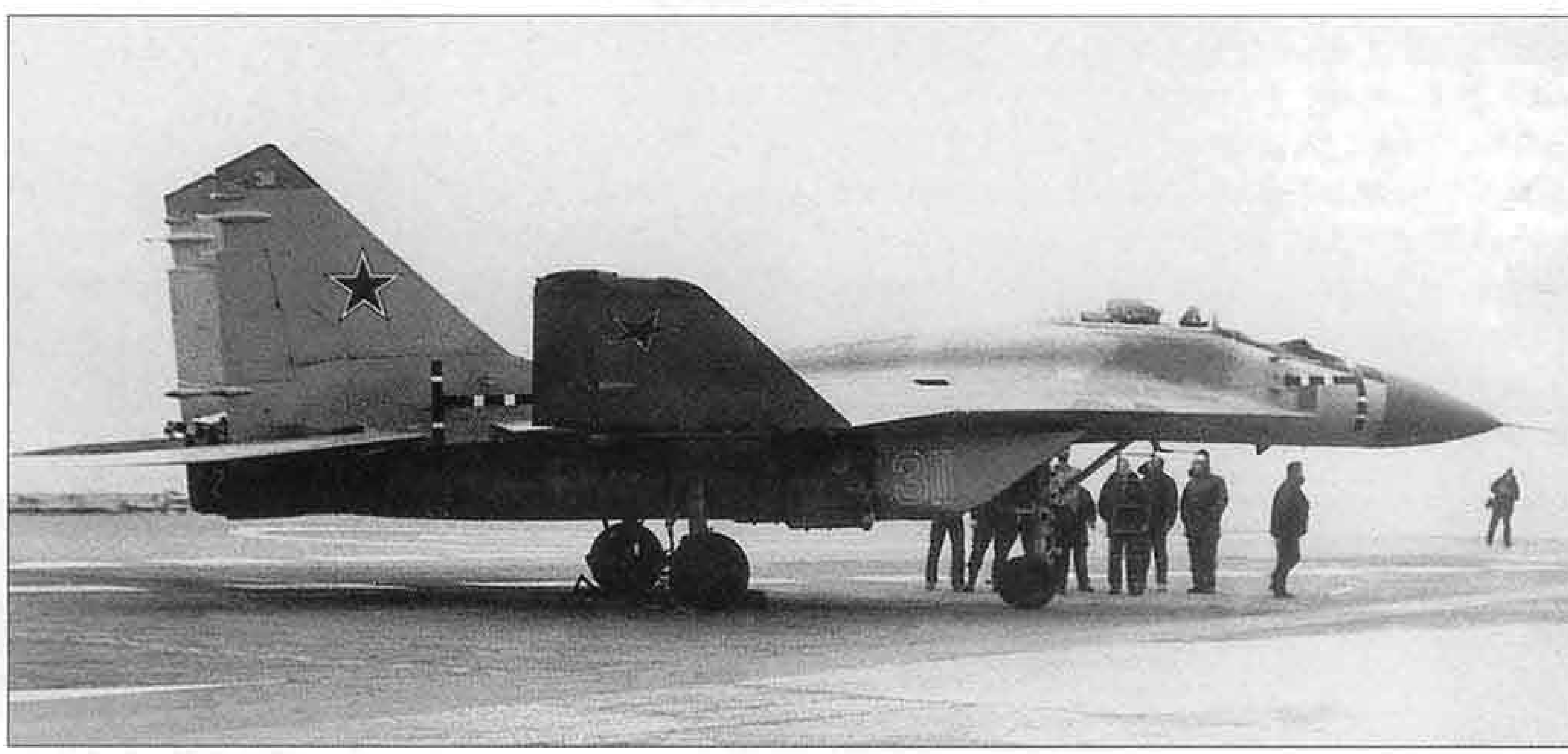

MiG-29K '311 Blue' folds its wings on the *Tbilisi*'s deck.

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Loaded with inert Kh-31As and R-73s, '311 Blue' prepares to take off from the *Tbilisi*'s No.2 launch position. Note the deployed LE flaps and the erected pop-up detents in front of the mainwheels.

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and, obviously in error, as 2016188; the latter number was probably stencilled on some airframe parts but obviously does not fit the *Fulcrum*'s construction number pattern.) Aptly coded '311 Blue' (that is, *izdeliye* 9.31 No.1), the aircraft took off for the first time on 23rd June with Toktar O. Aubakirov at the controls; he was to remain project test pilot throughout the trials programme which ended in 1991.

The first prototype did not utilise the specially developed 'navalised' manufacturing technologies and was not fitted with a weapons control system. The aircraft was painted in standard two-tone grey camouflage and soon received T-shaped black/white phototheodolite calibration markings on the nose and tail. A small Soviet Navy flag was added on the port air intake next to the tactical code, with the Mikoyan OKB logo located symmetrically on the starboard intake.

After making a few test flights in Zhukovskiy to evaluate its performance and handling, '311 Blue' was ferried to Novofyodorovka AB. There the aircraft was used for extensive trials on the 'unsinkable carrier' along with the MiG-29KVP testbed. By then the Nitka RDTC had been equipped with a representative S-2 arrester wire system and a Luna-3 (Moon-3, pronounced *loona*) visual approach slope indicator (VASI). The results of these test flights confirmed the fighter's performance (especially field performance) and paved the way to actual carrier compatibility trials.

Trials at Novofyodorovka AB included taxying (deck manoeuvrability) trials, verification of the aircraft's acceleration on take-off and engine operation at the take-off contingency rating. The reliability of the pop-up detents restraining the aircraft until the engines went to full power was also tested. Special attention was paid to the no-flare landing technique demanding high accuracy; the glideslope angle during such landings was 3°30'-4°. Mikoyan OKB engineers calibrated the Luna-3 VASI so that the aircraft touched down in the required landing area – a 12-m (39-ft) circle painted on the deck – with a sink rate variance of no more than 0.5 m/sec (1.6 ft/sec).

A special naval simulator designed by TsAGI engineers Konstantin V. Zakharov and Oleg I.


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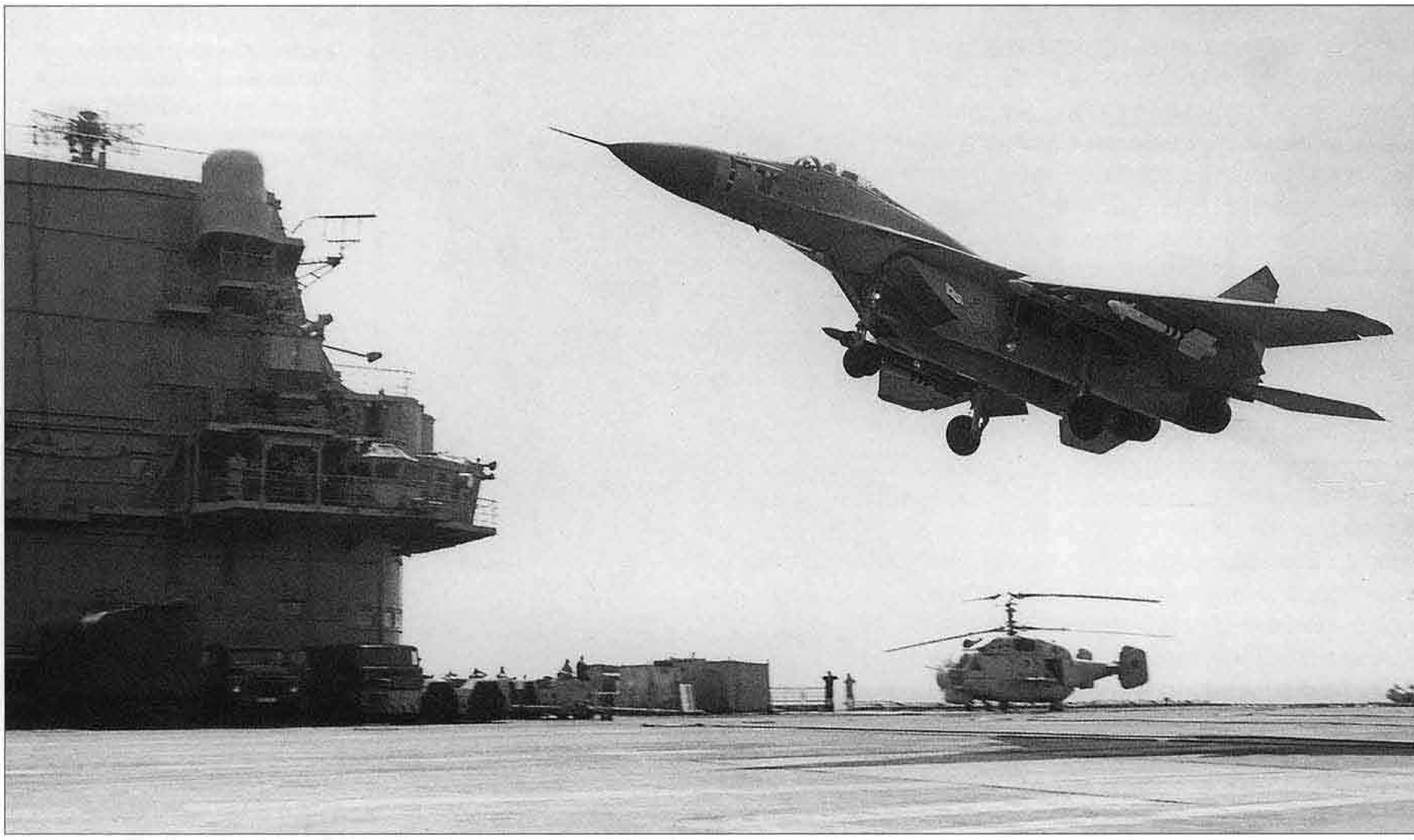
► **The first prototype MiG-29K makes low passes over the *Tbilisi*'s deck, culminating in a touch-and-go – the final step before the real thing. Note that the arrester hook remains retracted throughout.**



ITAR-TASS

▲ **With a Ka-27PS SAR helicopter ready to take off at a moment's notice, MiG-29K '311 Blue' makes another low pass over the carrier with a load of missiles on its pylons.**

Tkachenko came in extremely handy during the trials programme. After practising on this simulator, Mikoyan test pilots Valeriy Ye. Menitskiy, Toktar O. Aubakirov, Roman P. Taskayev, Anatoliy N. Kvochur and Pavel N. Vlasov became proficient enough to maintain constant speed on final approach and catch the wire successfully even without engaging the autothrottle.

Construction of the aircraft carrier, laid down pursuant to order No.0-105 at the Black Sea Shipyard in Nikolayev, the Ukraine, proceeded in parallel. Laid down as SNS *Riga* on 1st April 1982 (some April Fool's Day joke, indeed), she was rechristened SNS *Leonid Brezhnev* in November that year after the Soviet Union's late leader (Brezhnev died in 1982) and was launched on 6th December 1985. In August 1987 the unfinished

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► **The MiG-29K makes its first real carrier landing, catching the No.2 wire of the *Tbilisi* on 1st November 1989.**

carrier was rechristened *again*, becoming SNS *Tbilisi*, and it was under this name that she was commissioned. (The Soviet Navy seemed to have a tradition of naming aircraft carriers after cities. There were the aforementioned ASW helicopter carriers SNS *Moskva* and SNS *Leningrad* and the V/STOL aircraft carriers SNS *Kiev*, SNS *Minsk* and SNS *Novorossiysk*.)

While the carrier was undergoing completion and outfitting (which took a long time), a sister ship was laid down – again as SNS *Riga*, becoming SNS *Varyag* in 1990. (*Varyag* is an archaic Russian word for the Vikings. The name has an honourable connotation in the Russian Navy. In the Russo-Japanese war of 1904-05 the damaged cruiser RNS *Varyag* was scuttled during the Battle of Tsushima when capture was imminent and went down with all hands rather than face the ignominy of surrender.) The third CTOL carrier, SNS *Ul'yanovsk* (Project 1143.7), was to have a nuclear powerplant and steam catapults.

SNS *Tbilisi* was a classic aircraft carrier with a straight-through flightdeck, an island offset to starboard and an angled landing deck equipped with a four-wire S-2N arrester system. The central part of the ship was occupied by the hangar featuring a turntable and conveyor belts for aircraft handling. For the first time in Soviet practice the deck lifts (which were large enough for two aircraft each) were placed on the starboard edge of the deck rather than in the middle of it and the hangar doors had watertight sliding shutters. Unlike most carriers in the same


RSK MiG

◄ **Mikoyan OKB test pilot Roman P. Taskayev was also actively involved in the MiG-29K programme.**

MiG-29K '311 Blue' clears the ski jump of SNS *Tbilisi* after launching from the beam position. ▼


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class, SNS *Tbilisi* had a ski jump on which two take-off heading lines converged.

Take-off station 1 was on the starboard side ahead of the forward deck lift, with Station 2 located symmetrically to port; the take-off run from either position was 105-110 m (344-360 ft). Station 3, located on the port take-off line 195 m (640 ft) from the bows at the intersection with the angled deck axis, was used by CTOL aircraft for high gross weight take-offs; alternatively it could be used by the Yak-41M for short (rolling) take-offs from the angled deck.

All three stations had hydraulically-actuated jet blast shields cooled by sea water to protect other aircraft waiting their turn for take-off; at Station 1 the shield also protected deck handling equipment and personnel assembled in the

▲ **The first prototype MiG-29K shares the deck with the second prototype Su-27K (T10K-2 '39 Blue'). Note that the latter aircraft has a stabilator folding feature as well.**

► **MiG-29K '311 Blue' sandwiched between two Ka-27PSs on the *Tbilisi*'s deck.**

The first prototype MiG-29K taxies past the landing signals officer's glazed enclosure on the carrier's deck. ▼

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◄
Another view of the MiG-29K taxying on the deck

MiG-29K '311 Blue' comes to a halt, pulling the arrester wire taut.
▼

The MiG-29K is just about to leave the angled deck of SNS *Tbilisi*, making a go-around after missing the wire.
▼▼

Afterburners blazing, the MiG-29K takes off from the ski jump.
▼▼▼

service area near the island. The take-off stations also featured pop-up detents for the aircraft's mainwheels, which an operator retracted by pushing a button; the three operators sat in semi-enclosed cabins buried in the flightdeck near the respective stations.

A white circle near the No.2 arrester wire marked the normal touchdown point. The four wires were set at 12 m (39 ft) intervals and normally lay flush with the deck; they were raised before touchdown and kept from sagging by sprung supports.

The gyrostabilised Luna-3 VASI was installed on an outrigger on the port side near the midship frame; in daytime the high-intensity approach lights were visible about 3 km (1.86 miles) out. The LSO sat in an enclosure on the stern, instructing the pilots by radio; it was his responsibility to authorise a landing or call a go-around.

Carrier compatibility trials were scheduled to begin in the autumn of 1989, even though the *Tbilisi* still wasn't 100% complete by then. They would show if the carrier satisfied the aircraft designers' requirements and whether the naval pilot training techniques were correct. On 21st October 1989 the carrier put to sea for the first time pursuant to a joint directive of MAP, MSP, the VVS and the Navy, making a voyage from Nikolayev to the Soviet Navy base at Sevastopol' for the official handover to the Navy.

Seagoing trials commenced at the end of the month. Before a landing could be risked, however, a new series of test flights at Novofyodorovka AB had begun on 30th August; these quickly progressed into low passes over the carrier. On 27th October at about 11:00 the second prototype Su-27K (T10K-2, '39 Blue') piloted by Sukhoi OKB test pilot Viktor G. Pugachov put in an appearance, flying over the

Nikolay Valuyev

Nikolay Valuyev

RSK MiG

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▲ The MiG-29K on final approach to the carrier, showing the fully deployed flaps and arrester hook.

Toktar Aubakirov makes another 'dry run' as the ship moves (note the wake). Note also the white circle near the No.2 wire and the compact deck handling tugs. ▼

ship at about 1,500 m (4,920 ft). The deck hands watched as the fighter circled over the ship, gradually descending, appearing suddenly out of the mist to thunder over the flightdeck.

Toktar Aubakirov appeared next in the MiG-29K prototype, much to the joy of the Mikoyan OKB representatives standing on the deck. At first he flew along the carrier's port side, assessing the effect of the carrier's wake turbulence to which the smaller and lighter MiG-29 was more susceptible. During one such flypast Eduard V. Yelian, acting chief of Mikoyan's flight operations section, ignored orders from the bridge and rushed out to the edge of the deck to greet the pilot. Seeing his salute, Aubakirov got high spirited and made a steep turn to starboard, passing over the carrier's bows.

Flights continued the following morning. Pugachov passed lower and lower over the ship, even making an unscheduled touch-and-go. Conversely, Aubakirov was wary, not risking a touchdown but making repeated passes about 1 m (3 ft) over the deck. Fact is, the flight plan for both pilots contained a rather vague phrase, 'practising carrier landing techniques'; no one could tell if this implied making an actual landing or not, so each pilot picked the technique he considered appropriate and safe. Meanwhile the carrier's crew made phototheodolite measurements, calibrated the approach radar, beacons and so on. Initially the flights progressed with the *Tbilisi* standing at anchor, her bows to the wind; later flights were made while the carrier moving at 10-13 kts on various headings.

Before making a real landing Mikoyan, Sukhoi and GNIKI VVS pilots practised day after day, mastering the unfamiliar no-flare landing

RSK MiG

technique. It was hard to get rid of the habit of hauling back on the stick before touchdown. Each pilot was to make some 400 landings on the 'unsinkable carrier' before he was cleared for real-life carrier landings.

The flights resumed on the morning of 1st November 1989. For safety's sake the air traffic was organised so that when one aircraft was on short finals the other fighter was halfway through the landing pattern. Mikoyan and Sukhoi OKB representatives, L. V. Belov (the *Tbilisi*'s chief designer) and his deputy Yuriy D. Sergeyev, shipyard director Yuriy I. Makarov, Mikoyan, LII and TsAGI specialists, ship's officers and members of the State commission gathered in the ATC room. The approaching fighters were plainly visible through the large windows, but only the ATC officer could see the actual moment of touchdown.

For more than an hour and a half the fighters circled while the commission watched; finally, at 13:46 local time the T10K-2 touched down, catching the second wire, and came to a halt after a landing run of about 90 m (295 ft). The first conventional carrier landing in the Soviet Union was successfully accomplished. At 15:12 the MiG-29K followed suit, touching down somewhat more roughly; in fact, it appeared to onlookers that the aircraft dropped onto the deck like a gliding brick.

The rival Sukhoi OKB had claimed the first carrier landing. Not to be outdone, Mikoyan decided to beat them to the first take-off which was slated for the following day. However, the weather turned out to be worse than expected; it was all the Mikoyan reps could do, sitting and waiting while dusk drew steadily nearer. Eduard V. Yelian and the carrier's ATC shift supervisor had an argument over whether the MiG should be authorised to take off, and tempers mounted

▲ **Mikoyan OKB personnel crowds around Aubakirov's MiG-29K as the fighter folds its wings after the first landing. Note the crowd of spectators on the deck and the island.**

Roman Taskayev in the cockpit of '311 Blue' aboard the *Tbilisi*. Note the mission markers below the canopy; some are marked '5' to denote five test flights. ▼

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▲ The second prototype MiG-29K ('312 Blue') sits in front of the erected jet blast shield of the Nitka 'unsinkable carrier', the afterburners belching terrific flames.

on both sides. The ATC's verdict was no, and with good reason – the Su-25UTG prototype which was in the air at the moment was running low on fuel and the ship was heading away from shore. The trainer had to land before nightfall; landing in the dark was out of the question.

Still, Yelian managed to receive the go-ahead and a few minutes later a deck handling tractor positioned the MiG-29K on take-off station 3, which afforded the longest take-off run. Aubakirov started the engines, engaged normal after-burner, then contingency mode and took off, making straight for Saki so as to clear the area for the Su-25UTG. This hurried take-off required no smaller skill than the preceding landing because the aircraft was light and tried to become airborne prematurely; the pilot had to keep it on the deck forcibly to avoid crashing into the ski jump which rose up ahead like a wall. Still, this was the most spectacular take-off of the trials programme.

Pictures of the first prototype aboard the carrier taken by A. Kremko, a correspondent of the TASS news agency, were circulated in November 1989, whereupon the MiG-29K received the NATO codename *Fulcrum-D*.

The first successful carrier landings and take-offs were followed by a period of intensive test flights both on SNS *Tbilisi* and on the 'Nitka' RDTC which lasted until 17th October 1991. Landing was possible in automatic, flight director (command link) and manual modes. To this end the carrier was equipped with VOR/localiser and glideslope beacons, approach radar and the Luna-3 VASI. The fighter approached the carrier on a 4° glideslope, touching down without flaring out, and the arrester hook caught one of the arrester wires raised 10-15 cm (4-6 in) above the deck, bringing the aircraft to a standstill. If the aircraft missed the wires the pilot could apply full throttle and make a go-around. An emergency barrier could be erected if a damaged aircraft was coming in or if the pilot was wounded. Touchdown speed was 230 km/h (142 mph) and the dynamic load limit during deceleration was 4.5 Gs.

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▲ Seen from the Ka-27PS SAR chopper, '312 Blue' raises a cloud of smoke as it prepares to launch from take-off station 3. Note the jet blast shield and the Su-25UTG and Su-27K parked beyond.

Sergey Skrynnikov

► The second prototype (seen here tied down on the *Tbilisi*'s deck) had a different and darker colour scheme with Soviet Navy flags on the tails. Note the open airbrake.

Trials held in 1990 were concerned mainly with autolanding system testing and aircraft-to-carrier avionics compatibility tests. SNS *Tbilisi* completed her seagoing trials same year. On 4th October she was rechristened once again, becoming SNS *Admiral Kuznetsov*. (The full official name is SNS *Admiral Flota Sovetskovo Soyuza Nikolay Kuznetsov* – Flt. Adm. Nikolay Kuznetsov.)

Also in 1990, Mikoyan test pilot Anatoliy N. Kvochur made the first night carrier landing and the first night take-off from the carrier. Until then the MiG-29K had operated from the carrier strictly in 'clean' condition but, also in 1990, Kvochur made the first take-off (in daytime) with a typical ordnance load of four missiles. One take-off was rather unusual. Post-flight inspection revealed a fatigue crack in one of the main gear oleos, which meant the aircraft had to be removed from the carrier for repairs. However, the carrier was at sea and waiting for it to return to base would take too long, so Kvochur was authorised to take off at night with a reduced fuel load to ease the strain on the gear. The take-off and the subsequent landing went well and the aircraft rejoined the trials programme after the damaged unit had been replaced.

In August 1991 the MiG-29K commenced its state acceptance trials. Besides Aubakirov and Kvochur, Mikoyan test pilot Roman P. Taskayev was now flying the aircraft. He soon mastered carrier operations, including take-offs with external stores. On several occasions Taskayev took off from station 1 with a full load of four dummy AAMs and three drop tanks amounting to a TOW of 22 tons (48,500 lb); such high gross weight take-offs were usually made from the far station 3.


Sergey Sergeyev


Sergey Sergeyev

◄▲
After several years of inactivity the two MiG-29K prototypes were returned to airworthy status in 2003 and received this even darker gloss grey colour scheme with Russian Navy 'St. Andrew' flags, as shown here by '312 Blue'. Note the powerful vortices streaming off the LERXes.

The first prototype MiG-29K starts up its engines during tests.
▼


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▶
MiG-29K '312 Blue' accelerates along the carrier's deck. Though still wearing the hull number 113, the ship has now been renamed SNS *Admiral Flota Sovetskovo Soyuza Kuznetsov* (Flt Adm Kuznetsov).

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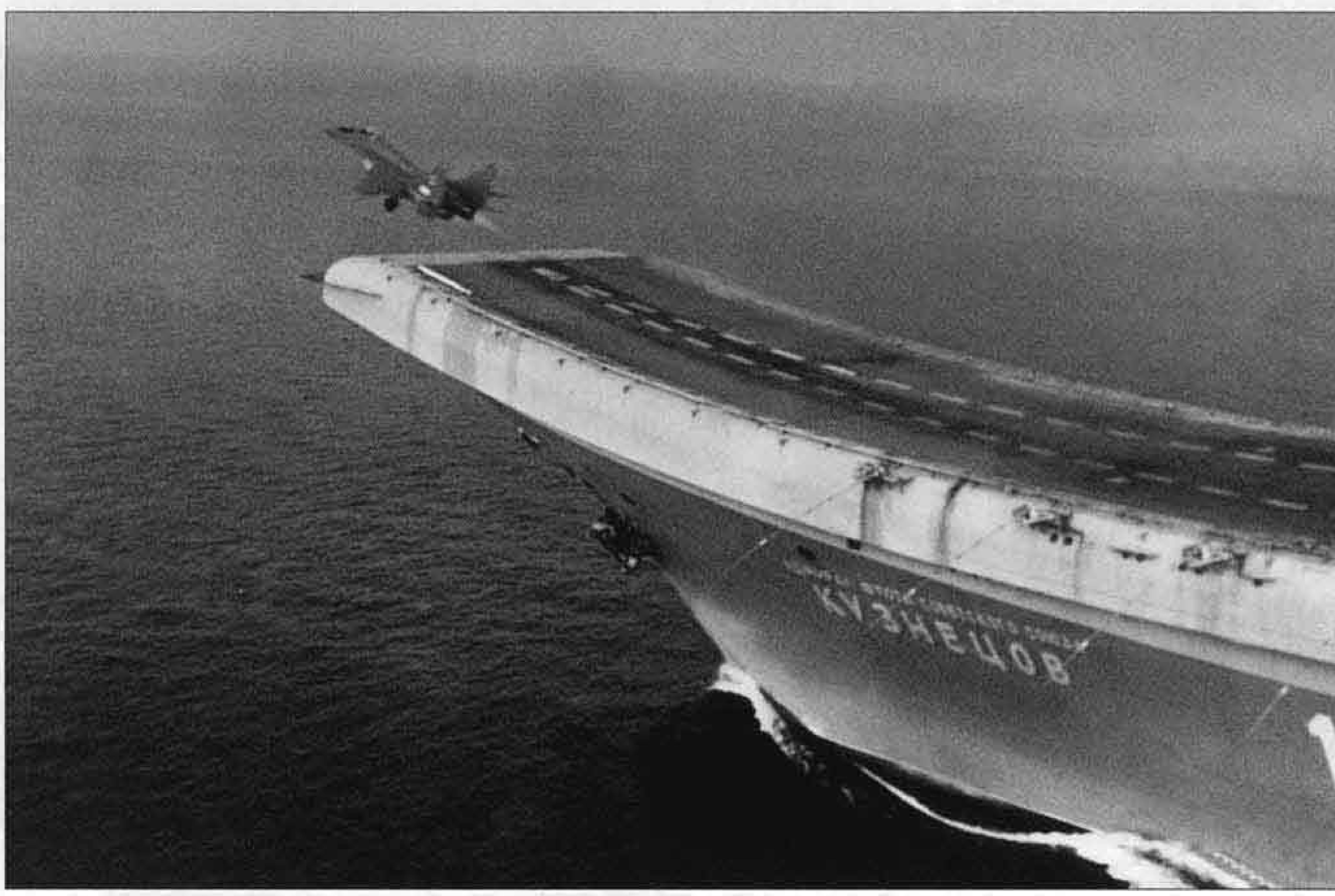

▶
A second later, the aircraft clears the ski jump and starts climbing.
▼

RSK MiG

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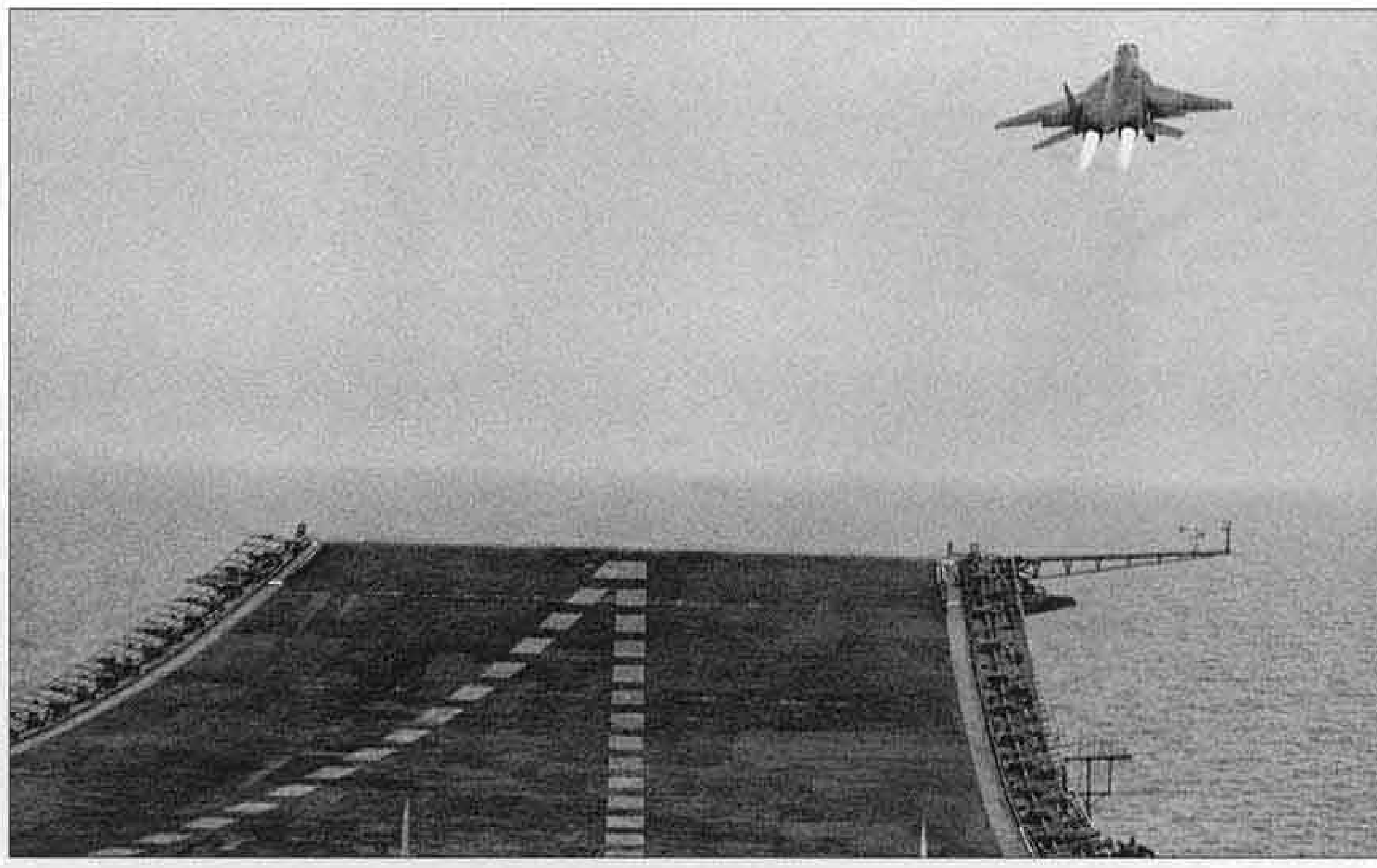
The second prototype, '312 Blue' (c/n 27579), joined the flight test programme at its final stage. Unlike the first prototype, this aircraft wore a naval colour scheme with dark bluish grey upper surfaces and light grey undersurfaces; it lacked calibration markings and wore the Soviet Navy flag on the fins rather than on the intakes. On '311 Blue' the IFR probe had been completely enclosed when retracted, with a rear door segment attached to the probe and a downward-hinging forward segment; however, the latter was omitted on the second aircraft. '312 Blue' was intended mainly for avionics testing and featured a complete WCS and weapons selection system. The aircraft had minor external differences from the first prototype: the IFR probe was plainly visible even when retracted) and the IRST 'ball' was black, not blue.

Once again, separate engineers in charge were assigned to the two prototypes: Sergey P. Belyasnik to '311 Blue' and Valeriy N. Ootkin to '312 Blue'.

Besides flying, the final stage of the carrier's state acceptance trials included aerodynamic trials of the jet blast deflectors. The latter were a constant source of annoyance – not least because their water cooling system had a propensity to explode when overheated, as demonstrated by the Su-27K on two occasions. A lot of aircraft were involved in the trials: two MiG-29Ks, three Su-27K prototypes, the Su-25UTG prototype (T8UTG-1, '08 Blue'), a Ka-27PS (this always took off before the fixed-wing aircraft did, ready to pick up ditched pilots in the event of an accident), Ka-29 *Helix-B* naval assault choppers and the second prototype Ka-31 ('032 Blue'). Curiously, the latter sported the Soviet flag and Aeroflot/***Ghid**romet**tsentr*** (Meteorological Office) titles, masquerading as a civil weather research aircraft!

Sukhoi test pilots Sergey N. Mel'nikov and Vyacheslav Yu. Aver'yanov and Mikoyan test pilot Roman P. Taskayev did a lot of flying at this stage (Taskayev had superseded Aubakirov who



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▲
Another view of MiG-29K '312 Blue' as it climbs away.

Su-27K '59 Blue' comes in to land past Su-27K '79 Blue', MiG-29K '312 Blue' and Su-25UTG '08 Blue'.
▼

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Seen here at Zhukovskiy during a Mikoyan presentation in February 2000, MiG-29K '311 Blue' carries two Kh-31As and two Kh-35 subsonic ASMs under the inner wings, plus two R-77s and two R-73s outboard for self-defence. Additionally, a laser-guided Kh-25ML, a TV-guided Kh-29T and a passive radar homing Kh-25MP ARM are arranged in front.

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The MiG-29K's outer wings are secured in the folded position by wire braces with turnbuckles when the aircraft is parked on deck. The aircraft is no longer airworthy and the air intake ramps have 'bled' down, creating the false impression of FOD prevention blocker doors (although the MiG-29K lacks the associated dorsal air intakes).

had begun training for a space mission). However, the political situation in the USSR was rapidly turning into untold chaos. Shortages of jet fuel and fuel oil for the carrier and, more importantly, the necessity to urgently prepare the ship for transition to the Northern Fleet forced a premature termination of the trials. The flights were suspended and SNS *Admiral Kuznetsov* was firmly anchored at the Navy base in Novorossiysk.

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Still in its original finish, the non-airworthy first prototype is seen in storage at RSK MiG's flight test facility.

The same aircraft in its new guise after returning to flight status. Here it is seen in the static display of the MAKS-2003 airshow.

The second prototype MiG-29K participated in the flying display programme of the MAKS-2003. Here it is seen completing its landing run on Zhukovskiy's runway 30. Note the RSK MiG titles.

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After landing the MiG-29K put on a lively display on the runway, demonstrating its wing folding feature and airbrake as it circled (or, as some observers put it, 'danced') in front of the cheering spectators.

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Three more views of MiG-29K '312 Blue' performing at the MAKS-2003.

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Two views of MiG-29K '312 Blue' at the MAKS-97 airshow, still in the earlier matt grey finish but already with the Russian Navy flag.

►
'312 Blue' takes off on a demonstration flight at one of the biennial Hydro Aviation Shows in Ghelendjik on the Black Sea. Note the flap setting.
▼

'312 Blue' with the landing gear extended and the arrester hook deployed.
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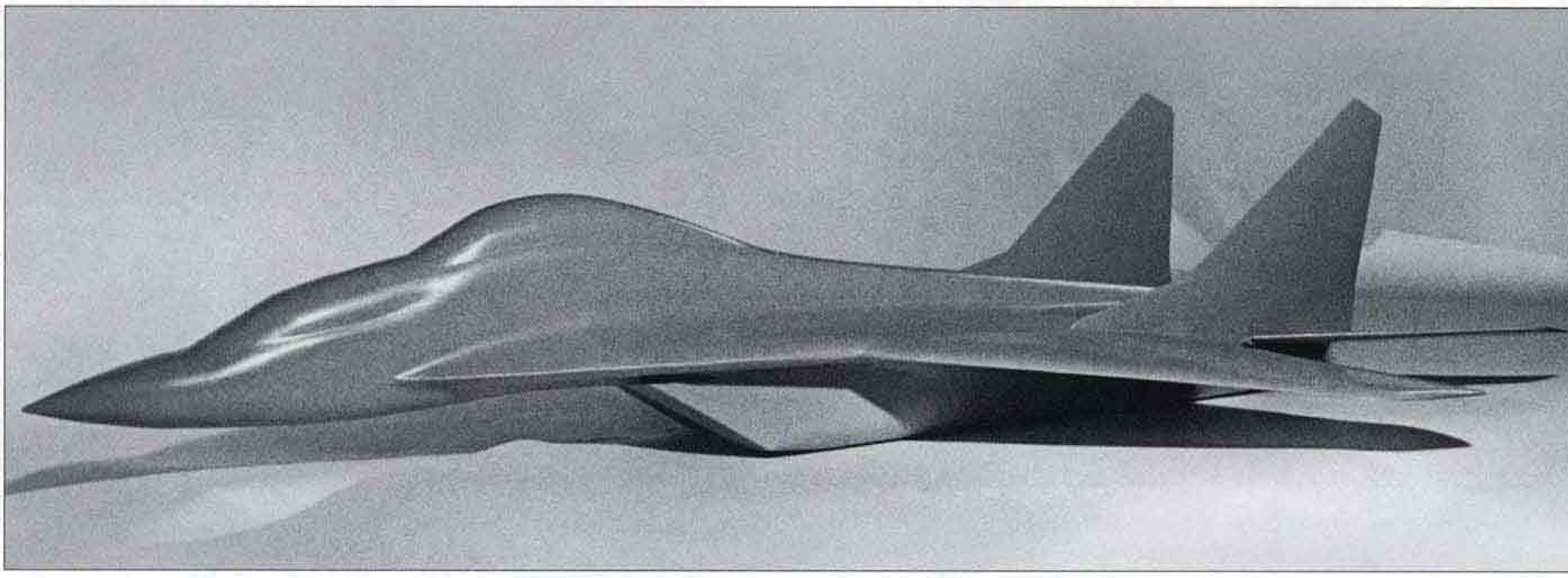

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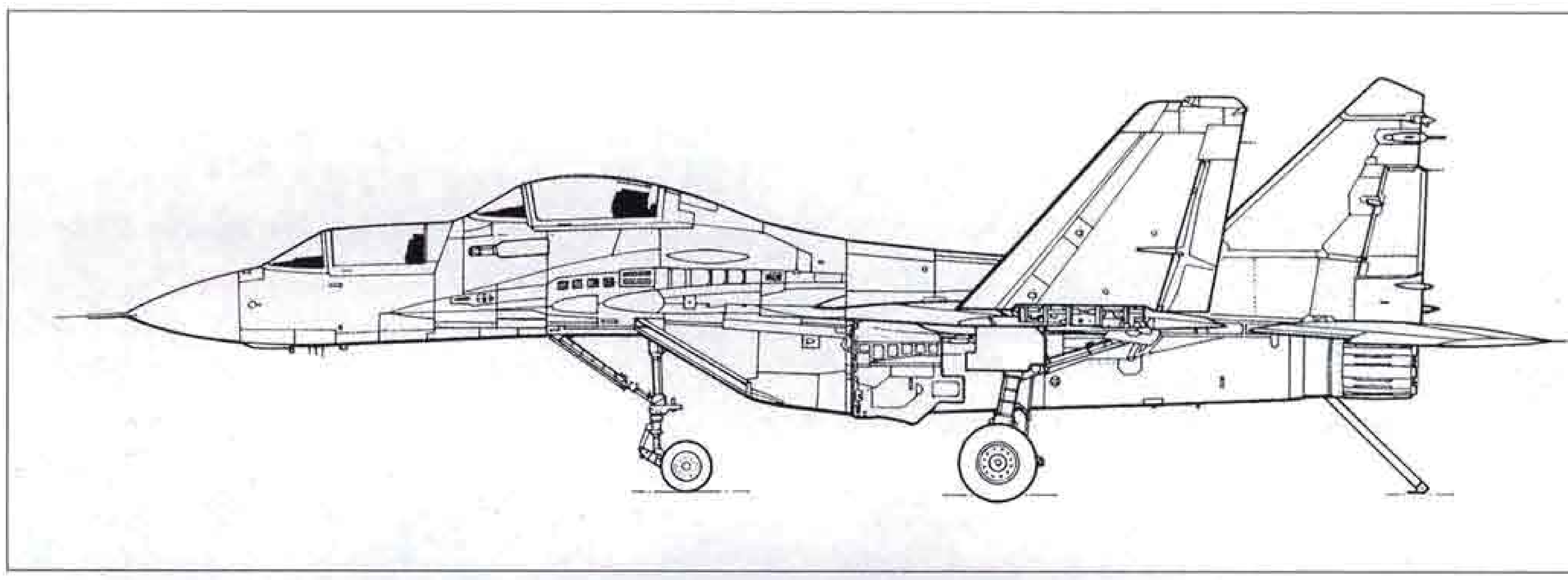
▲ A wind tunnel model of the projected MiG-29KU shipboard trainer, showing the stepped-tandem cockpits.



► A very provisional drawing of the MiG-29KU with wings folded. The fuselage contour does not match that of the model.

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► This large model of the MiG-29KU (appropriately marked '962 Yellow') is displayed in the RSK MiG company museum.

Robert J. Ruffle archive

► Draped in cloth, a wooden mock-up of the MiG-29KU's cockpit section lies in a hangar of the Air Force Academy in Monino.

Thus the *Fulcrum-D* never got the chance to complete its state acceptance trials. There was another reason for this – a rather absurd accident. In the 13th flight of the state acceptance trials programme GNIKI VVS test pilot V. M. Kandaoorov landed normally after a 1.5-hour sortie and inadvertently worked the landing gear control switch, selecting 'gear up'. Realising his mistake, he immediately selected 'gear down' – too late. The retraction jacks and hydraulic lines burst and aircraft sank down on its belly, suffering serious damage. While '311 Blue' was being repaired the carrier departed for Novorossiysk – and that was it. Finito.

The first prototype made a total of 313 flights, including 13 under the state acceptance trials programme. Between them Mikoyan and GNIKI VVS test pilots made 74 carrier landings and a number of aerial refuellings. After the accident described above '311 Blue' made another seven flights, bringing its total score to 320. The second prototype was grounded after only six flights. The uprated RD-33K engines behaved well throughout the trials programme. The state acceptance trials were suspended in early 1992.

The Sukhoi OKB had better luck with the Su-27K. This aircraft began its state acceptance trials earlier and managed to complete them successfully; in fact, the *Flanker-D* was selected as the prime contender for the carrier-based fighter after the trials commenced. True, the Su-27K suffered from payload restrictions because of its high gross weight; besides, the MiG-29K had a broader weapons range (in fact, some of its weapons remain classified as of this writing). However, the Sukhoi fighter had longer range, high agility, state-of-the-art avionics, ten hardpoints for assorted AAMs and ASMs and, most importantly, a higher thrust/weight ratio. Hence the Su-27K emerged as the winner, entering production in 1989 as the Su-33 and becoming the Soviet Union's (Russia's) first and only operational CTOL ship-board fighter.

As noted earlier, the MiG-29M was to supersede the *Fulcrum-A/C* on the production lines in the early 1990s. Plans also included the production of 27 MiG-29Ks between 1986 and 1995. However, Mikoyan's gamble on advanced weapons systems did not pay off. Defence spending cuts and the subsequent complete termination of state support for the programme prevented the MiG-29K from reaching maturity in time.

Besides, the collapse of the Soviet Union and lack of funding has caused construction of further aircraft carriers to be put on hold indefinitely. When the Black Sea Shipyard in Nikolayev became property of the newly-independent Ukraine in early 1992, construction of the 70% complete SNS *Varyag* was suspended and finally abandoned. SNS *Ul'yanovsk* laid down in November 1988 fared even worse – starting in February 1992 the 20% complete hull was gradually broken up. Given all this, continuing work on a second CTOL shipboard fighter was pointless: the carrier wing of Russia's so far only CTOL carrier, RNS *Admiral Kuznetsov*, could manage with the Su-27K (Su-33).

Still, while there's life there's hope. Early operational experience with the *Flanker-D* and the *Admiral Kuznetsov*'s first Mediterranean cruise in December 1995 – March 1996 made the Russian Navy give some serious thought to reviving the MiG-29K programme. According to Anatoliy A. Belosvet, former Deputy General Director of ANPK MiG, the time elapsed since the state acceptance trials has been sufficient to eliminate the fighter's main bugs which affected its mission avionics suite; now the company hopes to refine the MiG-29K to production standard.

The MiG-29K had its airshow debut on 13th February 1992 when the second prototype was demonstrated to top-ranking military officials and the leaders of the CIS states at Machoolishchi AB with two red star mission markers below the cockpit denoting arrester wire engagements. From 11th-16th August of that year '312 Blue' was demonstrated to the general public for the first time at MosAeroShow '92 in Zhukovskiy. The same aircraft was present again in the static park at the MAKS-93 and MAKS-95 airshows, displaying the newly-readopted St. Andrew flag (Russian Navy flag) instead of the earlier Soviet Navy flag and six mission markers.

In September 1996 '312 Blue' participated in the first hydro aviation show in Ghelendzhik on the Black Sea. Later the aircraft went to the 929th GLITs in Akhtoobinsk for use in the MiG-29M's WCS trials. Since the second prototype was unavailable for display purposes, the static park at MAKS-97 (19th-24th August 1997) featured the hastily polished-up first prototype proudly displaying its 50 mission markers and carrying Kh-31A and Kh-35 anti-shipping missiles. The same aircraft was displayed with a full ordnance load alongside the MiG-29SMT mock-up when the latter version was officially unveiled at Zhukovskiy on 29th November 1997.

Although the MiG-29K was not selected for service by the Russian Navy, the effort was not in vain. The MiG-29K programme was reborn in the 21st century, as described in Chapter 7, giving the two prototypes a new lease of life.

MiG-29KU (*Izdeliye* 9.62) Shipboard Trainer (Project)

Training shipboard aircraft crews, especially fighter pilots, is an extremely complex affair. Pilot error on take-off or landing almost inevitably ends in disaster. To facilitate conversion training the Mikoyan OKB developed a two-seat version of the *Fulcrum-D* designated MiG-29KU (*kora**bel'**nyy oo**cheb**nyy [samo**lyot**]* – shipboard trainer). Curiously, the manufacturer's designation was *izdeliye* 9.62 – that is, '*izdeliye* 9.31 times two' because this was a two-seater!

Experiments with the MiG-29UB quickly showed that the *Fulcrum-B* was no good for training naval pilots, as visibility from the rear seat was totally inadequate for carrier landings. Therefore, the MiG-29KU's forward fuselage was totally redesigned, featuring separate cockpits for the trainee and instructor in a stepped-tandem arrangement à la MiG-25PU/RU *Foxbat-C*. This arrangement afforded both crewmembers an excellent (and identical) field of view at high alpha. Like the single-seat MiG-29K, the MiG-29KU would be powered by uprated RD-33K engines and feature restyled air intakes, folding wings and arrester hook.

However, the project was terminated at an early stage when the MiG-29K programme was suspended. Only a full-scale mock-up of the new forward fuselage was built, and this currently survives as a teaching aid at the Air Force Academy named after Yuriy A. Gagarin in Monino.

MiG-29SMT (*Izdeliye* 9.17K) Shipboard Fighter (Project)

In late 1997 ANPK MiG proposed a navalised version of the MiG-29SMT to Russia's Ministry of Defence. The principal differences from the existing MiG-29K were increased range on internal fuel and a revamped cockpit with an EFIS identical to that of the MiG-29SMT. By February 1998 the project was still at the preliminary development stage.

If *izdeliye* 9.17K does not find its way aboard Russian Navy carriers, Mikoyan is considering offering the aircraft to the Indian Navy. Alternatively, the aircraft could be purchased by the air force (!) since the STOL capability, beefed-up landing gear and arrester hook could enable it to operate from short tactical airstrips equipped with ski jumps and arrester systems.

MiG-29K *Fulcrum-D* '312 Blue' (c/n 27579) in 1997 colours

MiG-29K *Fulcrum-D* '311 Blue' (c/n 27578) as originally flown

PART SIX

NEW LORDS, NEW UPGRADES

MiG-29SMT Multi-Role Fighter (*Izdeliye* 9.17, *Izdeliye* 9.17A)

Operational experience with the MiG-29 proved that it was indeed a high-performance combat aircraft with better manoeuvrability, speed, rate of climb and service ceiling than the best Western fighters in its class – the F-16, F/A-18 and Mirage 2000. Its range, on the other hand, was rather inadequate. Besides, the *Fulcrum*'s armament developed in the early 1980s no longer met the more stringent modern requirements. Due to Russia's economic troubles of the early 1990s the Russian Air Force was compelled to stop new hardware acquisition, giving up on the MiG-29M (*izdeliye* 9.15) which was much more advanced than the production *Fulcrum-A/C*. A mid-life update (MLU) of the existing aircraft was thus the only alternative.

By then Rostislav A. Belyakov had retired due to advanced age and had been succeeded as General Director and General Designer by Mikhail V. Korzhooyev. At the latter's initiative ANPK MiG launched a radical upgrade of the production MiG-29. The upgrade involved increasing the fighter's fuel capacity, integrating new types of weapons, installing a new fire control radar with ground mapping capability and introducing a modern 'glass cockpit'.

The upgrade work began in 1997. Known in-house as *izdeliye* 9.17, the new version was based on the 'fatback' MiG-29S (*izdeliye* 9.13S) and was to feature the upgraded N019MP Topaz multi-mode radar (the P stands for *poverkhnost'* – surface, a reference to the ground mapping capability) which had by then been tested on MiG-29 *Fulcrum-C* '04 Blue' (c/n unknown, f/n 0404). The aircraft also incorporated some features of the MiG-29M and some projects that never materialised or were still in the making.

At the initial design stage the *izdeliye* 9.17 introduced the following changes as compared to the baseline versions. The forward fuselage was new, featuring a raised cockpit offering better visibility and provisions for a retractable IFR probe. The air intakes and inlet ducts were borrowed straight from the MiG-29M, with downward-hinging FOD protection grilles replacing the earlier intake blocker doors; the auxiliary dorsal intakes were thus eliminated.

The fuselage spine was even fatter than on the *Fulcrum-C*, increasing the avionics bay volume by 500 litres (110 Imp gal). It terminated in a MiG-29M-style boattail fairing between the engine nozzles; the fairing housed the brake parachute container. The spine incorporated two strap-on fuel tanks totalling 1,650 litres (363 Imp gal). Additionally, the deletion of the auxiliary dorsal intakes created room for 930 litres (204.6 Imp gal) of extra fuel in the LERXes (in the No.1 tank).

A new MiG-29M-style dorsal airbrake was fitted, the twin actuating rams being attached between fuselage frames 8 and 9. The ventral airbrake was retained, albeit in modified form.

New wings were fitted; while having the same total area they incorporated four hardpoints each instead of three and the integral tanks held 390 litres (85.8 Imp gal) of additional fuel. The MiG-29SMT had new increased-area stabilators with a leading-edge dogtooth and broader-chord fin root sections, both of which were again borrowed straight from the MiG-29M.

The main landing gear struts and wheels were beefed up. The No.3A fuselage fuel tank was reinforced and its capacity enlarged by 200 litres (44 Imp gal). Additionally, the aircraft could carry larger 1,800-litre (396 Imp gal) drop tanks under the wings and had provisions for a MiG-29K style fully retractable IFR probe.

As already mentioned, the N019MP Topaz multi-mode radar could engage both aerial and ground targets. The air-to-ground capability was possible thanks to a synthetic aperture radar (SAR) mode allowing ground mapping with a 15-m (49-ft) resolution. ANPK MiG opted for upgrading the radar, as this was cheaper than fitting a new radar. The N019MP is a centimetre-waveband radar which is unaffected by fog, rain or snow, giving the aircraft true all-weather capability. By comparison, millimetre-waveband


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▶ **Mikhail V. Korzhooyev, who succeeded Rostislav A. Belyakov as General Designer, was the man behind the initial version of the MiG-29SMT upgrade.**

radars do not work well in these conditions because the waves are absorbed and dissipated by precipitation.

In ground mapping mode the radar turned the aircraft into a reconnaissance platform, allowing it to scan an area of land measuring 15 x 15 km (9.3 x 9.3 miles), 24 x 24 km (14.9 x 14.9 miles), 50 x 50 km (31 x 31 miles) or 77 x 77 km (47.8 x 47.8 miles), depending on the resolution. Radar imagery could be transmitted to GCI centres in real time via satellite, Il'yushin/Beriyev A-50 *Mainstay* AWACS aircraft or directly by data link. Yet, while the radar could detect such objects as bridges and vehicles, a more detailed view was often necessary for tactical reconnaissance. In that case a marker on the radar screen would be placed over an area of particular interest as commanded by ground control (or by the pilot, using a small joystick). The seeker heads of optically guided weapons, which have a higher resolution than the radar, are then aimed at the target and a 'bomb's eye view' is transmitted. Depending on the situation, the pilot or forward area controller can identify a high-priority target, which is then taken out immediately with a precision-guided munition.

The air-to-air weapons range included R-27R and R-27R1 semi-active radar homing medium-range AAMs, R-27T and R-27T1 infrared-homing medium-range AAMs, R-27ER and R-27ET extended-range AAMs, R-77 (RVV-AE) medium-range AAMs and R-73E IR-homing short-range AAMs. The R-77 had inertial mid-course guidance and active radar homing at the terminal guidance phase, which gave it ascendancy over its American counterpart, the AIM-120 AMRAAM. Together with the R-27ER/R-27ET featuring longer-burn rocket motors it gives a significant boost to the MiG-29's beyond visual range (BVR) engagement capability.

Air-to-surface weapons included the Zvezda Kh-31A (AS-17 *Krypton*) active radar homing anti-shipping missiles, Kh-31P passive radar homing missiles for use against enemy radars, Kh-29T and Kh-29TE (standard and increased-range) TV-guided missiles and KAB-500Kr TV-guided 'smart bombs'. Cannon pods with movable cannons were also planned.

The air-to-surface weapons could be aimed and fired automatically at known targets, using target data supplied to GCI centres by reconnaissance aircraft and then uploaded to the fighter via data link. This feature increased combat efficiency and survivability in low-level strike. Typically in low cloudbase conditions, aircraft with millimetre-waveband radars have to fly a low-level high-speed attack profile to use the radar and TV/laser-guided weapons. This leaves the pilot very little time for taking aim and complicates weapon targeting. Reducing the speed inevitably increases the danger of being shot down; also, many aircraft are unstable in fully-loaded condition at low speed, as proved by Chechen war experience. The new WCS allowed this situation to be avoided.

The cockpit featured an electronic flight instrumentation system (EFIS) with four rectangular multi-function displays (MFDs): two 130 x 180 mm (5.1 x 8.1 in) full-colour liquid crystal displays (LCDs) on the main instrument panel and two input/output units with 75 x 75 mm

Artur Sarkisyan

▲ **A mock-up of the MiG-29SMT's 'glass cockpit' as originally designed. The EFIS includes two large colour MFDs on the main instrument panel and two smaller input/output units on the side consoles. The electromechanical back-up artificial horizon is centrally located.**

Yefim Gordon

A full-scale mock-up of the MiG-29SMT converted from the non-flyable 'aircraft 925'. Its former identity is revealed by the tactical code ('25 Blue') and the narrow-chord rudders. The fuselage contour does not match the real MiG-29SMT. Kh-31P anti-radiation missiles and R-73 and R-77 AAMs are fitted to the pylons.

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The same mock-up at a later date; a semi-retractable IFR probe has been added. In this case four R-77s, a KAB-500Kr 'smart bomb' on the port inboard pylon and a KAB-500Kr-U acquisition round on the starboard inboard pylon have been fitted.

(2.95 x 2.95 in) monochrome LCDs on the side consoles. The LCDs had better backlight compensation than cathode-ray tubes. For safety's sake backup electromechanical instruments were retained in the centre of the panel.

An advanced control system utilising the HOTAS (hands on throttle and stick) concept was incorporated, allowing the pilot to select and fire the weapons without losing concentration on flying the aircraft. The avionics and weapons communicated via a MIL-STD-1553B digital databus, allowing Western avionics and weapons to be integrated at customer request.

Finally, a combined fly-by-wire/mechanical flight control system similar to that of the MiG-29M was incorporated. The overall effect of

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MiG-29 *Fulcrum-C* '331 Blue' (ex-'05 Blue', f/n 0405) shown here taxying at Zhukovskiy was the MiG-29SMT's 'glass cockpit' demonstrator. Later it received a MiG-29SMT-style bulged spine (see page 154).

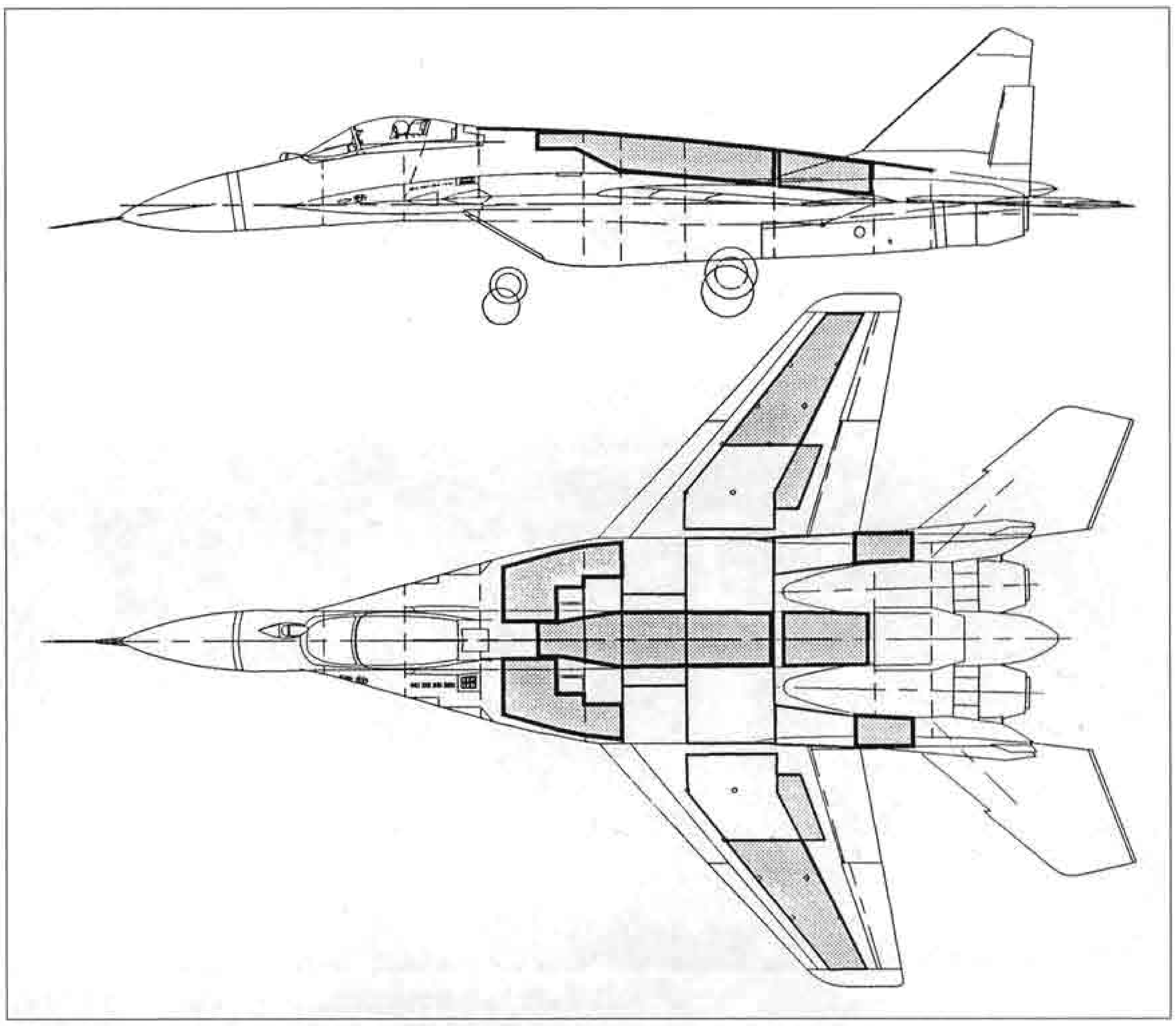
these measures was to increase the fighter's combat potential several times.

Izdeliye 9.17 received the official designation MiG-29SMT, the T denoting ***top****livo* (fuel) and referring to the increased fuel capacity. The designation was clearly patterned on the MiG-21SMT *Fishbed-K*, another 'fatback fighter'. As originally designed the internal fuel capacity and the fuel load were increased by 3,170 litres (697.4 Imp gal) and 2,490 kg (5,890 lb) respectively.

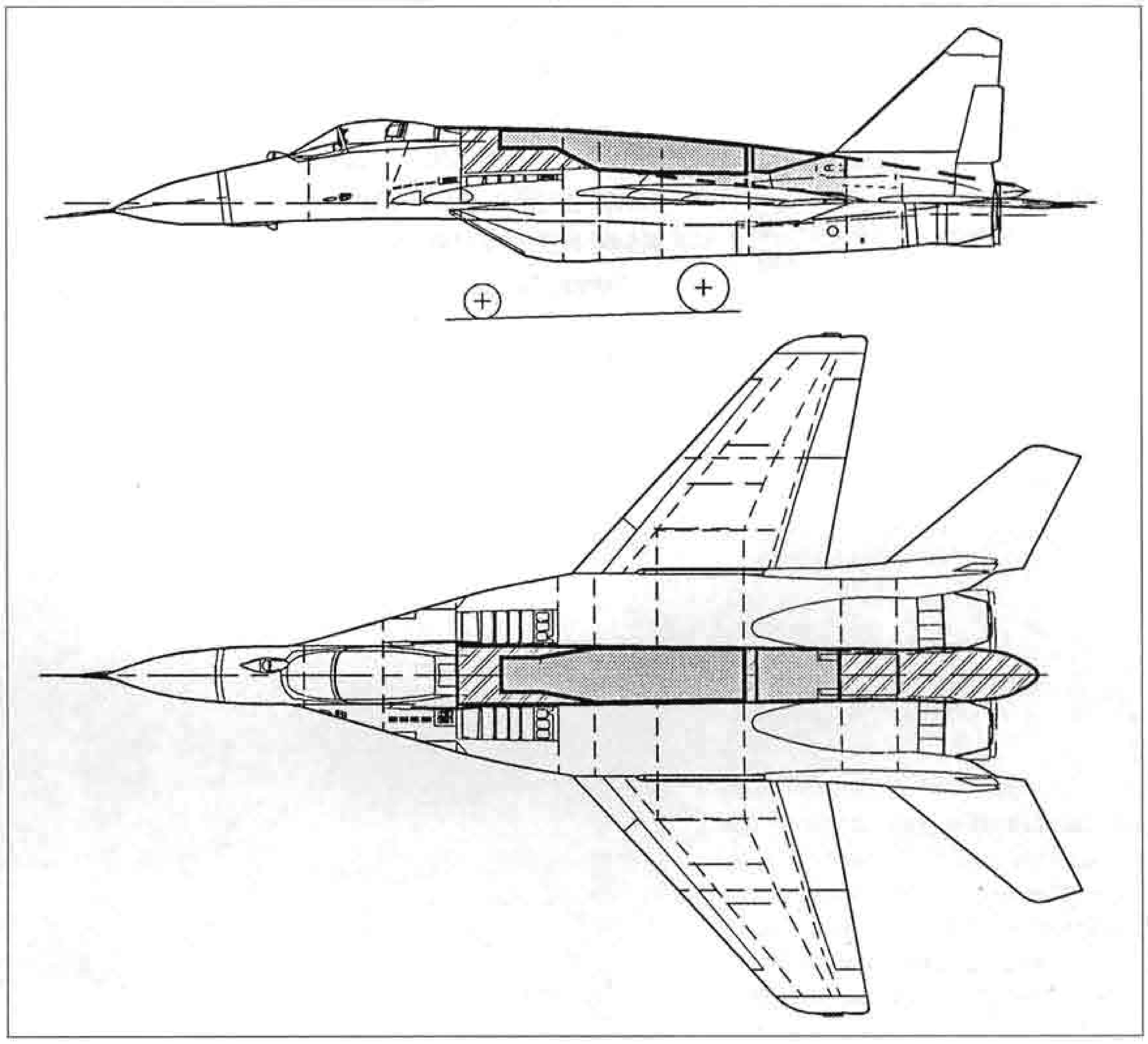
In the original project the MiG-29SMT's estimated normal take-off weight was 16,000 kg (35,270 lb) and the maximum TOW in overload condition was 21,000 kg (46,300 lb), including a 4,500-kg (9,920-lb) maximum ordnance load. Range on internal fuel was increased to 3,500 km (2,174 miles), or 6,700 km (4,161 miles) with a single in-flight refuelling. The top speed at high altitude was the same as for previous versions (2,450 km/h or 1,521 mph); so was the rate of climb (330 m/sec; 64,944 ft/min). The thrust/weight ratio was 1.04 on take-off and 1.5 in combat mode. Like the other *Fulcrums*, the MiG-29SMT was stressed for 9 Gs.

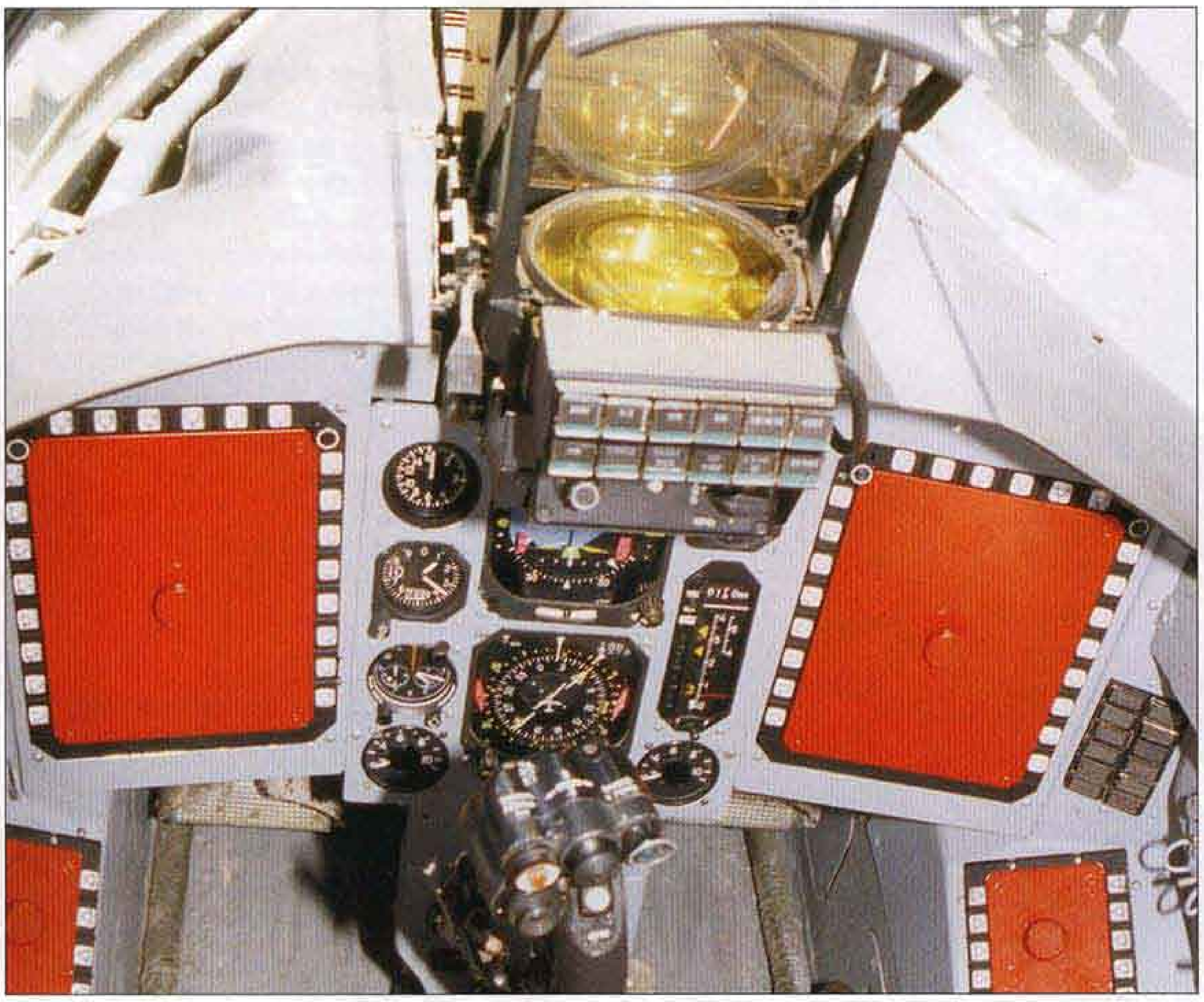
However, in late 1997 the Mikoyan engineers changed the project considerably – not least because the production plant which built the MiG-29 and was part of the MAPO MiG association objected to such a drastic redesign entailing major changes of technology. The main problem was that the complex redesign of the air intakes was not worth the effort, giving only a slight increase in fuel capacity. Also, it became clear that the fighter would be overweight and agility would go to the dogs. Therefore, Mikoyan engineers chose to retain the anti-FOD blocker doors and auxiliary intakes of the *Fulcrum-A/B/C*, adding only strap-on fuselage tanks to increase range. The wings and tail unit were likewise left unchanged. Thus, the enhanced combat potential was due solely to improved avionics and weapons.

The 'technical outlook' of the MiG-29/*izdeliye* 9.17 (a document of that name was authorised by chief project engineer Valeriy V. Novikov on 2nd December 1997) stated that the internal fuel capacity would be increased by only 1,880 litres (413.6 Imp gal) and the fuel load by 1,475 kg (3,250 lb). In accordance with the revised project the forward strap-on tank holding 1,400 litres (308 Imp gal) or 1,100 kg (2,425 lb) of fuel was located between fuselage frames 3B and 7 and shaped in such a way as to not obstruct the existing equipment bay access hatches. The aft strap-on tank holding 480 litres (105.6 Imp gal) or 375 kg (826 lb) of fuel was located between frames 7 and 8. The two tanks were removable to facilitate access to control system compo-nents and other equipment during maintenance. Appropriate changes were made to the fuel delivery, fuel tank pressurisation/venting, single-



▲
Schematic drawings of the preliminary (above) and final versions of *izdeliye* 9.17. The shaded areas are extra fuel tanks. Note the dogtooth stabilators on the original project version.
▼





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▲ The cockpit of the MiG-29SMT mock-up ('25 Blue'); the LCD screens are closed by protective covers.

point refuelling, inert gas pressurisation and fuel metering subsystems, and a fuel jettison sub-system was introduced. Once again the standard aft-mounted split airbrake fitting around the brake parachute container gave place to a MiG-29M-style arrangement with a dorsal airbrake (whose actuators were attached between frames 8-9) and a recontoured ventral airbrake. The aircraft featured twin brake parachutes and KT-209 mainwheels borrowed from the MiG-29M.

The 'new' MiG-29SMT retained the basic *Fulcrum-C*'s six underwing hardpoints and standard drop tanks. The weapons range would include two R-27R1/RE1 medium-range AAMs, two R-27T1/TE1 medium-range AAMs, up to six R-77 medium-range AAMs or R-73E short-range AAMs, two Kh-29T/TD AGMs, two Kh-31A anti-shipping missiles or Kh-31P anti-radiation missiles, up to four KAB-500Kr or KAB-500-OD guided bombs (the latter is a fuel/air bomb), B-8M1 rocket pods with 80-mm S-8 FFARs, and 240-mm S-24 heavy unguided rockets. The R-77 missiles were to be carried on AKU-170 or AKU-170E ejector racks, the various versions of the R-27 on AKU-470 ejector racks, the R-73 AAMs on P-72-1D launch rails, and the Kh-29 and Kh-31 missiles on AKU-58M ejector racks. The guided bombs were to be carried on BD3-UMK2B beam-type racks (also used for free-fall bombs of up to 500 kg/1,102 lb calibre, FFAR pods and heavy unguided rockets); alternatively, up to four MBD3-U4T tandem multiple ejector racks for two 500-kg bombs or four 250-kg bombs each could be fitted.

This version had a maximum TOW of 16,850 kg (37,150 lb), including a maximum ordnance load of 4,000 kg (8,820 lb). The upgrade was to give the MiG-29SMT a 2,100-km (1,304-mile) range on internal fuel with a normal weapons load, which is equal to the *Fulcrum-A*'s range with the centreline drop tank; this increased to 2,700 km (1,677 miles) with one drop tank and 3,300 km (2,049 miles) with three drop tanks. If an IFR probe was fitted, range became virtually unlimited.

This configuration of the MiG-29/*izdeliye* 9.17 with the strap-on dorsal tanks, updated radar with ground mapping capability and an upgraded cockpit would allow numerous operational *Fulcrums* to be upgraded fairly easily, resulting in a significant improvement of their capabilities. ANPK MiG was prepared to tailor the aircraft to the needs of potential customers. The designers believed the MiG-29SMT would be able to take on such advanced fighters as the Dassault Rafale,

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► The former *Fulcrum-C* '331 Blue' taxies at Zhukovskiy after conversion to the MiG-29SMT aerodynamics demonstrator (note the grossly bulged spine). The aircraft is now coded '405 Blue' to reflect its fuselage number (0405).

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◄ **This rear view shows that, despite the new fat spine, '405 Blue' retained the standard brake parachute container.**

Eurofighter EF2000 Typhoon and Boeing (McDonnell Douglas) F/A-18E/F Super Hornet which were scheduled to enter service at the beginning of the 21st century – and even outperform them in some respects.

The 'production-standard' upgraded aircraft were to be powered by improved RD-33 engines with a service life extended to 2,000 hours; such a figure had been unheard-of for Russian fighter engines until then. This placed the RD-33 among the world's best fighter engines, vastly improving its export potential; low engine life had been the chief source of criticism levelled at this engine by Western specialists.

A mock-up of the EFIS-equipped MiG-29 cockpit was displayed at the 42nd Paris Air Show at Le Bourget in June 1997. The complete aircraft was unveiled on 19th August 1997, the opening day of the MAKS-97 airshow, creating a minor sensation. However, this was in reality a mock-up of the original project configuration hastily converted from the long since retired last pre-production *izdeliye* 9.12, as evidenced by the tactical code '25 Blue' and the narrow-chord rudders. Surprisingly, the aircraft sported the c/n 25975 – probably applied as an afterthought, obviously bogus and intended to pass it off as a new-build aircraft. Oddly, this c/n was also painted on the first prototype *Fulcrum-C* ('04 Blue/404'), but it does not fit *that* aircraft either!

The mock-up was demonstrated to the Russian President Boris N. Yeltsin who visited the airshow on opening day amid stepped-up security measures (which, incidentally, created a traffic jam beyond description and general confusion). Yeltsin climbed into the cockpit, inspecting it thoroughly, and, after listening to the comments and arguments of the Mikoyan representatives, agreed that the mid-life update idea was a good one.

In order to verify the ideas and design features that had gone into the MiG-29SMT, ANPK MiG modified three fighters, two of which had been used earlier as development aircraft in

The first real prototype MiG-29SMT, '917 Blue', at ANPK MiG's flight test facility in Zhukovskiy. ▼

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▲ MiG-29SMT '917 Blue' in an early test flight. The fighter has no IFR probe as yet.

'917 Blue' retracts its landing gear as it commences another test mission. ▼

the MiG-29S programme. In the autumn of 1997 one of the *Fulcrum-Cs* previously operated by the 929th GLITs (formerly GNIKI VVS) in Akhtoobinsk as a weapons testbed – '05 Blue' (c/n 2960505533, f/n 0405), the original second prototype *izdeliye* 9.13 – was modified for trials under the MiG-29SMT programme. The conversion concerned only the cockpit, which was equipped with an EFIS to MiG-29SMT standard to improve flight and target data presentation.

Recoded '331 Blue' and sporting ten red 'kill' stars on the port side of the nose to mark successful missile launches, the aircraft was to make its first post-conversion flight at Zhukovskiy on 27th November. However, inclement weather intervened, delaying the flight until 29th November. The IA PVO C-in-C, the Deputy Minister of Defence (Armament) and numerous TV crews and aviation journalists were there to witness the eight-minute first flight performed by Test Pilot 1st Class Marat R. Alykov, one of ANPK MiG's youngest test pilots. The aforementioned mock-up was displayed again for the occasion.

In early 1998 the aircraft underwent further modifications at the company's experimental plant in Moscow, being fitted with the strap-on fuel tanks and receiving the appropriate strongly convex spine and dorsal airbrake. The 'beaver tail' was not fitted, though, and the standard brake parachute container stuck out brazenly. On 22nd April the MiG-29SMT was unveiled again to aviation dignitaries and the aviation

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▲ **The MiG-29SMT prototype with a load of Kh-31, R-73 and R-77 missiles.**

press at Mikoyan's flight test facility in Zhukovskiy. This time it was the real thing, and it was a lot different from the mock-up presented in 1997. Now wearing the appropriate code '405 Blue' to reflect its fuselage number (0405), the prototype was flown by Vladimir M. Gorboonov, Hero of Russia, who had succeeded Roman P. Taskayev as Mikoyan's CTP in the autumn of 1997. Still, this was little more than an avionics and aerodynamics testbed for the *izdeliye* 9.17, as the two additional strap-on fuel tanks in the recontoured spine were non-functional! '405 Blue' was intended for stability and handling trials and testing the upgraded avionics suite.

In May 1998 the MiG-29SMT demonstrator ('405 Blue') was displayed statically at the ILA'98 airshow at Berlin-Schönefeld with a Thomson-CSF CLDP laser designator pod suspended under the fuselage. A non-functional semi-retractable IFR probe similar to that of the Royal Malaysian Air Force's MiG-29Ns was fitted to the port side of the nose to demonstrate the type's unlimited upgrade capabilities.

As already mentioned, MiG-29 '04 Blue' (f/n 0404) had been in use as an avionics testbed for the N019MP radar since September 1997. Unlike thee earlier N019M, this radar made it possible to detect maritime targets and attack them with radar-homing missiles, or use unguided weapons against ground targets, in any weather and any time of day or night. This upgrade of the RLPK-29 radar targeting system undertaken jointly with

One more view of MiG-29SMT '917 Blue' at Zhukovskiy. Note that the APU air intake is located laterally because of the bulged spine. ▼

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NIIP involved replacing the Ts100 series processors with MVK and ***Baghet*** (Picture frame) series processors. The Baghet, which served as a signals processor, deserves special mention, since it had been originally created with combat vehicles (particularly tanks) in mind, not aircraft. Nevertheless, NIIP designers decided that the processor's performance was adequate for use as a component of the upgraded N019MP radar. Accordingly a stock processor designed for installation in a tank made 15 successful flights in the MiG-29; the unit functioned reliably at altitudes up to 5,000 m (16,400 ft), putting the sceptics to shame and disproving the popular saying 'once a reptile, always a reptile'. A specialised aircraft version of the Baghet processor was created in due course for the N019MP.

The third aircraft used in the tests was a late-production *Fulcrum-A* (c/n 2960535400, f/n 4710) set aside by Mikoyan for conversion in late 1997. Originally the aircraft carried only a single 500-litre (110 Imp gal) strap-on tank for fuel system and aerodynamics testing, which gave a range increase of only 180 km (111 miles); in this guise it entered flight test on 28th November 1997. In March 1998 the aircraft was turned over to Mikoyan's experimental shop for complete conversion to *izdeliye* 9.17 standard, becoming the first 'true' MiG-29SMT prototype meeting the project specifications completely (including the 'beaver tail' rear fairing).

Aptly coded '917 Blue' to match the manufacturer's designation, the aircraft took to the air on 14th July 1998 with Vladimir Gorboonov at the controls. The first flight lasted more than an hour, providing some indication of the fighter's capabilities.

Throughout August 1998 Marat Alykov practised his flying display for the Farnborough International '98 airshow. On 2nd September '917 Blue' took off from Zhukovskiy with three drop tanks, bound for Tver'. The following day the fighter arrived at Farnborough after a non-stop flight; the stopover at Tver'-Migalovo was necessary because headwinds are less likely on the Tver'-Farnborough route, helping to save fuel. The MiG-29SMT's flying display at FI'98 showed that the fatter spine had virtually no adverse effect on the fighter's manoeuvrability. In late November the MiG-29SMT was displayed at Airshow China '98 at Zhuhai-Sanzao, since China had expressed an interest in the aircraft.

The test programme was completed in late 1998, whereupon Mikoyan's experimental shop received the first operational MiG-29 earmarked for upgrading to *izdeliye* 9.17 standard ('12 Blue', ex-'01 Red', c/n 2960520165); this aircraft belonged to the Russian Air Force's 4th TsBP i PLS in Lipetsk. Repainted in a new camouflage scheme and recoded '01 Blue', the aircraft was completed on 29th December 1998 and delivered to Zhukovskiy. The first flight took place in January 1999. On 12th January MiG-29SMT '01 Blue' was demonstrated to top-ranking Russian officials, foreign military attachés and the press at Zhukovskiy along with other new Mikoyan products. Guests at the ceremony included Army General Igor' Sergeyev (the then Defence Minister), Col. Gen. Anatoliy Kornookov (Air Force/Air Defence Force C-in-C), Lt. Gen. Yuriy Klishin (Deputy C-in-C) and Yevgeniy Shaposhnikov (Presidential advisor on aviation matters).

The avionics suite of the *izdeliye* 9.17 flying prototypes was built around a triplex digital data processing system which utilised a so-called open architecture based on multiplex data exchange channels. The system included the following:

- an upgraded radar targeting system based on the N019MP fire control radar with ground mapping capability;
- an optoelectronic targeting system comprising the IRST/LR unit and a helmet-mounted sight;
- a navigation suite;
- a new ECM-resistant communications and guidance suite comprising two R-833 radio sets, secure data link channels and a command link channel;
- an ECM suite;
- a Karat-B data storage suite including a compact video monitoring system recording the tactical situation and the pilot's actions;
- a Regata built-in test/usage monitoring system;
- a weapons selector system and other equipment.

The cockpit data presentation and control system included two full-colour MFDs rimmed

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▲ **MiG-29SMT '917 Blue' in the static park of the MAKS-2001 airshow, demonstrating its new semi-retractable IFR probe and the logos of the programme participants.**

◄ **MiG-29SMT '917 Blue' is displayed with some of the weapons it can carry. Front row: four R-73s and two R-27ETs plus the GSh-301 internal cannon; second row: Kh-25ML laser-guided ASMs, KAB-500L laser-guided bombs, Kh-31A/P ASMs and 1,150- and 1,500-litre drop tanks.**

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▲ MiG-29 *Fulcrum-A* '12 Blue' (c/n 2960520165) in the process of conversion to a MiG-29SMT at ANPK MiG's experimental shop in Moscow. Note the IFR probe.

► The finished aircraft has been dismantled and is being loaded into a special 'spyproof' trailer for delivery to the Zhukovskiy flight test facility. The shape of the rear fairing is clearly visible. Note the hydraulic rams actuating the trailer sides/roof which close around the aircraft, making the trailer look like any ordinary 'big rig'.

Now coded '01 Blue', the same aircraft rests on jacks for landing gear operation checks. ▼

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with function keys, a head-up display, a multi-function control/display unit with a monochrome LCD screen, back-up instruments and HOTAS controls with buttons on the stick and throttles. As compared to the standard MiG-29 the number of instruments, caution/warning lights and control switches/levers was reduced by 50% (from 30 to 16), 60% (from 82 to 34) and 40% (from 193 to 136) respectively.

As compared to the MiG-29SM the list of compatible weapons was augmented by the Kh-31P anti-radiation missile and the Kh-31A anti-shipping missile (two Kh-31As or 'Ps could be carried). Otherwise the MiG-29SMT's armament was identical to that of the MiG-29SM.

The internal fuel capacity rose by more than 40%, the extra fuel being accommodated in strap-on tanks in the grossly bulged spine running the full length of the centre/rear fuselage. Range and endurance could be further increased by fitting three drop tanks and a detachable semi-retractable IFR probe as tested on MiG-29 '357 Blue' (c/n 2960536034, f/n 4808).

In addition to the pilots who flew the first version of *izdeliye* 9.17, Mikoyan engineers A. V. Yefimov, V. P. Loginov, A. D. Ovechkin, I. F. Monakhov, V. V. Il'yin and S. P. Belyasnik made a major contribution at this stage, as did the specialists of the Roosskaya Avionika (Russian Avionics) company.

In the years when Mikhail V. Korzhooyev was at the helm, ANPK MiG developed a further upgrade of the MiG-29SMT (the so-called Stage 2). This was a long-term modernisation programme for the entire *Fulcrum* family intended to maintain the MiG-29's combat efficiency and operational reliability for another 10-20 years, making the fighter capable of opposing fifth-generation fighters which would appear by then. Stage 2 centred on the following issues:

• increasing the aircraft's range by further increasing the internal fuel capacity in the fuselage and wings;

• enhancing the fighter's agility by introducing a triplex digital FBW control system including engine thrust vector control (TVC);

• improving the powerplant by fitting a thrust-vectoring version of the RD-33 engines, with provisions for installing more powerful new-generation engines later on;

• integrating a new-generation mission avionics suite – first and foremost an all-new and much more capable ***Zhem****chug* (Pearl) multi-mode phased-array radar developed by NIIP, with a detection range of 130 km (80.75 miles) and 180° scanning in azimuth. The radar will

make use of new-generation electronic components and be capable of tracking ten targets at a time while guiding missiles to four priority threats. Additionally, a new podded optoelectronic targeting system with laser, TV and infrared channels will be fitted, as will an inertial navigation system making use of ring laser gyros and satellite correction (a global positioning system module working with GLONASS and NAVSTAR satellites);

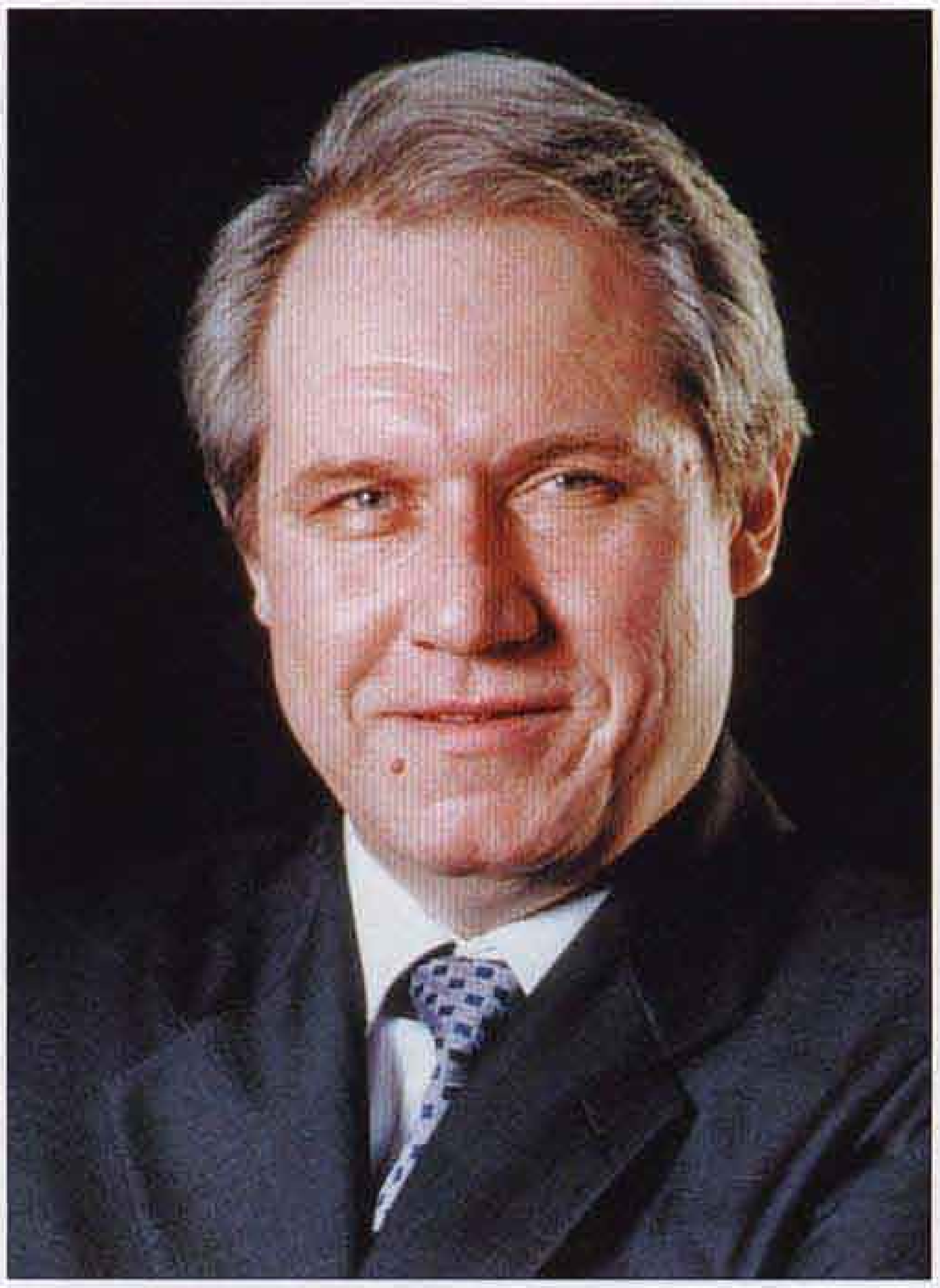
• increasing the chances of survival in actual combat by integrating an advanced ECM/ESM suite and utilising radar-absorbing coatings to give a measure of stealth;

• integrating highly efficient new-generation weapons and increasing the maximum ordnance load to 5,500 kg (12,125 lb);

• extending the MiG-29's designated service life and TBO. Measures have already been taken to increase the airframe's service life from 2,500

▲
Front view of MiG-29SMT '01 Blue' with the IFR probe extended.

This rear view of the same aircraft shows clearly the bulged spine and the tail fairing; the dorsal airbrake is barely discernible.
▼



Nikolay F. Nikitin succeeded Korzhooyev as head of ANPK MiG, which then changed its name to RSK MiG. After that the MiG-29SMT underwent significant changes, receiving a different 'glass cockpit'.

to 4,000 hours, which allows the aircraft to remain operational until 2010-2015. Similar measures have been implemented on the RD-33 Srs 3 engine whose time until the first overhaul is increased to 1,000 hours and the designated service life to 2,000 hours;

• easing maintenance by switching from rigidly set overhaul intervals to operation on a 'technical condition' basis with maintenance checks every 1,000 hours of total time.

The Russian Air Force intended to upgrade at least 10-15 *Fulcrums* to MiG-29SMT (*izdeliye* 9.17) standard at the military aircraft repair plants, using the first 'production' example ('01 Blue'), which was undergoing trials at the 929th GLITs, as a pattern aircraft. However, yet another sudden change of management at ANPK MiG foiled these plans. When Nikolay F. Nikitin was appointed the company's new General Director and General Designer, the development of the MiG-29SMT took a completely new turn.

This situation calls for some explanation. Before becoming the company boss at ANPK MiG, Nikitin had worked for Mikoyan's arch-rival, the Sukhoi OKB, as chief designer of the Su-27M (Su-35) but had been forced to quit because of an irreconcilable conflict with the company's General Designer Mikhail P. Simonov. After that, Nikitin was out of business for a while but then, in the late 1990s, he became involved in a scheme to unseat Mikhail Korzhooyev, the head of ANPK MiG (rumour has it that Nikitin was, in fact, the chief conspirator). Nikitin was opposed to using the products of Roosskaya Avionika, a private enterprise, for upgrading the Russian Air Force's operational fighters and held the opinion that only enterprises where the state was the main stockholder should be allowed to act as subcontractor for such upgrades. He managed to win the support of several top-ranking officials in the Russian government and possibly the MoD as well. As a result of this lobbying, the government fired Korzhooyev, appointing Nikitin as his successor. Eat or be eaten, so it goes. Concurrently Vladimir I. Barkovskiy, another former Sukhoi OKB employee, who enjoyed a

Three-quarters rear view of MiG-29SMT '01 Blue'. The number '172' on the fin caps stands for '*izdeliye* 9.17 No.2'.

well-earned good reputation in the Russian aircraft industry, was appointed head of the Mikoyan OKB which was one of the elements of what was now known as the MiG Russian Aircraft Corporation (RSK MiG).

As the saying goes, new lords, new laws. When Nikolay F. Nikitin started enforcing his 'new order', several prominent designers quit in protest, being at odds with the company head over several key issues, including the upgrading of operational MiG-29s. These included former MiG-29 chief designer Valeriy Novikov and former MiG-31 chief designer E. K. Kostroobskiy. The office of MiG-29 chief designer was taken over by Arkadiy B. Slobodskoy, a highly experienced designer who had participated in

Victor Drushlyakov

▲
Another operational *Fulcrum-A*, '51 White' (c/n 2960518051), being converted to a MiG-29SMT (*izdeliye* 9.17A) at the Russian Air Force's ARZ No.121.

Sergey Balakleyev

◄
This view shows the strap-on tanks, IFR probe and the new dorsal airbrake already in place. Note the sheet of paper with the aircraft's identity taped to the nose.

Another view of the unfinished MiG-29SMT '51 White'. The work stopped half-way through and the aircraft has been sitting at ARZ No.121 ever since.
▼

Victor Drushlyakov

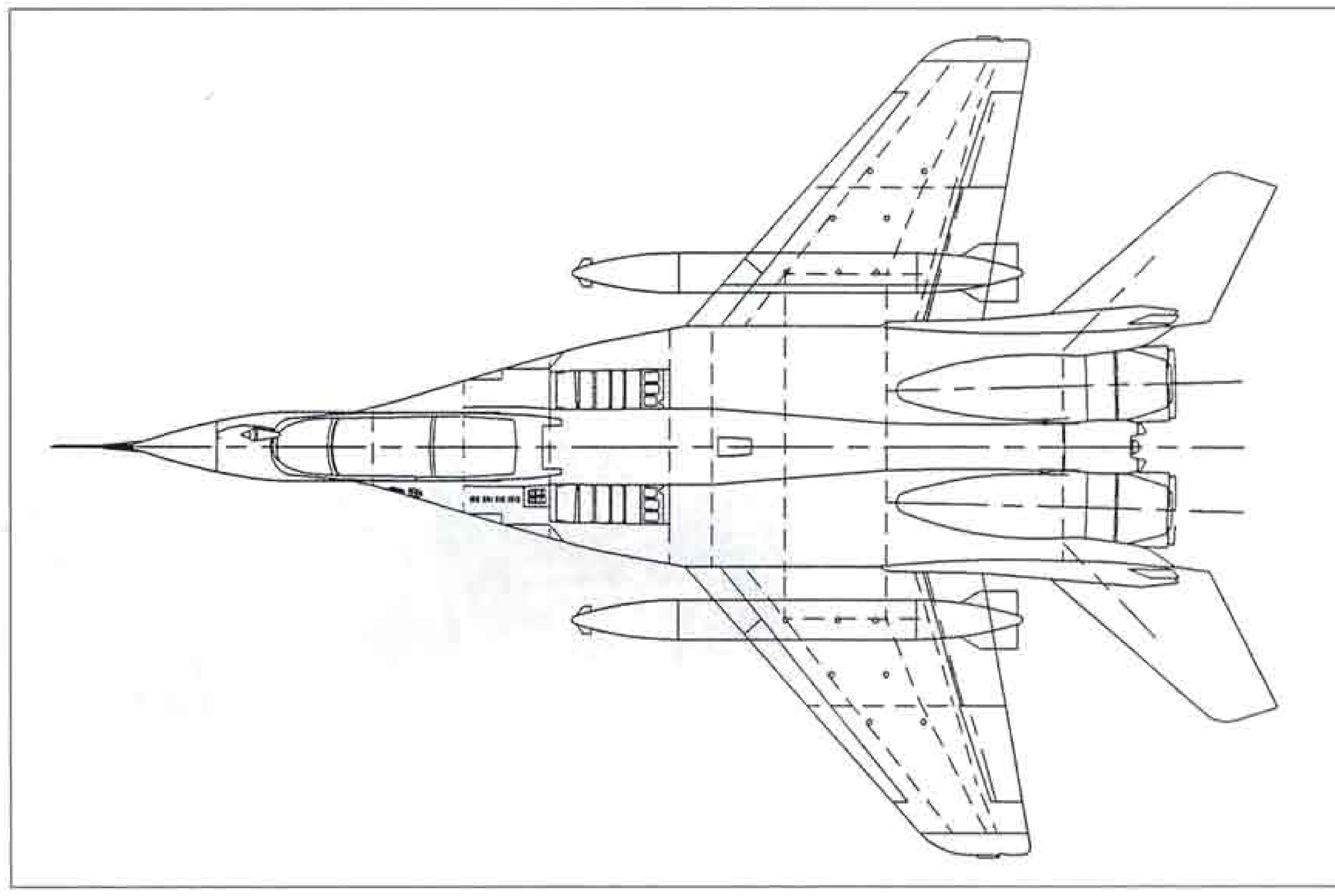
Yefim Gordon

Yefim Gordon

Yefim Gordon

the *Fulcrum's* test programme from the outset. Before this new appointment he had been responsible for product support of the German MiG-29s.

Nikitin, who (as already mentioned) was dead set against Roosskaya Avionika, put the proverbial new broom to good use. At his insistence the *izdeliye* 9.17 project documents were reviewed and the equipment supplied by the undesirable private company was eliminated. Instead, RSK MiG took the MiG-29M and its avionics suite as a model; the suite used components supplied by the Ramenskoye Instrument Design Bureau (RPKB), except for the Zhuk radar which was a Phazotron product. RPKB was a state-owned company with a wealth of experience in designing weapons control systems for fighters; also, the same company was responsible for the mission avionics of the Su-27M fighter (later redesignated Su-35) which, as we know, was Nikitin's brainchild and which was undergoing trials almost concurrently with the MiG-29M. This pretty much explains why RPKB was selected as the new avionics contractor for the MiG-29SMT. In its new guise the aircraft was known as the *izdeliye* 9.17A.



The new version of the MiG-29SMT was intended to feature the updated Zhuk-M radar. Also, the agility and handling of the heavier, hunchbacked *izdeliye* 9.17 left something to be desired, which led the designers to consider eliminating the 'excessively large' dorsal fuel tank altogether, or at least reducing its capacity somewhat.

▲ **A schematic drawing of the MiG-29UBT (the shape of the spine is incorrect).**

'304 Blue', the first prototype MiG-29UBT, with bulged spine and precision-guided munitions. ◄▼

Yefim Gordon


Yefim Gordon

▶ **The second prototype MiG-29UBT at RSK MiG's flight test facility. Note the slightly larger radome and the IFR probe. The tactical code '52 Blue' refers to the in-house designation *izdeliye* 9.52; this is *not* a conversion of the second prototype MiG-29UB (see page 66).**

Soon enough the MiG-29SMT prototype ('917 Blue') had been modified in line with the new ideas. This did not lead to any external changes at the moment – the large, smoothly curving fuselage spine and the relocated airbrakes were retained. This was logical enough, as altering the airframe was not required for demonstrating the 're-upgraded' fighter's new avionics suite.

After more changes to the equipment the 'nikitinised' MiG-29SMT (*izdeliye* 9.17A) made its public debut at the ILA-2001 airshow. Meanwhile, Nikitin tried his best to convince the Russian Air Force top brass that 'his' upgrade was ripe for service and that several more MiG-29s should be modified in this fashion for Air Force evaluation. Even as the first 'production' machine ('01 Blue') was undergoing trials in Akhtoobinsk, the Air Force sent a further *Fulcrum-A* ('51 White', c/n 2960518051) to its aircraft repair factory (ARZ) No.121 at Kubinka AB for conversion. However, when the conversion was well advanced (the large strap-on fuel tanks, new airbrakes and IFR probe were already in place), the funding dried up and the work stopped. Moreover, Nikitin, too, was removed from office and his upgrade project fell victim to yet another change of design ideology concerning the MiG-29SMT. This designation was then reassigned to a new aircraft known as *izdeliye* 9.18 which is dealt with in Chapter 7.

MiG-29SMTK Shipboard Fighter (*Izdeliye* 9.17K) (Technical Proposal)

In late 1997 ANPK MiG proposed navalising the MiG-29SMT (*izdeliye* 9.17) in its initial form. The resulting cross-breed between the extended-range MiG-29SMT the and the MiG-29K received the designation MiG-29SMTK (*izdeliye* 9.17K). The idea was not pursued further.

MiG-29UBT Combat Trainer (*Izdeliye* 9.51T, *Izdeliye* 9.52)

After the advent of the MiG-29SMT it appeared logical that the MiG-29UB combat trainer should receive a similar upgrade. In the summer of 1998 ANPK MiG's experimental shop began converting a MiG-29UB into the prototype MiG-29UBT (known in-house as *izdeliye* 9.51T); once again, the T stood for ***toplivo*** – [extra] fuel. The aircraft in question was the well-known MiG-29UB demonstrator, '304 Blue' (c/n 4029692486), which participated in many airshows. (Some sources, though claim it is a different MiG-29UB with the c/n N50903008134.)

The principal changes introduced on the MiG-29UBT were as follows:

• two strap-on dorsal fuel tanks were added aft of the rear cockpit, greatly increasing range;

• an electronic flight instrumentation system and a new data processing system were installed;

• provisions were made for installing a Pazotron ***Osa*** (Wasp) compact multi-mode radar, as well as for the integration of R-77 (RVV-AE) medium-range AAMs, a wide range of air-to-surface missiles (such as the TV-guided Kh-29T and Kh-59) and guided bombs, and enabling concerted action by a group of aircraft involving tactical information exchange;

• the number of external stores hardpoints was increased from six to eight.

Again, the increased fuel tankage resulted in a bulged fuselage spine, although the standard aft-mounted split airbrake and brake parachute container were retained. The shape of the two-seater's canopy resulted in a slight kink in the MiG-29UBT's upper fuselage contour just aft of the cockpits.

The flight and mission avionics were virtually 100% new. In addition to the Osa centimetre-waveband pulse-Doppler radar in the nose, provisions were made for carrying a podded millimetre-waveband navigation/attack radar optimised for use against ground targets. The front cockpit was virtually identical to the MiG-29SMT's, with two 6 x 8" full-colour liquid-crystal MFDs on the main instrument panel, while the rear cockpit featured three such MFDs.

The upgraded WCS enabled the MiG-29UBT to fire R-27T AAMs in addition to the familiar R-73s. The air-to-surface weapons included Kh-31P anti-radiation missiles, Kh-29T TV-guided AGMs, Kh-25ML laser-guided AGMs and KAB-500L laser-guided bombs.

The conversion was completed in late May 1998 and the 'fatback' trainer entered flight test on 25th August at the hands of Oleg Antonovich (front seat) and Vladimir M. Gorboonov. The first prototype lacked the intended radar. On 3rd September 1998, after only five test flights, the aircraft arrived at Farnborough in company with MiG-29SMT '917 Blue' to participate in the FI'98 airshow.

Working in close cooperation with the 'Sokol' Nizhniy Novgorod aircraft factory, RSK MiG completed the second prototype MiG-29UBT ('52 Blue', c/n N50903025982) in the spring of 1999. Unlike the first prototype, this machine was equipped not only with the Osa-2 X-band phased-array air-to-air/air-to-ground radar but also with a semi-retractable IFR probe identical to that of the MiG-29SMT. The radar was enclosed by a much-enlarged radome which, on this particular aircraft, did not blend too well into the nose contour. Also, the aircraft featured the redesigned airbrakes and 'beaver tail' fairing of the *izdeliye* 9.17. In this guise the MiG-29UBT received a new manufacturer's designation, *izdeliye* 9.52, which explains the tactical code of the second prototype (the aircraft was also marked '952 White' on the dielectric fin caps).

Yefim Gordon

◄ **MiG-29UBT '52 Blue/952' takes off from runway 12 at Zhukovskiy with two inert R-73s under the wings.**

The second prototype comes back after a test flight, landing on runway 30. The fuselage contour and the new tail fairing are clearly visible. ▼

Yefim Gordon

Victor Drushlyakov

▲ **The second prototype MiG-29UBT equipped with a drop tank and carrying a Kh-29T AGM. Note the Russian flags on the rudders.**

MiG-29UBT '52 Blue' made its first flight on 24th May 1999, making its world debut in the new configuration at the 43rd Paris Air Show in June. On 17th-22nd August the aircraft participated in the MAKS-99 airshow in Zhukovskiy where it was shown both statically (the radome was removed at least once to expose the radar array) and in flight. A further-upgraded aircraft, with four-pylon wings, IFR probe and Osa-2 radar had reportedly joined the programme by 2000, and in 2002 two more MiG-29UBs were being upgraded by MAPO and NAZ Sokol to MiG-29UBT standard.

The upgrade, which was a private venture funded by RSK MiG, increased the *Fulcrum-B*'s combat potential by a factor of 6.5 in counter-air mode and 8 in strike mode. Importantly, the cost of upgrading a MiG-29UB to MiG-29UBT standard was only 30% of the flyaway price of a new aircraft. The trainer became a true multi-role fighter with potential for replacing the Sukhoi Su-24 *Fencer* tactical bomber or for 'pathfinder' use and suppression of enemy air defences (SEAD); the back-seater is a weapons systems operator (WSO) and a rated pilot who can take control if the captain is incapacitated.

The Russian Air Force was expected to order some 20 MiG-29UBT conversions and up to 120 more could be upgraded for foreign customers. For export the MiG-29UBT can be fitted with Western avionics, including a Thomson-CSF (now Thales) RC 400 radar in the nose. Additionally, a missile launch and trajectory control system, with antennas buried in the wing roots, could be fitted.

The Weapons Options of the MiG-29UB and the MiG-29UBT

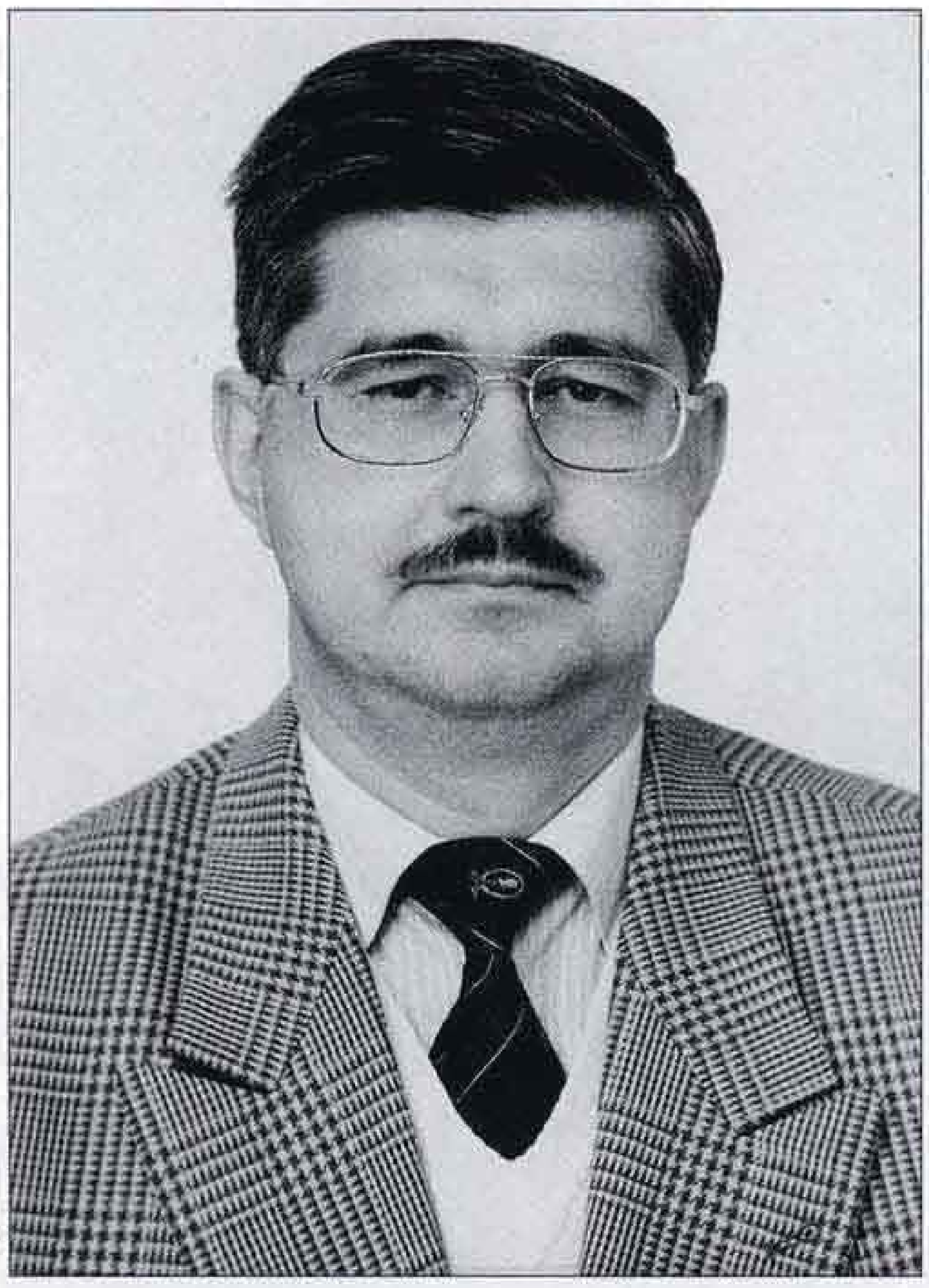
	MiG-29UB	MiG-29UBT
Short-range AAMs	6 x R-60 or R-73	8 x R-60M or R-73M
Medium-range AAMs	–	6 x R-77 (+ 2 x R-73)
		2 x R-37ER/ET/EP (+ 6 x R-73)
		4 x R-37ER/ET/EP (+ 4 x R-73)
Air-to-surface missiles	–	2 x Kh-29T/TD/L *
		2 x Kh-31A/P
		2 x Kh-35
		2 x Kh-59/Kh-59M
		4 x Kh-25ML * (+ 4 x R-73)
Unguided rockets:		
FFARs	80 x S-8 †	–
heavy unguided rockets	4 x S-24B	4 x S-24B
Submunitions dispensers	4 x KMGU-2	4 x KMGU-2
Bombs	4 x FAB-500 (FAB-250)	8 x FAB-500 (FAB-250)
		4 x KAB-500Kr/KAB-500L
		4 x RBK-500 cluster bombs
		4 x ZB-500 napalm tanks
Drop tanks	2 underwing + 1 centreline	2 underwing + 1 centreline
Cannon	GSh-301 with 200 rounds	GSh-301 with 200 rounds

* In conjunction with a target designator pod; † In four B-8M1 pods

PART SEVEN

THE 21st CENTURY GENERATION

Vladimir I. Barkovskiy, Director of RSK MiG's Engineering Centre. The current MiG-29SMT was developed under his guidance.



RSK MiG

The MiG-29's development continued in the 21st century, and this chapter deals with the fighter's latest versions.

MiG-29SMT (MiG-29SMT2) Single-Seat Multi-Role Fighter (*Izdeliye* 9.18)

Currently RSK MiG is pursuing a number of MiG-29 upgrade programmes to meet orders from the Russian MoD and several foreign customers. These include the MiG-29SMT multi-role fighter. The designation may sound a bit misleading, as several upgraded MiG-29s had been tested in the 1990s under the MiG-29SMT designation. These aircraft were known in-house as *izdeliye* 9.17 and, interestingly, the avionics fit had changed with each successive change of the company leader. The original version of *izdeliye* 9.17 had been outfitted by the Roosskaya Avionika company whose boss Mikhail Korzhooyev also headed ANPK MiG at the time. When Nikolay F. Nikitin took over as General Director of ANPK MiG, the MiG-29SMT received a new avionics suite based on that of the MiG-29M (*izdeliye* 9.15) fighter prototypes.

In contrast, the aircraft described here could be called the 'second-generation' MiG-29SMT (hence it is sometimes referred to as the MiG-29SMT2). Its flight and mission avionics (WCS) have substantial commonality with the latest versions of the *Fulcrum* now under development – the revamped MiG-29K/MiG-29KUB and the 're-upgraded' MiG-29M/MiG-29M2, which are described separately.

In accordance with the design ideology of the 'new' MiG-29SMT (aka *izdeliye* 9.18) the fighter's technical outlook is determined by the customer in accordance with his requirements – and his wallet. In other words, *izdeliye* 9.18 has no 'standard' version and is tailored to the needs of each specific customer by combining three basic upgrade packages as required.

The first basic package comprises an upgrade of the WCS which turns the air superiority fighter into a multi-role combat aircraft. The MiG-29SMT (*izdeliye* 9.18) features a Zhuk-ME radar developed by Phazotron-NIIR specially for new versions of the *Fulcrum*. This is a pulse-Doppler radar with a mechanically scanned slotted array intended for medium and heavy fighters; the Zhuk-ME has passed a complete cycle of ground and flight tests (the latter were performed on modified MiG-29s), meeting its performance target in full. The radar can operate in ground attack, mapping, weather (storm warning) and terrain following modes. As compared to the N019 fitted to production *Fulcrums*, the Zhuk-ME offers 50% greater aerial target detection range and the ability to attack two priority threats at a time and introduces the abovementioned air-to-ground modes with a resolution of 5 x 5 m (16 ft 6 in x 16 ft 6 in); Phazotron-NIIR is working on enhancing the resolution to 3 x 3 m (10 x 10 ft). Of the many radars created by the corporation in recent years the Zhuk-ME turned out to be the best option for the MiG-29's new versions, beating even the seemingly more advanced Zhuk-MFE electronically-scanned phased-array radar. The Zhuk-ME is produced in quantity at Phazotron-NIIR's own facilities.

Apart from its early aircraft radars, Phazotron-NIIR is well known for the *Kop'yo* (Spear) radar

The MiG-29SMT (*izdeliye* 9.17) prototype in its latest guise at the MAKS-2005 airshow. The aircraft wears a rather garish three-tone blue display colour scheme.

Yefim Gordon

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▲
Two views of MiG-29SMT '917 Blue' at RSK MiG's flight test facility. The aircraft is carrying two inert Kh-29T missiles on the inboard pylons, with KAB-500Kr guided bombs further outboard and dummy R-77s on the outermost pylons.
▼

Yefim Gordon

Yefim Gordon

▲
Two more views of MiG-29SMT '917 Blue' in that psychedelic blue splinter camouflage. The aircraft carries 'RSK MiG' and 'MiG-29SMT' titles on the fuselage; the multi-coloured 'lightning bolt' on the tails is actually a very stylised 'MiG' inscription in Russian.
▼

Yefim Gordon

intended for upgrading the MiG-21*bis* fighter. A MiG-21*bis* retrofitted with the Kop'yo radar can wage aerial combat against even the latest fighters at long, medium and short range. The Zhuk-ME was developed by the same design team, using the same components; however, the corporation took into account the operational experience with the Kop'yo accumulated by the Indian Air Force and is working on increasing the Zhuk-ME's reliability to several times that of the older model.

The MiG-29SMT's upgraded WCS makes the fighter compatible with a much wider range of air-to-air and guided/unguided air-to-surface weapons as compared to the basic versions. Retaining the dogfighting capability of the standard *Fulcrum*, the aircraft acquires a strike potential comparable to that of the most up-to-date modern fighters, such as the Lockheed Martin F-16C Block 50 Fighting Falcon, Boeing F/A-18E/F Super Hornet, Dassault Mirage 2000-5 and Dassault Rafale C Mk 2.

The second basic package involves an increase in fuel capacity (both internal and external) and other refinements to the fuel system, as well as the installation of an in-flight refuelling system compatible with both Russian and Western tanker aircraft.

The third package deals with the avionics. This gives the fighter a completely new data presentation and control environment featuring full-colour multi-function liquid-crystal displays. The state-of-the-art flight instrumentation and navigation suite includes a satellite navigation module and is fully compliant to NATO and ICAO standards, which makes the MiG-29SMT more attractive for foreign customers and facilitates long-range flights outside Russia.

In its *izdeliye* 9.18 form the MiG-29SMT has the WCS and the navigation system combined into the OPrNK-29SM integrated optoelectronic navigation/attack suite (***o**ptiko-elektro**n**nyy **pr**i-**tsel'**no-navigatsio**n**nyy **k**ompleks*); a version of this suite designated OPrNK-29SMU has been developed for the MiG-29UBT, should there be a demand for this two-seat combat aircraft. This suite, which enables the fighter to navigate safely and use its air-to-air and air-to-surface weapons throughout its designated combat envelope, was developed by the Ramenskoye Instrument Design Bureau (RPKB – ***R**amenskoye **p**ribor-o-stro**i**tel'noye kon**s**trook**t**orskoye by**u**ro*) headed by Givi I. Djandjgava. The SAU-451-05SMT automatic flight control system (*si**s**te**m**a avtoma-**ti**cheskovo oopravl**eni**ya*) for the MiG-29SMT (*izdeliye* 9.18) and its SAU-451-05UBT version for the MiG-29UBT were jointly developed by the Elara Joint-Stock Co. from Cheboksary and MNPK Avionika ('Avionics' Moscow Scientific & Production Complex).

If the customer goes for a 'full option' upgrade, the MiG-29SMT becomes a Generation 4+ fighter whose combat potential closely matches that of the MiG-29M and the best Western fighters – in fact, it surpasses them in

Specifications of the Phazotron-NIIR Zhuk-ME Fire Control Radar

Air-to-Air Mode

Functions:

1. Detection of aerial targets in the fighter's forward hemisphere in open airspace and in look-down mode
2. Target tracking in track-while-scan mode and multiple target attack
3. Single target tracking
4. Dogfight mode:
   vertical scan
   fixed-beam mode
5. Recognition of multiple (group) targets and definition of target types

Performance:

Target detection range (target RCS = 5 m^2 / 54 sq ft):
in head-on mode – 120 km (74.5 miles)
in pursuit mode – 50 km (31 miles)
Target lock-on/tracking range in dogfight mode: 15 km (9.3 miles)
Target lock-on range:
single target – 0.75 of the detection range
track-while-scan – 0.85 of the detection range

Air-to-Ground Mode

Functions:

1. Ground mapping:
   actual beam mode
   Doppler beam narrowing
   synthetic aperture mode
2. Tracking an d attack of one or two ground targets
3. Detection and tracking of moving maritime or ground targets
4. Air-to-surface rangefinding

Performance:

Radar map resolution:	5 x 5 m (16 ft 6 in x16 ft 6 in); to be enhanced to 3 x 3 m (10ft x 10 ft)
Surface ship detection range:	up 250 km (155 miles)
Ground target detection range:	up 150 km (93 miles)

General Data

Antenna:	slotted array of 624 mm (2 ft $0\frac{9}{16}$ in) diameter scanned through ±85° in azimuth and +56°/–40° in elevation
Weight:	220 kg (485 lb)
Radar set output:	1.6 kW
Power consumption:	10.2 kVA
Non-stop operation time:	150 hours
Built-in test equipment	

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◄
The 'new' MiG-29SMT (*izdeliye* 9.18) prototype, aptly coded '918 White' (c/n 2960536050, f/n 4815), at the MAKS-2005 airshow. The Lada-2120 Nadezhda 'people carrier' on the right is fitted out as a mobile systems test laboratory.

▲
The flags of the MiG-29's operator nations (numbering 29!) on the fuselage of '918 White'.

◄
MiG-29SMT '918 White' in Akhtoobinsk, loaded with Kh-31Ps, T-77s and R-73.

The semi-retractable IFR probe of '918 White'.
▼◄

Yefim Gordon

Yefim Gordon

some respects. Such an aircraft will remain highly effective and hence competitive on the world market for two decades to come.

Importantly, RSK MiG is prepared to perform the upgrade entirely on the customer's home ground, using the customer's own facilities. The corporation is currently performing MiG-29 upgrade work under contract with several nations; the first batches of *Fulcrums* upgraded to MiG-29SMT/MiG-29UBT standard have now been delivered to several foreign customers, including Yemen.

Notwithstanding the fact that the number of active MiG-29 units in the Russian Air Force is declining by the year and a large number of early-production MiG-29s (mostly *Fulcrum-As* and MiG-29UBs) have been consigned to storage depots in Lipetsk and elsewhere, the Russian Air Force top command is showing an interest in having the *Fulcrum-Cs* (*izdeliye* 9.13) and MiG-29Ss (*izdeliye* 9.13S) updated to MiG-29SMT standard. Most of the design features that have been mastered in the course of upgrade work for foreign customers will probably be incorporated on the Russian Air Force's MiG-29SMTs, reducing the modernisation time and cutting costs.

Among other things, three aircraft sharing the MiG-29SMT designation but upgraded in different years and differing in avionics fit and

RSK MiG

RSK MiG

RSK MiG

Three views of MiG-29SMT '918 White' at Zhukovskiy with a drop tank but no weapons pylons. Note that the 'SMT' titles are in Russian to port and in English to starboard.


Dmitry Pichugin


Dmitry Pichugin


Sergey Krivchikov

◄ **This photo sequence shows MiG-29SMT '918 White' taking off and climbing away in full afterburner at the beginning of a demonstration flight at the Dubai 2005 airshow in November 2005.**

systems/structural design were used both in the MiG-29SMT programme and in the reborn MiG-29K/MiG-29KUB programme described later. These were '917 Blue' (c/n 2960535400, f/n 4710), '777 Blue' (c/n 2960535403, f/n 4711) and '918 White' (c/n 2960536050, f/n 4815). By August 2005 '917 Blue' had been repainted in a rather shocking three-tone blue splinter camouflage scheme with stylised 'MiG' titles on the fins for the MAKS-2005 airshow but the systems and structure remained unchanged since the late 1990s – the grossly bulged fuselage spine housing additional fuel tankage was retained. This aircraft served as a testbed for certain systems and avionics components.

In contrast, '918 White' (which basically matches the current specification of *izdeliye* 9.18) has an identical detachable semi-retractable IFR probe but retains the concave upper fuselage contour of the *izdeliye* 9.12 from which it was converted. Likewise sporting a splinter scheme (this time in sand/brown 'desert' colours), the aircraft was displayed at several international airshows, including MAKS-2003. For a while '918 White' was flown by the pilots of the 929th GLITs; as such it was among the static exhibits at Vladimirovka AB during the festivities on the occasion of the Centre's 85th anniversary on 21st September 2005, being displayed with a full weapons load.

'777 Blue' initially had the systems updated to *izdeliye* 9.18 configuration (this included avionics standardised with those of the new-generation MiG-29 versions and the detachable IFR probe). Thus it was outwardly identical to '918 White' for a while, except for the paint job. In this guise the aircraft completed the opening stage of the trials. Next, in early November 2005 it was retrofitted with a 950-litre (209 Imp gal) fuel tank aft of the cockpit, which gave it a singularly ungainly humpbacked appearance (the aircraft looked like a cross-breed between the *izdeliye* 9.12 and the *izdeliye* 9.17) and gained a three-


Dmitry Pichugin

► **MiG-29SMT '918 White' performs a snap roll at the IDEX 2005, displaying full details of its 'desert' camouflage. This aircraft is known as the prototype of the so-called 'Yemeni version'.**

Dmitry Pichugin

Dmitry Pichugin

Sergey Krivchikov

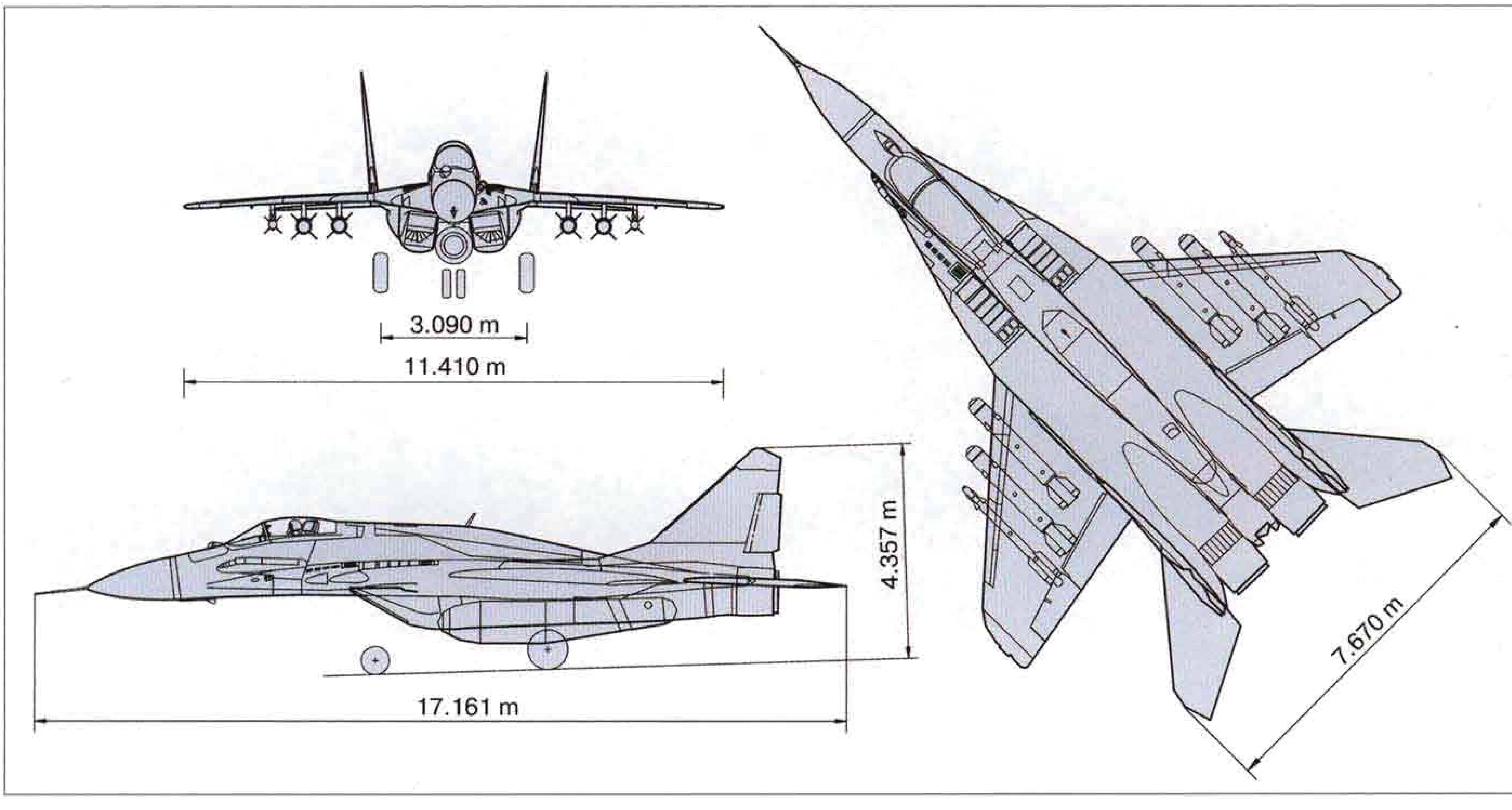
▶ 'She's not just a pretty face, She's got everything it takes...' MiG-29SMT '777 Green' (c/n 2960535403, f/n 4711) displayed statically at IDEX 2005 represents yet another variation on the theme. It hasn't got the looks to kill, but it sure has everything else to kill.

tone green/grey camouflage for the Dubai 2005 airshow, where it was displayed statically as '777 Green' together with '918 White', which participated in the flying display. MiG-29SMT c/n 2960535403 came to represent the finalised baseline configuration of *izdeliye* 9.18.

As already mentioned, the MiG-29SMT prototypes were primarily avionics testbeds (in particular, they were used to verify the central data processing system, the INS and the MFDs); the avionics fit was largely identical to that of the MiG-29K/KUB and MiG-29M/M2. Additionally, the State Research Institute for Aircraft Systems (GosNII AS) built a special test rig for integrating the avionics and armament of the *izdeliye* 9.18.

RSK MiG has now begun certification trials of the MiG-29SMT jointly with the Russian Air Force. Several versions of the national defence budget for 2006 are under consideration as of this writing, and all of them envisage upgrading the existing MiG-29 fleet. The number of aircraft to be upgraded depends on which version of the budget is endorsed by the State Duma (Parliament); what is certain, however, is that a

Originally dismissed as a 'crude approximation', this drawing unexpectedly turned out to be accurate after all, representing MiG-29SMT '777 Green'. ▼



Sergey Krivchikov

Dmitry Pichugin

▲
Another view of MiG-29SMT '777 Green' in Dubai. Note the stylised Cyrillic 'MiG'/'SMT' titles on the tail.

◄
Close-up of the MiG-29SMT's forward fuselage, showing the kinked upper fuselage contour where a simple fairing tapers off from the single strap-on tank.

Close-up of the weapons carried by '777 Green' – Kh-29T AGMs, R-77 and R-77 AAMs.
▼

Sergey Krivchikov

substantial number of MiG-29s will be modernised, not just a handful of fighters for show purposes, which will give the Russian Air Force a tangible improvement in combat capability. The Air Force is due to place its initial order for the upgrade of operational *Fulcrums* to the current MiG-29SMT standard in 2006.

The upgrade increases the basic MiG-29's combat potential (especially in air-to-ground mode) 2.5 times. By the time MiG-29SMT '918 White' made its airshow appearance at Zhukovskiy RSK MiG had completed live weapons tests involving the use of precision-

MiG-29SMT (*izdeliye* 9.17) '917 Blue' (c/n 2960535400, f/n 4710)
1998 configuration

The same aircraft as it looked in August 2005

MiG-29SMT (*izdeliye* 9.18) '918 White' (c/n 2960536050, f/n 4815)

MiG-29SMT (*izdeliye* 9.18) '777 Green' (c/n 2960535403, f/n 4711)
November 2005

First prototype MiG-29UBT '304 Blue' (c/n 4029692486)

guided munitions – Kh-31A active radar homing anti-shipping missiles, Kh-31P anti-radiation missiles, Kh-29T TV-guided missiles and KAB-500Kr 'smart bombs' – with this aircraft at the 929th GLITs. Vladimir I. Barkovskiy, Director of the corporation's Engineering Centre, says the tests showed that the MiG-29SMT's new navigation suite developed by RPKB has significantly improved targeting accuracy with all types of unguided air-to-surface weapons.

In its current guise the MiG-29SMT has also attracted considerable interest on the part of some third-world countries. Yemen became the launch customer, placing an order for a batch of the upgraded fighters in 2003 (which is why MiG-29SMT '918 White' is sometimes referred to as 'the Yemeni version' because of its 'African' camouflage). RSK MiG continues its efforts to market the fighter in other parts of the world. At least one more export order for the MiG-29SMT is due to be signed by the end of 2005, says Barkovskiy, and two more nations may introduce this version in 2006.

MiG-29K Single-Seat Shipboard Fighter (*Izdeliye* 9.41)
MiG-29KUB Two-Seat Shipboard Fighter (*Izdeliye* 9.47)

On 20th January 2004 Russia and India signed yet another defence contract worth more than US$ 700 million. Under this contract RSK MiG was to deliver sixteen MiG-29K shipboard fighters to the Indian Navy; these aircraft were to form the carrier wing of India's first CTOL aircraft carrier. The Soviet, and later Russian, aircraft industry has a long history of cooperation with the Indian Air Force and the Indian Navy; in particular, Mikoyan aircraft have formed the backbone of the IAF's fighter element for many years. Several hundred MiG-21s, MiG-25s, MiG-27s and MiG-29s are currently in service with the IAF, and the MiG-23 used to be operated as well. Moreover, Hindustan Aeronautics Ltd. (HAL) assisted by Soviet/Russian specialists has mastered licence production, repair/refurbishment and upgrading of several Mikoyan types. The MiGs, and Russian fighters in general, have long since earned the respect of Indian pilots and military specialists.

A few words have to be said about the abovementioned contract. Apart from the delivery of twelve MiG-29K single-seaters and four MiG-29KUB combat trainers, it included the training of the customer's flying personnel and technical staff, the delivery and commissioning of flight simulators, spares supplies and the organisation of maintenance at the customer's facilities. Deliveries are to begin in 2007, the last of the 16 aircraft being delivered in 2009. The Indian Navy also signed an option for a further 30 MiG-29K/KUBs to be delivered in 2010-2015; this may bring the Indian Navy's MiG fleet to 46.

The fighters will operate from the Project 1143 aircraft carrier formerly known as RNS *Admiral Gorshkov* which will be extensively converted to enable CTOL operations (this involves installation of a ski jump, among other things); the upgraded carrier, now known as Project 11430, has already been rechristened INS *Vikramaditya*. Its carrier wing will include up to 24 MiG-29K/KUBs. The fighters may also be based aboard the Indian Navy's future carrier provisionally known as the ADS (Air Defence Ship).

Now we come to the most important bit. Despite sharing the MiG-29K designation of the *izdeliye* 9.31 (*Fulcrum-D*) shipboard fighter developed for the Soviet Navy and described in Chapter 5, the multi-role aircraft now being developed under the Indian contract is rather different – a thoroughly updated version of the original design. The design staff of RSK MiG had to go to great lengths to adapt the fighter to the Indian Navy's requirements and the new ship from which the MiG-29K will now operate. This was also because the MiG-29K programme had been put on hold for a long time (the Russian Navy had rejected the *izdeliye* 9.31, selecting a single type – the Sukhoi Su-27K (Su-33) – to equip the carrier wing of its sole CTOL carrier RNS *Admiral Kuznetsov*) and the MiG-29's development has not been standing still. The existing know-how, experience and hardware were a great help, but major changes had to be made to meet the new challenges.

As recounted in Chapter 6, two MiG-29K (*izdeliye* 9.31) prototypes – '311 Blue' and '312 Blue' – had been built in the late 1980s, successfully passing carrier compatibility trials aboard the Project 1143.5 aircraft carrier SNS *Tbilisi* (later SNS *Admiral Kuznetsov*) in 1989-91, whereupon the fighter received the preliminary go-ahead for production and service from the Soviet Ministry of Defence. By the end of August 1992 the two prototypes had made more than 420 flights between them, including 80-plus carrier landings; shipboard operations had been performed both by Mikoyan test pilots and the pilots of what was then GNIKI VVS. MiG-29K '311 Blue' has the distinction of being the first Soviet/Russian aircraft to perform a conventional take-off from an aircraft carrier (this was done by test pilot Toktar O. Aubakirov on 1st November 1989). However, the demise of the Soviet Union and the ensuing economic chaos forced the Russian MoD to postpone new hardware procurement for many years. The MiG-29K programme was suspended and the prototypes were mothballed. Still, they received a new lease of life in the late 1990s when India started negotiating the purchase of the aircraft carrier RNS *Admiral Gorshkov* with Russia. The *Admiral Gorshkov* had been built with Yakovlev Yak-38 V/STOL attack jets in mind and was 'laid off' after the Yak-38 had been withdrawn; however, she had the potential for upgrading into a multi-role CTOL carrier with a ski jump. In 1996 Russia offered the MiG-29K to the Indian Navy as the main type for the prospective carrier. Thus the two MiG-29K prototypes were reactivated; '312 Blue' resumed flights in July 1999 and was joined by '311 Blue' in September 2000.

The airframer (RSK MiG) and the avionics houses involved were facing new requirements which, in effect, necessitated the development of a new shipboard fighter – quite a formidable task. Two versions were developed in parallel: the MiG-29K single-seat multi-role fighter (which, in its new guise, received the new in-house designation *izdeliye* 9.41) and the two-seat MiG-29KUB (*izdeliye* 9.47) which could be used both as a fighter and as a combat-capable trainer. To save time and cut costs the two versions will have more than 90% commonality as regards the airframe and systems and nearly 100% commonality as regards avionics and armament; in other words, basically the MiG-29K differs from the MiG-29KUB only in having an extra fuel tank occupying the two-seater's rear cockpit.

The single-seat MiG-29K fills the following basic roles:

• air defence of carrier task forces in BVR engagement or dogfight mode and interception of aerial targets flying at 20-27,000 m (65-88,580 ft) and speeds up to 2,500-2,700 km/h (1,552-1,677 mph) in any weather, day or night;

• destruction of enemy air assets (anti-submarine warfare, transport/assault and airborne early warning and control aircraft and helicopters) in areas where 'friendly' sub-marines are in operation;

• anti-shipping strikes against the enemy's naval task forces, supply convoys and solitary ships, as well as strikes against ground targets, using both precision-guided munitions and unguided weapons;

• destruction of anti-assault pillboxes on the coastline and providing close air support to assault groups;

• support and protection of other (shore-based) naval aircraft en route to and from the battle area;

• reconnaissance.

In addition, the two-seat MiG-29KUB can be used for proficiency training and conversion training for the single-seat MiG-29K. Also, workload distribution between the crewmem-bers during a combat sortie (the back-seater searches for the targets and selects the weapons) enhances the two-seat fighter's efficiency in both air-to-air and air-to-surface

Victor Drushlyakov

The MiG-29K/KUB developed for the Indian Navy will be a lot different from its namesake created for the Soviet Navy, but even so the existing MiG-29K prototypes are being used actively in the Indian programme.

mode as compared to single-seat competitors. Both versions retain the basic *Fulcrum*'s excellent air combat capabilities. If a 'buddy' refuelling pod is fitted, the MiG-29K and MiG-29KUB can refuel probe-equipped sister aircraft, extending their range and endurance.

The 'Indian' MiG-29K (*izdeliye* 9.41) incorporates all of the best features that have proved their worth on production *Fulcrums*, as well as the special features characteristic of shipboard fighters that have been tested on the *izdeliye* 9.31 prototypes. At the same time its combat potential is vastly improved thanks first and foremost to the state-of-the-art avionics and weapons.

Structurally and from a manufacturing technology point of view the airframe of the MiG-29K (*izdeliye* 9.41) and the MiG-29KUB (*izdeliye* 9.47) is broadly similar to those of production MiG-29 versions. The principal changes concern the wing structure and high-lift devices, the forward fuselage and the landing gear. The tail unit, airbrake and landing gear (including the arrester hook) are similar to those of the original MiG-29K (*izdeliye* 9.31).

The forward fuselage deserves a more detailed description. As already mentioned, the single-seat MiG-29K and the two-seat MiG-29KUB have an identical forward fuselage design. In practice this means that the odd-looking stepped-tandem arrangement of the original MiG-29KUB (*izdeliye* 9.62) project has been abandoned. Instead, the current shipboard versions look like a cross-breed between the *Fulcrum-A/C* and the MiG-29UB, combining the latter's tandem cockpits enclosed by a common aft-hinged canopy with a 'normal' large radome. The chosen arrangement gives both pilots (in the case of the MiG-29KUB) a good field of view; the downward field of view over the nose from the front seat is increased to 16°.

The pilots sit on Zvezda K-36D-3.5 zero-zero ejection seats. This is an improved version of the famous K-36DM seat fitted to most of Russia's production fourth-generation combat aircraft; it offers a G load during ejection limited to 3.5 and thus reduces the risk of spinal injuries without compromising safety. MNPK Avionika has developed the BLP-3.5-2 ejection sequencing module (*blok* ***logi****ki* [*ava****reey****novo*] *poki****da****niya*) specially for the MiG-29KUB; this module precludes ejection seat collision during a simultaneous ejection from an aircraft whose cockpits are enclosed by a common canopy.

Like the original *izdeliye* 9.31, the new-generation shipboard fighters have a fully retractable L-shaped IFR probe on the port side of the nose in line with the cockpit windshield. The aerodynamics of the new forward fuselage have now been verified on a similar hybrid – the MiG-29M2 (MRCA) prototype ('154 White') described later in this chapter.

The wings of the MiG-29K (*izdeliye* 9.41) and the MiG-29KUB (*izdeliye* 9.47) are broadly similar to those of the *Fulcrum-D* as regards planform, span, airfoils, the wing folding mechanism, the configuration of the integral fuel tanks and the number of external stores hardpoints. The main differences lie in the trailing-edge flaps, the leading-edge flaps and the installation of additional vortex flaps on the LERXes in line with the leading edge.

The double-slotted TE flaps of the MiG-29K/MiG-KUB feature increased chord and area, protruding beyond the trailing edge when retracted. The simple LE flaps are replaced by double-hinged ones and their maximum deflection is increased from 20° to 30°; the LE flaps are now continuously controlled by the aircraft's flight control system, deploying automatically to the required angle in concert with the ailerons and stabilators in accordance with the current AOA and Mach number. The vortex flaps are strictly landing devices; on take-off and in cruise mode they are retracted flush with the underside of the LERXes. As they deploy during landing approach, they generate additional vortices which enhance wing lift and reduce dangerous fore-and-aft oscillations. The changes to the high-lift devices are meant to improve the MiG-29K/KUB's manoeuvrability and enhance flight safety during the approach and landing phase at airspeeds of 250-260 km/h (155-161 mph).

MNPK Avionika and the Elara JSC are jointly developing a new quadruplex digital fly-by-wire control system designated KSU-941 (***kom****pleks-naya* *sis****tem****a oopravl****en****iya* – integrated control system for *izdeliye* 9.41) for the MiG-29K/KUB; its introduction will give a major improvement of flight safety. The KSU-941 is a derivative of the fly-by-wire control system developed for the MiG-AT advanced trainer; it enables manual control or automatic control (using inputs from the AFCS) in all three channels.

Speaking of the automatic flight control system, its electronic component is built around the BARK digital data-processing suite which controls the engine starting procedure, controls the engines and engine air intakes throughout the flight envelope and monitors the engine parameters. The BARK suite operates in conjunction with the IDK-42 built-in test equipment system (*informatsi**on**no-diagnos**tic**heskiy **kom**pleks*).

Like the 'landlubber' MiG-29M, the MiG-29K and MiG-29KUB have traded the forward air intake blocker doors and spring-loaded dorsal doors for FOD prevention grilles further downstream. This frees up internal space inside the LERXes, allowing it to be used for additional fuel.

Because the MiG-29K/KUB will operate in a salty oceanic environment, special corrosion protection measures for the airframe, avionics/equipment and the engines will be implemented, utilising the latest know-how of the Russian research establishments and industry. Radar-absorbing material (RAM) coatings will reduce the fighter's RCS by a factor of 4 to 5 as compared to the standard MiG-29.

Changes have been made to the powerplant as well. The Indian Navy versions will be powered by the new RD-33MK afterburning turbofan developed by NPO Klimov in St. Petersburg. The RD-33MK, which is due to enter production at the Moscow Machinery Enterprise named after V. V. Chernyshov, is a derivative of the production RD-33 Srs 3 which has been powering the MiG-29SE and the MiG-29SMT since 1995. It incorporates changes based on the experience gained with the RD-33K engine that powered the original MiG-29K and the MiG-29M; apart from the addition of full authority digital engine control (FADEC), the RD-33MK features revisions to the low-pressure and high-pressure compressors, the combustion chamber and the HP and LP turbines. This increased the mass flow by 6.5% and the turbine temperature by 40°K. The overall effect of these changes was to increase the thrust in full afterburner by 8% to 9,000 kgp (19,840 lbst) and at full military power by 1% to 5,400 kgp (11,905 lbst). The use of a so-called smokeless combustion chamber has helped to address a perennial problem – the RD-33's high smoke signature which can be seen for miles, ruining stealth. Also, while retaining the 1,000-hour TBO of the RD-33 Srs 3, the RD-33MK has had the designated service life doubled (to 4,000 hours).

The RD-33MK has passed a complete cycle of bench tests at NPO Klimov and subsequently at TsIAM. In 2002 the first two RD-33MKs were fitted to MiG-29K '312 Blue' and are currently undergoing flight tests.

NPO Klimov has also developed the all-new KSA-33M accessory gearbox specially for the MiG-29K (*izdeliye* 9.41) and the MiG-29KUB (*izdeliye* 9.47). As distinct from the KSA-2 and KSA-3 accessory gearboxes fitted to earlier versions of the *Fulcrum*, the KSA-33M consists of two independent sections powered by the respective engines, each section driving its own set of generators and hydraulic and fuel pumps and carrying its own APU (jet fuel starter). This significantly enhances reliability and operating efficiency in extreme climates, allowing the advantages of the twin-engine layout to be used to the full.

The VK-100 APU (another NPO Klimov product) used on the MiG-29K and MiG-29KUB is also new; it is a derivative of the well-known GTDE-117 and offers more shaft horsepower. Unlike previous versions of the MiG-29, the APU exhausts are located dorsally to reduce the fire hazard during carrier operations and enable the carriage of a new enlarged centreline drop tank. (In contrast, on all previous versions of the fighter with a ventral APU exhaust port the PTB-1250 centreline drop tank incorporates a straight-through duct for the APU exhaust.)

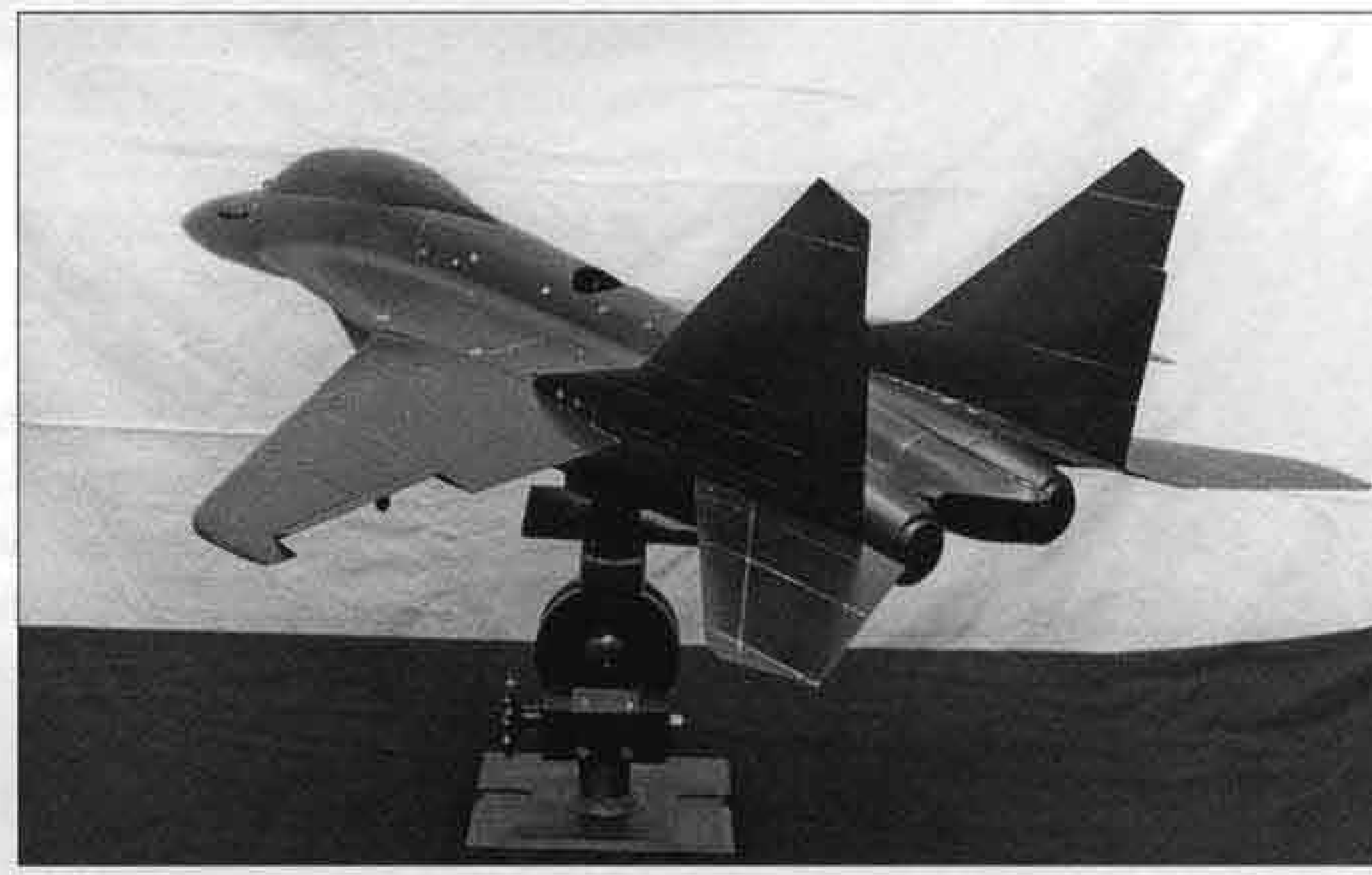
Currently HAL has mastered licence production and refurbishment of the baseline RD-33 powering the Indian Air Force's MiG-29s. The fact that India is currently negotiating manufacturing rights for the RD-33 Srs 3 testifies to the high appraisal given to this engine by Indian specialists. Hence the Indian Navy is not likely to experience any major maintenance problems with the MiG-29K/KUB's powerplant.

The internal fuel capacity of the MiG-29K (*izdeliye* 9.41) is more than 50% greater than the basic MiG-29's and more than 16% greater than that of the original MiG-29K (*izdeliye* 9.31). The increase is due to the provision of additional fuselage tanks (including a 500-litre (110 Imp gal) tank in the fuselage spine and smaller tanks in the LERXes) and the installation of a 630-litre (138.6 Imp gal) auxiliary tank occupying the rear cockpit; this latter tank is omitted on the MiG-29KUB. Additionally, the capacity of the centreline drop tank has been increased from 1,250 litres (275 Imp gal) to 2,150 litres (473 Imp gal) and the number of underwing drop tanks holding 1,150 litres (253 Imp gal) each has been increased from two to four.

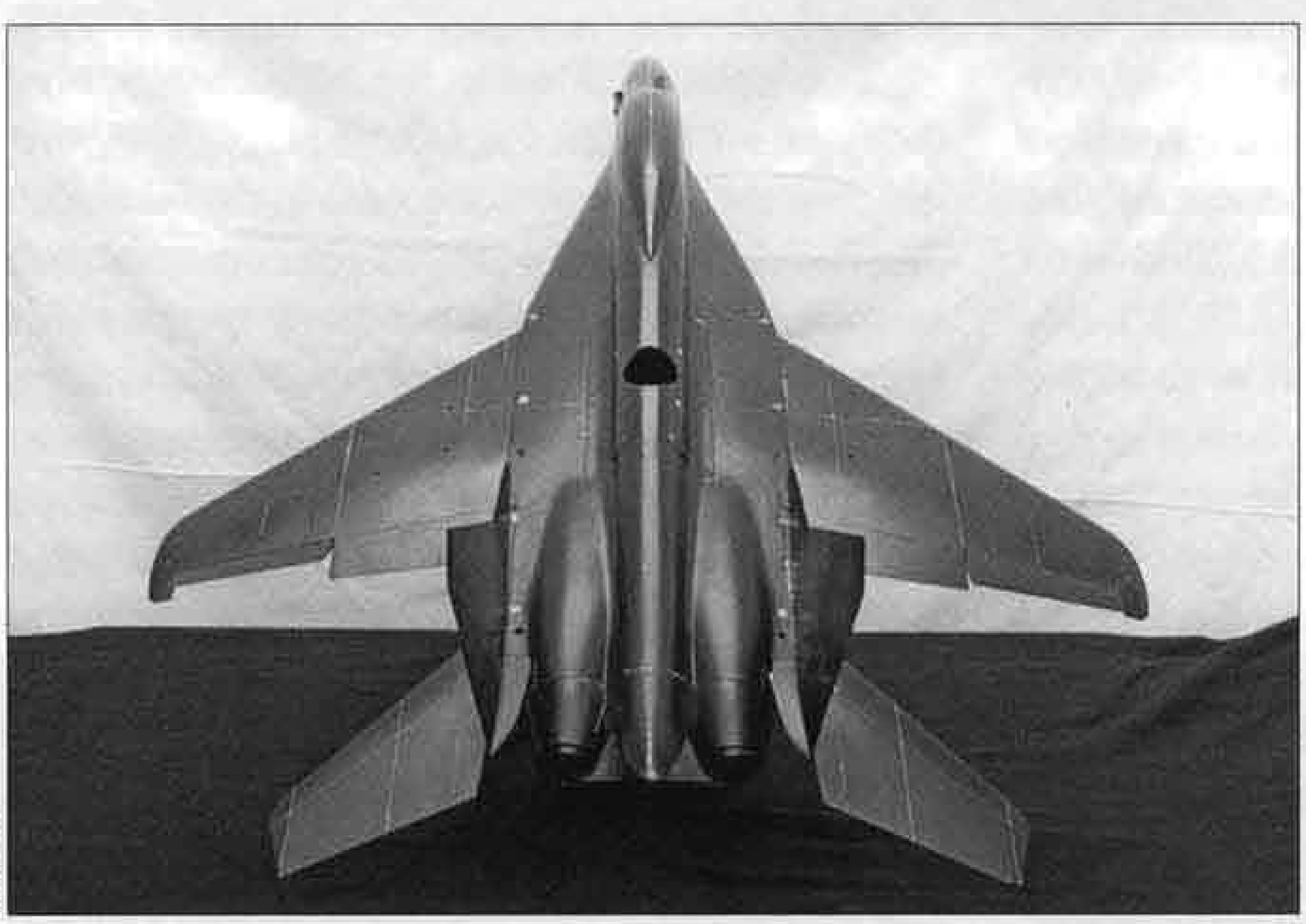
As already mentioned, the MiG-29K (*izdeliye* 9.41) and the MiG-29KUB (*izdeliye* 9.47) have IFR capability. The fully retractable IFR probe is tipped with a versatile adapter which is compatible with both Russian and Western refuelling drogues. Fitting four underwing drop tanks and a PAZ-1MK hose drum unit turns the MiG-29K/KUB into a 'buddy' refuelling tanker able to refuel other shipboard fighters. The

RSK MiG

RSK MiG



RSK MiG



RSK MiG

RSK MiG

PAZ-1MK was developed by NPP Zvezda specially for the Indian naval versions as a derivative of the well-known UPAZ-1 HDU used by the IL-78 tanker and Russian tactical aircraft; its overall length has been reduced to about 3 m (9 ft 10 in), allowing centreline carriage by aircraft fitted with arrester hooks.

As compared to its *Fulcrum-D* namesake, the MiG-29K (*izdeliye* 9.41) has an avionics fit which is at least 80% new and has considerable commonality with the production-standard MiG-29SMT (*izdeliye* 9.18) developed both for the home market and for export. In accordance with the Indian Navy's wishes the MiG-29K/KUB will feature some avionics items of Indian and French origin.

The PrNK-29K and PrNK-29KUB navigation/attack suites developed for the MiG-29K and MiG-29KUB respectively permit navigation and engagement of aerial and ground/surface targets throughout the aircraft's designated combat envelope, singly or as part of a group, regardless of whether the fighter operates from the carrier or from a shore base. Both versions of the suite have been developed by the RPKB Federal Research & Production Centre which is

▲
Five views of a wind tunnel model of the MiG-29K/KUB shipboard fighter (*izdeliye* 9.41/9.47). Oddly, it is marked '915', although it has a long canopy not found on the MiG-29M. Note the lines on the wings and stabilators suggesting that the MiG-29K/KUB may have a folding horizontal tail; otherwise the stabilators would protrude beyond the wing folding line. Note also that the stabilators lack the leading-edge dogtooth.

responsible for the systems integration of the 'Indian' naval versions.

At the initial design stage the St. Petersburg-based Elektroavtomatika OKB was responsible for developing the navigation/attack suite's design philosophy. This enterprise formulated the structure and the basic operating principles of the shipboard fighter's avionics suite. However, the proposed avionics suite utilised technologies of the 1980s which were becoming obsolete; in particular, the 'new' MiG-29K was to have the same N010 Zhuk radar (with modifications to reduce background clutter over water) that had been fitted to the 'old' MiG-29K. Hence in the late 1990s, when the details of the future MiG-29K/KUB deliveries to the Indian Navy were being worked out, the management of RSK MiG changed its mind and selected RPKB as the project's avionics integrator. The choice was influenced by RPKB's previous integration work on Sukhoi fighters (which the management of RSK MiG had studied carefully).

By then RPKB had already gained some experience of systems integration with the Su-30MKI for the Indian Air Force and the Su-30MKK for the People's Liberation Army Air Force of China (PLAAF). Of course, this know-how, as well as the research done by the Technocomplex Research & Production Centre were put to good use when developing the structure and actual hardware of the MiG-29K/KUB's avionics suite.

Size and weight issues loomed large at this point. Avionics items which were fine for a 'heavy' fighter like the Su-30 proved to be unacceptably bulky and heavy for a light fighter like the MiG-29. Unique solutions had to be sought to minimise the avionics modules' size and weight without sacrificing performance. Still, the navigation/attack suites developed for the MiG-29K and MiG-29KUB drew mainly on the features evolved for the Su-30MK export series.

The avionics have an open (modular) architecture based on the MIL-STD-1553B digital databus and are sourced from several nations. The suite is built around a digital data processing system which, like the three principal targeting systems – the Zhuk-ME radar, the IRST/LR and the system downloading target information to the passive seeker heads of the anti-radiation missiles – is Russian-made. On the other hand, the customer may specify the French-made Thales Topsight helmet-mounted sight (the model is available on export Dassault Mirage 2000-5 fighters). Another French component is the INS which includes the Sagem Sigma-95 satellite navigation module; this system is also fitted to the Su-30MKI and the export version of the MiG-29SMT (*izdeliye* 9.18).

Avionics components of Indian origin include:

- two short-range radio navigation systems (for tactical area navigation and approach/landing) manufactured under licence from Thales;
- the radio altimeter;
- a UHF radio (these two items are also fitted to the Indian Air Force's Su-30MKIs);
- an ELINT set developed jointly with Russian avionics houses;
- an active ECM pod carried on the No.8 hardpoint under the starboard wing.

The other two communications radios fitted to the MiG-29K (the No.2 UHF radio and the VHF radio used for long-range communications) are manufactured in Russia. The MiG-29K/KUB will feature a secure data link system enabling concerted action by a group of fighters. Due to the importance and complexity of the missions which the fighter will have to fulfil, the data link system will have set channels with a high data transmission rate making use of the latest type of interface – a new feature for a Russian aircraft.

The IRST/LR fitted to the MiG-29K (*izdeliye* 9.41) and the MiG-29KUB (*izdeliye* 9.47) will incorporate measures increasing its reliability. The Russian-made IRCM system comprises two 16-round flare dispensers located on the sides of the engine nacelles below the fins and firing downwards. The calibre of the flares has been increased from 26 mm (1⅟₆₄ in) as used on previous MiG-29 versions to 50 mm (1³¹⁄₃₂ in); this increases their burn time and heat signature, thus offering greater protection against heat-seeking missiles.

The MiG-29K/KUB's data presentation system was developed by RPKB to meet Indian specifications. It comprises a ShKAI wide-angle monochrome HUD and three (or, on the MiG-29KUB, seven) MFI 10-7 high-performance liquid-crystal multi-function displays framed by function keys. The MFI 10-7 (***mno****gofoonktsio*-***nahl'****nyy indi****kah****tor* – MFD; 10-7 means 'ten-inch screen, Version 7') is a brand-new model and Russia has not offered anything like it for export before. The 6 x 8" (152 x 203 mm) display has a resolution of 1,024 x 768 pixels, reproducing all kinds of graphics with fidelity. Thus, in addition to the primary flight instrument mode the MFI 10-7 can display a digital terrain map and tactical situation data (information about aerial and ground/surface targets), singly or in overlay mode, and other important information, allowing the pilot to maintain situational awareness and use his weapons effectively. Importantly, the data display area in the cockpit of the MiG-29K (*izdeliye* 9.41) is greater than on any other Russian single-seat combat aircraft.

The new ShKAI head-up display (*shee-roko'**ugol'**nyy kolli**mah**tornyy aviatsi**on**nyy indi-**kah**tor* – wide-angle collimator display for aircraft) fitted to the MiG-29K/KUB offers high performance; among other things, the field of view is 26° versus 18° on earlier MiG-29 versions. This allows the pilot to keep an eye on a much wider sector of airspace and use his weapons effectively in that sector; as a result, the fighter's combat efficiency is greatly increased (especially in a dogfight). Another advantage offered by the ShKAI is that its cathode-ray tube generates an image six times brighter than the CRTs of the HUDs used on earlier MiG-29 versions.

For the first time in Russian practice the ShKAI is built integrally with the control panel which is now located top centre on the instrument panel (directly below the HUD's optical module). A new CRT with a special coating was developed for the HUD by the research institute in Fryazino, Moscow Region; the wide-angle optical components were created in Sergiyev Posad (also in the Moscow Region), while RPKB supplied the electronic part of the unit. Interestingly, all of the HUD's components are housed in a single body (unlike earlier models where some of the auxiliary units were located remotely); this saves space and cuts weight. A prime example is the control panel which used to be located on one of the side consoles; placing it on the HUD itself makes operating the HUD a lot easier. The MiG-29KUB has a second HUD control panel in the rear cockpit.

In accordance with the customer's demands the MiG-29K/KUB will feature a helmet-mounted sight showing flight and target information on a minute screen right in front of the pilot's eyes. This obviates the need to look at the instrument panel during a dogfight when concentration is vital, allowing the pilot to keep his eyes glued to the adversary aircraft.

Thus to all intents and purposes the MiG-29K and MiG-29KUB have a 'glass cockpit' without back-up electromechanical instruments – except one which HAL manufactures under British licence and will install *in situ*. This is a navigation instrument that will allow the pilot to bring the aircraft home in the unlikely event of a total avionics failure.

The Zhuk-ME fire control radar developed by the Fazotron-NIIR corporation is the primary targeting system of the MiG-29K (*izdeliye* 9.41) and the MiG-29KUB (*izdeliye* 9.47). Since 2004 this radar is available for export (if installed on the MiG-29SMT multi-role fighter).

One of the principal new features implemented on the 'Indian' shipboard versions is the increased-capacity databuses linking the aircraft's avionics. The aircraft's 'nervous system' comprises four multiplex databuses, which considerably speeds up communication between the miscellaneous electronic systems and increases its reliability; no previous Russian fighter could boast a similar system. The more efficient data exchange system facilitates the integration of add-ons, should the need arise – as is the case with other Russian 'Generation 4+' fighters featuring an open avionics architecture; the additional avionics can be connected to any of the four databuses, which creates numerous upgrade possibilities. For the first time on a Russian aircraft, the data transmission rate conforms to the toughest existing standard (fibre channel). Actually copper wires are still used as of now, but fibre-optic cables will be incorporated later on.

This avionics architecture is unique among today's fighters, rendering the MiG-29 extremely adaptable and upgradeable (quite a few plans for further upgrade are in hand as of now). The MiG-29K/KUB's avionics arguably meet the toughest world standards. Development of the Indian naval versions' avionics suite began in June 2004 and RPKB is due to deliver the first shipset to RSK MiG in March 2007, 33 months after the commencement of the work.

While the avionics are of an international nature, the armament of the MiG-29K (*izdeliye* 9.41) and the MiG-29KUB (*izdeliye* 9.47) is purely Russian as of now. The fighter is armed with a 30-mm (1.18 calibre) GSh-301 fast-firing cannon in the port LERX and has eight underwing weapons hardpoints plus a centreline hardpoint which can likewise be used for carrying bombs. The two inboard pylons under each wing can be fitted with tandem bomb racks, which effectively increases the number of hardpoints to 13.

Air-to-air weapons include the R-77 (RVV-AE) active radar homing medium-range missile and the R-73E short-range AAM. For anti-shipping strike missions the aircraft can carry Kh-31A and Kh-35E active radar homing missiles; the Kh-31P passive radar homing variety is used for destroying enemy radars during suppression of enemy air defences (SEAD) missions. Pinpoint strikes against ground targets are made possible by Kh-29T TV-guided missiles and KAB-500Kr TV-guided HE bombs (or KAB-500OD fuel-air bombs). The ordnance load includes up to eight AAMs, or up to four air-to-surface missiles, or up to six 'smart bombs'.

The anti-shipping missiles deserve special mention, since the MiG-29K/KUB will be used primarily for overwater missions. The supersonic Kh-31A can be used against all types of surface ships up to and including destroyers (which, as we may snidely add, turn into 'destroyees' after being hit by the missile!) in visual or instrument meteorological conditions, day or night. The missile has a top speed of 1,000 km/h (621 mph) and a maximum launch range of 70 km (43.5 miles).

Additionally, the fighter can carry the subsonic Kh-35E – the air-launched version of the missile forming part of the Uran-E (Uranus – or uranium; pronounced *oo**rahn***) shipboard or shore-based anti-shipping missile system. While the air-launched version has 90% commonality with the baseline surface-to-surface missile, it is more than 50 cm (1 ft 7 in) shorter and 100 kg (220 lb) lighter because it does not need a solid-fuel rocket booster for launch.

The Kh-35E has a maximum launch range of 130 km (80 miles), allowing the aircraft to stay safely out of range of the target ship's air defence systems. The missile cruises at 10-15 m (33-50 ft) above the water, descending to just 4 m (13 ft) when it comes within approximately 14 km (8.7 miles) of the target, which makes it hard to detect and track for the ship's air defence radars. The ARGS-35E active radar seeker head (*ak**tiv**naya **rah**diolokatsi**on**naya go**lov**ka **sa**monave**de**niya*) created by the Radar-MMS company is engaged and achieves target lock-on at this stage, leaving the target no room for evasive action, and the 145-kg (320-lb) HE/fragmentation warhead is certain to cause extensive damage.

The folding wings of the 'Indian' MiG-29K/KUB will be similar to those of the original MiG-29K (seen here), except for the leading-edge devices. ▼

Kommersant

The unguided weapons to be used on the MiG-29K/KUB include ordinary and cluster bombs of up to 500 kg (1,102 lb) calibre (up to eleven FAB-500 HE bombs can be carried), 240-mm (9.44-in) S-24B heavy unguided rockets (up to six) and 80-mm (3.14-in) S-8KOM FFARs in up to six 20-round B-8M1 pods. The maximum ordnance load is 5,500 kg (12,125 lb).

The MiG-29K/KUB will be capable of day/night, all-weather, year-round operation in any climate, including tropics with ambient temperatures up to +35°C (+95°F) and air humidity up to 100%. The aircraft will be able to operate singly or in groups in the face of enemy fighter opposition and in an ECM environment, operating from CTOL carriers equipped with a ski jump or from shore bases. The take-off run on a carrier deck equipped with a bow ski jump is estimated as 125-195 m (410-640 ft).

As compared to existing MiG-29 variants the Indian Navy versions will have a longer designated service life and lower operating costs (due to being operated on a 'technical condition' basis with no rigidly set overhaul intervals). The service life of the MiG-29K/KUB is set at 4,000 hours and 40 years; in contrast, existing *Fulcrums* have a 2,500-hour service life and last 20 years. All maintenance and repair is to be performed *in situ* (the fighters will not have to go to Russia for refurbishment). The maintenance plan during operation on a 'technical condition' basis includes scheduled maintenance every 300 flight hours and technical condition checks every 1,000 hours or every ten years; in other words, the MiG-29K/KUB will have only three major checks during its lifetime. In contrast, the planned preventive maintenance system currently in force for the *Fulcrum* family prescribes routine maintenance every 100 flight hours (or every 12 months, whichever comes first), heavy maintenance every 200 hours (or 24 months) and refurbishment at an aircraft overhaul plant every 800 and 1,500 hours (9 and 17 years respectively). A switch to the 'technical condition' maintenance system cuts operating costs per flight hour by nearly 40%.

A special warehouse for spares stocking is to be built in India for supporting MiG-29K/KUB operations. This will reduce spares delivery time to the units to a maximum of 72 hours, ensuring a fleet serviceability rate of 80-90%.

All four principal divisions of RSK MiG – the Production Centre named after P. A. Voronin, the Engineering Centre named after Artyom I. Mikoyan (both located in Moscow), the No.2 Production Centre in Lookhovitsy (Moscow Region) and a further plant in Kalyazin – will participate in the MiG-29K/KUB production programme. The work will be distributed as follows. The Engineering Centre named after Mikoyan will manufacture the principal new airframe components (the forward fuselage, the dorsal fuel tank, the FOD protection grilles for the air intakes, the IFR probe, the arrester hook and so on). The plant in Lookhovitsy will supply the wings, tail unit, airbrake and all composite structures (the engine cowlings, ailerons, TE flaps, non-stressed portions of the fins, starboard LERX, fuselage spine fairing, access covers and non-stressed upper fuselage panels and so on). The Production Centre named after Voronin will manufacture the fuselage and be responsible for final assembly. Additionally, the drop tanks, the external stores pylons and some of the manufacturing jigs will be subcontracted out to the Sokol plant in Nizhniy Novgorod which built the MiG-29UB; this plant will handle 8-9% of the workload.

The first manufacturing drawings of the 'new' MiG-29K were issued in the autumn of 1999 and the first metal was cut immediately. The greater part of the manufacturing documents for the fuselage were completed in 2000; those for the wings followed in 2001 and those for the systems and equipment in 2001-03. In 2002, proceeding from the test results obtained with the MiG-29M2 prototype (see below), the designers took the decision to use a common forward fuselage design for the single-seat and two-seat versions, and the manufacturing documents were amended accordingly. By the end of 2004 the prototype construction shop of RSK MiG's Engineering Centre had completed six forward fuselage assemblies of the new naval fighter – five in two-seat configuration (*izdeliye* 9.47) and one single-seater (*izdeliye* 9.41).

In early 2005 two prototypes – a MiG-29K and a MiG-29KUB – had reached an advanced stage of construction; these are to be completed to full production standard and be used in the manufacturer's flight test programme. Static and fatigue test airframes are also under construction. The first prototype MiG-29KUB is expected to enter flight test in December 2005 or early 2006, the prototype of the single-seat MiG-29K (*izdeliye* 9.41) following in the spring of 2006. Pavel N. Vlasov (Hero of Russia), Director of RSK MiG's flight test facility, has been appointed project test pilot.

Kommersant

▲
RSK MiG General Director Aleksey Fyodorov (left) shows the partially completed MiG-29KUB prototype to Indian Minister of Defence Pranab Mukherjee (centre) during the latter's visit to RSK MiG in late 2005.

28 test rigs are to be built under the MiG-29K/KUB programme at RSK MiG's Engineering Centre, GosNII AS and at several test ranges. Among other things, GosNII AS is constructing an avionics/weapons integration rig for the new aircraft as a high-priority project. This rig is unusual in that both Russian and foreign-made systems and interfaces are installed and need to 'learn a common language'. These include navigation equipment (among other things, a satellite INS), the radio altimeter, the IFF transponder, the HMS, ECM equipment and more. The Russian avionics designers know from experience that proper integration of avionics sourced from far and wide is possible only on such specialised rigs.

The GosNII AS avionics/weapons integration rig features a unique module developed by GosNII AS and simulating radar returns from multiple moving aerial or ground targets (for testing and debugging the Zhuk-ME radar), an IR target simulator for testing IRST/LR units, an ECM environment simulator and wide-angle visualisation systems. The latter turn the rig into a flight simulator for perfecting the techniques of engaging aerial and ground targets within the

▲ The 1/4th scale gliding model built by LII to explore the control characteristics of the MiG-29M2. It is catapult-launched and lands on a parachute at the end of the mission.

A three-view of the MiG-29M2 two-seat multi-role fighter. ▼

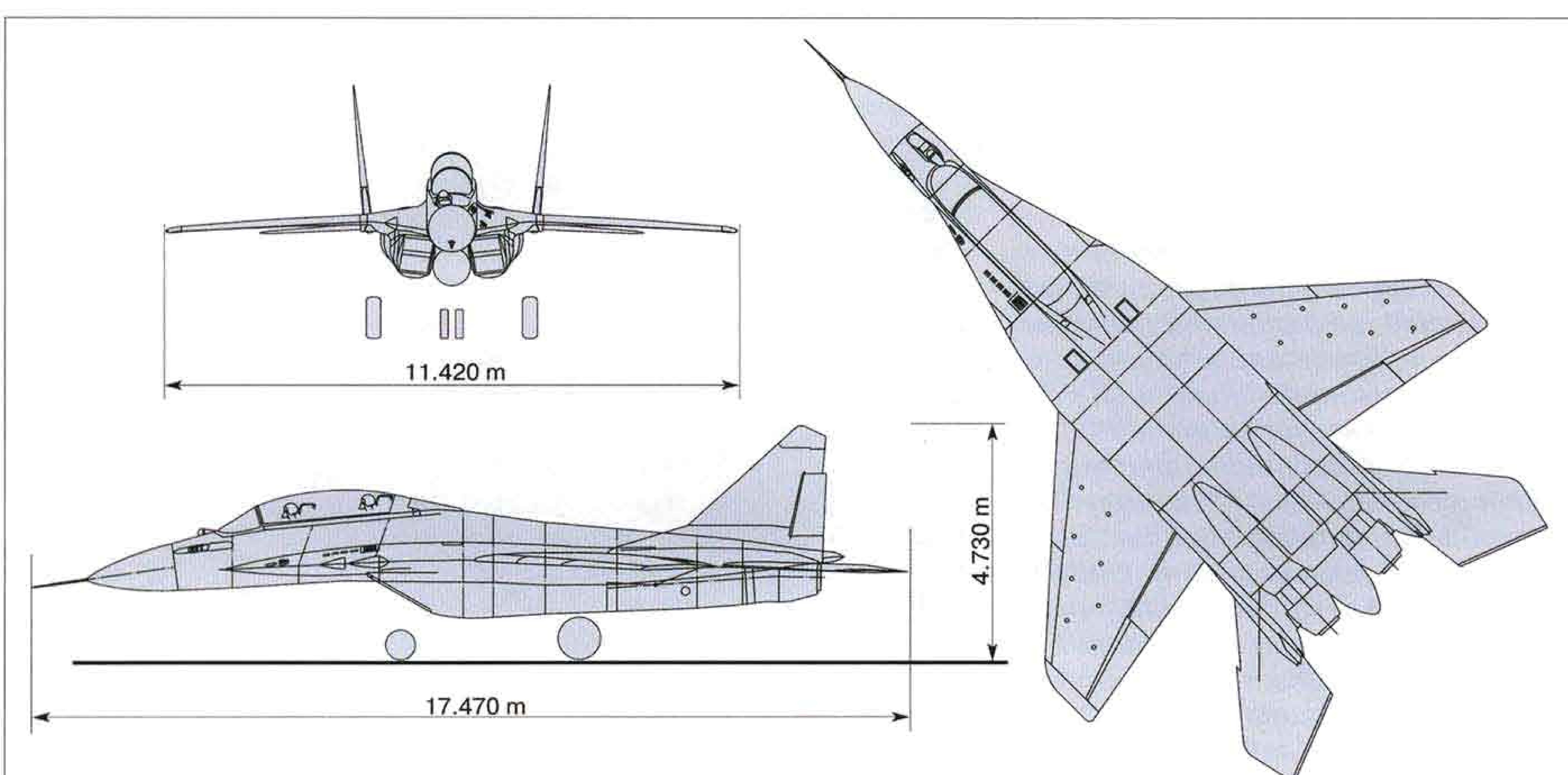
pilot's field of view. The rig also simulates the external stores carried by the fighter, allowing the weapons use options to be tested (this also includes simulation of miscellaneous malfunctions). It also allows the navigation/attack suite's multiplex data exchange channels to be monitored.

Special workstations forming part of the rig serve for testing the avionics' integration with the actual armament control modules responsible for missile launch. A further workstation is set aside for testing the new Karat-B29K system developed jointly by the Kursk-based ***Avia**avto**matika*** (Automatic Aviation Devices) OKB and GosNII AS. This system combines the functions of built-in test equipment (BITE), systems monitoring equipment and the flight data recorder/cockpit voice recorder with a protected solid-state memory module, capturing flight data, systems failure warnings and the pilot's air-to-ground or air-to-air communications on a common medium. Together with the other avionics installed on the rig, the Karat-B29K workstation allows all possible malfunctions of the MiG-29K/KUB's avionics suite to be simulated.

A special data processing centre built around high-performance versatile computers and high-speed data exchange channels coordinates the operation of the rig's assorted components. The accurate rendering of the fighter's movement and the missiles' (or bombs') movement, together with the rig's ability to simulate real-life tactical situations, makes it possible to train future MiG-29K/KUB pilots, allowing the aircraft's capabilities to be used fully.

The test/integration rigs developed by GosNII AS cut development costs considerably and save a lot of time, ensuring that the end result is a highly efficient avionics suite.

Until the MiG-29K (*izdeliye* 9.41) and MiG-29KUB (*izdeliye* 9.47) prototypes are ready to fly, RSK MiG uses other *Fulcrums* in the programme. As already mentioned, in 1999-2000 the two MiG-29K (*izdeliye* 9.31) prototypes were returned to airworthy condition, making more than 200 flights by December 2004. '311 Blue' was used for practising the take-off and landing techniques and testing the modified



Pavel Novikov

◄ **The MiG-29M2 prototype ('154 White') sits in front of the Mikoyan hangar at Zhukovskiy with smoke generator pods (similar to the American 'Smokewinders') on the outermost wing hardpoints.**

high-lift devices, while '312 Blue' served as a propulsion testbed for the RD-33MK engine and the new powerplant accessories. Additionally, as noted in the previous section, all three MiG-29SMT prototypes are used in the MiG-29K/MiG-29KUB programme, as are the MiG-29M2 and two MiG-29UBs (f/ns 1607 and 2410). The MiG-29SMTs act as avionics testbeds, since they have an identical central data processing unit, a similar INS and similar MFDs. The two-seat MiG-29M2 was used to explore the aerodynamics of the new forward fuselage, as well as for testing the control system, the ejection system, the air conditioning system, new air data sensors and, to a certain extent, the avionics. The MiG-29UBs were used for weapons tests with unguided rockets/bombs and precision-guided munitions (the Kh-29T and the KAB-500Kr). In all, the eight aircraft involved in the development of the new-generation shipboard *Fulcrum* made some 600 test flights in 2002-04.

MiG-29M Single-Seat Multi-Role Fighter (*Izdeliye* 9.61)
MiG-29M2 Two-Seat Multi-Role Fighter (*Izdeliye* 9.67)

The management and top design staff of RSK MiG regard the MiG-29M (in its current guise) and the MiG-29M2 as the new generation of the fighter's land-based versions. As of now, 1,500 production copies of the 'first-generation' MiG-29 (*Fulcrum-A/C* and MiG-29UB) have been built; while the MiG-29SMT (*izdeliye* 9.18) is regarded as the principal upgrade standard of today for existing aircraft, the MiG-29M and the MiG-29M2 are set to be the next new-production models. If enough orders are accumulated to resume production it will begin within a few years.

The single-seat MiG-29M (which, in its new guise, received the new in-house designation *izdeliye* 9.61 reassigned from the stillborn MiG-29UBM trainer) and the two-seat MiG-29M2 (*izdeliye* 9.67) are designed with the maximum possible degree of structural, avionics and armament commonality. As in the case of the MiG-29K (*izdeliye* 9.41) and the MiG-29KUB (*izdeliye* 9.47), both versions have an identical forward fuselage with a long canopy, the rear cockpit being occupied by an auxiliary fuel tank on the single-seater. Structurally and as regards equipment and armament the land-based MiG-29M and MiG-29M2 have a lot in common with the shipboard MiG-29K/KUB described above. Again, the workload distribution between the crewmembers of the MiG-29M2 ('front seat flies, back seat fires') enhances the aircraft's combat efficiency during strike/seek-and-destroy missions. Both versions will be equipped with the latest avionics and armament which, coupled with the excellent aerodynamics, will enable them to fulfil air defence/air superiority, overland or maritime strike and reconnaissance missions with success. The MiG-29M/M2 will be able to detect, identify and destroy well-protected aerial, ground and maritime targets in the daytime and

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▲
This view shows the MiG-29M2's stabilators (or tailerons) at maximum differential deflection for roll control, as well as the 'beaver tail' fairing and the dorsal airbrake.

►
As distinct from the MiG-29UB trainer, the canopy of the MiG-29M2 has no forward vision periscope for the back-seater. Here the aircraft is loaded with dummy Kh-31P, R-77 and R-73 missiles and KAB-500Kr bombs.

◄
The grey/green splinter camouflage of the MiG-29M2 does not extend to the vertical tails, which carry the stylised 'lightning bolt' 'MiG' titles. The tactical code '154 White' reveals this is a conversion of MiG-29M '154 Blue'.

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▲ Close-up of the MiG-29M2's forward fuselage, showing the fully retractable IFR probe. Note the custom-made boarding ladder with a side platform enabling the WSO to climb into the rear cockpit without slipping on the LERX.

at night, in any weather and in an ECM environment, operating singly or as part of a group.

The chief difference between the MiG-29M (*izdeliye* 9.61) and the MiG-29K (*izdeliye* 9.41) – and, accordingly, between the MiG-29M2 (*izdeliye* 9.67) and the MiG-29KUB (*izdeliye* 9.47) – is that the MiG-29M and MiG-29M2 lack the wing folding feature, reinforced landing gear and arrester hook of the naval versions. The wings, with their eight hardpoints, and the landing gear match those of the MiG-29M (*izdeliye* 9.15), giving a weight saving of some 800 kg (1,760 lb); the MiG-29M (*izdeliye* 9.61) will have a take-off weight around 17,850 kg (39,350 lb). In other words, implementation of this programme will result in a unique foursome of Generation 4+ combat aircraft (the shipboard MiG-29K/KUB and the land-based MiG-29M/M2) having 90% commonality. This approach offers several important advantages, cutting production costs (and hence the flyaway price), simplifying operational procedures (including flight and ground crew training), facilitating spares procurement and streamlining the operator's fleet. This, together with the high flight performance and combat potential, makes the new-generation MiG-29 family a strong player on the world fighter market.

Importantly, the MiG-29M (*izdeliye* 9.61) and the MiG-29M2 have considerable commonality with the MiG-29SMT (*izdeliye* 9.18) as regards avionics and armament. This means that most of the test flights performed by the MiG-29SMT and the MiG-29K (*izdeliye* 9.41) will earn certification points for the MiG-29M/M2 as well, greatly speeding up the latter models' certification and production entry.

Many prominent Russian aviation and electronics industry enterprises and R&D establishments cooperate with RSK MiG in the course of the MiG-29M/M2 programme. Specifically, as mentioned above, GosNII AS is working on avionics/armament integration rigs which ensure high efficiency at minimum cost in terms of time and money.

A few words need to be said about the systems and equipment of the MiG-29M/M2. Like the MiG-29K/KUB, these versions have a quadruplex FBW control system. Currently (pending installation of the envisaged thrust-vectoring engines, which will be dealt with a while later) the MiG-29M2 prototype ('154 White') retains the SDU-915-01 control system developed for the original MiG-29M. This is no surprise, since the aircraft is a conversion of the fourth prototype *izdeliye* 9.15 ('154 Blue'); the machine was converted *in situ* by the 929th GLITs at Vladimirovka AB by grafting a MiG-29UB style cockpit section onto the former single-seater; the dogtooth on the stabilator leading edges and the lack of a forward-vision periscope are the giveaway that '154 White' is a MiG-29M with an added cockpit, not a MiG-29UB with an added radar.

Later, when the intended RD-33MK engines with KLIVT vectoring nozzles are installed, the MiG-29M/M2 will feature the SDU-915OVT control system (OVT = *otklo**nya**yemyy* ***vek**tor* ***tya**ghi* – thrust vector control); the new version was developed by MNPK Avionika, the main contractor for the previous FBW control systems, jointly with the Elara JSC. The new version is basically the SDU-915-01 augmented by a quadruply redundant digital processor responsible, among other things, for controlling the vectoring nozzles in accordance with stick and pedal movements; this makes for efficient control of the aircraft at minimum airspeeds and extreme angles of attack.

As already mentioned in the MiG-29K/KUB section, the avionics have an open architecture based on the MIL-STD-1553B digital databus, which allows avionics and weapons of non-Russian origin to be integrated at the customer's demand. Once again, RPKB acts as the MiG-29M/M2's systems integrator.

The new fighter family's WCS includes a multi-mode radar (featuring air-to-air, air-to-surface and ground mapping modes), a new IRST/LR unit and a helmet-mounted sight. The original plans called for the MiG-29M (*izdeliye* 9.61) and the MiG-29M2 to be equipped with the same Phazotron Zhuk-ME radar as the MiG-29K (*izdeliye* 9.41) and the MiG-29KUB. In fact, the MiG-35 (the proposed export version of the

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MiG-29M/M2) will probably be submitted for the Indian Air Force's fighter tender, of which more will be said later, with this radar. Recently, however, the Moscow Institute of Instrument Engineering named after Viktor V. Tikhomirov (NIIP – *Na**ooch**no-is**sled**ovatel'skiy insti**toot** pri**bor**ostro**yen**iya*) has been aggressively marketing the new Bars-29 phased-array radar which has been displayed at several major international airshows, including Aero India-2005; the radar's name means 'leopard'.

NIIP, which is now part of the ***A**erokos-**mich**eskoye obo**roo**dovaniye* (Aerospace Equipment) corporation, is one of Russia's main radar houses and a famous company with a long history. It was this establishment that created the unique RP-31 *Zas**lon*** (Shield) WCS for the MiG-31 *Foxhound* heavy interceptor in the 1970s (the capabilities of this aircraft and its radar remained unmatched for many years) and the WCS of the Su-27 fighter. Later, in the 1990s, NIIP used the know-how gained in these

▲
The landing gear is just beginning to retract as the MiG-29M2 takes off from runway 12 at Zhukovskiy.

Mikoyan test pilot Belyayev engages the smoke generators at the start of a demonstration flight at the 929th GLITs's 75th anniversary celebrations on 21st September 2005.
▼

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programmes to create the N011 radar for the Su-27M (Su-35) multi-role fighter; this soon evolved into the N011M Bars phased-array radar which entered production and is fitted to the Su-30MKI and Su-30MKM export multi-role fighters.

The Bars-29 radar is a version of the N011M featuring a smaller antenna array which fits inside the narrower nose of the MiG-29 (hence the designation). The design ideology and the proven software of the radar remain unchanged but new electronic components are used in the radar set; this, together with the smaller antenna, saves weight and increases the radar's reliability.

NIIP makes no secret of the fact that the Bars-29 was designed as a competitor to the Zhuk-ME specifically with the MiG-29M/M2 and the Indian tender in mind. Currently the Indian Air Force is seeking to purchase 126 imported and/or locally produced fighters under the Multi-Role Combat Aircraft (MRCA) programme. This is a clever move, since the Su-30MKI is currently the Indian Air Force's main fighter type and any kind of component commonality between different aircraft types would be welcomed by the IAF; also, the N011M radar is due to enter licence production in India. (Incidentally, the MiG-29M2 prototype originally carried 'MRCA' titles on the fins, which caused many a raised eyebrow when it was unveiled at the MAKS-2001 airshow on 14th-19th August 2001; the MRCA designation originally applied to the Panavia Tornado IDS fighter-bomber.)

While we are on the subject of radars and the IAF, the N011M Bars has earned a good reputation in India, a country which traditionally buys military hardware from the East and the West alike and is thus in a position to compare Russian and Western products. Now the Bars-29 (which has been dubbed, rather unkindly, Barsik – a common name for a mongrel tomcat – in its home country) is almost equal to the 'Big Bars' in terms of performance. This radar will expand the MiG-29M/M2's combat potential appreciably.

In air-to-air mode the Bars-29 fire control radar has the following functions:

• tracking and illumination of aerial targets and simultaneous missile attack of up to four threats in BVR combat;

• tracking a single target and guiding AAMs towards it in a dogfight;

• tracking and attack of enemy ECM aircraft.

In air-to-surface mode the Bars-29 has the following functions:

• ground mapping in actual beam mode;

• ground mapping in Doppler beam narrowing mode;

• ground mapping in synthetic aperture mode;

• selection of moving ground targets;

• tracking (and coordinate computation) of one or two ground targets, including moving targets

• tracking one ground target while scanning the airspace, with the ability to engage one aerial target;

• tracking one or two maritime targets and attacking them, one at a time, with Kh-31A missiles.

In track-while-scan mode the Bars-29 is able to track up to 15 aerial targets. The new capabilities of this radar (hitherto demonstrated only by the larger N011M Bars) include the ability to determine the class of the aerial targets in track-while-scan mode by their spectrum characteristics; up to ten targets at a time may be classed as fixed-wing aircraft, helicopters or cruise missiles.

The MiG-29M2 streams spectacular smoke spirals generated by the wingtip vortices. ▼

Opposite page: Highlights from the MiG-29M2's flying display featuring loops, tailslides and tight turns. Note the vortices coming off the LERXes.

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The Bars-29 scans an area of ±70° in azimuth and ±40° in elevation; scanning in azimuth is both electronic (within ±40°) and mechanical (the antenna array tilts through ±30°). In head-on mode a typical fighter-type target with an RCS of 5 m^2 (54 sq ft) can be detected at a maximum range of 100 km (62 miles) in open airspace and 85 km (53 miles) in look-down mode; in pursuit mode the range is reduced to 50 km (31 miles) and 45 km (28 miles) respectively. A large ship, such as an aircraft carrier, with an RCS around 50,000 m^2 (537,640 sq ft) can be detected at up to 170 km (105.5 miles). In air-to-ground mode, bridges and other large structures are detected at 80-120 km (50-74.5 miles), while a Pershing-2 theatre ballistic missile on its launcher or a group of tanks can be detected at 40-50 km (25-31 miles). Ground targets travelling at 15-80 km/h (9.3-50 mph) can be selected at a range of up to 75 km (46.5 miles).

The Bars-29 has a phased-array antenna of 620 mm (2 ft 0$\frac{13}{32}$ in) diameter, which allows the radar to be fitted to the MiG-29 or even the MiG-23 *Flogger* (if someone should want to upgrade it), as well as to non-Russian types – the Shenyang J-8 II, Shenyang J-10, Dassault Mirage 2000 and others. In the configuration offered to the IAF the radar's data processing facilities comprise the Russian-made Ts551I programmable signal processor and two digital computers of Indian design and manufacture (the RC-1 and RC-2). Should an official order for the Bars-29 be secured, the radar will be produced by the same Ryazan' State Instrument Plant that builds the N011M.

The new IRST/LR unit featuring a state-of-the-art infrared sensor, a laser rangefinder and a hemispherical fairing made of leucosapphire offers high performance and is capable of detecting aerial targets in both head-on and pursuit mode. The laser rangefinder/target designator can be used against aerial and ground targets alike. The helmet-mounted sight is likewise more advanced than the Shchel'-1UM used hitherto; it provides target information to the missiles' seeker heads and projects flight/navigation and target information right into the pilot's eyes, regardless of which way he is looking.

The cockpits are broadly similar to those of the MiG-29K/KUB, featuring the same large full-colour MFDs and utilising the HOTAS (hands on throttle and stick) principle.

As on the MiG-29K/KUB, the navigation/attack suite of the MiG-29M/M2 incorporates ring laser gyros and built-in satellite navigation

The MiG-29M2 makes a knife-edge pass. ▼

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▲ **The MiG-29M2 performs a barrel roll, showing off its splinter camouflage.**

receivers, as well as radio navigation aids and other equipment enabling quick and accurate positioning and computation of the aircraft's motion parameters, the data being fed to relevant systems. The navigation/attack suite allows a mission profile prepared personally by the pilot on a computer to be uploaded from a flash card; the digital map saved in the profile will be displayed on the MFDs.

The communications suite comprises a UHF radio and a VHF radio, one of which can operate in data link mode. The integrated ECM/ESM suite includes an RHAWS, an active jammer, a missile warning system (MWS), a laser illumination warning system and chaff/flare dispensers. The MiG-29M/M2 is equipped with an oxygen generator, the new KSA-33 two-section engine accessory gearbox and twin VK-100 APUs, and the FOD prevention grilles which are more effective than the forward blocker doors and dorsal inlets.

The armament of the MiG-29M/M2 is identical to that of the MiG-29K/KUB, including the ability to carry Kh-31A and Kh-35E anti-shipping missiles. Guided and unguided weapons of non-Russian origin may be integrated at the customer's demand.

The combat radius of the new fighter family is considerably greater than the standard *Fulcrum-A/C*'s thanks to the increased internal and external fuel capacity and the provision of IFR capability. The IFR probe is compatible with Russian and Western tankers alike. The aircraft will also have 'buddy' refuelling capability. The MiG-29M/M2's range on internal/external fuel (unrefuelled) is estimated as 1,650-1,800 km (1,024-1,118 miles).

The MiG-29M/M2 is to be powered by uprated engines with FADEC and a low smoke signature derived from the RD-33MK powering the MiG-29K/KUB; the principal change as compared to the RD-33MK is the addition of KLIVT all-axis vectoring nozzles (see next section). The addition of thrust vectoring control (TVC) will not only assist control during manoeuvres, giving the fighter superagility (sustained flight capability at extreme AOAs and low speeds) but also help to stabilise the aircraft around all three axes in normal flight, reducing the trimming requirements and hence the fuel burn. TVC will provide high roll rates and increase directional control efficiency at high AOAs where the conventional control surfaces have insufficient authority; it will also improve the

▲ **Even without thrust vectoring, the MiG-29M2 displayed high agility.**

pitch rate. The use of engines with all-axis vectoring nozzles will allow the pilots to fly the MiG-29M/M2 more confidently both in normal flight modes and in superagility mode, not being encumbered by AOA limitations. This will give the fighter an advantage in a dogfight and reduce the pilot workload, allowing the pilot to concentrate on the mission.

The cumulative effect of these design changes increases the MiG-29M/M2's combat potential over the *Fulcrum-A/C* by a factor of 2.5-3.5 in strike mode and 1.7-1.8 in air-to-air mode.

It should be noted that Russia pledges to provide uninterrupted product support to hypothetical export customers for the MiG-29M/M2. This means maintenance and supplies of spares, accessories and ground support equipment over a period of at least 40 years after the final aircraft rolls off the assembly line.

Speaking of customers, theoretically the Russian Air Force could order the MiG-29M/M2, given the proper funding. However, a number of other nations traditionally operating Soviet/Russian military hardware are far more likely to order it – first and foremost India.

The Indian Air Force's most ambitious programme for the current decade is arguably the MRCA programme. It envisages the purchase and licence production of a total of 126 modern multi-role fighters to supplant the MiG-23MF (known locally as the Rakshak and now being phased out by the IAF) and to complement the IAF's MiG-29s and Mirage 2000Ns. In the IAF's prospective three-tier structure the MRCA is to occupy a position between the HAL LCA light combat aircraft and the upgraded MiG-21*bis* (at the lower end of the scale) and the heavy Su-30MKI.

On 28th December 2004 the Indian Ministry of Defence officially confirmed its intention to hold a tender under the MRCA programme in 2005. Requests for proposals were sent to RSK MiG, Dassault Aviation, Lockheed Martin and SAAB/BAe; this meant that the MiG-29 was on the shortlist together with the Mirage 2000, the F-16 Fighting Falcon and the JAS39 Gripen.

The future tender was one of the main sources of intrigue at the Aero India 2005 airshow at Yelahanka AB near Bangalore. Of the four contenders only the MiG-29M2 put in an appearance, which bolstered its chances immediately. Defence experts believe that the Gripen's chances of securing an Indian contract are low, while the prospects of F-16 sales to India are dubious for political reasons (the type is already operated by Pakistan, India's arch enemy). Thus the tender boils down to a choice between the MiG-29 and the Mirage 2000; both types are already operated by the IAF and have their supporters among the Indian MoD top brass and in the Indian government.

At the Aero India 2005 show, RSK MiG announced its plans to submit the latest versions of the *Fulcrum* – the single-seat MiG-29M and the two-seat MiG-29M2 – for the Indian tender. Both versions are to enter production towards the end of the decade. Later, at the MAKS-2005 airshow, RSK MIG General Director Aleksey Fyodorov said that the version submitted for the Indian tender would be called MiG-35. No details of the fighter's systems and equipment were disclosed, except that the MiG-35 will be powered by the thrust-vectoring version of the

RD-33MK. Actually it is a bit too early to discuss technical details, considering that India hasn't made the choice yet; it remains to be seen whether the 'pro-MiG' lobby or the 'pro-Mirage' lobby wins.

The MiG-35's strong points in this tender are, firstly, its considerable commonality with other Russian types operated by the IAF as regards avionics and armament – and, importantly, with the MiG-29K/KUB ordered by the Indian Navy for the carrier wing of the recently acquired INS *Vikramaditya*. Secondly, RSK MiG has a long history of cooperation with HAL which has been building Mikoyan types under licence for years and is due to master licence production of the RD-33 engine. Finally, the MiG-35 is going to cost less than its Western competitors.

The contract with the winner of the tender (which, according to estimates, will be worth US$ 4.5 billion) is expected to be signed in 2006 or 2007. However, India is notoriously slow... well, let's put it differently: cautious in making such important decisions and the final verdict may be postponed.

MiG-29OVT Development Aircraft

The highlights of the MAKS-2005 airshow included a breathtaking flying display by a development aircraft presented by RSK MiG – the MiG-29OVT experimental super-agile multi-role fighter (OVT = *otklo**nya**yemyy* ***vek****tor* ***tya****ghi* – thrust vector control) flown by the corporation's CTP Pavel N. Vlasov. Actually the fighter ('156 White') had been unveiled at the MAKS-2001 airshow... but more on that later. The aircraft, which had been converted from the final prototype of the MiG-29M (*izdeliye* 9.15) – in effect, a pre-production example, – was really a propulsion testbed meant to verify a version of the RD-33 engine fitted with an all-axis vectoring nozzle. In other words, '156 White' was a TVC (thrust vector control) technology demonstrator – or a control configured vehicle (CCV).

The story began in the mid-1990s when NPO Klimov commenced development of its own TVC concept as an answer to the rival Lyul'ka-Saturn design bureau's AL-31FP thrust-vectoring afterburning turbofan created for the Su-27 family. NPO Klimov's vectoring nozzle was intended for light fighters and branded KLIVT (***Kli****movskiy* ***vek****tor* ***tya****ghi* or Klimov's Vectoring Thrust). The same enterprise, as the reader knows, had developed the RD-33 afterburning turbofan in the mid-1970; this engine had been progressively modified over the years to increase its service life, improve reliability, increase the thrust and cut the fuel consumption. However, while addressing these burning issues (no pun intended), the designers had been working on long-term development projects; one of these was a thrust-vectoring version of the RD-33.

After analysing the TVC research undertaken in the Soviet Union and abroad by then, the engineers of NPO Klimov concluded that tilting the entire axisymmetrical nozzle (as was the case with the AL-31FP) was inexpedient; it made more sense to deflect the nozzle's supersonic section (the petals). This option made the design not only simpler and lighter but also reduced the deflection time – and, most importantly, allowed the nozzle petals to move in any direction, not just in the vertical plane. All the petals of the supersonic section were deflected at the required angle simultaneously, the motion being imparted via push-pull rods from a single control ring; this, in turn, was powered by three hydraulic actuators located at equal intervals on a fixed ring fitting around the afterburner. The position of the actuator rams rigidly determined the spatial orientation of the control ring and hence the position of the nozzle petals and the thrust vector. The actuators were enclosed by relatively compact fairings. Because of the additional forces applied to the engine casing and the nozzle during thrust vectoring, some elements of the afterburner had to be reinforced.

A number of other changes were to be introduced into the design of the RD-33 concurrently with the vectoring nozzle. The engine was to receive a new FADEC system and be uprated from 5,040 to 5,600 kgp (from 11,110 to 12,345 lbst) at full military power and from 8,300 to 9,000 kgp (from 18,300 to 19,840 lbst) in full afterburner. In this guise the engine was initially known as the RD-133, making its public debut at the ***Dvig****ateli-98* (Engines '98) exhibition in Moscow; the following year the engine was on display again at the MAKS-99 airshow in Zhukovskiy. In the late 1990s NPO Klimov had plans to develop modernised versions of the RD-33 delivering up to 10,000-12,000 kgp (22,045-26,455 lbst) in full afterburner. At various airshows and industry fairs these projects were announced as the RD-333, RD-33-10M and VKS-10M (the S was a reference to Sarkisov, the project chief). Later, however, the company reverted to displaying the RD-133, which was merely a production RD-33 mated to a KLIVT nozzle. Recently the RD-133 designation was dropped altogether, the engine being referred to simply as the 'thrust-vectoring RD-33'.

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▲ In 2001 the sixth prototype MiG-29M was modified to become the MiG-29OVT demonstrator.

When unveiled at the MAKS-2001 airshow the MiG-29OVT had wingtip missile rails in the fashion of the F-16 or the SAAB Gripen. ▼

The first prototype of the KLIVT nozzle had been completed by early 1997. After installation on an RD-33 engine the nozzle underwent 50-hour bench tests, which involved close to 1,000 changes of the thrust vector in various operating modes, including full afterburner. The vectoring angles were ±15° in all directions; the maximum angle speed was eventually increased from an initial 30°/sec to 60°/sec.

Flight tests of the thrust-vectoring engine on a suitably modified MiG-29 were to commence in late 1997, but even then, when the Russian bank crisis had not yet struck, the prospective customer (the Russian Air Force) was unable to fund the project and the work was halted. In 2001 two non-functional RD-133s were installed on MiG-29M '301 Blue' (ex-'156 Blue'). Built in July 1991, this aircraft had made 86 flights when the programme was suspended in September 1993.

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After that the aircraft was mothballed and remained on the ground for nearly ten years (although in August 1995 it had an 'outing' in the static park of the MAKS-95 airshow as '301 Blue'). Eventually it was reactivatd in 2001 for testing the RD-133 engine, making its debut at the MAKS-2001 airshow. The fighter was repainted for the occasion, receiving a two-tone grey camouflage strikingly similar to the USAF's 'Egypt One' scheme, with Cyrillic '29OVT' titles on the fins, and became '156 White' (the original code remained on the fin caps). Concurrently, launch rails for R-73E AAMs were added to the wingtips in the manner of the F-16.

▲
At MAKS-2001 the MiG-29OVT was displayed in this USAF-style grey camouflage scheme.

The vectoring nozzles were non-functional at first. Here '156 White' is seen with ordinary RD-33s.
▼

Victor Drushlyakov

Yefim Gordon

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◄ Four views of the MiG-29OVT, finally fitted with flight-cleared thrust-vectoring engines in 2003 and painted in this smart display colour scheme. Note that the wingtip missile rails are gone. The centre photo on the opposite page shows '156 White' taxying at Zhukovskiy in August 2003 with Pavel Vlasov at the controls.

▲ The non-standard MiG logo on the port intake of the MiG-29OVT.

Two years later '156 White' finally received a shipset of flight-cleared RD-133s and a smart new paint job in the national colours of white, blue and red with 'lightning-style' 'MiG' titles and a huge red star on the upper fuselage; the normal wingtips were reinstated in so doing. In August 2003 test pilot Pavel Vlasov took the re-engined fighter into the air for the first time. When the MAKS-2003 airshow opened a few days later, the MiG-29OVT had not yet logged enough flight hours to be admitted to the flying display and thus stayed firmly on the ground. At the show it was announced that future production MiG-29Ms and MiG-29M2s would be powered by similar thrust-vectoring engines, while the data placard in front of the aircraft said the MiG-29M/M2 would have the 9,000-kgp thrust-vectoring version of the RD-33MK.

By early August 2005 RSK MiG test pilots Pavel Vlasov and Mikhail Belyayev had made more than 50 flights in '156 White' in which the TVC system was put through its paces and its integration with the FBW control system was verified. This prompted the decision to demonstrate the aircraft at the MAKS-2005 airshow. Those who witnessed the aircraft's

This 'OVT' badge on the starboard intake shows the MiG-29OVT's all-axis thrust-vectoring capability. ▼

Dmitriy Komissarov

Yefim Gordon

◄ Close-up of the MiG-29OVT's distinctive KLIVT nozzles with three actuator fairings installed at 120° intervals. Note that the legends on the inner faces of the fins read 'OVT' (in Russian) to port and 'VTC' (vectoring thrust control) to starboard.

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Lightnings R Us (and thunder, too). The lightning decor has become a distinctive feature of the company's MiG-29 demonstrators; the titles on the inside of the starboard fin are in English. Note that the IRST 'ball' has been removed.


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▲ As an APA-100 based on a Ural-4320-0611 chassis provides ground power, RSK MiG chief test pilot Pavel Vlasov dons his PPK-3 G-suit for a demonstration flight in the MiG-29OVT at Zhukovskiy on 5th August 2005.

►▲ Under the watchful eyes of his crew chief Pavel Vlasov climbs into the cockpit.

demonstration flights at the show said the MiG-29OVT was at least equal, or maybe even superior, in manoeuvrability to the super-agile Su-30MKI which had by then become a regular airshow performer; the aircraft could do loops and spirals literally around its own nose. However, there's more to it than just spectacular and unique aerobatics at an airshow; RSK MiG Chief Designer Nikolay N. Boontin, who is in charge of the MiG-29K/KUB, MiG-29M/M2 and MiG-29OVT programmes, says that all-axis thrust vectoring control endows the new MiG with entirely new capabilities both in normal flight modes and in superagility mode.


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► Pavel Vlasov sits in the cockpit of the MiG-29OVT, awaiting take-off clearance while other pilots practise for the MAKS-2005 airshow, then two weeks away.

The airframer and the engine maker alike were entirely happy with the results obtained with the MiG-29OVT. The specialists involved in the test programme believe that production of the thrust-vectoring RD-33 could begin right away for the future new-build MiG-29M (*izdeliye* 9.61) and MiG-29M2 (*izdeliye* 9.67). Five such engines had been manufactured by August 2005; two of them were in use for bench tests, two more had been fitted to the MiG-29OVT. The fifth engine (manufactured as a spare) found itself unwanted – the two examples fitted to '156 White' behaved faultlessly.

In the course of its research into thrust vectoring control NPO Klimov came to the conclusion that the design of the KLIVT nozzle can be adapted to other engine types, including Western ones. The MiG-29M/M2 and its derivatives with TVC may find a market both in Russia and abroad; among other things, the thrust-vectoring MiG-35 has been entered for the Indian Air Force's MRCA tender.

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▲ **Afterburners blazing and smoke generators on, the MiG-29OVT pulls up into a loop at the MAKS-2005 airshow.**

MiG-29BM Single-Seat Multi-Role Fighter ('*Izdeliye* 9.11')

Established in June 1992, the Belorussian Air Force took over all Soviet Air Force assets stationed in the former Belorussian Defence District, including 80-plus *Fulcrum-A/Cs*. In the 1990s, when the Belorussian Armed Forces downsized their materiel requirements considerably, a lot of fairly modern combat aircraft found themselves surplus to requirements, and some of them were put up for sale on the export market. As a result, by the turn of the century the Belorussian Air Force was left with just over 40 MiG-29s based at Byaroza (Beryoza) and Baranovichi. Drawing on the Russian experience gained with the MiG-29SMT 'Mk I' (*izdeliye* 9.17) in the late 1990s, Belorussia decided to upgrade part of its *Fulcrum* fleet. Although the Russian partners involved in the Belorussian upgrade have not been disclosed, it is easy to guess that Roosskaya Avionika is the company in question.

This view shows the large MiG logo and the English 'MiG' legend applied to the underside of the wings. Note how the colour division line runs across the inside of the main gear door. ▼

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▲ The MiG-29OVT's demonstration flights at the MAKS-2005 overshadowed those of its Sukhoi competitors; the machine could manoeuvre ► literally around its own nose. Note the wing vortices in the lower photo. ▼

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A sequence of snapshots from one of the MiG-29OVT's displays at Zhukovskiy. In addition to the usual manoueuvres and high-alpha/low-speed passes (centre left), the aircraft performed 360° turns with 90° bank (centre right) and literally hung in the air on the thrust of its engines, barely moving forward (bottom left and right).

►
Its twin brake parachutes thrashing in the engine exhaust, the MiG-29OVT vacates runway 30 at Zhukovskiy and is waved in to its parking space by the crew chief after a demonstration flight.

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It was this company that supplied the avionics for the first version of the MiG-29SMT which was tested in 1997 and subsequently brushed away by the 'new broom', as described earlier. Yet the effort was not wasted; at the start of the new century the original upgrade aroused the interest of the Belorussian military. As a result, the Republican Unitary Production Enterprise 'ARZ No.558' in Baranovichi assisted by Russian specialists quickly performed and tested not just one but three mid-life updates – the MiG-29BM and Su-27UBM1 fighters and the Mi-8MTKO1 assault/transport helicopter.

The MiG-29BM (*belo**roos**skaya moderni-**zah**tsiya* – Belorussian upgrade), also known unofficially in Belorussia as 'aircraft 9.11' (the

Pavel Vlasov climbs out of the cockpit and exchanges a few words with the crew chief.
▼

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558 ARZ/Air Fleet

Belorussian Air Force *Fulcrum-C* '05 Red' being upgraded to the MiG-29BM prototype at ARZ No.558 in Baranovichi, which owns it. Note the KAB-500Kr guided bomb and the B-13L FFAR pod under the port wing.

The same aircraft after the conversion, showing the fixed IFR probe and the new weapons pylons. The bold Belorussian flag on the tails is noteworthy; usually Belorussian AF aircraft wear Soviet-era red stars.

558 ARZ/Air Fleet

product code is obviously not authorised by RSK MiG, as it denotes a MiG-29 preliminary development project!), successfully completed its test programme by July 2003 and ARZ No.558 started performing the first upgrades of operational *Fulcrum-Cs* for the Belorussian Air Force's 61st Air Base. The mid-life update is performed concurrently with general refurbishment of the aircraft.

The MiG-29BM upgrade involves making changes to existing avionics/equipment and adding new avionics, expanding the range of compatible weaponry and providing in-flight refuelling capability. Specifically this means:

MiG-29BM '05 Red'

• R-77 (RVV-AE) and R-27ER/R-27ET medium-range AAMs are added to the list of air-to-air weapons (the standard MiG-29 can only carry R-27R/R-27T medium-range AAMs and R-60M and R-73 short-range AAMs). The R-27ER/R-27ET offers extended 'kill' range thanks to its longer-burn rocket motor. Two such missiles can be carried on the inboard wing pylons.

The range of precision-guided munitions used against ground or maritime targets is augmented by the Kh-29T/Kh-29TD TV-guided missile, the Kh-29L and Kh-25ML missiles with semi-active laser seeker heads, the Kh-31P anti-radiation missile and the Kh-31A anti-shipping missile, as well as the KAB-500Kr and KAB-500L 'smart bombs'. The MiG-29BM can carry two ASMs and two or four guided bombs. The L-150-22 guidance pod is carried if Kh-31P ARMs are used. Pending integration of an opto-electronic target designator pod, the MiG-29BM can use laser-guided PGMs (the Kh-29L, Kh-25ML and KAB-500L) only in conjunction with an external (aircraft-mounted or man-portable) laser designator.

The fire control radar has several additional operating modes. Designated N019P, the MiG-29BM's radar has overland and overwater look-down capability with the ability to detect single and multiple pinpoint or large-area targets with a high radar signature – that is, an RCS of 10-5,000 m² (107.5-53,760 sq ft). The radar then feeds the target coordinates to the seeker heads of PGMs. It enables the use of the new weapons, including the R-77 AAM and the Kh-31A anti-

▲
The Belorussian Air Force badge and a rather non-standard MiG OKB badge on the MiG-29BM.
▼

◄
Four Belorussian Air Force MiG-29BMs ('07 Red', '05 Red', '06 Red' and '03 Red') pass over Minsk during a military parade.

MiG-29BM '06 Black' (ex-'06 Red', c/n 2960715177) arrives at Zhukovskiy for MAKS-2005.
▼

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▲ **Two views of '06 Black' parked on the taxiway at Zhukovskiy. The non-retractable IFR probe is clearly visible.**

shipping missile. The existing 20PM6 weapons selector system is updated to cater for the additional weapon types.

The capabilities of the navigation suite are greatly enhanced. The suite can store the coordinates of up to 99 waypoints, radio beacons and airfields instead of just six, as on the standard aircraft. Also new is the ability to designate and store up to eight possible flight routes, position determination with an error margin of less than 80 m (260 ft) instead of 700 m (2,300 ft), ground speed computation with an error margin of 0.2 m/sec (0.65 ft/sec) and the ability to work with VOR/ILS navigation and landing aids on international airways. The new N-911 navigation suite comprises the MVK-NVG navigation computer, a satellite navigation receiver working with the Russian GLONASS and Western NAVSTAR systems, the A-323 SHORAN, and VOR/ILS and DME modules. The MiG-29BM retains the standard Ts-050 attitude and heading reference system (AHRS), the SVS-11-72-3-2i air data system, the A-037 radio altimeter, the SOS-1-3 angle-of-attack/G load limiter system, the KPP artificial horizon and the PNP-72-12 navigation display; modifications are made to the SAU-451-04 automatic flight control system.

The cockpit data presentation and input systems are upgraded. The obsolete IPV-2 monochrome CRT display for the radar and IRST/LR is replaced by an MFI-55 5 x 5" colour liquid-crystal MFD. The latter shows navigation, targeting and systems status data, as well as 'bomb's eye views' transmitted by the seeker heads of TV-guided PGMs (the Kh-29T/TD missile and the KAB-500Kr 'smart bomb'). The cockpit data presentation system also supplies the WCS and other avionics with inputs from the function keys surrounding the MFD. The MiG-29BM retains the standard SYel-31-1 joint data presentation system (less the IPV-2 display) which shows target information on the ILS-51 head-up display.

The built-in test equipment/crew alerting system and the flight data recorder are upgraded. The Ekran-OZM BITE/CAS is modified to monitor the additional equipment and download systems status information via digital data link to the ground-based Aïst (Stork) real-time data analysis system. The MiG-29BM is the first aircraft to have this capability; the Aïst supplies ground command, control and communications centres with real-time information on the systems status of a given 'friendly' aircraft, its current position and the targets it has detected. Additionally, the MiG-29BM introduces a powerplant and systems monitoring suite which records up to 1 Gb of flight data furnished by the Tester-UZL, Ekran-OZM and BPK-88 Srs 3KM on a hard drive for decoding and express analysis. The communications suite is augmented by an R-800L2 UHF radio.

A fixed S-shaped IFR probe was installed on the port side of the forward fuselage; it featured a GPT-2E versatile adapter which is compatible with both Russian and Western drogues. The IFR system allowed both the internal tanks and the three drop tanks to be refilled. Refuelling was possible in the daytime in VMC permitting visual

The MiG-29BM retains the standard number of hardpoints. ▼

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▲ **These views of MiG-29BM '06 Black' (c/n 2960715177) show the three-tone grey/green camouflage characteristic of the Belorussian *Fulcrums* overhauled by ARZ No.558.**

contact with the tanker, taking place at 2,000-8,000 m (6,560-26,250 ft) and speeds of 400-600 km/h (248-372 mph) or up to Mach 0.85. A single top-up extended the MiG-29BM's range by up to 80% and increases the endurance accordingly. The IFR probe did not hamper the aircraft's manoeuvres or its ability to deliver its weapons.

After conversion to MiG-29BM standard, new modules constitute 23% of the fighter's avionics and another 6% are subjected to modifications. The 'authors' of the upgrade believe that the integration of new avionics and weapons will increase the MiG-29BM's combat potential over the original aircraft by 80% in air-to-air mode and by a factor of 4 in strike mode. The overall combat potential (supposing a 50/50 mix of counter-air and strike missions) increases by a factor of 2.9. Thus the MiG-29BM surpasses some Western fighters of today; by comparison, the combat potential coefficient as compared to the original MiG-29 is 2.8 for the Eurofighter EF2000 Typhoon, 2.65 for the Dassault Rafale B and 2.05 for the SAAB JAS 39 Gripen. While being slightly inferior to the Typhoon and the Rafale in BVR air-to-air combat (the combat potential coefficient as compared to the original

MiG-29 is 1.8 versus 2.1 for the Typhoon and 1.9 for the Rafale), the MiG-29BM enjoys undisputed supremacy in strike mode (the combat potential coefficient is 4.0.

Five *Fulcrum-Cs* upgraded to MiG-29BM standard – '03 Red' (c/n 2960714345), '04 Red', '05 Red' (the prototype), '06 Red' (c/n 2960715177) and '07 Red' – made the new version's public debut in July 2004 during a military parade in Minsk; '07 Red' carried large Belorussian flags on the fins in addition to the red star which the Belorussian Air Force still uses. Belorussian President Aleksandr G. Lukashenko, who is known as a staunch supporter of the nation's Armed Forces, reacted with the following comment: 'Within a two-year period we have created unique machines, turning these fighters into attack aircraft.'

Repainted in a new three-tone camouflage and recoded '06 Black', MiG-29BM c/n 2960715177 made a surprise appearance at Zhukovskiy in August 2005 as a last-minute entry at the MAKS-2005 airshow. This created a veritable sensation; Belorussia, a country certainly not famed for openness (especially in military matters), had demonstrated to the world that it could, quickly and at relatively low cost, develop combat aircraft that were quite a match for contemporary Western types. The capabilities of the MiG-29BM upgraded by ARZ No.558 turned out to be broadly similar to those of the MiG-29SMT (*izdeliye* 9.18) currently offered for export by RSK MiG – and at a fraction of the latter aircraft's price. Also, unlike the Russian upgrade, the MiG-29BM has been operational for several years now (albeit only four are in service) – a fact that may win the favour of potential upgrade customers. It should be noted that ARZ No.558 has a wealth of experience with the type, having overhauled 86 MiG-29s since 1994. It was this plant that handled the MiG-29s sold by Belorussia to Peru and Algeria.

In the spring of 2005 the MiG-29BMs hit the headlines again when Belorussian Air Force pilots and their colleagues from ARZ No.558 set a string of world records. The idea had been floated by the Aviation Sports Federation of Belorussia (FAS – *Fede**rah**tsiya aviatsi**on**novo **spor**ta*). On 4th and 10th March three Air Force pilots, who took turns flying MiG-29BMs '06 Black' and '07 Red', set several speed and time-to-height records. This included climbing to

Front view of the MiG-29BM, showing the angle of the IFR probe.
▼

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▲ **Close-up of the MiG-29BM's IFR probe.**

▲ **The badge of the 558th ARZ features a MiG-29 silhouette.**

One more view of the IFR probe. ▼

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3,000; 6,000; 9,000 and 12,000 m (9,840; 19,685; 29,530 and 39,370 ft) with no payload or a 1,000- and 2,000-kg (2,204- and 4,409-lb) payload. In four flights the team set a total of 15 world records. It should be noted that no attempts to set a time-to-12,000 m no-load record, or closed-circuit speed records on 100-, 500- and 1,000-km (62-, 310- and 621-mile) circuits had been made in this class of aircraft before.

Of the 15 world records, twelve time-to-height records were established on 4th and 10th March by Pilot 1st Class Lt. Col. Vyacheslav Brovchenko, Senior Flight Safety Inspector of the Air Force and PVO. On 10th March Sniper Pilot Col. Aleksandr Bochkaryov, flight test facility chief at ARZ No.558, set the speed records on the 100- and 500-km circuits; a similar record on a 1,000-km circuit was set by Pilot 1st Class Maj. Yuriy Kovalyov, the Navigator of the 61st Air Base (Western Theatre & Tactical Command). Kovalyov also led a flight of MiG-29s at a military parade which was part of the V-Day 60th Anniversary festivities in Belorussia.

The parameters of the record-breaking flights were registered by Russian RAS representatives accredited in Belorussia in accordance with the FAI Sports Code. The results were judged as meeting FAI rules and submitted for official approval. On 6th May 2005 Belorussian Air Force C-in-C Lt. Gen. Oleg Paferov handed medals awarded for the flights to Lt. Col. Vyacheslav Brovchenko and the technicians involved in the flights.

Given the lack of a similarly upgraded trainer, the Belorussian Air Force nevertheless quickly resolved the issue of conversion training for the MiG-29BM. Roosskaya Avionika and ARZ No.558 joined forces to develop and build the KTS-MiG-29BM integrated flight simulator (***kom**pleksnyy **tre**na**zhor** samo**lyo**ta*); the first simulator has now been commissioned at the 61st Fighter Air Base in Baranovichi. The KTS-MiG-29BM enables simulation of day/night flights in any weather and region. The simulator features a fixed MiG-29BM cockpit with fully functional controls and indicators, the instructor/operator's workstation, a data processing suite and an auxiliary training station.

A projection system displays a detailed and realistic image of the sky, ground/sea and aerial/ground targets on a large wraparound projection screen spanning 120° in azimuth and 30-40°. At the instructor/operator's workstation featuring the simulator's controls, a screen shows the tactical situation superimposed on a terrain map, the aircraft's flight path, the 'view from the cockpit' (including the HUD and instruments) and information on the flight's dynamics and systems malfunctions. The data processing suite makes for interaction between the simulator's subsystems and simulates the flight, the operation of the aircraft's navigation suite, WCS, armament and so on and supplies the 'bad news' (simulated malfunctions). The auxiliary training station is a computer acting like the Microsoft Flight Simulator on your home PC, allowing formation flying to be practised.

The KTS-MiG-29BM allows pilots to master the use of the radar, IRST/LR and all kinds of weapons in air-to-air and strike modes. It also allows IFR techniques (including rendezvous with the tanker) to be mastered. Lately, however, all MiG-29BMs had the IFR probes removed due to a change in the nation's defence policy.

PART EIGHT

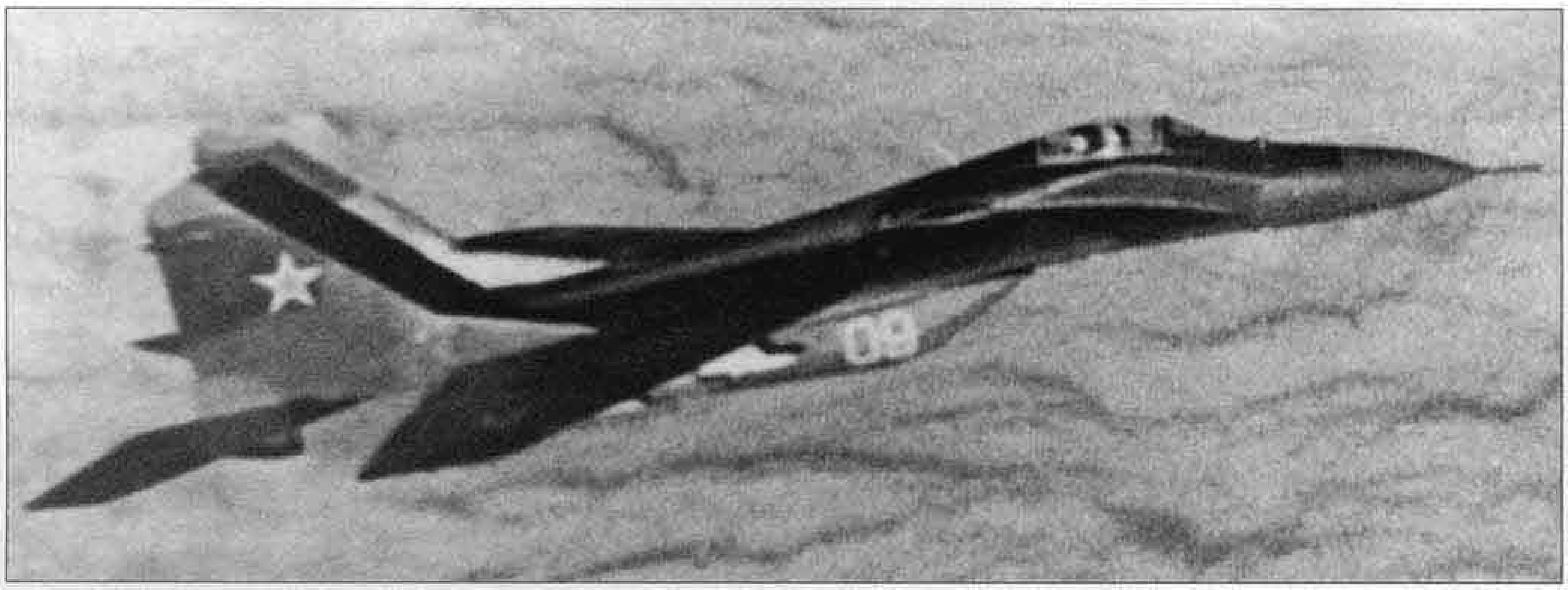
THE MiG-29 IN ACTION

The MiG-29 story would be sorely incomplete without an account of the aircraft's service career and combat operations.

Typically of the Soviet Air Force, the MiG-29 achieved initial operational capability (IOC) several months before the State commission signed the Act of acceptance formally clearing the fighter for service. The first unit to receive the production-standard *izdeliye* 9.12 fighter was the 455th Instruction and Test Composite Air Regiment (IISAP – *in**strook**torsko-ispy**tah**tel'nyy* ***smesh**annyy* ***a**via**polk***) constituting part of the Lipetsk-based 4th Combat and Conversion Training Centre (TsBP i PLS – *Tsentr boye**voy** podgo**tov**ki i pere**oo**chivaniya **lyot**novo sos**ta**va*) named after Valeriy P. Chkalov. This unit had traditionally been responsible for the conversion of the Soviet Air Force's flying personnel to new types of fighters. The Centre's main objective for 1983 had been set as training the pilots of the 234th Guards Fighter Regiment (GvIAP – *Gvar**dey**skiy istre**bi**tel'nyy **a**via**polk***) stationed at Kubinka airbase west of Moscow and the 968th Fighter Regiment (IAP), then based in the Belorussian town of Ross', to fly the MiG-29. The 4th TsBP i PLS was followed shortly afterwards by the 760th Training Centre based in nearby Voronezh; between them these two units took delivery of the first 37 operational *Fulcrum-As*.

Established in 1938, the 234th GvIAP bore the honorary appellation *Pros**koo**rovskiy* (awarded for the unit's contribution to liberating the Russian town of Proskoorovo during the Great Patriotic War of 1941-45) and was awarded the Red Banner, Kutuzov and Aleksandr Nevskiy Orders. While it was chosen as the first service unit to master the MiG-29, this regiment was in fact a 'showcase' unit that traditionally demonstrated new Soviet fighter types to members of the Soviet government and potential foreign customers.

Apart from the unit's elite Guards status, which was awarded only for special gallantry in actual warfare (thus being another indication that this is a World War Two-vintage unit), the 234th GvIAP's special position was due to the fact that the famous ace Ivan N. Kozhedoob, who had earned three Hero of the Soviet Union (HSU) titles in the war and now had considerable clout in the upper echelons of the Air Force, had served with this unit. It may as well be said now that in post-Soviet days the regiment was

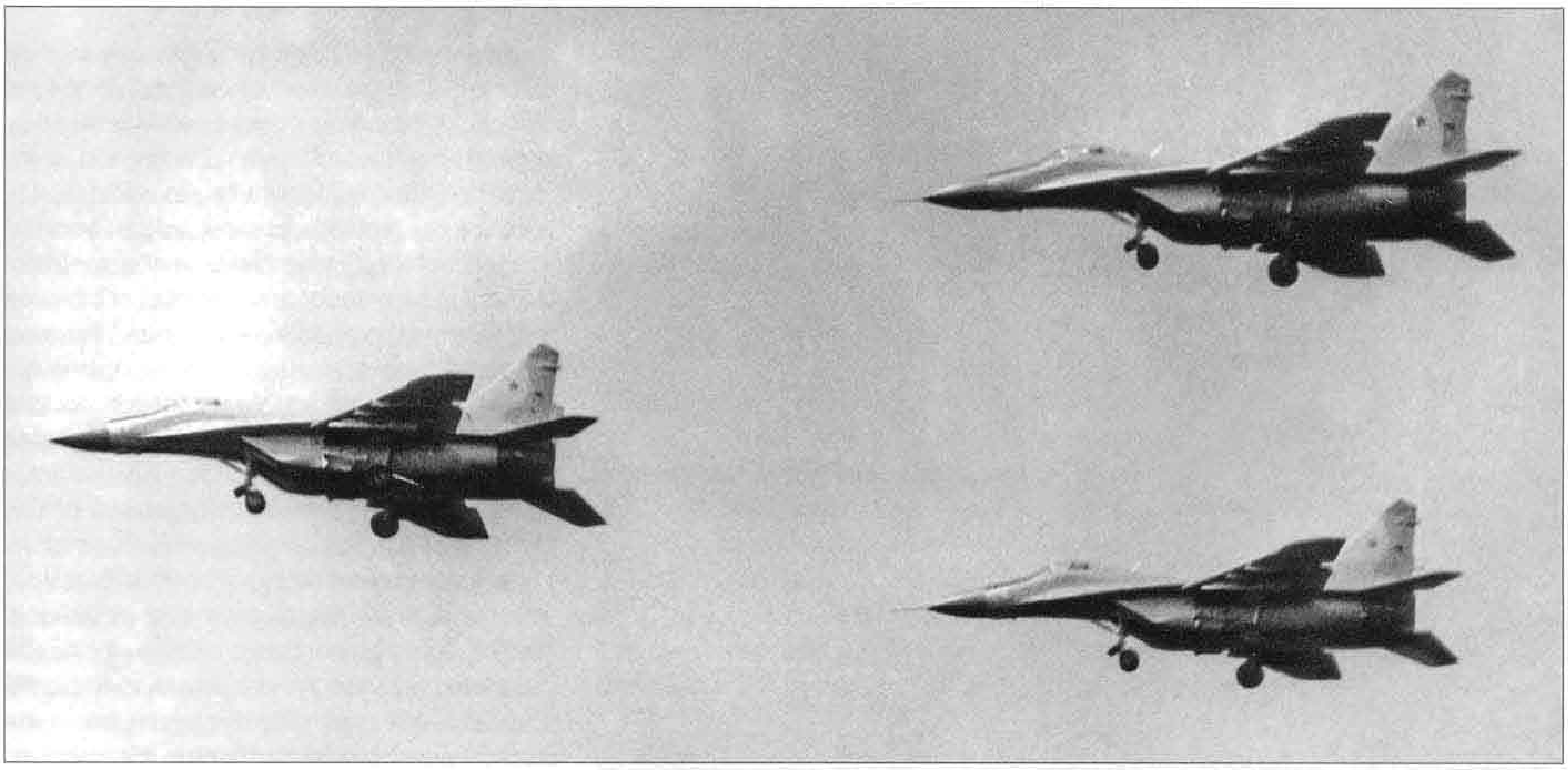


Krasnaya Zvezda

In common with previous Soviet fighter types, the first operational MiG-29s delivered to the Soviet Air Force wore a dark green/dark earth camouflage.

Three very early MiG-29s with ventral fins and narrow-chord rudders ('02 White', '06 White' and '08 White') operated by the 234 GvIAP of the 9 IAD, the first service unit to operate the type.

Krasnaya Zvezda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reorganised as the 237th TsPAT (*Tsentr pokazov aviatsionnoy tekhniki* – Aircraft Display Centre) named after Ivan N. Kozhedoob.

Soon the regimental headquarters in Kubinka received a classified directive from the Air Force's Chief HQ in Moscow ordering the first pilots selected for conversion to the MiG-29 to be sent to Lipetsk in September 1983. The service introduction of the *izdeliye* 9.12 was regarded as a matter of national importance. The Soviet government and the Communist Party of the Soviet Union entrusted the command of the Moscow Defence District and its Air Army with putting this important plan into effect.

From the outset the carefully selected pilots became the charges of Lt. Gen. Bobrovskiy, the commander of the 4th TsBP i PLS, and the MiG-29's Chief Designer Mikhail R. Val'denberg who literally followed them wherever they went. A course on the aircraft's aerodynamics, airframe, powerplant, avionics, equipment and armament was delivered by Mikoyan OKB representatives. At first the training was confined to pure theory and the pilots were not even allowed to see the aircraft they were to fly because the damn thing was top secret. Another complication was that the aircraft was so brand-new that no teaching aids whatever existed for it, never mind flight simulators – in fact, there was only *one pilot's manual* available for the lot! As a result, most of the pilots left Lipetsk, having seen the MiG-29 only on photos and 'live' but from a respectable distance (determined by an armed sentry) while the aircraft was parked in a special shed designed to preclude observation from above. Only the top brass of the delegation from Kubinka were allowed to see the MiG-29 'up close and personal'.

The first impression was quite disappointing. Until then, Mikoyan fighters had been charac-

▲
Grey-camouflaged 234th GvIAP MiG-29s in 'Vee' formation. Note the old-style nose gear doors.

A 234th GvIAP pilot climbs into the cockpit of his MiG-29.
▼


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Victor Drushlyakov

▲ **'21 Blue', another 234th GvIAP *Fulcrum-A*, on final approach to Kubinka AB. This aircraft already has the later nose gear door design but retains the ventral fins; with some machines it was the other way round.**

terised by a dart-like, need-for-speed appearance. In contrast, the newcomer was an ugly duckling – a hunchbacked, droop-snoot 'dragon' painted a yucky swampy grey-green colour; some compared it to The Little Humpbacked Horse, a Russian fairy tale character. However, when the airmen came closer and climbed into the cockpit, the tune changed. The high-set, extensively glazed cockpit with its frameless wraparound windshield and the drooped nose commanded a view that had been unheard-of in any previous Soviet fighter. At long last the pilot no longer felt like he was sitting in a trench with a very limited field of view.

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▲ **234th GvIAP MiG-29 '18 Blue' sits parked at Kubinka AB, its cockpit and radome protected by a canvas cover.**

Two MiG-29s in formation flight in the vicinity of Kubinka ▼

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By then the qualified flying instructors (QFIs) in Lipetsk were already beginning to fly the MiG-29. Because Western surveillance satellites passed over Lipetsk every now and then, ingenious concealment measures were taken to hide the new fighter's existence. Apart from the abovementioned anti-satellite shelters, special fabric and wire hoods were fitted over the nose and wings during parking and ground handling to distort their shape and hopefully make the aircraft appear as an older type on satellite imagery – though the efficacy of this measure appears questionable, given the sophistication of Western long-range operations (LOROP) cameras of the day. The disguise was removed immediately before engine start-up and take-off; no sooner were the engines shut down after landing than the ground crews fitted the hoods back into place and the aircraft was towed to the shelter. Since the satellites were not there literally every minute of the day, it was hoped that the operations would take place in the brief pauses between 'every now' and 'then'.

Security was by no means limited to anti-satellite measures. Even at the Centre, information about the MiG-29 was distributed on a need-to-know basis among the very few people involved in the training process, and nobody who was not supposed to know realised that pilots from Kubinka AB were converting to the new type. The pilots were in a sort of vacuum; they were forbidden to contact anyone outside their group and behaved as if they were deaf and dumb when not in class. After a month's training they passed seven theory tests within just two days and were authorised to take practical conversion training for the *izdeliye* 9.12 at their home base.

And so it was that, even though the joint state acceptance trials were officially still in progress, twenty brand-new MiG-29s were ferried from Lookhovitsy-Tret'yakovo to Kubinka AB for delivery to the 234th GvIAP.

Here it should be mentioned that some of the unit's pilots were lucky enough to see the new fighter as early as 7th April 1981. This opportunity arose during the first official display of the MiG-29, when Mikoyan OKB test pilot Boris A. Orlov gave a five-minute flying display to show then Minister of Defence, Marshal Dmitriy F. Ustinov, what the new fighter could do.

'I engaged full 'burner, – Orlov reminisced, – *and the nearly 16 tons* [35,270 lb] *of thrust pressed the aircraft's nose down. At a weight of 13 tons* [28,660 lb] *the brakes could not hold the fighter and it crawled forward, the tyres squealing*

against the runway. I let go the brakes and the aircraft rushed forward like a dog that has burst its leash. The speed grew quickly... NOW! I pulled back on the stick and the aircraft became airborne immediately. I continued hauling back to put it into a vertical climb as I retracted the gear. Now, climbing vertically at 400 km/h [248 mph], *I checked the altitude – 1,200 m* [3,940 ft], *made a barrel roll and put the nose down. At low altitude I checked my position and made a skewed loop, then a wingover, a turn, a three-quarters loop, putting the fighter into a vertical dive, then a half roll in the dive before pulling out. Finally, I passed over the runway, making a barrel roll over the middle of it, and broke to land.'*

Along with the MiG-29 Marshal Ustinov examined other advanced combat aircraft, including an early Su-27 prototype (one of the original ogival-winged *Flanker-As*). The latter also made a demonstration flight at the hands of Sukhoi test pilot Vladimir S. Il'yushin. The MiG-29, however, stole the show thanks to its high manoeuvrability and the pilot's skill.

No sooner had the unit taken delivery of the new hardware than the top brass in Moscow began demanding that flights should begin pronto. From then on things picked up speed. The first (and natural) thing to do was to begin with taxying techniques in order to get a feel of the machine. After a few high-speed runs the pilots would promptly taxi to the shelters. Security, sweet security.

The legendary pilot Maj. Gen. Aleksandr V. Fedotov (HSU), the Mikoyan OKB's chief test pilot and winner of the prestigious Lenin Prize, came to Kubinka to lend the service pilots a hand. Val'denberg, too, stayed somewhat longer than he had expected to; together with Fedotov he patiently explained the peculiarities of the aircraft's behaviour to the service pilots.

The general rule is that no service pilot ever makes his first solo flight in a new combat aircraft without being given a familiarisation 'ride' in its two-seat trainer version. In this case, however, neither a trainer version nor a flight simulator existed (the unit took delivery of the first MiG-29UBs in 1986 and the simulator was commissioned in 1985)! The Mikoyan OKB originally held the opinion that no need existed for a two-seater version of the MiG-29, since even a pilot who had previously flown the MiG-21 could fly the new fighter without any trouble.

Val'denberg began pursuing this point, urging First Deputy VVS C-in-C Air Marshal A. N. Yefimov to authorise service pilots to convert to the new fighter. He was supported by Igor' Dmitriyev (Commander of the Moscow Defence District's Air Force), A. V. Fedotov and the Air Force general responsible for flight safety. Yefimov resisted for a long time and eventually left without giving a definitive yes or no. It was up to the remaining 'top brass' to resolve the matter now; the answer, of course, was a thumbs-up and the 234th GvIAP re-equipped with the MiG-29 without having a single trainer. Well, as a matter of fact, the unit still had a few MiG-23UBs, but these trainers could not give the pilots the faintest idea of how the MiG-29 could really fly – especially its acceleration parameters. Therefore

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▲ **A 234th GvIAP pilot discuss flight details with his colleague sitting in a MiG-29. Note the triple rear view mirrors on the canopy frame.**

A typical Soviet-era publicity shot of two pilots discussing the merits of their new MiG-29s. Again, this is a very early aircraft with narrow-chord rudders. Note the star on the pilot's helmet. ▼

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Sergey Balakleyev

▲ **A 234th GvIAP MiG-29 coded '54 Blue' (ex-'23') flies above the Russian countryside.**

the pilots found themselves in a sink-or-swim situation; the training proceeded according to the counterproductive 'do as you are told' principle instead of the customary and time-honoured 'follow my example'.

First-Line Service

In 1983 the first MiG-29s of the prescribed complement of 36 were delivered to the aforementioned 968th *Sevas**top**ol'skiy* IAP – another fighter unit of Great Patriotic War fame awarded the Red Banner and Suvorov (3rd Grade) Orders. This unit then belonged to the 95th IAD (*istre**bit**el'naya* ***a**viadi**vee**ziya* – Fighter Division) of the 26th VA (*voz**doosh**naya* ***ar**miya* – Air Army) and was based at Ross', Belorussian DD. In keeping with a well-established tradition this was the first real first-line unit to master new Mikoyan fighters (the 234th GvIAP, as already mentioned, was a breed apart). It is a little-know fact that the 968th IAP was the first air regiment to re-equip completely with fourth-generation fighters, and it was there that the MiG-29's Air Force evaluation took place.

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▶ **A MiG-29 carrying two B-8M1 FFAR pods and a centreline drop tank is inspected by a technician at the 'last chance' checkpoint.**

The first 12 MiG-29s earmarked for the 968th IAP were scheduled to make the delivery flight from the factory airfield in Lookhovitsy to Ross' on 24th November 1983, making a refuelling stop at Machoolishchi AB near Minsk en route. In reality the *izdeliye* 9.12 could easily make the 1,100-km (683-mile) trip non-stop; however, the first production examples were still beset by teething troubles and prone to 'acting up', so an intermediate stop was planned at the insistence of the 26th VA's Chief Navigator Maj. Gen. Mikhail Sakharov, just to be on the safe side. The fighters were ferried by civil test pilots working for the Lookhovitsy Machinery Plant (LMZ).

However, the best-laid plans of mice and men have a tendency to go terribly wrong. Nobody could imagine the huge scandal that would erupt. To avoid attracting undue attention the approach and landing of the MiGs at Machoolishchi AB was timed to coincide with a routine training session of the resident 121st TBAP (*tyazhe**lo**bombardi**rov**ochnyy **avia**polk* – Heavy Bomber Regiment). The latter unit's Tupolev Tu-22KD missile carriers were very active that day, disturbing the peace above the suburbs of Minsk with the din of their mighty Dobrynin RD-7M2 turbojets, and it was hoped that amid the commotion the nimble fighters would slip through unnoticed. And so they did – all except one. It is open to conjecture if poor weather (the cloudbase that day was only 300 m/ 980 ft) or a malfunction of the communications equipment was the cause, but the pilot of the tail-end fighter did not make it to Machoolishchi AB. According to Ghennadiy Klepikovskiy, who was the airfield area ATC shift supervisor at the base that day, the pilot behaved strangely, to say the least. As it made the turn for final approach, the MiG flew below glide path and, what was worse, on a reciprocal heading to the Tu-22s that were on finals at the moment. Ignoring the shift supervisor's commands to level out and climb, the pilot continued the descent until he broke out of the clouds, then executed a turn near the outskirts of the city and landed at... Minsk-Loshitsa airport (alias Minsk-1)! By sheer luck the runway was unoccupied at the moment and there was no immediate danger of the unexpected visitor colliding with an airliner.

Realising he was at the wrong airfield, the luckless pilot taxied into the nearest parking 'pocket' beside the taxiway, shut down the engines, then jumped out of the cockpit and dashed to the nearest airport building, yelling, 'Canvas! Get me some canvas!' (to cover the aircraft with, that is). Of course, no towbars compatible with the MiG-29 existed at the civil airport, and the top secret fighter could not be removed to the security of a hangar, sitting in plain view of both Soviet and foreign passengers at Minsk-Loshitsa for a while. All the personnel could do was to disguise the fighter with canvas

▲ **The badge of the Lipetsk Aviation Centre, better known as the 4th TsBP i PLS. This outfit played an important role in the service introduction of the MiG-29.**

This MiG-29 coded '29 Red' is operated by the 4th TSBP i PLS at Lipetsk and wears white quick-identification stripes on the fuselage and fins. ▼

Sergey Balakleyev




Sergey Balakleyev

A sequence of stills showing another 4th TsBP i PLS MiG-29, '22 Red', as it fires an R-73 AAM in a dive.

and await assistance. Presently a refuelling bowser hastily summoned from Machoolishchi AB arrived on the scene, and the wayward fighter was refuelled and ferried to Ross'.

So it was that the MiG-29's service career got off to a rather eventful start. The early years were characterised by a fair share of teething troubles, and the pilots and ground crews literally could not relax for a minute. Technicians who worked with the MiG-29 in those days recall that all sorts of malfunctions occurred almost daily and a huge amount of work was needed to rid the fighter of its many 'bugs'.

The first serious accidents occurred at that stage, too. On 7th February 1989, as a pair of MiG-29s were taking off on a routine practice mission from Ross', the wingman decided to change formation by making a barrel roll around his leader (!). He misjudged the distance and the two fighters collided; luckily the pilots were skilful enough to land them in one piece. As they replaced the damaged components, the technicians overlooked a cracked spar in the starboard fin on one of the fighters. Later, when the 968th IAP's CO Sergey I. Drozdov started an aerobatics session in this aircraft, the damaged fin broke away and the aircraft crashed, out of control; the pilot ejected safely. On another occasion the GTDE-117 APU tossed a turbine blade during engine start-up and the departing blade punctured a fuel tank, causing a massive fire which inflicted irreparable damage.

All of the unit's aircraft had tactical codes of a decidedly uncommon yellow (or rather orange) colour outlined in red (Soviet Air Force fighters normally wore red, white or blue codes); most aircraft had the code repeated in small digits on the outer faces of the fins (again in yellow) for quick identification on the flight line. It is believed that the non-standard colour was selected personally by Lt. Col. V. V. Tkachenko, Commander of the unit's 2nd Squadron, who accepted the new fighters on delivery at LMZ.

Little by little other Soviet Air Force units started re-equipping with the MiG-29. The

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These two MiG-29s seen at Kubinka AB in 1995 make an interesting contrast. The resident MiG-29UB '58 Blue' is in standard camouflage, while the visiting *Fulcrum-C* '29 Red' from Lipetsk (with obvious signs of recoding) has a non-standard dark bluish grey finish. and the white identification stripes.

'01 Blue', a Soviet Air Force MiG-29 *Fulcrum-C* belonging to a Guards Fighter Regiment, in standard factory finish

regiments based in the western and southern defence districts, which would be the first to engage the adversary in a hypothetical conflict with the NATO, enjoyed priority in this respect.

On the southern borders of the Soviet Union, the 176th GvIAP based at Mikha Tskhakaya AB (part of the 34th VA headquartered in Tbilisi, Transcaucasian DD) became the first unit to receive 35 of the new superfighters. This unit gained unwelcome publicity due to the widely known (and only) case when a MiG-29 was stolen by a defector.

Capt. Aleksandr M. Zooyev was a first-class fighter pilot but a thoroughly rotten person; he was known as a 'pocket Napoleon', extremely vain and egotistical. At one time he was a candidate for the VVS' Test Pilots School but this did not materialise. Moreover, Zooyev had been suspended from active duty some time before the incident because of poor discipline; indeed, his track record was so poor that his superiors were considering a dishonourable discharge. Obviously resentment at this, coupled with his personality, led him to commit treason.

After drugging the pilots and ground crew of the quick reaction alert (QRA) flight putting sedative into a cake which he treated them to, he cut the telephone cables to prevent anyone from raising the alarm, then shot and seriously wounded a sentry on the flight line who tried to stop him. Then he took off in one of the QRA MiG-29s coded '44', despite also being wounded in the shootout. Subsequent analysis of the flight data recorder readouts showed that Zooyev had twice attempted to strafe the airfield as a parting gesture before making for the border but luckily a safety feature of the cannon foiled his plan.

The Turkish border was a mere ten minutes' flight from Mikha Tskhakaya AB. Another 176th IAP MiG-29 scrambled to intercept the defector seven minutes later but could not get within firing range before the target entered Turkish airspace. Two fighters from a neighbouring base took even longer (12 minutes) to get airborne. Surface-to-air missile sites in the area were alerted but failed to detect the target because Zooyev was flying at ultra-low level to avoid radar detection. Thus Zooyev was able to cross the border unscathed, landing at the civil airport in Trabzon.

The stolen fighter was returned in undamaged condition the very next day in keeping with a Soviet-Turkish agreement. The defector's fate is unknown; despite insistent demands from the Soviet government, Zooyev was not extradited by whatever country he ended up in. As for the fighter, it served on at its home base until the 176th GvIAP was eventually disbanded.

Next, the new MiGs were delivered to the 145th IAP of the 14th VA (Carpathian DD) based

'23 Red', a Soviet Air Force MiG-29 *Fulcrum-C* belonging to a Guards Fighter Regiment, in four-tone tactical camouflage

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'92 Blue', an early-production *Fulcrum-A* operated by the Black Sea Fleet Air Arm's 119th MIAD. Note the Soviet Navy flag below the cockpit.

at Ivano-Frankovsk, western Ukraine, and to the 119th IAD (*istre**bi**tel'naya **a**viadi**vee**ziya* – Fighter Division) of the 5th VA headquartered at Tiraspol', Moldavia. This division comprised two regiments: the 86th GvIAP based at Markuleshty AB, Moldavia, and the 161st IAP based at Limanskoye AB on the Crimea Peninsula, the Ukraine. In 1989 the 119th Division was transferred to the Black Sea Fleet Air Arm and became the 119th MIAD (*mor**ska**ya istre**bi**tel'naya **a**viadi**vee**ziya* – Naval Fighter Division), the constituent units changing their designations to the 86th GvMIAP and the 161st MIAP. These were the only Soviet Naval Aviation (AVMF – *Avi**ah**tsiya vo**yen**no-mor**sko**vo **flo**ta*) units to operate the MiG-29.

Interestingly, the 161st MIAP was the first MiG-29 unit to apply badges and other artwork to its aircraft. AVMF aircraft traditionally carried an emblem shaped like a fluttering Soviet Navy flag; on the MiG-29 the emblem was applied below the cockpit canopy. The naval MiGs had blue tactical codes.

Shortly afterwards the 53rd GvIAP based at Siauliai, Lithuania (Baltic DD), transitioned from MiG-23s to MiG-29s.

The 'Aggressors'

In 1989 the first MiG-29s were delivered to the 1521st Air Base located at Maryy-1 AB (pronounced like the French name Marie) in Turkmenia. This was a very special outfit within the structure of the Soviet Air Force. In the early 1970s the top command of the Soviet Air Force decided that the valuable experience of aerial combat gained in the Arab-Israeli wars should be put to good use and implemented in all units. Also, the top command was aware that the US Air Force and the US Navy had set up special 'aggressor' squadrons emulating the performance of Soviet fighters and Soviet tactics in order to train their own pilots in aerial combat techniques. Therefore it was decided to establish the Soviet Air Force's own 'aggressor' unit. While this name is not to be found in any official Soviet document (after all, the Soviet Union was officially a peace-loving nation!), informally the 1521st Air Base was known as the 'aggressor' unit among fighter jocks. Maryy was chosen as the home base for this special unit because it offered favourable weather conditions throughout the year, enabling intensive flying training. The 1521st Air Base became the proving ground where all Soviet Air Force fighter units honed their skills and passed the test for their ability to defend the nation's airspace.

The pilots of the 'aggressor' unit could always pride themselves on their excellent airmanship, and they were always tough adversaries in mock combat. The two squadrons of the 1521st Air Base were mostly staffed with Pilots 1st Class and Sniper Pilots (official Soviet

MiG-29 '92 Blue', Soviet Navy/Black Sea Fleet, 119th MIAD.

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degrees reflecting skill levels); the 'snipers' always made up 35-40% of the total. Flying two sorties per day, the pilots had to shoulder a high workload, and before long they no longer cared who they were up against – they were prepared to take on the devil, or even a squadron of devils!

Each fighter regiment arriving at Maryy-1 AB for a check-up had to complete the following disciplines:

- check-up of the individual pilots' flying skills, including complex manoeuvres and aerobatics;
- ultra-low-level flying over terrain devoid of natural landmarks (desert areas);
- dogfighting and check-up of the unit's QRA performance;
- tactical exercises (including the principal fighter missions) performed by the entire regiment and individual squadrons;
- live missile launch and gunnery practice against remote-controlled target drones manoeuvring in such a way as to emulate a given type of adversary aircraft and in accordance with the current tactical situation.

Here it should be noted that if 100% accuracy was achieved in the latter discipline the aircraft was awarded red 'kill' stars. Some fighters carried as many as nine 'kills' below the canopy!

A typical 'pair versus pair' mock combat session looked like this. Each pair (the 'good guys' and the 'bad guys') had its own combat control radio channel; before the mission the leader of each pair would arrange with his command, control and communications officer to report the position of the other pair to him at certain intervals. The dogfight lasted up to ten minutes. If a pilot managed to latch onto his opponent's tail he would report to his C³ officer: 'Target in sight!', then activate the radar lock-on mode and switch his radio to the opponent's frequency, informing him: 'I see you! You're under attack!' Unless the other pilot could shake off the pursuer immediately, the dogfight was discontinued because it was an obvious 'gotcha'.

The date of the checkout session at the 1521st Air Base was set individually for each regiment at the beginning of the practice year. As the day drew near, the entire regiment's resources were committed to the preparation for 'the Maryy experience'. The unit could ill afford to fail the test because the results reflected the unit's training and combat readiness level, and getting an A in the course was not easy at all.

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▲ **Seen in these three views at Kubinka AB during overhaul at ARZ No.121, '09 Red' (c/n 2960507649), a very early MiG-29 with ventral fins operated by the 1521st Air Base / Sqn 2, carried this hornet motif. The 'AM' stood for 'Aviabaza Maryy'. Note the nose gear doors modified to late production standard.**

This sharkmouthed MiG-29UB was operated by Sqn 1 of the 1521st Air Base, hence the 'winged 1' on the fins (barely visible in this photo). ▼

M-Hobby

MiG-29 *Fulcrum-A* '01 Red', Soviet Air Force, 1521st Air Base/Sqn 2, Maryy-1 AB. Note the white paintwork around the canopy to make it look larger.

Some of the MiG-29s at Mary sported awesome-looking sharkmouths. Note the white-painted canopy frame; the colour continued aft along the spine to make the canopy look longer for visual similarity with the F-15.

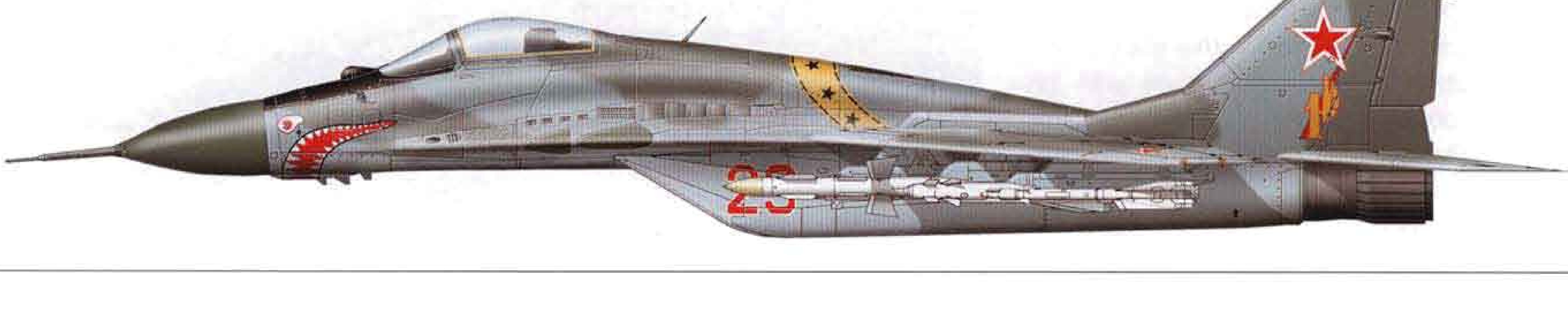

via Internet

The 1521st Air Base badge with the legend 'Aviabaza Maryy' and an eagle ripping a fighter apart.

Sharkmouthed MiG-29 '21 red' of the 1521st AB's Sqn 1 has been dismantled for airlifting. Note the fixture on top of the fuselage for hooking up to the transport aircraft's overhead hoists.


Alfred Matusevich

MiG-29 *Fulcrum-C* '23 Red', Soviet Air Force, 1521st Air Base/Sqn 1, Maryy-1 AB. Note the 'brandy stripe' quick-identification markings.



The 1521st Air Base's 1st Squadron began re-equipping with the humpbacked *izdeliye* 9.13 (*Fulcrum-C*) which took over from the MiG-21*bis* fighters flown previously. The fighters were delivered in the standard factory finish of dark greenish grey over neutral grey. Now, whereas the *izdeliye* 9.12 (*Fulcrum-A*) had no set camouflage pattern and the finish of individual aircraft varied considerably, the camouflage of the later version was pretty much standardised. On the *Fulcrum-C* the extremities of the airframe – the forward fuselage, the outer wings, the upper halves of the fins and the stabilator tips – were painted a darker colour, making the aircraft appear more compact when seen from a distance; the colour division line on the wings ran strictly chordwise from the inner/outer LE flap section joint to the TE flap/aileron joint.

Of course, the aircraft earmarked for the 'aggressor' unit received no special treatment, being delivered in the standard camouflage scheme. This created a problem: in a group dogfight the pilots had difficulties telling friend from foe, especially if they were flying the same type of aircraft. As was usually the case, the idea of applying quick identification markings to the 'aggressor' aircraft arose at the 'grass roots' level; the commanders thought over the initiative and eventually approved it. Soon the drab colours were gone and the resident MiGs received special markings and nose art. However, this was by no means a 'flight of fancy' matter – indeed, a scientific approach was used! Some MiG-29s were painted up to make them resemble the McDonnell Douglas F-15 – the wingtips and stabilator tips were painted yellow with a black outline, this visually altered their shape, making them appear to be raked as on the F-15. Angled black stripes converging in a black and yellow chevron were applied aft of the cockpit, making the canopy appear longer and more similar to that of the Eagle.

As for the nose art (this was allowed, since the aircraft were supposed to represent NATO fighters), this was left up to the technicians, and each aircraft was slightly different. Thus, '31 Red' was probably the most colourful MiG-29 at Maryy. In addition to the 'F-15 disguise' it sported a sharkmouth, a so-called 'brandy stripe' (*kon'**yach**naya polo**sa***) – a yellow identification stripe with stars similar to those found on brandy bottles – on the centre fuselage and the legend ***A**via**ba**za Ma**ryy*** aft of the cockpit, while the fins were adorned with the badge of the 1st Squadron (a winged '1' superimposed on a red arrow) and a sabre-toothed tiger.

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▲ **A sharkmouthed MiG-29 awaits overhaul at ARZ No.121. The blue tactical code suggests this is not one of the 'aggressor' aircraft from Maryy; the 1521st Air Base's aircraft were red-coded.**

The airmen at Maryy-1 AB recall that '31 Red' was meant to be a sort of standard-setter; however, for various reasons not all of the unit's MiGs were painted up in this fashion. For instance, '21 Red' lacked the 'brandy stripe'. The fighters coded '23 Red', '25 Red', '26 Red', '28 Red' through '30 Red' and '32 Red' had no tiger motif; instead, '30 Red' sported a leaping leopard which was painted on below the canopy to starboard.

The unit's 2nd Squadron flying MiG-23MLD 'swing-wing' fighters was originally planned to re-equip with Sukhoi Su-27s, but, as it often happens, there was a last-minute change of plans and the unit soon began receiving heaps of high-time early-production *Fulcrum-As* from all across the nation. These, too, received special markings to assist friend-and-foe differentiation; a few weeks after being taken on charge the newcomers were recoded in an orderly fashion (the codes were again red) and adorned with artwork. The most colourful ones wore a large sharkmouth and a white triangle on the upper fuselage extending aft from the cockpit; this incorporated the base's crest (a shield with an eagle breaking an aircraft in two) on both sides. The outer faces of the fins carried the squadron badge – a sour-faced hornet superimposed on a red lightning bolt – and the letters 'AM' (standing for *Aviabaza Maryy*) above it. When the unit came under Turkmenian jurisdiction after the demise of the Soviet Union, the letters were removed because in the Turkmen language *am* is an obscenity (the *c-word*).

Of the 24 MiG-29s based at Maryy-1 AB, several single-seaters of both varieties and one MiG-29UB were flown to Zherdyovka AB (Tambov Region, Russia) in August 1992. In keeping with a Russian government directive most of the MiGs stationed at the latter base were transferred to the Kazakstan Air Force in late 1995/early 1996.

Overseas Deployment

By the end of 1991 MAPO's divisions at Moscow-Khodynka and Lookhovitsy-Tret'yakovo had built some 1,200 single-seat MiG-29s between them, and nearly 200 MiG-29UB trainers had been assembled in Gor'kiy. More and more VVS units re-equipped with the new fighter as production increased. By 1991 the VVS had some 800 *Fulcrums* on strength. They were operated by 25 fighter regiments, usually with 32 fighters to a unit (though some units had as many as 48 or 54 aircraft).

Large numbers of MiG-29s were permanently deployed abroad (in East Germany, Hungary and Czechoslovakia); the reason for this was the fighter's ability to deliver tactical nuclear weapons. The biggest *Fulcrum* contingent (around 250) was stationed in East Germany with the GSVG (***Groo**ppa so**vet**skikh voysk v Gher**mah**nii* – Group of Soviet Forces in Germany). This included eight regiments equipped with MiG-29s, united into three fighter divisions which in turn were part of the 16th VA headquartered at Wünsdorf. Since 1989, the contingent was called ZGV (***Zah**padnaya **groo**ppa voysk* – Western Group of Forces).

The first MiG-29s came to East Germany in 1986, replacing MiG-23M *Flogger-Bs* with the 33rd IAP based at Wittstock AB and forming part of the 16th ***Sveer**skaya* GvIAD (*Gvar**dey**skaya istre**bi**tel'naya **a**viadi**vee**ziya* – Guards Fighter Division) awarded the Order of the Red Banner; the honorary appellation had been given for its part in the battles on the River Sveer' during the war. This regiment was actually but the fourth VVS unit to fly the *Fulcrum*, following the units at Kubinka, Ross' and Mikha Tskhakaya AB. The regiment 'traded in' its MiG-23MLs for MiG-29s in several stages; the first MiG-29s arrived in December 1985, further deliveries following from 8th January 1986. The two-seat MiG-23UBs were retained, however, because the MiG-29UB was still unavailable.

The first MiG-29s deployed to East Germany were *Fulcrum-As*, including some early aircraft with ventral fins; these were later supplemented by *Fulcrum-Cs*. By the late 1980s the ZGV operated a mix of MiG-29s and some MiG-23s.

The intensive operation of the fighters patrolling the skies of East Germany led to the first 'combat loss' of a MiG-29. During a practice intercept on 15th September 1993 involving simulated gunnery, with one aircraft acting as the target, 33rd IAP pilot Maj. Nikolay Starikov flying MiG-29 '20 White' (c/n 2960520565; f/n 1817?) was shot down accidentally by his wingman in

An impressive row of 'fatback' 787th IAP MiG-29s on the flight line at Finow AB, with two MiG-29UBs at the far end. The flight line is equipped with a centralised refuelling system (the housings behind the aircraft). The Ural-4320 lorry carries a placard reading *Lyudi* (People, = personnel transport). ▼

Guido Buehlmann

MiG-29 '23 White' (c/n 2960518454) who nailed him with three cannon shells. The aircraft crashed near the village of Wulfersdorf 8 km (5 miles) north-west of Wittstock AB; luckily the pilot ejected safely.

The cause of this tragicomic incident lay in careless operation of the weapons control system. The MiG-29's gunfire control system includes three switches: the trigger located on the control stick, the master switch of the WCS and a guarded safety switch low on the port side cockpit console.

In the practice mode, when the safety switch disables the cannon, squeezing the trigger

Guido Buehlmann

Chris Lofting

◄▲
787th IAP MiG-29 *Fulcrum-C* '03 White' (c/n 2960710941) taxies out at Finow AB, Germany, past a row of resident sister ships and MiG-23UBs and a visiting Mil' Mi-8PS VIP transport helicopter. Note the patchwork appearance – the scuffed paintwork was touched up with whatever paint was available.

activates the gun camera which allows the aiming accuracy to be analysed. The master switch is normally activated only for actual missile launches, gunnery or bomb drops. However, if it is selected on during a simulated attack, the WCS becomes fully functional; that is, in a simulated gunnery attack using the radar or the IRST a buzzer sounds in the pilot's headphones when the target comes within safe range, telling him it is OK to fire. This procedure is prescribed by the flight manual, and the pilot 'played by the book', wishing to hear the 'OK to fire' buzzer.

The safety switch, however, should be set to 'on' in this situation; it is only selected off (to 'fire', that is) for a real-life sortie or QRA duty by a

Chris Lofting

◄
A 31st GvIAP *Fulcrum-C* coded '29 Red' (c/n 2960728105) takes off from Falkenberg AB, Germany. Unusually, the tactical code is repeated on the fins proper rather than on the fin caps. The Guards badge was later supplemented by a sharkmouth and Russian flags on the rudders when the unit moved to Zernograd, Russia.

Marinus D. Tabak

▲▶
Some 33rd IAP MiG-29s, like *Fulcrum-C* '39 White' (c/n 2960705580), carried the unit's large round badge on the tails.
▼

technician, with the pilot monitoring his actions. Why on earth it was selected off on that particular aircraft on that particular mission will never be found out for certain. One can only conjecture that the technician had forgotten to activate the safety feature after the aircraft had been taken off QRA duty – or that it was standard operational procedure in the 33rd IAP to have the safety switch selected off. The latter seems doubtful, since all aircraft always carried a full load of cannon ammunition. (Some sources suggest that the wingman's own *Fulcrum* went unserviceable immediately before the sortie and the pilot was ordered to take off in another aircraft whose safety switch had been selected off.)

Curiously, the MiG-29s of the 33rd IAP carried a unit badge openly featuring the regimental number. This was an extremely rare occurrence in those days of tight security – not to mention that all manner of nose art was *not*

Marinus D. Tabak

Chris Lofting

▶
In contrast to the white-coded single-seaters, this 33rd IAP MiG-29UB (c/n N50903008094) had a low-visibility tactical code ('64 Black outline'). Note the scuffed paint on the fin caps.

welcome in the VVS, being regarded as 'pro-Western' and 'ideologically harmful' (the proximity of the West was probably beginning to rub off!). Well, actually this badge did not appear until shortly before the unit returned to Russia, and then only on a few selected fighters. Initially an early version of the badge was applied to just one aircraft coded '10 White' (c/n 2960520149), representing a white MiG-29 silhouette and a winged red bison, above which was the legend '33 ИАП' (33rd IAP); the bison signified the unit's Belorussian origins – the European bison, or *zoobr*, is native to Belorussia. This emblem (reportedly designed by L. E. Kopachevskiy) was carried on the port side of the nose below the cockpit. The definitive version of the unit badge was applied to the starboard fin; the aircraft's silhouette was now dark blue and the motif was superimposed on a white circle with blue and red outlines (similar to the World War One-vintage Imperial Russian Air Fleet roundel). This version of the badge was also worn by single-seat MiG-29s '01 White' (c/n 2960518084), '08 White' (c/n 2960518074), '36 White' (c/n 2960518751), '37 White' (c/n 2960518479), '39 White' (c/n 2960705580) and MiG-29UBs '55 Black outline' (c/n N50903007603) and '64 Black outline' (c/n N50903008094). '01 White' also carried a Mikoyan OKB logo.

The two trainers mentioned here had been transferred from the 773rd IAP in 1993 and from the 968th IAP in 1990 respectively. In so doing their tactical codes were changed from blue and orange respectively to the low-visibility

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▲ **Here There Be Tygers. Some MiG-29s operated by the 773rd IAP, such as MiG-29UB '74 White' (c/n N50903005603) pictured here, carried this leaping tiger nose art.**

Martin Baumann

◄ **'46 Orange', a very early MiG-29, carries the blue 'winged star' badge of the 968th IAP.**

Martin Baumann

◄ **'07 Orange' (c/n 2960507641), another 968th IAP aircraft, was the oldest known MiG-29 to be stationed in East Germany. It later became '20 Red' with an unidentified unit.**

Chris Lofting

▲ **'83 White' (c/n 2960715151), a 787th IAP *Fulcrum-C*, carries an 'Excellent aircraft' maintenance award badge. This aircraft was previously operated by the 5th GvIAP in Hungary.**

version; '64' also lost the blue 'winged star' badge of its previous unit. Additionally, *Fulcrum-A* '37 White' and MiG-29UB '91 Red' (c/n N50903017124) carried a stylised lightning bolt on the nose.

The 16th GvIAD's 773rd IAP at Damgarten (Pütnitz), previously a MiG-23MLD *Flogger-K* operator, followed in 1987. (Note: NATO and the VVS often used different names for the same East German airbases. In such cases the Soviet name comes first with the NATO name following in parentheses.) Unlike the 33rd IAP, this unit received its allotted complement of MiG-29UB trainers from the outset, which undoubtedly facilitated the transition from third-generation to fourth-generation fighters.

Initially the unit's single-seaters were all *Fulcrum-As*, including a few initial-production machines with ventral fins and no IRCM flare dispensers. Later, however, the 773rd IAP acquired a number of *Fulcrum-Cs* as a result of aircraft rotation between units; some of them were transferred from the 33rd IAP, while others came all the way from the Southern Group of Forces stationed in Hungary. The 234th GvIAP also contributed five MiG-29s which were recoded '20 White', '21 White' (c/n 2960515125), '22 White' (c/n 2960515840), '24 White' (c/n 2960512125) and '26 White' (c/n 2960516768).

The intensive operations, coupled with the open storage and the inevitable wear and tear during maintenance when the technicians crawled all over the aircraft, caused the paintwork on the unit's MiG-29s to become chipped and faded. The damaged spots were painted up at the unit's maintenance shop without bothering about an exact colour match, and some aircraft assumed a rather untidy 'patchwork' appearance. Moreover, since the tactical codes of VVS aircraft are usually simply the aircraft's number in the regiment (as noted earlier), they are changed when an aircraft is transferred to another unit. Many ZGV MiG-29s showed obvious signs of such re-coding: the old code on the air intakes was overpainted (often with whatever colour was within reach) and the new code applied over the resulting blotch. The old code, however, remained on the fins.

▶ **'27 White', a 787th IAP aircraft (c/n 2960714627), carries a MiG OKB badge on the tails. The code applied over a darker area on the air intake where the old code '62' (still carried on the tail) has been overpainted reveals that the aircraft was previously with a different unit.**

Martin Baumann

This was no good of course, and presently four 773rd IAP MiG-29s were repainted completely on site. It should be noted that, apart from the camouflage pattern, the factory finish of the *izdeliye* 9.12 and *izdeliye* 9.13 differed in the shape of the black anti-glare panel; on the *Fulcrum-A* it terminated in line with the front of the windshield, whereas on the 'fatback' it continued all the way aft to the joint with the hinged canopy section. Well, the anti-glare panel was the only standard element of the paint job retained on the four MiG-29s in question – '02 White' (c/n 2960710829), '03 White' (c/n 2960718034), '44 White' (c/n 2960705585) and '21 White' (c/n 2960515125), which received a locally invented 'wraparound' olive drab/green-grey camouflage vaguely reminiscent of the US Air Force's 'wraparound SEA scheme'. In the unit they were popularly known as 'the frogs'. According to some reports, the fourth aircraft painted in the 'wraparound ZGV scheme' was '53 White' (c/n 2960707707), rather than '02 White'.

In addition, the 773rd IAP boasted three aircraft wearing nose art. The abovementioned 'frog' coded '21 White', another single-seater coded '23 White' (c/n 2960512149) and MiG-29UB '74 White' (formerly '73 White' with the 33rd IAP, c/n N50903005603) were adorned with a leaping tiger on the starboard side of the nose. The single-seaters lost this nose art when they were refurbished at ARZ No.121 after the unit returned to Russia; conversely, the trainer was transferred to another unit (the 28th GvIAP) and recoded but retained the tiger artwork. Two other MiG-29UBs, '55 Blue' and '66 Blue' (c/ns N50903007603 and N50903008303), had been transferred from Siauliai and retained their previous unit's blue codes throughout their service with the 773rd IAP because the ground staff were too lazy to repaint them!

The 787th IAP based at Finow AB (Eberswalde) 25 km (15.5 miles) north-east of Berlin was the last unit in the 16th IAD to re-equip with the new hardware. Earlier this unit had been tasked with missions of special importance, which included intercepting the Lockheed SR-71A Blackbird spyplanes operating from RAF Mildenhall; hence the 787th IAP had been the 16th VA's only unit to operate the MiG-25PD Mach 3 interceptor since 1982. However, when the USAF retired its last remaining Blackbirds in 1989, the MiG-25s became superfluous and the 787th IAP converted to *Fulcrum-C/-Bs* in November that year.

Stationed at Zerbst, the 35th APIB (***avia**polk* *istre**bit**eley-bombardi**rov**shchikov* – Fighter-Bomber Regiment) of the 126th Red Banner GvIAD forming part of the 16th VA was transformed into a fighter regiment in 1987, re-equipping with MiG-29s (*izdeliye* 9.12) and MiG-29UBs. This change was accompanied by a seemingly strange personnel rotation: the 35th IAP and the Siauliai-based 53rd GvIAP, which was then flying MiG-29s, switched pilots and commanding officers! The entire flight personnel of the 53rd GvIAP and its CO P. I. Yarmak moved to Zerbst, while the pilots of the 35th Regiment went to Siauliai to take conversion training to the MiG-27K fighter-bomber. The ground personnel of both units stayed at their present locations. Yet this move was in fact perfectly logical: as a result, the 16th VA immediately came into possession of an entire regiment ready to operate the new fighters.

In April 1988 the 35th IAP took delivery of 28 *Fulcrum-Cs* which replaced some of the existing *Fulcrum-As*. At least three of the unit's aircraft are known to have worn special markings. Thus, '21 Red' (c/n 2960510183), a 1st Squadron aircraft, had the 'Excellent aircraft' maintenance award badge (a stylised aircraft silhouette within a State Quality Mark pentagon), while at least two 2nd Squadron machines, including '45 Red', sported an unusual *Komsomol* (Young Communist League) badge – probably to denote that the ground crews allocated to these aircraft were all Komsomol members.

Next, the 73rd *Volgogradsko-Venskiy* GvIAP of the same 126th GvIAD (awarded the Red Banner and Bogdan Khmel'nitskiy Orders and based at Köthen AB) traded its MiG-23MLDs for MiG-29s. Their honorary appellation was awarded for the defence of Stalingrad (now Volgograd) and the liberation of Vienna. The unit received a mix of *Fulcrum-As* and *-Cs*, and *in situ* conversion training began straight away. The training schedule was so intensive that the pilots had five flying days per week – a not-too-common occurrence. The unit's three MiG-29UB trainers – '60 Red', '70 Red' (c/n N50903017048) and '91 Red' (c/n N50903017124) – shouldered the main workload, but the unit still kept two MiG-23UBs ('84 Blue' and '86 Blue') which also helped. Inevitably, spills occurred at the transition stage – sometimes the young pilots were too hasty in retracting the landing gear or could not stop the aircraft in time, overrunning the runway.

In keeping with a wartime tradition, all of the unit's aircraft wore the Guards badge to reflect the unit's status. Most machines carried it on the air intake trunks, while on some aircraft the badge was applied near the cockpit. Some of the

▲
The well-known MiG logo was applied as a 'private venture' to many operational MiG-29s. This pretty much standard version was applied in the 787th IAP.

▲
The trouble is that not all of the 'regimental artists' can render the logo correctly! This crude 'counterfeit' version was invented in the 33rd IAP.

▲
This psychedelic version of the MiG logo was worn by a MiG-29S demonstrator ('333 Silver') in 1993. Really, MAPO should have known better than to 'adorn' one of its aircraft with *this*!

▲ This 'homegrown' version of the RSK MiG logo was applied to MiG-29 '55 Blue' (c/n 2960515824) stored at Lipetsk.

▲ A 'reversed' version applied to a MAPO demonstrator aircraft.

▲ Another lop-sided homemade version of the MiG logo, this time from a Ukrainian Air Force *Fulcrum*.

73rd GvIAP's MiG-29s were later transferred to the units based at Zerbst and Wittstock.

In 1989 it was the 85th GvIAP's turn to re-equip with the new fighter; this unit based at Merseburg and flying MiG-23Ms was likewise awarded the Red Banner and Bogdan Khmel'-nitskiy Orders. It was part of the glorious 6th *Donetskaya* and *Segedskaya* GvIAD decorated with the Red Banner and Suvorov Orders. Again, the regiment received all three basic versions (*izdeliye* 9.12/9.13 and MiG-29UB) and all aircraft wore the Guards badge; additionally, many of them sported nose art (a leaping leopard) on the starboard side of the cockpit and the 'Excellent aircraft' badge to port.

The 31st *Nikopol'skiy* GvIAP at Falkenberg AB (Alt Lönnewitz) – thus named for its part in the liberation of the Ukrainian city of Nikopol' and awarded the Red Banner and Suvorov Orders – was the division's second unit to master the MiG-29 in 1989. It was the same story here: the regiment operated a mix of all three versions and the aircraft were red-coded; most of them sported the Guards badge.

The 6th GvIAD's third unit to re-equip was the previously mentioned 968th IAP, now transferred to the 16th VA and stationed at Altenburg (Nöbitz). This unit redeployed to East Germany in July 1989, replacing the 296th APIB flying MiG-27s; in turn, a regiment of Su-24 tactical bombers withdrawn from East Germany (Brand AB) took up residence at Ross'.

A peculiarity of the 968th IAP was that this was the only Soviet Air Force regiment stationed abroad to be equipped entirely with *Fulcrum-As*, not a mix of versions. However, this situation did not last long; soon the aircraft due for overhaul – and there were quite a few – returned to the Soviet Union. By way of replacement, the unit took delivery of 12 brand-new *Fulcrum-Cs* (coded '01', '03', '05', '06', '21', '22', '25', '26', '35', '36', '38' and '39'). These fighters came complete with red tactical codes and red rectangle markings on the dorsal air intake 'gills'.

The MiGs which redeployed to Altenburg not only retained the original non-standard orange codes but also gained a unit badge with a long history – a raked red star with a long blue wing (known as the 'bird's wing'). This emblem dated back all the way to 1943, originating in the 402nd IAP of which the 968th IAP was the successor; in the wartime years it had been applied to Yak-3s and came in a dozen versions. Dimar Garifoollin, the local artist at Altenburg AB, had contemplated combining the 'bird's wing' with the Mikoyan logo, but eventually decided to leave well enough alone and settled for the 1945 version of the emblem – a more windswept and 'aggressive' version. At first the badge was applied to the port air intake trunk, but the regiment's senior political officer Lt. Col. Volkov put his foot down, and the badge was applied where it had always been – on the port side of the cockpit.

By 1990 nearly 250 MiG-29s were stationed in East Germany, apart from MiG-29UBs and the East German Air Force's own *Fulcrums*. Details of the ZGV's MiG-29 fleet are given in the table on the opposite page; MiG-23UBs used as a 'stand-in' for the MiG-29UB are also listed for the sake of completeness.

The MiG-29 was also stationed in other Warsaw Pact states, though in much smaller numbers. In Hungary, where the 36th VA of the Southern Group of Forces was deployed, the first MiG-29s were delivered to the 14th *Leningradskiy* GvIAP of the 11th GvIAD; this regiment (which received its name for its part in breaking the siege of Leningrad) was awarded the Red Banner and Suvorov Orders. After the unit's pilots had taken their training at the Lipetsk centre, the first five *Fulcrum-Cs* (coded '01' through '05') arrived at Kiskunlachaza AB on 15th August 1986, flown by Lt. Col. P. N. Svechkar', Maj. V. G. Bylitskiy, Capt. V. S. Doobrovnyy, Capt. N. Kh. Bogdanov and Capt. V. V. Voronov. A total of 30 single-seaters was delivered before the end of the year. However, for proficiency training the unit had to make do with MiG-23UBs until 1989 when four *Fulcrum-Bs* finally arrived. All the aircraft were blue-coded and wore the Guards badge on the air intake trunks.

Interestingly, during the 'pre-*Fulcrum* era' the NATO fighters often 'played tag' with the Soviet jets stationed in Hungary, latching onto the MiG-23's tail with no trouble at all. When MiG-29 came on the scene, the tables were turned and the NATO airmen quickly gave up these games!

The conversion training programme was completed on 1st August 1987. In five tactical exercises the MiG-29 pilots of the 14th GvIAP destroyed eight Lavochkin La-17M target drones, ranking second in the Southern Group of Forces as far as combat readiness levels were concerned.

Just like anywhere else, the day-to-day operations of the MiGs stationed in Hungary were sometimes marred by incidents. On 24th April 1987 a DC battery exploded, setting off a fire, as a MiG-29 coded '32 Blue' was lining up for take-off. The mission was aborted and the crash

MiG-29s Operated by the ZVG			
Unit	**Base**	**Type**	**Known Tactical Codes**
6th GvIAD/31st GvIAP	Falkenberg (Alt Lönnewitz)	MiG-23UB	60 Red, 61 Blue, 63 Red, 64 Red
		MiG-29 (*izdeliye* 9.12)	01 Red, 12 Red, 21 Red, 22 Red, 23 Red, 35 Red
		MiG-29 (*izdeliye* 9.13)	02 Red, 03 Red, 04 Red, 06 Red, 07 Red, 08 Red, 10 Red, 11 Red, 20 Red, 24 Red, 25 Red, 27 Red, 28 Red, 29 Red, 30 Red, 31 Red, 32 Red, 33 Red, 34 Red, 35 Red, 36 Red, 37 Red, 38 Red, 40 Red, 45 Red, 46 Red; 54 Red?
		MiG-29UB	60 Red, 61 Blue, 63 Red, 64 Red
6th GvIAD/85th GvIAP	Merseburg	MiG-23UB	71 Blue
		MiG-29 (*izdeliye* 9.12)	01 Blue, 02 Blue, 03 Blue, 04 Blue, 06 Blue, 07 Blue, 08 Blue, 10 Blue, 14 Blue, 22 Blue, 23 Blue, 24 Blue, 25 Blue, 26 Blue, 27 Blue, 29 Blue, 30 Blue, 32 Blue, 33 Blue, 34 Blue
		MiG-29 (*izdeliye* 9.13)	31 Blue, 38 Blue, 39 Blue, 40 Blue
		MiG-29UB	71 Blue, 76 Blue
6th GvIAD/968th IAP	Altenburg (Nöbitz)	MiG-23UB	91 Red, 96 Orange, 97 Yellow
		MiG-29 (*izdeliye* 9.12)	07 Orange, 15 Orange, 16 Orange, 34 Orange, 41 Orange, 42 Orange, 43 Orange, 46 Orange, 49 Orange, 50 Orange, 52 Orange, 57 Orange, 58 Orange, 59 Orange
		MiG-29 (*izdeliye* 9.13)	01 Red, 03 Red, 05 Red Red, 06 Red, 09 Red, 21 Red, 22 Red, 25 Red, 26 Red, 35 Red, 36 Red, 38 Red, 39 Red
		MiG-29UB	64 Yellow, 65 Yellow
16th GvIAD/33rd IAP	Wittstock	MiG-23UB	66 White outline, 68 White outline, 69 White outline
		MiG-29 (*izdeliye* 9.12)	01 White, 02 White, 03 White, 05 White, 06 White, 07 White, 08 White, 09 White, 10 White, 11 White, 12 White, 20 White, 21 Blue, 22 White, 23 White, 24 Blue, 26 Blue, 27 Blue, 28 Blue, 29 White, 30 White, 31 White, 33 White, 34 White, 36 White, 37 White
		MiG-29 (*izdeliye* 9.13)	38 White, 39 White
		MiG-29UB	55 White, 64 White outline, 71 White, 72 White, 91 Red
16th GvIAD/773rd IAP	Damgarten (Pütnitz)	MiG-23UB	50 Yellow, 60 White, 90 White, 96 Blue
		MiG-29 (*izdeliye* 9.12)	20 White, 21 White, 22 White, 23 White, 24 White, 25 White, 26 White, 32 White, 34 White
		MiG-29 (*izdeliye* 9.13)	01 White, 02 White, 04 White, 05 White, 06 White, 07 White, 08 White, 09 White, 10 White, 11 White, 12 White, 41 White, 42 White, 44 White, 45 White, 49 White, 51 White, 52 White, 53 White, 54 White
		MiG-29UB	66 Blue, 74 White, 80 White
16th GvIAD/787th IAP	Finow (Eberswalde)	MiG-23UB	20 Red, 22 Red, 52 Red, 62 Blue, 65 Red
		MiG-29 (*izdeliye* 9.13)	01 White, 02 White, 03 White White, 04 White, 05 White, 06 White, 07 White, 08 White, 09 White, 10 White, 68 White, 69 White, 70 White, 71 White, 73 White, 74 White, 75 White, 76 White, 77 White, 78 White, 79 White, 80 White, 82 White, 83 White, 84 White, 85 White, 87 White, 89 White
		MiG-29UB	11 White, 33 White, 72 White
126th GvIAD/35th IAP	Zerbst	MiG-23UB	64 Red, 90 Red, 91 Red, 92 Red, 93 Red, 94 Red, 96 Red, 97 Red
		MiG-29 (*izdeliye* 9.12)	09 Red, 10 Red, 11 Red, 12 Red, 20 Red, 21 Red, 22 Red, 23 Red, 24 Red, 26 Red, 27 Red, 28 Red, 29 Red
		MiG-29 (*izdeliye* 9.13)	01, 02, 03, 04, 05, 06, 07, 08, 34, 40, 41, 42, 43, 44, 45, 46, 47, 49 (all codes blue?)
		MiG-29UB	60 Red, 70 Red, 91 Red
126th GvIAD/73rd GvIAP	Köthen	MiG-23UB	89 Blue, 90 Blue, 93 Red
		MiG-29 (*izdeliye* 9.12)	21 Red, 22 Red, 23 Red, 24 Red, 28 Red, 29 Red, 30 Red, 43 Red, 44 Red, 45 Red, 46 Red, 47 Red, 48 Red, 54 Red
		MiG-29 (*izdeliye* 9.13)	01 Red, 02 Red, 03 Red, 04 Red, 05 Red, 06 Red, 07 Red, 08 Red, 09 Red, 10 Red, 11 Red, 12 Red, 13 Red, 14 Red, 20 Red, 40 Red, 41 Red, 42 Red
		MiG-29UB	70 Red, 91 Red

MiG-29 *Fulcrum-A* '07 Orange' (c/n 2960507641)
Soviet/Russian Air Force, 6th IAD/968th IAP, Altenburg AB

MiG-29 *Fulcrum-A* '10 White' (c/n 2960520149)
Soviet/Russian Air Force, 16th IAD/33rd IAP, Wittstock AB

MiG-29 *Fulcrum-A* '21 White' (c/n 2960515125) in 'wraparound ZGV camouflage'
Soviet/Russian Air Force, 16th IAD/773rd IAP, Damgarten AB

MiG-29 *Fulcrum-A* '23 White' (c/n 2960518454)
Soviet/Russian Air Force, 16th IAD/33rd IAP, Wittstock AB

A different *Fulcrum-A* coded '23 White' (c/n 2960512149)
Soviet/Russian Air Force, 16th IAD/773rd IAP, Damgarten AB

MiG-29 *Fulcrum-A* '23 White' (c/n 2960518479)
Soviet/Russian Air Force, 16th IAD/33rd IAP, Wittstock AB

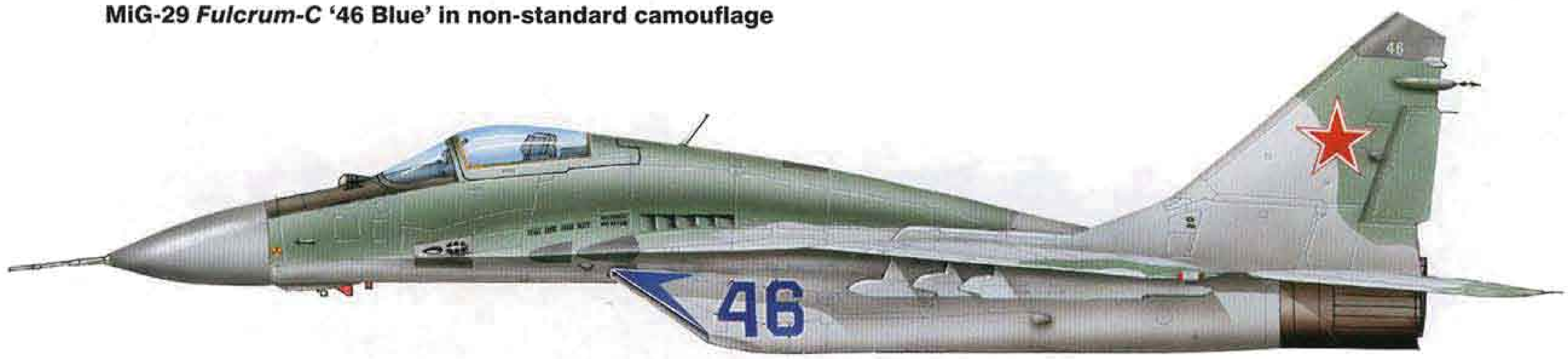
MiG-29 *Fulcrum-C* '09 White' (c/n 2960705561, f/n 1617)
Soviet/Russian Air Force, 16th IAD/787th IAP, Finow AB

MiG-29 *Fulcrum-C* '77 White' (c/n 2960715130)
Soviet/Russian Air Force, 16th IAD/787th IAP, Finow AB

MiG-29 *Fulcrum-C* '23 White' (c/n 2960715133)
Soviet/Russian Air Force, 16th IAD/787th IAP; note the difference in camouflage

MiG-29 *Fulcrum-C* '75 White' (c/n 2960714933)
Soviet/Russian Air Force, 11th IAD/5th GvIAP, Sarmellek AB, Hungary

MiG-29 *Fulcrum-C* '46 Blue' in non-standard camouflage



rescue team was on the scene within minutes, smothering the fire with foam. Later the aircraft was returned to service by the local maintenance shop; however, apart from the fire damage, both engines had to be replaced due to the onset of corrosion (the two soldiers ordered to remove the remnants of the fire extinguishing foam had been thoughtless enough to use water from the nearest pond). On another occasion in 1987 a ground support vehicle struck the wingtip of MiG-29 '29 Blue', but the damage was minor and the fighter was soon back in service.

In 1988 the 11th GvIAD's 515th *Pomeranskiy* IAP (the honorary appellation refers to the region of Pommern, Germany) stationed at Tököl AB and awarded the Bogdan Khmel'nitskiy Order exchanged its MiG-21*bis* fighters for MiG-29s. The division's third unit, the 5th *Berlinskiy* GvIAP awarded the Red Banner and Bogdan Khmel'-nitskiy Orders, completed its conversion training course from the MiG-23M to the MiG-29 that same year, but the actual re-equipment did not take place until the 515th IAP disbanded in July-August 1989, ceding its aircraft to the 5th GvIAP. On 4th August all of the former regiment's red-coded MiG-29s (*Fulcrum-Cs* '01' through '12', '14' through '17', '19', '22', '24', '25', '27' through 35', '41' through '43', '47', '55', '57', '60', '62' through '64', '66' through '72', '74' through '79', '84', '85', '89' and MiG-29UBs '10', '30' and '63') were taken on charge at their new home, Sármellek AB. Some single-seaters ('62', '72' and '75' through '79') later gained the 'Excellent aircraft' badge.

The Central Group of Forces stationed in Czechoslovakia had a small complement of MiG-29s. Its only unit to operate the new fighter was the 114th Red Banner GvIAP of the 131st SAD (***smesh****annaya* ***a****viadiveeziya* – Composite Air Division) stationed at Mladá-Milovice AB. Until the day when Russian troops pulled out of Czechoslovakia the unit received only ten *Fulcrums*, operating them alongside the 26 MiG-23MLDs flown hitherto.

The political developments of the late 1980s in Eastern Europe and the subsequent collapse of the Soviet Union affected the fate of MiG-29 units a good deal. Tensions between East and West were relaxing. On 6th July 1990 NATO's London summit passed a declaration on impending German reunification (which formally took place on 3rd October 1990). Hence on 12th September a truly historic treaty was signed in Moscow under which the Soviet Union pledged to gradually withdraw its troops from Germany.

Other East European states plunged eagerly into capitalism, breaking away from their socialist past and the bullying and patronising Big Brother personified by the Soviet Union. The end of the Cold War rendered the Warsaw pact unnecessary; brotherhood gave place to estrangement and the Warsaw Pact designed to oppose NATO aggression quietly died a natural death.

Keeping Soviet troops in Eastern Europe was no longer justified. The Soviet MoD found itself facing the herculean task of relocating numerous Soviet Army and VVS units back home. These included the ten MiG-29 regiments stationed in the former East Germany, Hungary and Czecho-slovakia; some of them had to be reorganised or disbanded entirely.

When President Mikhail S. Gorbachov signed the abovementioned treaty on the withdrawal of Soviet troops from Eastern Europe (a move which many denounced as a hasty retreat), the intensity of the flying training in the units stationed on the territory of the former Warsaw Pact allies declined sharply. First, a ban was imposed on night sorties (this was triggered by a series of accidents which led the local authorities to insist that all flying should take place between 08:00 and 20:00) and on flying on public holidays; then flying on weekends was also banned. The situation was aggravated by the troop rotation which coincided with these developments and by the inadequate training of the young fighter pilots who logged less than


Yefim Gordon

▲
The original logo of the Russian Air Force's 929th GLITs named after Valeriy P. Chkalov.

one flight hour per annum (!) because of the Air Force's fuel shortages. Indeed, in some regiments there weren't enough qualified pilots available to ferry the fighters to the Soviet Union!

The units stationed at the airfields lying directly within city limits were the first to pull out. The dubious honour of being the first befell the 5th GvIAP; in October 1990 most of its aircraft redeployed to Belorussia, going to the 927th IAP at Martynovka AB and the 61st IAP at Beryozy AB, while the remaining 20 MiG-29s were distributed between the 787th and 773rd IAPs.

◄
'05 Red', a *Fulcrum-C* operated by the 929th GLITs, poses for a photo session near Akhtoobinsk. Note that the fighter carries four MBD3-U2T1 tandem bomb racks.
▼

Yefim Gordon

From then on the withdrawal proceeded as follows. Having transferred part of its aircraft complement to the 35th IAP, in April 1991 the 73rd GvIAP left Köthen AB and redeployed to Shaykovka AB in Russia with 20 *Fulcrum-Cs* and two MiG-23UBs. A month later the 85th GvIAP moved from Merseburg to Starokonstantinov in the Ukraine.

The pullout of the 968th IAP proceeded in two stages. First, as already mentioned, the high-time fighters departed for Kubinka AB, where they were to be refurbished by the 121st ARZ, and were replaced by new *Fulcrum-Cs*. Then, on 22nd April 1992 the unit said farewell to Germany and flew to Lipetsk where it was disbanded. After the decommissioning ceremony the 'fatbacks' were handed over to the resident 4th TsBP i PLS, while the older *Fulcrum-As* travelled all the way to the Far East to see service with the 404th IAP at Orlovka AB.

On 10th June 1992 the twelve *Fulcrum-As* of the 35th IAP's 1st Squadron and the sixteen *Fulcrum-Cs* of the 2nd Squadron left Zerbst, relocating to Zherdyovka AB and thence to Lipetsk. The unit's three MiG-23UBs were scrapped on site. The 35th IAP served on at the new location until it was disbanded in 1996.

The 787th IAP departed Finow AB amid a festive ceremony with extensive media coverage on 11th May 1993, moving to Ross' in Belorussia. Just over a month later, on 15th June, the 31st GvIAP ended its sojourn on German soil and left for Zernograd.

The 773rd IAP pulled out together with the 33rd IAP, which had relocated to Damgarten AB for the occasion. Those who witnessed the event recall that huge crowds of the local people came to the base to see the Russian airmen off in spite of the rainy weather, and the departure took place amid a veritable thunderstorm of photo flashes which reflected off the glistening wet aircraft, giving them a unique charm. Two 33rd IAP aircraft, '08 White' and '09 White' (c/ns 2960518074 and 2960518091), were the last Russian Air Force MiG-29s to leave German soil; the latter aircraft actually proved reluctant to leave because of an avionics glitch. These two units likewise redeployed to Zernograd, where they were decommissioned on 1st June 1994.

Meanwhile, on 22nd April 1991 the 14th GvIAP left Hungary, its single-seat MiG-29s, two MiG-29UBs and eight MiG-23UBs flying non-stop from Kiskunlachaza to Martynovka AB. Actually, not all of them did; two *Fulcrum-Cs* made a precautionary landing at Uman' in the Ukraine, due to an accessory gearbox oil level warning on one of the fighters.

All ten MiG-29s of the 114th IAP were flown to Ivano-Frankovsk in the Ukraine in 1991.

In the southern regions of the former Soviet Union the Russian Air Force was losing ground as well as the new independent republics laid claim to the bases and units located on their territory. Part of the aircraft fleet operated by the 1521st Air Base (the famous 'aggressor' unit in Maryy) was transferred to the new Turkmenian Air Force. Later, these fighters were refurbished by the aircraft repair plant in L'vov, the Ukraine, exchanging their gaudy artwork for an unusual two-tone blue camouflage.

73rd GvIAP MiG-29s shortly after arriving at their new home, Shaykovka AB. ▼

Yefim Gordon

Nikolay Nikolayev

Units Large and Small

Back at home, ten MiG-29 regiments totalling some 350 aircraft were based in the European part of the Soviet Union. Two-thirds of these units were stationed outside the Russian Federation. Here, we should by all means mention the 168th IAP of the 24th VA based at Starokonstantinov, the Ukraine, and the 92nd IAP of the 14th VA based at Mookachovo, the Ukraine. In the late 1980s/early 1990s these units took delivery of 36 and 39 *Fulcrum-Cs* respectively.

Almost concurrently the 642nd GvAPIB of the 5th VA stationed at Martynovka AB near the town of Voznesensk (Kirovograd Region, the Ukraine) received its first MiG-29s. Established in 1940, the regiment had been a strike unit throughout its history, consecutively operating the Su-2 tactical bomber, the Ilyushin IL-2 and IL-10 attack aircraft, the MiG-15 (in its fighter-bomber guise), the Su-7B, MiG-23BN and MiG-27 fighter-bombers. In 1988 the 642nd GvAPIB became the first fighter-bomber unit to re-equip with the MiG-29. The unit did not intend to change its specialisation and the *Fulcrums* were used in the uncommon fighter-bomber role, the typical ordnance load comprising four 500-kg (1,102-lb) FAB-500ShN parachute-retarded HE bombs designed for low-level strike, S-24 heavy

▲▲ ▲

'06 Red', a *Fulcrum-C* from the 14th GvIAP based near Kursk, and a close-up of the Guards badge and the Kursk city crest painted on its nose.

▲

The 14th GvIAP unit badge.

Anton Pavlov

Yefim Gordon

◄◄

This MiG-29, '23 Red' (unit unknown), carries a Russian flag across the fins and rudders.

◄

A 968th IISAP MiG-29, '32 Red' (ex-'58', c/n 2960731668) based at Lipetsk, has the entire rudders painted in Russian flag colours

▲ **The badge of the Rusavia company (primarily a publishing house but also known for its restorations of Soviet warbirds) was carried by three 968th IISAP MiG-29s.**

unguided rockets and S-8 FFARs rather that air-to-air missiles. The reason was that the Air Force anticipated the service entry of the multi-role MiG-29M armed with guided air-to-surface weapons in the mid-1990s (which, unfortunately, failed to materialise). The basic MiG-29's efficiency in the strike role was far lower than that of the older MiG-27 and Su-17 which were dedicated fighter-bombers (especially the latest MiG-27K *Flogger-J2* and Su-17M4 *Fitter-K*).

Because of the unit's strike role all 37 MiG-29s were delivered in an 'aggressive' dark green/dark earth/tan tactical camouflage instead of the usual air superiority grey. The blue tactical codes were augmented by the Guards badge on some aircraft; the fighters coded '08', '43' and '46' wore this badge on both sides of the cockpit rather than on the air intakes.

In 1990 the 642nd GvAPIB briefly deployed to Tiraspol' in Moldavia but returned home just in time to avoid being embroiled in a civil war when the republic's Transdniestrian region declared independence.

When the Ukraine gained independence after the demise of the USSR and the Fighter-Bomber Aviation was disestablished as being contrary to the nation's official non-aggressive policy, the regiment became a fighter unit as the 642nd GvIAP. In the late 1990s it was considered non-operational; in 2001 the 642nd GvIAP was officially put on active duty but then finally disbanded a year later.

In Belorussia the 927th *Kenigsbergskiy* APIB (part of the 26th VA headquartered in Minsk; thus named for its part in the taking of what was Koenigsberg during the war and is now the Russian city of Kaliningrad) with 51 aircraft based at Beryoza-Kartoozskaya AB re-equipped with the MiG-29 in 1990.

In Kazakhstan, Loogovaya AB was home to the 715th UAP (*oo**cheb**nyy **a**via**polk*** – Training Air Regiment) which had been mainly tasked with conversion training of pilots from 'friendly nations'. This became the 715th Air Base of the Kazakhstan Air Force, retaining a total of 14 MiG-29s (early-production *Fulcrum-As* and a few MiG-29UBs).

Next door, in Uzbekistan, Kokaidy AB near Karshi hosted the 115th GvIAP, a famous unit which had earned glory in the Great Patriotic War. It was this unit that dominated the skies of Berlin on 1st May 1945, the day when the first Soviet flag was planted on the Reichstag. One of the 24 fighters in the combat air patrol group piloted by Lt. (SG) K. Novosyolov had a red banner folded and stowed into the wing recess for the trailing-edge flaps. At 12:25, as the group passed over the Reichstag, the leader of the group ordered Novosyolov to deploy the flaps; the timing was so perfect that the released banner drifted squarely to the dome of the Reichstag, unfurling as it fell.

Why do we mention this episode at all? The fighters that patrolled over Berlin in May 1945 had worn the legend *Sovetskaya Litva* (Soviet Lithuania), since they had been paid for by the residents of the Lithuanian Soviet Socialist Republic via subscriptions. As a tribute to the wartime airmen, this handwritten legend had been applied to the 115th GvIAP's aircraft ever since; even though nose art and other non-standard paint jobs were generally frowned upon in the Soviet Air Force until the beginning of Gorbachov's *perestroika* policy. Thus, the handwritten legend was worn by the MiG-21*bis* fighters which saw a lot of action in the Afghan War, and it was later inherited by some of the 37 brand-new *Fulcrum-Cs* delivered to the unit.

Nearly all of the 115th GvIAP's MiG-29s were delivered in the rarely seen three-tone tactical camouflage which proved very appropriate in those parts. All 37 single-seaters and the three MiG-29UB trainers that a regular unit was supposed to have were delivered with red tactical codes and the Guards emblem already applied by the factories. Later the aircraft of the 3rd Squadron ('24', '26', '41' through '52' and '54') gained the legend *Moskva* (Moscow) – also inherited from the MiG-21s. Unlike the legend *Sovetskaya Litva*, which was red and therefore tended to blend with the surrounding colour, the new inscription was boldly stencilled in white. The artwork was inspired and applied to the aircraft by Leonid Besaraba.

The close proximity of the 'hot' Afghan border and the likelihood of incursions gave the pilots of the 115th GvIAP plenty of opportunities and motivation to hone their skill. The airmen, who were very interested in transitioning to more advanced aircraft, soon realised the strong points of the new fighter to the full. The most obvious difference from the 'balalaika' (as the MiG-21 was dubbed because of its distinctive planform with delta wings) was the MiG-29's enormous thrust/weight ratio and excellent rate of climb; the new fighter was an avid flyer. It should be noted, however, that in training sorties it was standard operational procedure to take off at full military power instead of full afterburner in order to save fuel and conserve engine life.

Air combat manoeuvring and live weapons training figured strongly in the training pro-

MiG-29 *Fulcrum-A* '44 Blue' (c/n 2960516793)
Russian Air Force, 20th IAD/404th IAP/Sqn 1, Orlovka AB, Far Eastern DD

MiG-29 *Fulcrum-C* '29 Red' *Nikolay Zelenov, HSU* (c/n 2960729359)
Russian Air Force, 5th PVO Division/14th GvIAP, Khalino AB

MiG-29 *Fulcrum-C* '32 Red' (ex-'58', c/n 2960731668)
Soviet/Russian Air Force, 968th IISAP, Lipetsk

MiG-29 *Fulcrum-A* '101 White' (c/n 2960515389)
Russian Air Force, 4020th BRS, Lipetsk; note the unusual camouflage

gramme. This is where the statically unstable aircraft with a blended wing/body layout really came into its own. A major weakness of the Soviet second-generation and even third-generation fighters was the limited ammunition supply for the cannon(s). True, the MiG-29's ammunition supply was just 150 rounds; however, it had a better gunsight and made use of better sighting techniques, which minimised the expenditure of ammunition and increased the 'kill' probability. Two main gunfire modes were possible – 70-80 rounds and 100 rounds (two-thirds of the total supply). There was also a practice mode in which bursts of seven to nine rounds were fired; experience showed this was enough to destroy a manoeuvring target drone.

The MiG-29 could use its entire range of air-to-air missiles in a dogfight. Each model had its strong points: the R-27R had a long-burn rocket motor and a powerful warhead with a sensitive

Yefim Gordon

▲ **Seen taxying at Lipetsk in August 2005, MiG-29UB '104 White' has an unusual three-digit code and an equally unusual dark camouflage. Both are meant to make the aircraft stand out among regular service machines because '104 White' has been temporarily taken out of storage at the 4020th BRS and returned to service in order to check how the aircraft are maintained at the facility.**

proximity fuse; the R-60M was agile and could be launched at high G loads and extremely short range, while the R-73 (the MiG-29's principal missile) had an all-aspect seeker head with a wide field of view and again boasted excellent agility, which rendered it usable against all kinds of aerial targets.

The commanders always gave the go-ahead for such weapons training sessions. Inevitably, emergencies occurred from time to time. On one occasion, when Lt. (SG) G. Tyurin had successfully destroyed a target drone with a missile and was about to return to base, he discovered that one of the afterburners would not shut down. Keeping his head cool, the young pilot shut down the affected engine and managed a single-engine landing; for this he was subsequently awarded the Bravery Medal.

There are persistent rumours that the MiG-29s of the 115th GvIAP saw action in the Afghan War, but the pilots who served with the unit in those days deny this. The only known case when the MiG-29 was used in Afghanistan sounds like a fishy story, but it is true. Two 115th GvIAP fighters on QRA duty were scrambled to intercept... two suspicious persons who had intruded into Soviet territory from Afghanistan and were building a temporary hut on an islet on the River Pyandzh! The pilots were ordered to make a low pass over the offending hut and demolish it with their jet blast! The 'dragon's breath technique' was successfully used and the mission was accomplished.

Unfortunately the 115th GvIAP ceased to exist in 1992 after the break-up of the Soviet Union. Most of the aircraft and other materiel were appropriated by the new Uzbekistan Air Force. Yet, several former 115th GvIAP MiG-29s found their way to Russia. These included '08 Red' (c/n 2960715564; f/n 2925?) which had been flown to Kubinka AB for refurbishment shortly before the demise of the USSR; due to the new political situation it was not redelivered, being transferred to LII instead. There it became part of a display pair together with another *Fulcrum-C* coded '26 Red', a much later example (c/n 2960715887; f/n 3526?), whose former unit is unknown. The fighters received a dark blue/yellow colour scheme and new serials, '925 Black' and '526 Black'; taking part in many air events both at home and abroad, they were eventually lost in a crash at RAF Fairford on 24th July 1993 (of which more below).

131 *Fulcrums* were based in the European part of the Russian Federation in 1990; most of them, however, were operated by training units and the Air Force's R&D establishments. Of these, the Lipetsk Conversion Training Centre's 968th IISAP (*in**strook**torskiy is**sled**ovatel'skiy* ***smesh**annyy* ***avia**polk* – instructional & research composite air regiment) had 37 aircraft. (Later, The Lipetsk centre's complement of MiG-29s has been reduced to 14 aircraft operated by the 968th IISAP's 2nd Sqn.

No fewer than 79 MiG-29s belonged to two instructional fighter regiments of the 1080th Flight Conversion Training Centre (UATs PLS – *oo**cheb**nyy aviatsi**on**nyy tsentr pere**oo**chivaniya* ***lyot**novo sos**ta**va*) in Borisoglebsk. Finally, fifteen *Fulcrums* were operated by what was now the 234th SAP (***smesh**annyy* ***avia**polk* – composite air regiment) at Kubinka AB. The above units were part of the Moscow Defence District in the late 1980s.

Another MiG-29 unit with 40 aircraft, the 404th IAP of the 20th IAD, operated from Orlovka AB in the Far East, reporting to the 1st VA (Khabarovsk). A number of *Fulcrums* were stationed in the Central Asian republics of the Soviet Union, including 22 aircraft in Turkmenia (Maryy AB), 30 in Uzbekistan and an unknown number in Kirghisia where Loogovaya AB near the capital, Frunze, traditionally served as the training centre for foreign MiG-29 pilots and ground crews.

The MiG-29 was also operated by the AVMF. In 1989 the 119th IAD comprising two MiG-29 regiments and a MiG-23 regiment was transferred to the Black Sea Fleet's air arm, becoming the 119th MIAD (*mor**ska**ya istre-**bit**el'naya* ***avia**di**vee**ziya* – naval fighter division). One of its two *Fulcrum* units (the 161st IAP) operated from Limanskoye AB near Odessa while the other (the 86th IAP) was based at Markuleshty AB in Moldavia.

In the early 1990s one squadron of MiG-29s (12 aircraft) was assigned to the Air Defence Command (PVO – ***pro**tivovoz**doosh**naya obo-*

rona). The squadron was part of a fighter unit reporting to the 19th Independent PVO Army and operated from Privolzhskiy AB near Astrakhan' on the Volga River.

Post-Soviet Operations

1991 brought even more dramatic changes than the need to withdraw from Eastern Europe. Torn apart by political unrest and economic problems, the 'unbreakable union of free republics' (to quote the opening lines of the Soviet state anthem) turned into a 'Soviet Disunion', fifteen new states bickering with each other over who owned what. (12 of these eventually formed the Commonwealth of Independent States, which helped sort things out.)

One of the worst problems was the division of the armed forces. Though Russia had become the Soviet Union's legal successor and accepted the latter's international obligations, much of the Soviet armed forces' weaponry and military bases remained outside the Russian Federation. This applied to the tactical arm of the VVS (FA – *Frontovaya aviahtsiya*) as well, since many FA units were stationed along the borders of the former Soviet Union.

The CIS leaders agreed that former Soviet Air Force units based in Belorussia (Belarus'), Turkmenistan, Uzbekistan and the Ukraine would remain there, becoming the basis of the air forces of these respective states. The fighter force of the Black Sea Fleet's air arm, on the other hand, effectively ceased to exist. The fleet's 119th MIAD was disbanded; one of the MiG-29 regiments (the 161st IAP) became part of the Ukrainian Air Force while the other (the 86th IAP) was included in the Moldovan Air Force.

By early 1992 the Russian Air Force (now referred to as VVS RF – *Voyenno-vozdooshnyye seely Rosseeyskoy Federahtsii*) had some 300

Victor Drushlyakov

▲
A sharkmouthed 120th IAP MiG-29UB ('77 White') is pictured here at Kubinka AB where it was due to be refurbished by ARZ No.121. Note the style and placement of the tactical code characteristic of this unit.
▼

Sergey Sergeyev

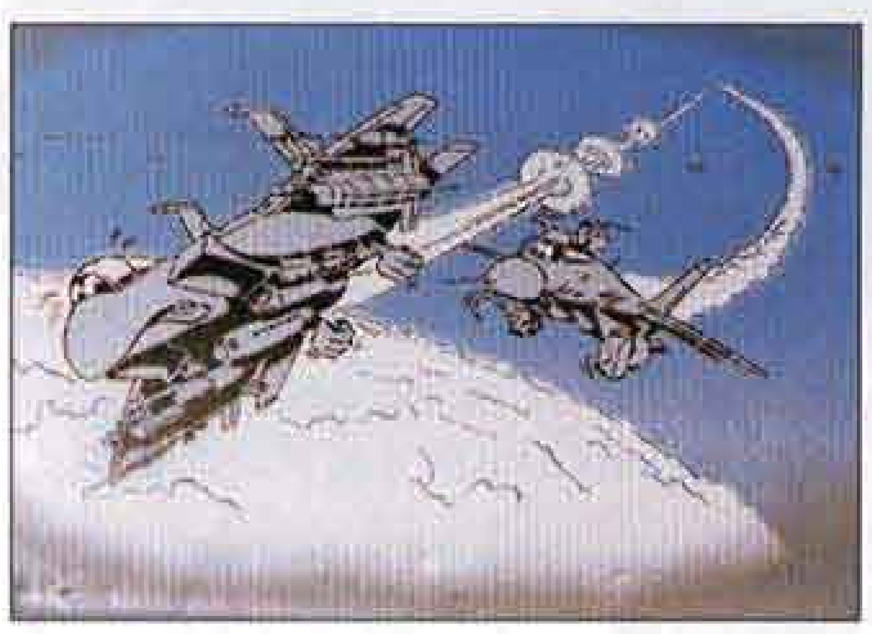
Alexandr vasil'yev

► The 120th GvIAP CO's *Fulcrum-A*, '01 White' (c/n 2960515803), in a revetment at its home base, Domna AB near Chita. Note the Russian flag and lightning bolts.

▲ The 'Instructor Vulture' artwork carried by the unit's trainers.

MiG-29s on strength; more than half of them were still in Germany, awaiting redeployment to Russian airbases. In 1992-93 the *Fulcrum* fleet was augmented by the addition of the 176th IAP which moved from Mikha Tskhakaya AB in Georgia to the Transbaikalian Defence District in Eastern Siberia.

Also in 1993, some of the units withdrawn from Germany, Hungary and Czechoslovakia, and the Moscow Defence District's Air Force



▲ 'F-15s Beware', a badge seen on one of the 120th GvIAP's MiG-29.

▲ The 120th GvIAP's 'Soaring Vulture' badge. Like all the other artwork seen here, it was designed by Capt. Valeriy Maksimenko in 1989.

Alexandr vasil'yev

►▲ The placement of the unit badge on MiG-29UB '75 White' (c/n N50903026969).

Alexandr vasil'yev

► Overall view of the same aircraft. The vicious-looking sharkmouth originated in the Afghan War and was originally carried by the unit's MiG-23MLDs.

units were organised into a new formation which inherited the 16th VA name and has its headquarters at Kubinka AB. Currently 16th VA *Fulcrums* equip the formation's fighter division, the Lipetsk training centre and the 237th TsPAT at Kubinka.

MiG-29s were also operated by the 1080th Training Centre in Borisoglebsk reporting to the 34th VA headquartered in Rostov-on-Don (which had up to 79 *Fulcrums*), by the Krasnodar Military Combined Flying and Technical School (KVOLTU – *Krasno**dar**skoye **vys**sheye aviatsi**on**noye **lyot**no-tekh**ni**cheskoye oo**chil**ishche*) of the Air Force's Reserve and Personnel Command, and by fighter units based at Domna AB and Orlovka AB (Khabarovsk region).

When the Soviet Union collapsed, two-thirds of the former Soviet Air Force's MiG-29 fleet found themselves outside Russia as a result of the MiG-29 units being stationed close to the borders. In 1992 the new Russian Air Force had only some 300 examples (mostly *Fulcrum-Cs*) on strength. By 1995 this number had increased to 410, including about 60 MiG-29UBs; another 47 examples were operated by the Russian Navy. Later, however, the number of active MiG-29s began shrinking steadily. After the merger of the VVS and the PVO in 1998 the united *Fulcrum* fleet totalled 315; by 2001 this figure had shrunk to 260 and the Su-27 had topped the list as the most widespread Russian fighter, with 340 *Flankers* on active duty.

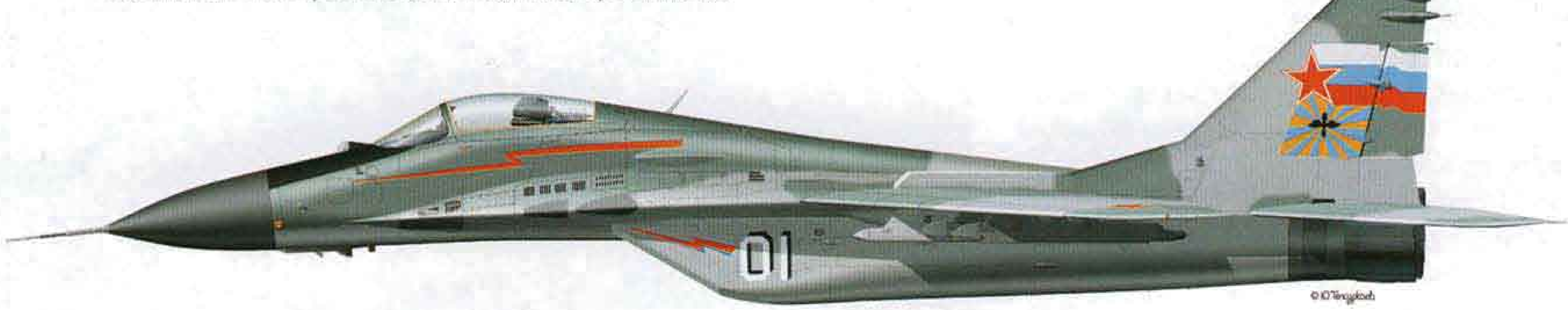
The Russian withdrawal from Eastern Europe and the ensuing disbandment of redundant units caused the base dumps (every airfield has its graveyard, you know) and the Air Force's storage depots to become crammed with hundreds of 'dormant dragons'. The Air Force's overhaul plants in Krasnodar and at Kubinka AB did accept MiG-29s for refurbishment but could not meet the delivery schedule; there were cases when the aircraft sat at the plants for three or four years or were redelivered in unsatisfactory condition. Spares supplies to first-line units were reduced to a trickle or dried up completely. As a result, aircraft were cannibalised for spares all over the place to keep others flyable – and, once cannibalised, such aircraft seldom returned to flying condition. The ongoing reorganisations did not help either – the constant change of priorities and the reassignment of MiG-29 units to the PVO or the Fighter-Bomber Aviation often caused the *Fulcrums* to give way to other types.

The 404th *Tallinskiy* IAP of the 20th IAD forming part of the 1st VA (Far Eastern DD) is a case in point. Stationed at Orlovka AB, this unit decorated with the Suvorov Order (3rd Grade) had upgraded from the MiG-23 to the MiG-29 in 1987, receiving an additional number of *Fulcrum-As* when the Russian pullout from Germany began. In 1996, however, the top brass decided that the MiG-29 could not cope with the missions the unit had to fulfil, so the 404th IAP began receiving Su-27s arriving from Smolensk, and in 2000 the regiment was disbanded altogether. Its aircraft and personnel were distributed between the 120th IAP at Domna AB (near Chita), which took the MiGs, and the 60th IAP at Komsomol'sk-on-Amur/Dzemgi airport,

Alexandr vasil'yev

▲
Some 120th IAP MiG-29s, including *Fulcrum-C* '23 White' (c/n 2960729019), carry the Russian 'double eagle' motif on the tails.

MiG-29 *Fulcrum-C* '47 White' (c/n 2960729025)
Russian Air Force, 21st OSAD/120th IAP, Domna AB



MiG-29 *Fulcrum-A* '01 White' (c/n 2960516803)
Russian Air Force, 21st OSAD/120th GvIAP, Domna AB

MiG-29 *Fulcrum-A* '52 White' (c/n 2960507683, f/n 0708)
Russian Air Force, 21st OSAD/120th GvIAP, Domna AB

MiG-29UB '23 White' (c/n N50903010376)
Russian Air Force, 21st OSAD/120th GvIAP, Domna AB

which took the Sukhois. The 60th IAP and the remnant of the 404th IAP were reorganised into the new 23rd IAP (which later became famous as the first unit to operate the upgraded Su-27SM in December 2004).

The MiG-29s of the 404th IAP had blue tactical codes which were not repeated on the fins. Some aircraft carried the badge of the 1st Squadron – a spread eagle clutching the numeral '1' flanked by an 'A' and an 'E' (а1э) – on the outer faces of the fins. Some aircraft carried the Mikoyan OKB logo beneath the canopy; additionally, '44 Blue' (c/n 2960516793) featured nose art in the shape of a spider in a cobweb on the starboard side of the nose.

The 960th IAP forming part of the 16th GvIAD of the 4th VA suffered a similar fate. Based at Primorsko-Akhtarsk AB, this unit had been reorganised from a training regiment belonging to the local military pilot college and flying Aero L-39C Albatros advanced trainers. In 1992 the new fighter regiment received 39 well-used early-model MiG-29s and four MiG-29UB trainers. Most of them had been refurbished and hence sported non-standard paint jobs: the two-tone camouflage consisted of a bluish dark grey over a lighter-than-usual base grey. The gun blast plates were usually overpainted, as were the gun exhaust vents. The dark blotches of the camouflage did not follow any set pattern whatsoever; only rarely did they coincide with the original contours. On some aircraft the workers at the repair plant had simply sloppily brushed on lighter paint over a darker background, and the result was a real disgrace. The Krasnodar plant applied the anti-glare panels with a carelessly sprayed fuzzy edge instead of a crisp border, and no attempt was made to maintain the difference in the panel's shape between the *izdeliye* 9.12 and 9.13. To top it all, the fighters arrived with tactical codes of every possible colour (white, red, orange and

Vyacheslav Martynyuk

▲ **120th GvIAP MiG-29UB '72 White' takes off past a cluster of hardened aircraft shelters at Domna AB.**

blue). Hence new codes running in sequence were allocated and applied at the local maintenance shop; the codes were red with a white outline. This followed the usual standard when a regiment had codes of a common colour running sequentially in each squadron, which allowed insiders to tell at a glance which unit in the division or air army operated this or that aircraft. Additionally, the outer faces of the rudders were painted in Russian flag colours. Some 960th IAP MiG-29s carried a curious emblem on the nose – it was a direct copy of the Strizhi display team's badge, except that the legend read 'MiG-29' rather than 'Kubinka'.

After six years of very active operations the unit was transferred to the attack component of the Air Force in 1998 and became the 960th ShAP (*shtoormo**voy** avia**polk*** – Attack Air Regiment), re-equipping with Su-25 *Frogfoot* attack aircraft. The MiG-29s ended up at the storage depots in Lipetsk – the 4020th BRS (***ba**za re**zer**va samo**lyo**tov* – Fixed-Wing Aircraft Reserve Base) – and Krasnodar.

A short way from Primorsko-Akhtarsk AB is the town of Millerovo (Rostov Region) where the 19th GvIAP is based. Departing from Germany in 1993 as a fighter-bomber unit (the 19th GvAPIB), the regiment had to relinquish its MiG-27s straight away when the Russian Air Force stopped operating single-engined combat aircraft; the MiG-27s went into storage in Orenburg and a new fighter unit flying MiG-29s was set up, inheriting the number and titles of the 19th GvAPIB. The new unit immediately found itself in adverse conditions – the airfield assigned to it (formerly operated by the abovementioned military pilot college) had been used only in the summer and was totally unsuited for full-time operation by a first-line fighter regiment. Hence the first months had to be spent on bringing the base up to the required standard, not on mastering the new hardware.

Another problem concerned the 42 aircraft proper: since LMZ had halted MiG-29 production by then, the fighters had to be sourced wherever possible, as it often happens. Some of the MiGs were taken over from the disbanded 968th IAP which ended its days in Lipetsk; others were former 31st GvIAP machines and so on. The MiG-29UBs were 'donated' by the 960th IAP when it switched to the ground-attack role and re-equipped with Su-25s. In late 1993, having

MiG-29UB '75 White' in cruise flight. The colour scheme makes an interesting comparison with the photos on page 252. ▼

via Anton Pavlov

Dmitriy Seden

▲ **'71 Red', a MiG-29UB belonging to the 19th GvIAP based at Millerovo, is seen from the cockpit of a sister ship during a formation take-off at their home base in October 2005.**

received the required additional flying personnel and passed the conversion training pipeline, the 19th GvIAP became operational.

By the book a three-squadron regiment in the Soviet Air Force should have 40 aircraft. In the 1990s, however, it became normal practice for a regiment to comprise two squadrons, and the units began disposing of 'surplus' aircraft. Aircraft due for overhaul were sent to aircraft repair plants; high-time aircraft were simply dumped, and eventually the 19th GvIAP was left with 24 single-seaters and six trainers. The single-seaters have dark blue codes outlined in white; '01' through '04', '09' and '15' have the tactical code repeated boldly on the outer faces of the fins. The fighters coded '23', '25', '26', '30' and '93' wear a Guards badge of the current (Russian) standard on the port side of the cockpit, while a few former 73rd GvIAP aircraft still have the old Soviet version. All but a few MiGs at Millerovo proudly wear a very non-standard version of the Mikoyan logo. Two of the fighters stand out from the lot. '04 Blue' c/n 2960727420) has a non-standard uniform grey finish which has earned it the sobriquet ***Se**raya mysh* (Grey Mouse). '44 Blue', a former

Anton Pavlov

► **The Russian Air Force's 'sunburst' flag has been painted on around the star insignia on the tails on '71 Red' and supplemented by the Russian flag on the rudders.**

Anton Pavlov

◄ ◄◄
Variations on the Russian flag theme displayed by two 14th GvIAP MiG-29s – *Fulcrum-C* '15 Blue' (ex-'23') and MiG-29UB '92 Blue'.

'aggressor' aircraft, wears the three-tone tactical camouflage rarely seen on MiG-29s. As a reminder of the days when this machine was home-based in desert areas, '44 Blue' has a small red camel painted on, and local wits promptly dubbed it 'Camel' – just like that, hinting at Camel cigarettes.

Unfortunately the bright southern sun causes the paintwork to become weathered very rapidly. In fact, on some machines the chrome yellow primer is beginning to show through the paint! The airmen say ruefully that the flight line looks as untidy as a remote hardstand of the L'vov ARZ! Squadron 1, which is largely equipped with former 968th IAP machines, stands out favourably in this respect; these aircraft are newer than the others and the *Fulcrum-C* type camouflage pattern is still clearly visible.

Anton Pavlov

◄
The nose of '93 Red', one of the 19th GvIAP's MiG-29UBs. Unlike '71 Red', it has red 'go faster' arrows on the air intakes.

Anton Pavlov

◄
Close-up of the modern Russian-style Guards badge and the very unusual MiG badge on MiG-29UB '93 Red'. The 19th GvIAP's aircraft generally have an extremely weathered finish.

Anton Pavlov

▲ **19th GvIAP MiG-29UB '92 Blue' sports a sharkmouth and a differently styled MiG logo. However, instead of giving a mean look the sharkmouth gives it a blasé expression.**

The unit in Millerovo has a superstitious tradition to keep the tactical codes with which the fighters previously saw service with other units; only the colour of the code is changed in accordance with local standards. As for the MiG-29UBs, it was decided to leave the codes alone, lest a change of identity should provoke problems with the unit's workhorses (superstitions are hard to explain!). This is why the unit's trainers have differently coloured codes – '71 Red', '89 Red', '93 Red', '90 Blue', '91 Blue' and '92 Blue'.

The 19th GvIAP's technical staff takes special pride in the nose art worn by some of the unit's MiGs. The first artistic endeavours were made in the same 1st Squadron. The abovementioned aircraft coded '04 Blue' briefly wore a variation of the famous 'flying star' theme – in lieu of a star the emblem featured a missile emblazoned '19th Guards IAP 1st Sqn'. The commanders, however, disliked the badge and ordered its removal. The second try was more successful: '02 Blue' (c/n 2960727448) gained an emblem featuring a winged tiger superimposed on the Air Force's 'sunburst' flag during an exercise in Zernograd. Born in 'combat', as it was, this 'flying tiger' proved popular and was soon duplicated on MiG-29UB '89 Red' which also retained the modified Strizhi badge since its days with the 960th IAP. MiG-29UB '92 Blue' sports a sharkmouth and streams Russian flags from the star insignia on the fins. Sister ship '71 Red' was the next to receive the attention of the local artists, receiving full-width Air Force flags on the fins and, for good measure, rudders in Russian flag colours.

This 19th GvIAP MiG-29 ('02 Blue', c/n 2960727448) sports a very local version of the famous Flying Tiger combined with the Russian Air Force flag. ▼

Anton Pavlov

Many 19th GvIAP aircraft wear numerous 'kill' markings testifying to the pilots' skill and high training intensity. After the turn of the century each of the unit's pilots averages 90 hours or more per year and is prepared to take on tasks of any complexity.

Several 19th GvIAP MiG-29s were transferred to the 3624th Air Base established in Armenia in October 1994 in order to provide air cover for the Russian Army's 102nd Base deployed there, as well as for the Republic of Armenia under the Commonwealth of Independent States' Collective Security Treaty. Originally the 3624th AB had operated MiG-23P interceptors taken over from the 472nd IAP; the decision to retire all single-engine combat types led the unit to re-equip with MiG-29s during December 1998 to October 1999. The aircraft were sourced from Millerovo and Zernograd; the first three 3426th AB *Fulcrum-Cs* arrived at Yerevan-Erebuni airport on 17th December 1998. Gradually the complement increased to sixteen *Fulcrum-Cs* ('01' through '10', '21' and '23' through '27') and two MiG-29UBs ('101' and '102'). These have yellow-outlined blue tactical codes.

It was probably the close proximity of the Turkish border (after taking off from Erebuni the fighters have to make an immediate climbing 90° turn to avoid staying across the Araks River and into Turkish airspace) and the local mentality that prompted the appearance of totally unique artwork on many of the unit's aircraft. Most 3624th AB MiG-29s carry the Russian flag on the rudders; '07' and '27' have wraparound Russian flag stripes on the tails, and the former of these two carries the Russian coat-of-arms on the port side into the bargain! The ex-Millerovo examples coded '02', '23' and '26' still wear the Guards badge. '01 Blue' is adorned with a Mikoyan logo and a bald eagle's head with the legend '426AG'

MiG-29 *Fulcrum-A* '30 Red'
Russian Air Force, 960th IAP, Primorsko-Akhtarsk AB, North Caucasian DD

MiG-29 *Fulcrum-C* '02 Blue' (c/n 2960727448)
Russian Air Force, 51st Air Corps/19th GvIAP, Millerovo

MiG-29S *Fulcrum-C* '29 Red' (c/n 2960728105)
Russian Air Force, 51st Air Corps/31st GvIAP, Zernograd

MiG-29UB '71 Red'
Russian Air Force, 51st Air Corps/19th GvIAP, Millerovo

to port (426th Air Group was the former designation of the 3624th Air Base). '08' looks particularly terrifying, since its entire underside bears the image of a three-engined… that is, three-headed dragon from Russian folklore spouting huge flames! The two-seaters were painted up identically to one of the *Fulcrum-Cs* ('01 Blue'); additionally, MiG-29UB '101 Blue' had the ace of spades painted on the air intake blocker doors in 2004. That same year the other trainer received markings fit for a NATO Tiger Meet – the outer faces of the fins and the centre fuselage sport the head and front paws of a tiger ripping the aircraft to shreds ('in order to get at the well-fed instructor pilot', the local wits said!). The Russian coat-of-arms is carried on the port side below the rear cockpit and the Mikoyan logo is applied in line with the windshield. On the starboard side the cockpit area features the legend '*Aviatsi**on**naya **ba**za 3426*' (3426th Air

Base) and a very basic rendering of the Pamir Mountains.

In the Transbaikalian DD, one of the Russian Air Force's 'youngest' units – the 120th IAP of the 14th VA stationed at Domna AB near Chita – has been operating the MiG-29 since April 1993. Established in 1969 in Belorussia, the unit equipped with MiG-21S fighters had been redeployed straight away to the eastern border 'due to the heightened political tension' (that is, the impending border conflict with China). Later the 120th IAP moved to Domna AB located next to the identically named station of the East Siberian Railway. Later, the unit saw action in the Afghan War, flying MiG-23MLDs.

▲ This picture of a peregrine falcon clutching a Lavochkin La-17MM target drone was seen on one of the MiG-29UBs in storage at the 4020th BRS.

The transition to the MiG-29 proceeded smoothly within just a couple of months, assisted by the pilots from Kubinka AB. The unit received a mix of *Fulcrum-As* and *-Cs* plus six brand-new MiG-29UBs. Most of the single-seaters were well-used examples obtained from disbanded units (the latter included the 176th GvIAP relocated to Bagai-Baranovka AB from Mikha Tskhakaya AB, and the famous MiG-29 '44 Red' that had been hijacked to Turkey was also transferred to the 120th IAP. A further 20 *Fulcrums* were transferred to Domna AB from the 404th IAP in the autumn of 1996, and the unit suddenly found itself operating twice the usual complement of fighters. The excess aircraft were mothballed at a storage facility organised in the 120th IAP's 3rd Squadron.

In the severe climate of the Eastern regions, operational problems with the MiG-29 began cropping up. The automatic engine starting system 'went on strike' when the ambient temperature dropped to –25°C (–13°F) or lower; since the fighters were constantly parked in the open, starting the engines without pre-heating was out of the question. The rubber grommets and gaskets, too, shrank from the cold and the pressure in the pneumatic system promptly bled down to zero. The troublesome WCS was a legend in itself; the technical staff literally had to work 24 hours a day to get the capricious radar to work as it should.

As the aeronautical common wisdom goes, 'what looks right, flies right'; and, with a little artistic touch, the technical staff at Domna AB tried to make their fighters look right. The main contribution to the noble cause was made by the 120th IAP's top artist, Capt. Valeriy Maksimenko (2nd Sqn). He had what you could call a blessed hand: none of the fighters he was responsible for after the Afghan War suffered accidents or major incidents. He was the author of the famous mean-looking sharkmouth and 'condor' artwork that had appeared on the unit's MiG-23s in Bagram during the Afghan tour of duty (TDY) and were henceforth associated with the 120th IAP.

In the summer of 1994 the artwork was applied to the unit's two newest MiG-29s manufactured in May 1990 – '47 White' and '51 White' (c/ns 2960729025 and 2960729031). The most widespread 'soaring vulture' emblem was carried on the starboard side aft of the cockpit. On the opposite side was a cartoon which reportedly originated from a calendar released by the Mikoyan OKB: a wild-eyed MiG-29 wearing a Soviet Army winter cap with 'spaniel ears' and brandishing a hammer and sickle was chasing a scared-looking F-15. Russian 'double eagles' were applied in black to the outer faces of the fins; on *Fulcrum-C* '47 White' the eagles subsequently received royal crowns (as on the Russian coat of arms), and the Mikoyan OKB logo was added to the port air intake trunk. Finally, both machines featured the famous sharkmouth and squinting eyes. (The original templates had survived from the days of the Afghan TDY but the paintbox had been stolen!)

Apart from that, '47 White' and '51 White' introduced a new style of tactical codes. At that point the unit had a mixed bag of fighters obtained from various units and sporting different code colours, which sometimes caused inconvenience; for instance, in bad weather the ground crews had trouble reading the blue and red codes and recognising the aircraft returning from a sortie. The CO heeded the personnel's opinion and ordered that the codes should be white (as they had been in the MiG-23 days); Capt. Maksimenko devised an angular style of digits with a black shadow making them appear 'raised'. When the technicians pointed out (as they often did) that the tactical codes shaded by the MiG-29's LERXes were poorly visible (or not visible at all if drop tanks were fitted), it was decided to repeat them on the inner faces of the fins. The same stencils were used in all locations, and the three-foot codes were plainly visible from any angle. Later, they were progressively applied to all of the unit's MiGs.

Three MiG-29UBs ('74 White', '75 White' and '77 White') were the next to be treated. Unlike the single-seaters, they wore a different emblem on the port side – a cartoon vulture in a ZSh-7 'bone dome' helmet and leather flying jacket demonstrating dogfight techniques (this 'instructor' artwork originated from the unit's MiG-23UBs). '77 White' was soon transferred to GNIKI VVS, leaving Domna AB for its new home at

Vladimirovka AB. MiG-29UBs '71 White' and '26 White' sported yet another emblem – an eagle pursuing a definitely scared duckling – and the legend 'Trener' (Russian for 'coach', in the sports meaning of the word).

MiG-29 '50 White' retained the 'winged star' badge of its previous operator (the 968th IAP) for a long time, but eventually this gave way to the badge of the 2nd Squadron (a yellow '2' superimposed on a fluttering Russian flag); the same badge was worn by the fighters coded '12', '40' and '43'. *Fulcrum-A* '33 White' (c/n 2960507760) stands out from the crowd, carrying the 'double eagles' on both sides of the nose rather than on the fins.

The idea of decorating the fighters soon became popular in the regiment. The unit CO's mount, '01 White' (c/n 2960515803), had the red star insignia on the tails augmented by the Russian flag and (on the port fin only) the Russian Air Force flag; the air intakes and fuselage nose were graced by red arrows. Two more machines, '03' and '10', also had the Russian flag added to the stars on the tails; '03' had blue arrows on the fuselage only, while the other aircraft lacked them altogether. MiG-29UB '73 White' had a huge Air Force flag occupying the entire port fin and eagle's head nose art.

In February 2000 the unit had to part with some of its colourful jets. *Fulcrum-Cs* '23 White' (c/n 2960729019), '47 White' and '51 White', together with MiG-29UB '73 White', were transferred to the 160th Training Centre in Borisoglebsk. In June 1998, when the Air Force and Air Defence Force merged into a single air arm, the 26th VA was disbanded. So was the 125th GvORAP (*Gvar**deysk**iy ot**del**'nyy raz-**ved**yvatel'nyy **avia**polk* – Guards Independent Reconnaissance Air Regiment) based next door to Domna AB; the 120th IAP took over the defunct unit's honorary titles and awards, becoming the 120th *Brestskiy* GvIAP awarded the Kutuzov Order. As of the time of writing, the unit operates 46 MiG-29s.

Until the turn of the century the 120th GvIAP's MiG-29s were the only sharkmouthed *Fulcrums* in first-line service in Russia. Now, however, they have been joined by more 'critters' – those of the

The artists of the 31st GvIAP based at Zernograd went one better than the rest and created a sabre-toothed sharkmouth, as illustrated by MiG-29S '29 Red' (c/n 2960728105). Note the unusually shaped anti-glare panel and the striped bands on the tail associated with the Red Banner Order which this unit was awarded.
▼

Sergey Kuznetsov

▲ The badge of the 28th Leningradskiy GvIAP based at Andreapol'. The ship graces the spire of the St. Peter & St. Paul Fortress in Leningrad (now St. Petersburg) and is generally recognised as the city's symbol.

28th GvIAP personnel pose with their MiG-29s at Kubinka AB in May 2005. The unit was on temporary deployment to Kubinka to guard the skies of Moscow during the 2005 VE-Day celebrations when numerous heads of state visited Russia. The fighter in the foreground ('33 Blue', c/n 2960728139) is named to honour N. Kh. Rzhavskiy, HSU. ▼

31st *Nikopol'skiy* GvIAP awarded the Red Banner and Suvorov Orders. Based at Zernograd, this unit has managed to retain its combat capability fully after the pullout from Germany. Retaining their red tactical codes and Guards badges, the unit's MiG-29s gained sabre-toothed sharkmouths. The 'eyes' are positioned directly below the edge of the anti-glare panel, which gives the aircraft a particularly intimidating 'frowning' look.

Known 35th GvIAP 'critters' include red-coded *Fulcrum-Cs* '04', '07', '09', '21', '24', '28', '29', '32', '37', '39', '40' and all of the unit's trainers. Additionally, '04 Red' (c/n 2960727424) and '07 Red' (c/n 29607436) carry the unit badge – a flying bald eagle superimposed on the Air Force flag – under the cockpit on the port side. *Fulcrum-Cs* '27 Red' and '28 Red' (c/ns 2960728101 and 2960728102; f/ns 4704 and 4705?) are adorned with a flying eagle clutching the orange/black 'St. George band' associated with several Soviet and Russian orders. After repairs at the local maintenance shop MiG-29UB '71 Red' (c/n N50903013814) received a non-standard striped two-tone grey camouflage, just as *Fulcrum-C* '09 Red' and *Fulcrum-A* '21 Red' (c/ns 2960727438 and 2960512120) had a while earlier. Two other aircraft – '12 Red' and '35 Red' (c/ns 2960518465 and 2960520115) – wear a locally applied tactical strike camouflage; both machines have been transferred from the 'aggressor' unit at Maryy-1 AB, as testified by the red camel nose art on one of them.

Shaykovka AB hosted the 73rd GvIAP for several years after the unit's pullout from Germany. The original 20 MiG-29s ('02', '05' through '11', '14', '20', '21', '23', '25'through '27', '40' through '42', '44', '70', '76' and '77') likewise retained the original red tactical codes and Guards badges. March 1993 was a special moment in the career of both the 73rd GvIAP and the MiG-29 in the Russian Air Force; this was when the first production MiG-29S (*izdeliye* 9.13S) fighters were delivered. The MiG-29S, which featured improved avionics and could use a wider range of weapons, was popular with the pilots and ground crews alike and was mastered within a very short time – the first sortie was flown a month after the delivery. The 73rd GvIAP had received ten MiG-29Ss by the time it was disbanded in 1998; with the exception of a single MiG-29UB, which had been written off in a fatal ground ejection accident, its aircraft were distributed between Zherdyovka AB, Kubinka AB and Lipetsk.

Incidentally, in 1994 the best pilots of several Russian AF air armies participated in a combat skill contest (rather like the USAF's William Tell contest). MiG-29 pilots from the Shaykovka unit commanded by Col. Vasiliy Podkorytov walked away with all the prizes. The flight led by Maj. Leonid Gaponov excelled in piloting techniques.

Victor Drushlyakov

Victor Drushlyakov

◄ 28th GvIAP *Fulcrum-Cs* '22 Blue' (c/n unknown) and '03 Blue' 2960728188) on TDY at Kubinka AB in May 2005. You don't see MiG-29s with live missiles very often... Tragically, '22 Blue' crashed fatally at Andreapol' on 12th May as it was returning from Kubinka.

Gaponov and Capt. Sergey Roomyantsev were also unequalled in air-to-air combat.

Today two MiG-29 units forming part of the 16th VA (now headquartered at Kubinka) are based in European Russia. One of them is the 14th *Leningradskiy* GvIAP awarded the Red Banner and Suvorov Orders; this is a glorious unit which fought gallantly on the Leningrad Front during the Great Patriotic War, providing cover for the Road of Life (a supply route over the frozen Lake Ladoga to the besieged Leningrad); ten of its pilots earned the HSU title.

After leaving Germany the unit operated from Zherdyovka AB (Tambov Region) until 1999; then, when the 472nd IAP flying MiG-23P interceptors was disbanded, the 14th GvIAP moved to the latter unit's former base near Kursk. The first MiG-29s arrived at Khalino AB on 14th May 1999; by the end of August the move had been completed and the unit had returned to active duty, guarding the skies over central Russia's bread belt. Currently the regiment has 43 MiG-29s, including ten MiG-29Ss ('01' through '10') and six MiG-29UBs ('72', '74', '75' and '81' through '83'); the other aircraft are standard *Fulcrum-Cs*.

Some time before the move to Khalino the unit had changed its tactical codes from blue to red, retaining the Guards badges. At least three aircraft had a black and yellow 'double eagle' with a shield and a golden crown painted on the fins beneath the star; yet this emblem devised by armourer Capt. A. Choovakov did not prove popular. Since 2002 all 14th GvIAP aircraft carry the city crest of Kursk and the repositioned Guards badge beneath the cockpit windshield on both sides. Some aircraft also sport a Russian flag – for example, '23 Red' carries it on the rudders while '24 Red' has small raked flags above the stars on the tail.

MiG-29 '29 Red' (c/n 2960729359) is named to honour Capt. Nikolay Zelenov (HSU), a fighter pilot. The legend '*Named after Hero of the Soviet Union, Guards Captain Nikolay Andrianovich Zelenov*' is applied in white on the starboard side and the Gold Star Order that goes with the HSU title is depicted alongside. This fighter sports a non-standard overall grey finish which came into being in rather comic circumstances. The aircraft had been transferred from another unit in 1998 and the paint had been extremely weathered everywhere except the cockpit section, which was normally under wraps when parked to protect the canopy. Such a scruffy aircraft was

◄ The Soviet-style Guards badge and the Kutuzov Order as applied to the 28th GvIAP MiGs.

28th GvIAP MiG-29 '05 Blue' (c/n 2960729387) at Kubinka AB, showing the badges on the port side. ▼

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MiG-29 *Fulcrum-A* '07 Blue'
Russian Air Force, 5th PVO Division/28th GvIAP, Andreapol'

MiG-29 *Fulcrum-C* '28 White'
Russian Air Force, 5th Division/28th GvIAP/Sqn 2, Andreapol'
(ex-14th GvIAP aircraft with 14th GvIAP artwork)

MiG-29 *Fulcrum-C* '33 Blue' *N. Kh. Rzhavskiy, HSU* (c/n 2960728139)
Russian Air Force, 5th PVO Division/28th GvIAP/Sqn 2, Andreapol'

unfit for the festive christening ceremony, and the 'ugly duckling' was sent to the paint shop for upgrading to 'swan' configuration. Time was running out, and so was the paint; as the deadline approached, only the nose section had been repainted fully and everywhere else only the most weathered spots had been touched up. Trying to avoid an embarrassing situation, the technicians attempted to turn these blotches of fresh paint into a camouflage pattern. However, when the 'repainted' aircraft appeared on the flight line the unit's 'brass hats' were aghast and ordered the fighter repainted again! Incidentally, '29 Red' is one of the unit's three fighters awarded the 'Excellent aircraft' badge.

Lately 14th GvIAP aircraft have been actively involved in various tactical exercises which the Russian Air Force has now resumed, after a long break. Live weapons training sessions at Privolzhskiy AB allow the pilots to polish their skill and check the performance of the aircraft once again. The MiG-29S is especially popular when it comes to weapons training, since it can use more sophisticated weapons than the basic version's R-27, R-60M and R-73 AAMs and unguided rockets.

The 16th VA's other unit operating the type is the 28th *Leningradskiy* GvIAP, awarded the Kutuzov Order and based at Andreapol'. In 1993, having consigned its MiG-23s to the Lipetsk storage depot, the unit re-equipped with the MiG-29s of the 33rd and 773rd IAPs which had been disbanded at Zernograd. Later, when some of the *Fulcrums* were sent off for refurbishment, replacement aircraft were obtained from Zherdyovka AB. Now the unit's two squadrons operate a total of 39 MiG-29s, only three of which are *Fulcrum-As*.

Because of the economic crisis affecting the entire nation in the 1990s and the resulting shortage of jet fuel (among other things), the 28th GvIAP's pilots had no possibility to maintain proficiency, except for the KTS-4 flight simulator – and more often than not it was unserviceable. In

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▲
Another view of 28th GvIAP *Fulcrum-Cs* parked at Kubinka AB. Left to right: '31 Blue', '33 Blue', '05 Blue', '22 Blue', '03 Blue' and '15 Blue'.

the winter months, even when fuel was available and the weather was fine (there is a common joke that Andreapol' is a lot like London – the weather may change from sunshine to rain before you get to the front door!), the airmen could only gaze wistfully at the aircraft lined up on the hardstands. The reason was that no chemical agents were available for cleaning the runway surface of the ice and snow. Hence the flying did not begin until springtime – and then the regiment's six MiG-29UBs really had to shoulder a big workload as the pilots tried to make up for time lost. The single-seaters were operated fairly intensively, too, as up to ten aircraft would participate in the day's flying. Now the situation has improved; fuel shortages are no longer a problem and the pilots are able to hone their skill. Of course, the operations are not as intensive as they used to be in Soviet days, but at least the unit now has three flight days a week. Live weapons training in Akhtoobinsk has resumed; up to five aircraft at a time are sent there for training sessions, allowing the young pilots to attack unguided targets and practise night interception of remote-controlled drones. In 2004 the 28th GvIAP participated in several combined-arms and special exercises, receiving a very high appraisal.

Once the immediate daily problems had been resolved, the unit's artists decided it was 'time to play'. In late 2003 the 28th GvIAP received a new unit badge reflecting the regiment's glorious history. The badge showed a 'double eagle' clutching a shield and a sword

Victor Drushlyakov

◄
'33 Blue' equipped with a drop tank departs Kubinka, going home upon completion of the VE-Day tour of duty.

Valeriy Kolodka

▲ '101 Blue', one of the two MiG-29UBs operated by the 3624th Air Base at Yerevan-Erebuni, taxies out while a single-seat MiG-29 is serviced by an APA-5DM ground power unit and a TZA-7.5-500A fuel bowser.

► Most 3624th AB aircraft, including *Fulcrum-C* '20 Blue', had the original '426th Air Group' tail titles.

►► The elaborate artwork on the unit's other MiG-29UB. All 3624th AB aircraft carried the Russian flag on the rudders.

Valeriy Kolodka

Valeriy Kolodka

▲ 'Scratch one trainer', or 'You've got a hungry tiger up your ***!' MiG-29UB '102 Blue' was surely the most colourful aircraft of the Russian detachment in Armenia.

superimposed on a chevron in the Russian flag colours of white, blue and red; the shield carried the unit's number and a red star. The eagle was soaring above the rising sun, and the spire of the St. Peter and St. Paul Fortress in Leningrad (St. Petersburg) was depicted on the right.

The emblem proved popular and, by way of experiment, was soon applied to several 1st Squadron aircraft along with the Guards badge and the Kutuzov Order. The emblem was applied beneath the windshield on the starboard side, the Guards badge and the


Valeriy Kolodka

Kutuzov Order on the other side. Gradually more and more aircraft in both squadrons gained various artwork. Known examples as of August 2005 are *Fulcrum-As* '01', '07' and '21', *Fulcrum-Cs* '02', '03', '05', '10', '11', '15', '25', '26', '31' and '33'; additionally, *Fulcrum-C* '23' carries only the unit badge so far. *Fulcrum-Cs* '28 White' and '29 White' operated by the 2nd Squadron still have the black and yellow 'double eagle with a shield' tail art which they had gained in their previous unit – the 14th GvIAP.

The 28th GvIAP also has 'personalised' aircraft. *Fulcrum-Cs* '02 Blue' (c/n 2960728185, 1st Squadron) and '33 Blue' (c/n 2960728139, 2nd Squadron) are named after A. S. Smirnov (twice HSU) and N. Kh. Rzhavskiy (HSU) respectively. The names are carried on the port side aft of the cockpit, together with the appropriate Gold Star Orders.

The 28th GvIAP is the Russian Air Force's only operational MiG-29 unit to have no standard tactical code colour. The machines obtained from Zernograd originally retained their old codes; later they were recoded in sequence, with white codes edged in blue (these were repeated in smaller digits on the outer faces on the fins). Then, in late 2003 the idea cropped up of changing to red codes; the idea was tested on MiG-29 '12' but eventually this aircraft remained a one-off because in 2004 the unit began

▲ **This 3624th AB *Fulcrum-C*, '27 Blue' (c/n 2960727439), had huge Russian flags occupying the outer and inner faces of both fins. Note the fresh paintwork.**

Another view of '27 Blue' taxying at Yerevan-Erebuni. Previously this aircraft had been '10 Red' with the 31st GvIAP and had worn a different colour scheme with a sharkmouth. ▼


Valeriy Kolodka

MiG-29 *Fulcrum-C* '27 Blue' (c/n 2960727439)
Russian Air Force, 3624th Air Base, Yerevan-Erebuni

MiG-29UB '102 Blue'
Russian Air Force, 3624th Air Base, Yerevan-Erebuni

▲ The badge of the 3624th Air Base depicting the mountains of Armenia.

▲ Many 3624th AB aircraft carried this badge reflecting the unit's earlier name, 426th Air Group. This is the starboard side version; the eagle faces left on the port side.

switching to blue codes edged in white! This is a lengthy process and only the machines wearing the regimental badge have been repainted.

As already mentioned, some of the unit's aircraft are former 33rd and 773rd IAP machines. These have lost all of the non-standard markings they had worn in Germany. The CO's mount, '01', had been operated by the 33rd IAP; after an overhaul at ARZ No.121 it received a fresh camouflage finish. As for the others, the original artwork was simply painted over, resulting in untidy blotches of grey; technicians say jocularly this has not affected their performance so far. The only exception is '04 White' (ex-'03 White', c/n 2960718034), one of the 773rd IAP's four 'frogs', now in a rather chipped and faded finish.

The 28th GvIAP's MiG-29UB trainers also received special markings in recognition of their daily and important work. For starters, '91 Blue' was adorned with narrow bands in Russian flag colours on the fins and the Guards badge beneath the windshield to port. The youngest three MiG-29UBs in the fleet – '87', '88' (dubbed *chetyre nolya* – 'four zeros') and '90' – carry the Guards badge on the port side and the regiment's emblem to starboard. MiG-29UB '82 White' (formerly '74' with the 773rd IAP) still carry the well-preserved tiger artwork along with the locally applied Guards badge. Sister ship '83 White' (formerly '55' with the 33rd IAP) is totally devoid of artwork.

A seventh MiG-29UB ('89 Blue') was added to the 2nd Squadron in the late 1990s. This second-hand aircraft, which had had a major check at ARZ No.275, came complete with Russian flag colours on the outsides of the rudders and a Mikoyan logo beneath the windshield.

After the 11th September 2001 terrorist attacks the Russian Air Force's fighter units, including the 28th GvIAP, were tasked with protecting major cities and other strategic facilities that might be targeted by terrorists. As an example, six 28th GvIAP *Fulcrum-Cs* were temporarily deployed to Kubinka AB to patrol the skies of the Moscow Region during the VE-Day 60th anniversary celebrations. As the resident Strizhi team (see next chapter) practised for the 9th May performance over Moscow, one of the visiting pilots grew jealous. As he took off on his patrol mission in MiG-29 ('31 Blue'), he pulled his fighter up into a spectacular vertical climb until it entered the clouds and disappeared from sight. The message was obvious: we can match those snooty Muscovites in every way! Eat that!

Mention should be made of the 968th *Sevastopol'skiy* IISAP awarded the Red Banner Order and Suvorov Order (3rd Grade). This unit was established at Lipetsk in the late 1990s from the remnants of the disbanded 455th IISAP and 968th IAP, inheriting the latter's number and titles. The 968th IISAP comprises four squadrons (No.1 flying Su-27s, No.2 flying MiG-29s, No.3 flying Su-24 tactical bombers and No.4 flying Su-25 attack aircraft). It conducts operational trials of new and upgraded aircraft due to be fielded by the Air Force and develops combat tactics. Apart from aerial combat, the unit's pilots practised using the baseline MiG-29 in the strike role, utilising the IRST/LR and HUD for aiming the bombs and unguided rockets. Typical air-to-ground weapons used were four S-24 heavy unguided rockets, or four B-8M rocket pods with twenty 80-mm S-8 folding-fin aircraft rockets apiece (32-round UB-32 pods with 57-mm S-5 FFARs were also used), or four FAB-500 or FAB-250M62 HE bombs. Strafing ground targets is also possible but the MiG-29 is considered to be too vulnerable in a gunnery attack. The aircraft is also capable of carrying a single tactical nuclear bomb but the Air Force prefers the Su-24 and the MiG-25RB as the delivery vehicle for such weapons.

Putting the experience gained with the 'aggressor' squadron in Maryy to good use, the Lipetsk centre applied white quick-identification stripes to the fuselages and tails of three of its MiG-29s ('20 Red', '22 Red' and '29 Red'). Lately the 968th IISAP has begun performing display flights at various air events; hence four *Fulcrums* ('28 Red', '29 Red', '31 Red' and '32 Red') gained large Russian flags on the upper fuselage and the rudders. Additionally, two single-seaters ('28' and '29') and two MiG-29UBs ('35 Red' and '38 Red') sport a 'double eagle' on the the fins.

It should be noted that there has always been intense rivalry between MiG-29 and Su-27 pilots, and the Lipetsk Centre is no exception in this respect. The two types sometimes meet in mock combat over Lipetsk, and every session won or lost goes to the credit of not just the individual pilot but the aircraft type as well ('guess who flies the better fighter'). In fairness, the score is about even, so the allegations of the *Flanker*'s ascendancy over the *Fulcrum* are no more than wishful thinking.

Another Russian Air Force training unit operating the type is the 713th UAP of the Armavir VVAUL (***Vy**ssheye **voyen**noye **aviatsion**noye **oochil**ishche **lyot**chikov* – Military Pilot College). This unit operates 24 *Fulcrums* in a mix of versions, predominantly MiG-29UBs. These include a MiG-29UB coded '100'. In Soviet times it was customary to assign three-digit tactical codes to aircraft operated by training units, but nowadays this tradition has vanished and this particular aircraft is an exception to the rule.

Safety and Maintenance Issues

Unfortunately, the MiG-29 has had its share of accidents. According to official sources, 45 *Fulcrums* had crashed as of 1st April 1998, with the loss of 23 pilots. The highest attrition rate was recorded in 1993: 22 of the 30 Russian Air Force aircraft lost that year were MiG-29s. However, only six crashes were caused by design and manufacturing defects. Over the years, the MiG-29 has become an extremely reliable aircraft; this goes for both airframe and engines (only four accidents were attributed to engine failure). In 90% of the cases pilot error was the cause of the accident. Still, the pilots can hardly be blamed, since the fuel shortages and budget cuts that followed the collapse of the Soviet Union inevitably caused a drastic fall-off in the number of flight hours. And staying on the ground certainly does not improve your flying skills!

In early February 1984 two experienced pilots – senior inspector pilot Col. A. A. Koreshkov and GNIKI VVS test pilot Col. V. A. Lotkov – were killed in identical circumstances within a few days, encountering reverse roll reaction to rudder input and losing control of the aircraft in a steep turn. Both crashed while practising for a display session at Kubinka AB when the MiG-29 was due to be demonstrated to government officials. Operational experience with the type was still scarce then and operational procedures had not yet been perfected.

On 14th December 1987 an early-production MiG-29 (tactical code and c/n unknown, f/n 0203) suffered an engine fire and crashed near Ivano-Frankovsk in the Ukraine, killing the pilot. A mid-air collision between a *Fulcrum-A* and a MiG-29UB occurred in the same parts (the date is unknown). The trainer crashed, killing both pilots; the single-seater managed a safe landing at the home base.

Every airfield has its graveyard. Here, the wreckage of a crashed MiG-29 mingled with the remains of a MiG-21 on the dump at a Russian airbase.
▼

Sergey Skrynnikov

Yefim Gordon

▲ **A long row of mothballed MiG-29s at the 4020th BRS storage depot in Lipetsk. The nearest aircraft, '32 Red', is a former 960th IAP machine.**

▲ **Close-up of the badge on a stored ex-960th IAP MiG-29. The badge closely resembles that of the Strizhi display team from Kubinka AB, except that the lower inscription reads 'MiG-29' instead of 'Kubinka'.**

The most famous accident occurred at the 38th Paris Air Show where MiG-29 '303 Blue' (ex-'10 Blue', c/n 2960516767) and MiG-29UB '304 Blue' (ex-'53 Blue', c/n 4029692486) were among the Soviet exhibits. On the opening day (8th June 1989) Mikoyan test pilot Anatoliy N. Kvochur was making a demonstration flight in the single-seater. During the high-alpha/low-speed pass at 160 m (525 ft) that was to conclude the *Fulcrum*'s aerobatics display, the starboard engine surged, belching a sheet of flame. Kvochur immediately selected full afterburner for the good engine; however, at 180 km/h (111 mph) he had insufficient rudder and aileron authority to counter the thrust asymmetry and the result was inevitably an irrecoverable departure.

The engine failed at 13 hrs 44 min 57 sec; the stricken fighter immediately yawed and rolled to starboard, the nose 'falling through' until the aircraft entered a vertical dive at 13:45.01. Two and a half seconds later Kvochur ejected at 92 m (302 ft) after making sure the aircraft would not hit the spectators. At 13:45.05 the fighter hit the ground beside the runway, erupting in a tremendous fireball. The pilot landed a mere 30 m (98 ft) from the wreckage, the ejection seat impacting right next to him.

To give credit where credit is due, the airport's rescue and firefighting team was on the scene 55 seconds after the crash. Kvochur was rushed to hospital but released the same day with nothing worse than bruises and a cut above his right eyebrow from the oxygen mask. Indeed, he had been extremely lucky as he had ejected outside the seat's operating envelope, not to mention the proximity of the fireball and the falling seat. Yet the incident spoke a lot for the design of the Zvezda K-36DM ejection seat, while the MiG-29 demonstrated its structural integrity (as well as the softness of the Le Bourget ground) by burying its entire forward fuselage, including cockpit, in the ground before exploding.

Naturally, there was a good deal of speculation as to the cause of the crash. Video footage showed that the MiG had suffered at least two lightning strikes immediately before the accident. However, examination of the wreckage and FDR analysis revealed that the starboard engine had been critically damaged by multiple birdstrike.

On 7th February 1992 the Lipetsk training centre suffered the loss of its chief, Gen. Sulambek S. Oskanov. During a night intercept training sortie his MiG-29 suffered a control system failure at low altitude and started rolling. Repeated attempts to stabilise the aircraft were unsuccessful, still the pilot did not eject because the fighter would drop on a major railway station and the death toll would be immense. When the aircraft was clear of the area it was too late for ejection. The MiG-29 crashed in a field near the village of Kozel'ki, killing the pilot.

On 17th September 1992 a 33rd IAP *Fulcrum-C*, '38 White' (c/n 2960707701), crashed near Augzin 17 km (10 miles) north of Parchim AB, Germany, during a training flight. Luckily the pilot managed a safe ejection.

On 3rd June 1993 two 120th IAP MiG-29s were flying a night intercept training sortie from Domna AB; one of the fighters was the 'hunter' and the other acted as the target for a simulated missile launch. The attacking aircraft was closing in on the target much too fast and the two fighters collided, crashing in an unpopulated area. The attacking pilot was killed, the other pilot ejected safely.

On 24th June 1993 a MiG-29 operated by the 1521st Air Base 'aggressor' unit suffered an uncontained failure of the port engine during an aerobatics session. When a fire warning sounded at the top of a loop the pilot (Lt. Col. Ghennadiy Markov) activated the fire extinguishers and requested an emergency landing. However, the brake parachute did not deploy and the wheel brakes operated inefficiently (probably because of shrapnel and/or fire damage to wiring and hydraulic lines). Realising he could not stop the aircraft in time, Markov ejected; the fighter overran, colliding with the localiser and exploding.

In the summer of 1995 MAPO test pilot S. N. Shaposhnikov was killed while practising aerobatics over Lookhovitsy-Tret'yakovo airfield prior to an airshow in South Africa. Pilot error was cited as the cause of the crash.

On 22nd August 1995 a group of six 23rd VA/120th IAP pilots were practising for their performance over Chita at the Aviation Day display marking the 50th anniversary of victory in the Great Patriotic War. The MiG-29s were flying over Chita's Kadala airport in close formation. The aerobatics display included numerous elements in quick succession, the aircraft pulling out of a dive at just 200 m (660 ft).

Locals watching the practice session from the balconies of apartment buildings surrounding the airport said that the six-ship formation climbed vertically, then turned sharply and went into a vertical dive (probably preparing for a Bomb Burst). As it did so, the rearmost aircraft coded '30' and piloted by Capt. A. Siplivets hit wake turbulence from another MiG-29. Rolling uncontrollably, the fighter dived into the ground near the runway threshold and exploded, disintegrating utterly; only the engines and pieces of the tail unit remained in the crater.

The flight data recorder was salvaged and promptly sent to the Alr Force's Aircraft Operations and Repair Techniques Institute (NII ERAT VVS – *Na**ooch**no-is**sled**ovatel'skiy insti-**toot** ekspluata**tah**tsii i re**mon**ta aviatsi**on**noy **tekh**niki*) in Lyubertsy, a suburb of Moscow. It turned out that the pilot never tried to eject, attempting to regain control of the aircraft to the very last. However, at low altitude there was just too little time for recovery.

Reprisal was swift. The unit's CO and chief of staff received a severe dressing-down 'for inadequate control'; the technical staff was disciplined for offences having nothing to do with the crash. The flight leader, Capt. Shapka, got the main blame; the investigators accused him of 'negligent training of personnel', implying that the pilots were not trained to keep formation properly. The highly skilled pilot was ignominiously fired from the Air Force. As if that weren't enough, the 120th IAP suffered one more loss that same day. Lt. Col. Svetlichnyy, the unit's executive officer, did not wait for the ruling of the investigation board and pronounced his own verdict. The XO, who had served his country with distinction and earned two Red Star Orders in Afghanistan, shot himself in his study...

On 4th March 1996 the 120th IAP suffered another setback when two MiG-29s collided over the vast expanse of taiga near Chita during a training sortie. The pilots, Maj. Anatoliy Yershov (Pilot 1st Class) and Capt. Vladimir Tyapkov (Pilot 3rd Class), ejected safely. The accident was attributed to lack of proficiency; small wonder, considering that the two pilots had logged only 28 hours between them in the past year!

On 25th September 1998 a 120th IAP *Fulcrum-A* coded '36 Red' crashed, killing Pilot 3rd Class Capt. Vladimir Yegorov. The mission was simple, envisaging acceleration to supersonic speed at the aircraft's service ceiling. However, a fire broke out in one of the engines immediately after take-off. The pilot did his best

Another view of the 4020th BRS hardstand in Lipetsk crammed with stored MiG-29s. Many of them are very weathered after years of open storage. ▼

Yefim Gordon

to bring the stricken fighter home, but when the runway was straight ahead the MiG-29 suddenly started yawing uncontrollably; incapacitated by the high G loads, Yegorov had no chance to eject. The fighter crashed and burned 9 km (5.6 miles) from the runway threshold; the flight had lasted just over four minutes. Yegorov's total time in the preceding five years had been 74 hours, including just 20 minutes (!) in the nine months before the accident.

On 24th March 2001 the Akhtoobinsk Flight Test Centre lost a MiG-29UB when an engine failed during a routine training flight. Both pilots ejected safely, the aircraft crashing in the steppe.

On 12th May 2005 a 28th GvIAP MiG-29 ('22 Blue') crashed on approach to Andreapol' as it returned from the VE-Day TDY to Kubinka AB; Pilot 1st Class Maj. Valeriy Goosev was killed. Investigation showed that the pilot had decided to show off, making a barrel roll at low altitude and miscalculating his manoeuvre.

A brand-new MiG-29UB was lost near Gor'kiy when 234th GvIAP pilots lost control of the aircraft during the pre-delivery checkout flight; both pilots ejected safely. Another *Fulcrum-B* crashed near Gor'kiy after repeated but unsuccessful attempts to recover from a spin, killing factory test pilot Kherodinov and Air Force pilot Bespalov. Air Force pilots Larionov and Mazur lost their lives in a MiG-29UB in similar circumstances.

The 3624th Air Base lost one of its aircraft on 12th November 2003 when *Fulcrum-C* '22 Blue' flicked into a spin and impacted at 2,557 m (8,389 ft), killing 39-year-old Pilot 1st Class Konstantin Kardash, the unit's Chief of Flight and Weapons Training. The investigation panel stated human error as the cause – the ATC shift supervisor had guided the aircraft into the mountains in poor weather, while the pilot did not act resolutely enough. A replacement aircraft ('10 Red', c/n 2960727438) was obtained from the 31st GvIAP; it received a new tactical code ('27 Blue') and a new set of artwork.

On another occasion a fuel line failed on take-off, causing a massive fire. Again, the pilot tried to save the aircraft – and died trying.

Not all accidents were in-flight ones. A single-seat MiG-29 and a MiG-29UB were destroyed by fire on the ground at the Air Force aircraft overhaul plant No.121 at Kubinka AB. Another single-seater burned out at Mikha Tskhakaya AB (no dates are known).

The usual reaction of the top brass to an accident was to impose new limits and instructions banning this and that, not to increase the number of flight training hours. Small wonder that the pilots, being kept on a tight rein and unable to use the MiG-29's unique dogfighting potential to the full, lost their skill. The result was sometimes embarrassing. On 28th January 2004 Lt. Gen. Yuriy Komissarov, Commander of the 4th VA's 51st PVO Corps, forgot to extend the undercarriage and made an unintended belly landing at Zernograd in a MiG-29 coded '34'. As the fighter slithered down the runway, the pilot ejected, obeying orders from the tower due to the risk of fire. Luckily there were no grave consequences; both pilot and aircraft returned to active duty shortly afterwards.

Yet in spite of these accidents the *Fulcrum* is well liked by service pilots of the Russian Air Force. The MiG-29 has earned a good reputation for its reliability and maintainability. While the Su-27 (dubbed the 'Goose' in the Russian Air Force) is very much a 'pilot's aeroplane', the MiG-29 is also a 'technician's aeroplane'. The relatively small size of the aircraft speeds up the pre-flight check procedure; the connectors and access panels are conveniently located so that virtually all maintenance is done from ground level, with no need for stepladders. The one-piece composite engine cowlings earned high praise; being surprisingly lightweight and rigid, they afforded almost unlimited access to the engines when removed. This, and the engine attachment point design, reduced the time needed for an engine change to just eight man-hours.

The aircraft is designed to be compatible with civil airfields meeting ICAO standards, as well as with military bases. The fuel and power connectors and the like are standardised, enabling the aircraft to use both Russian and Western ground support equipment (though in past years Western observers used to phrase this a bit differently: 'designed to be compatible with captured NATO equipment'!). The modular structure of the aircraft's systems and high degree of systems component interchangeability have eased maintenance and repair. The built-in test equipment monitors more than 80% of the aircraft's systems.

The *Fulcrum* at War

The first real war in which the MiG-29 saw action was the Gulf War of 1990-91. However, when the Western coalition launched Operation *Desert Storm*, Iraq made no real effort to oppose the Allies. According to the US Department of Defense, three Iraqi MiG-29s were shot down on 17th January 1991 and two more on 19th

January. The others escaped destruction by seeking sanctuary in Iran.

It could hardly have been different, considering that in modern warfare the outcome of a battle depends on pilot skill and adequate information support as much as on the aircraft's capabilities – and the Iraqi pilots were definitely lacking in the first and second. Speaking of information support, German reunification gave NATO a chance to evaluate the MiG-29 in mock combat with the F-15 and F-16, which was especially welcome because Operation *Desert Storm* was already brewing at the time. The verdict was that the *Fulcrum* was an excellent weapons system if used properly. But, as a saying goes, equipment is but a piece of metal in the hands of a savage.

The type was also involved in the war in ex-Yugoslavia. No information is available whether the MiG-29 (or L-18, as it was known locally) was used in the civil war stage. However, when NATO began Operation *Allied Force* on 24th March 1999, Yugoslav Air Force (JRV) MiG-29s were brought into play against the attackers. At first, things did not look too good for the *Fulcrums*. One aircraft was destroyed on the ground at Batajnica AB by a direct hit of a Tomahawk cruise missile targeted by a surveillance aircraft. Three more (some sources say five more) were shot down by NATO fighters, including one downed on the very first day by a Royal Dutch Air Force/322 Sqn Lockheed Martin F-16C (J-063).

Three days later, however, the MiGs – and the Serbs at large – were avenged in spectacular fashion when a USAF (49th FW/8th FS 'Black Sheep') Lockheed Martin F-117A Nighthawk fighter-bomber (82-0086/'HO') operating out of Aviano AB in Italy was shot down 30 km (25 miles) north-west of Belgrade. The pilot, Capt. Ken Dwelle, ejected and was rescued by a USAF combat search-and-rescue (CSAR) team. The cause of the loss was immediately the subject of much speculation; NATO spokesmen claimed it was due to poor weather or mechanical problems.

In Russia, the original theory was that the supposedly invulnerable stealth aircraft had been downed by a *Kvadraht* (Square; NATO SA-4 *Ganef*) surface-to-air missile. In May, however, the Russian MoD daily ***Krasnaya Zvezda*** (Red Star) reported that the F-117 had been downed by a JRV MiG-29 flown by Lt. Col. Gvozden Djukić. According to Djukić, he had spotted the enemy aircraft at dusk 1.5 km (0.9 miles) ahead while flying a combat air patrol mission along Serbia's western border, recognising it instantly as an F-117 by its distinctive shape, and attacked it with IR-homing missiles. The fighter-bomber started disintegrating after being hit by the first missile and the pilot ejected immediately. It should be noted that Djukić probably did not switch on the radar, using either the IRST or the HMS to guide the missile, otherwise the American pilot would have had ample warning.

'I felt as pleased as an Indian who had just taken a scalp, or even more', Djukić recounted. 'Capt. Ken Dwelle probably did not know we were hunting for him when he flew to wreak death and destruction on our cities. He also hadn't heard of our proverb: "A black sheep is a bad sheep". Mr. Dwelle's squadron was named "Black Sheep"; perhaps the name had played a dirty trick on him!' For this 'kill' Djukić was awarded a medal, receiving it from President Slobodan Milošević.

However, it has to be said that the JRV had tried to use its aircraft as little as possible, relying mainly on anti-aircraft artillery and SAMs. The Yugoslavs were clearly learning from the mistake of Saddam Hussein who had flung all of his assets into the fray and lost a lot of aircraft. Waging an all-out war against the NATO bombers with a handful of fighters was pointless.

Yefim Gordon archive

◄ An Iraqi Air Force MiG-29 serialled 29060. Several Iraqi MiG-29s were destroyed during the Gulf War and others fled to Iran, which kept them.

Alexandar Radić

Yugoslav (Serbia and Montenegro) Air Force MiG-29 '18111' taxies at Batajnica AB. It was one of the MiG-29s destroyed during Operation *Allied Force*.

The badge of the Yugoslav Air Force's sole MiG-29 unit, the 127th Fighter Regiment 'Vitezovi' ('Knights').

The most recent war in which the MiG-29 was involved is the border conflict between Ethiopia and Eritrea, which has been flaring up periodically since 1991 when Eritrea (formerly a northern province of Ethiopia) gained independence. The apple of discord is the Badme border region. The Soviet Union had supplied military aid to Ethiopia in the 1970s and 1980s. This time Russia supplied weapons to both belligerents. Among other things, a handful of well-used Su-27s were supplied to the Ethiopian Air Force (EtAF), while the Eritrean Air Force (ERAF) procured MiG-29s elsewhere in the CIS; thus, here we have a rather improbable 'dog eat dog', or 'MiG eat MiG' situation.

Additionally, Russian (or, at any rate, Russian-speaking) military advisors and instructors were also present in both countries; the Eritrean MiG-29s were procured with the assistance of Col. Vladimir Nefyodov, a former representative of the Rosvo'orouzheniye arms export company.

On 25th February 1999 Ethiopia initiated Operation *Sunset*. MiG-23BNs struck at key points in Eritrea, including the logistical centre at Harsele, water supply installations in Aseb and the airfields at Asmara and Aseb. Two ERAF MiG-29s scrambled to intercept the intruders. Locating them proved easy, and the *Fulcrums* attacked with R-27 missiles but missed. In turn, the Ethiopian pilots apparently called in reinforcements, and these arrived in the shape of Su-27s flown by Russian mercenary pilots. The Eritreans attempted to disengage but the Su-27s gave pursuit and attacked with R-27s. Both of the MiG-29s were damaged by the missiles exploding close behind, which allowed the Sukhois to finish off one of them with a single R-73 missile. The pilot ejected and was captured. The other MiG-29 (reportedly flown by none other than the commander of the Eritrean Air Force, Brig. Gen. Habte Zion Hadgu) escaped but crashed only some 6 km (3.72 miles) from Asmara: the fate of the pilot is unknown.

Alexandar Radić

A Yugoslav Air Force MiG-29 concealed under camouflage netting.

Alexandar Radić

◄ **NATO personnel examines the wreckage of a Yugoslav MiG-29 (18113) shot down on 26th March 1999. The fighter appears to have impacted in a flat spin.**

The following morning the Eritreans evened up the score: as the Ethiopian attacks continued, a solitary ERAF MiG-29UB (flown by one of the former EtAF pilots who remained in Eritrea in 1991) intercepted two MiG-23BNs, destroying both with R-73 missiles. Shortly after, however, two Su-27s arrived on the scene and fired two R-27s at the MiG. Some reports indicate that both missiles missed and the contact with the MiG-29 was lost shortly afterwards. However, Ethiopian sources say that although the first two missiles indeed missed, the Su-27's female pilot Capt. Esteher Tolossa then attacked either with R-73s or guns, and shot the Eritrean fighter down. While this kill remains unconfirmed, the fact is that only one of the two MiG-29UBs delivered to the ERAF was ever seen again.

Alexandar Radić

▲ **The woodworking shop of MAPO? Not at all – quite simply, the Serbs built lots of plywood MiG-29 mock-ups to deceive the NATO attackers during Operation *Allied Force*.**

Alexandar Radić

◄ **One of the 'plywood MiGs' – a reasonable likeness of the real thing – in position at a Yugoslav airfield. Before the attack...**

Alexandar Radić

▲
...and after. Long live Operation *Allied Farce*.

►
Three Eritrean Air Force MiG-29s (ERAF 504, ERAF 506 and ERAF 507) in Asmara.

via Internet

Another Eritrean MiG-29 (ERAF 505) in flight.
▼

via Internet

Soon afterwards Ethiopia launched Operation Westwind, delivering massive air strikes against Eritrean positions on Mereb-Setit front several times a day. On 18th March, as Eritrean *Fulcrums* tried to repel the MiG-21s and MiG-23s flying ground attack, they were pounced upon by the Ethiopian Su-27s flying top cover. As the first two Eritrean MiG-29s approached, the Sukhois fired at least two R-27s against each opponent. Again, one MiG-29 got away but the other was damaged by an R-27 exploding nearby and crashed, killing the pilot.

Interestingly, the 1999 border conflict between Ethiopia and Eritrea showed very poor performance of the R-27 missiles with which most of the 'kills' were scored; the 'kill' ratio was only about 16.6%. Out of sixteen R-27s on which details are known, only one scored a direct hit, three or four proximity fused, and the results of the other two remain unconfirmed, for four confirmed and one unconfirmed kills. At least ten, but probably 18, others missed or failed to launch. Especially surprisingly, the far more experienced Russian and Ukrainian mercenary pilots had no better luck. Also surprising was that not a single R-27 fired by ERAF MiG-29s scored a hit. Reports from both air forces stress that rough handling during transport, harsh storage conditions, and ill-trained weapons personnel account for this appalling performance.

PART NINE

THE MiG-NIFICENT DISPLAYS

Amazing the West

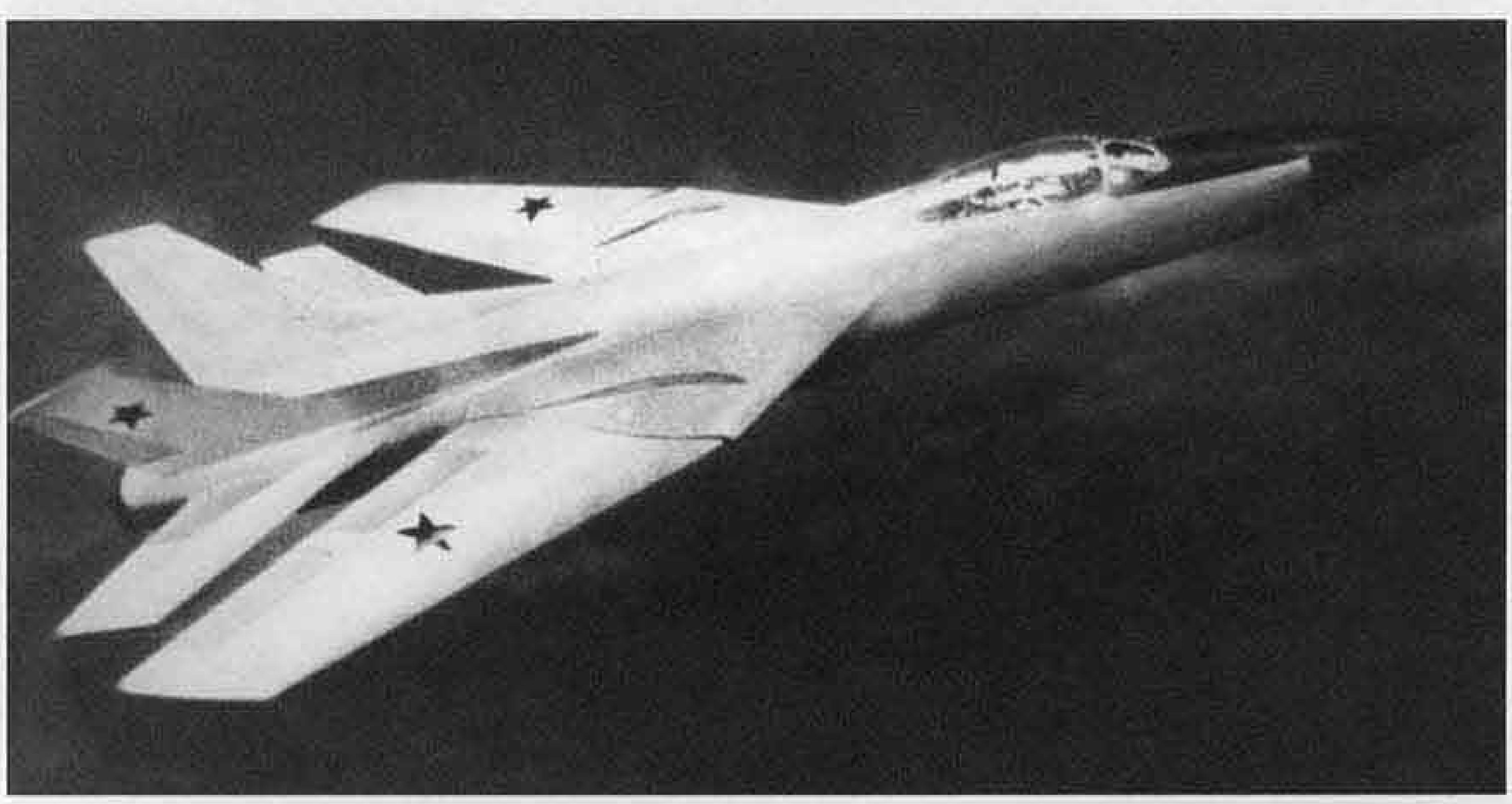
The first reports of new-generation fighters under development in the Soviet Union appeared in the Western press in the mid-1970s. In August 1977 *International Defence Review* revealed that a new Soviet fighter designated MiG-29 was *'undergoing trials in the Ramenskoye flight test centre'* (this, as mentioned earlier, was the Western misnomer for LII, which is located in Zhukovskiy, not Ramenskoye). The designation was based on 'educated guesswork', as a) Soviet fighters received odd-number designations and b) the MiG-27 was bound to be followed by the MiG-29. However, the magazine writer was mistaken, as the MiG-29 had not yet flown at the time; the aircraft in question was almost certainly the first prototype Su-27 (T10-1) which entered flight test on 20th May 1977.

The IDR feature was presaged by photos of the ramp at Zhukovskiy made by a US surveillance satellite. These depicted several new combat aircraft of as yet unknown origin, including two fighters which received the temporary reporting names *Ram-K* and *Ram-L*. As mentioned earlier, such names were allocated instead of the usual 'by class' reporting names (F for fighter, B for bomber, M for miscellaneous and so on) until the aircraft's manufacturer and role had been positively identified. For instance, the Su-25 *Frogfoot* attack aircraft was initially referred to as *Ram-J*, the Tu-160 *Blackjack* strategic bomber as the *Ram-P* and the Myasishchev M-17/M-55 *Mystic* high-altitude reconnaissance aircraft as the *Ram-M*. In due course the *Ram-K* and *Ram-L* were identified as the T10-1 and the first prototype MiG-29 ('aircraft 901') respectively, becoming the *Flanker* and the *Fulcrum*.

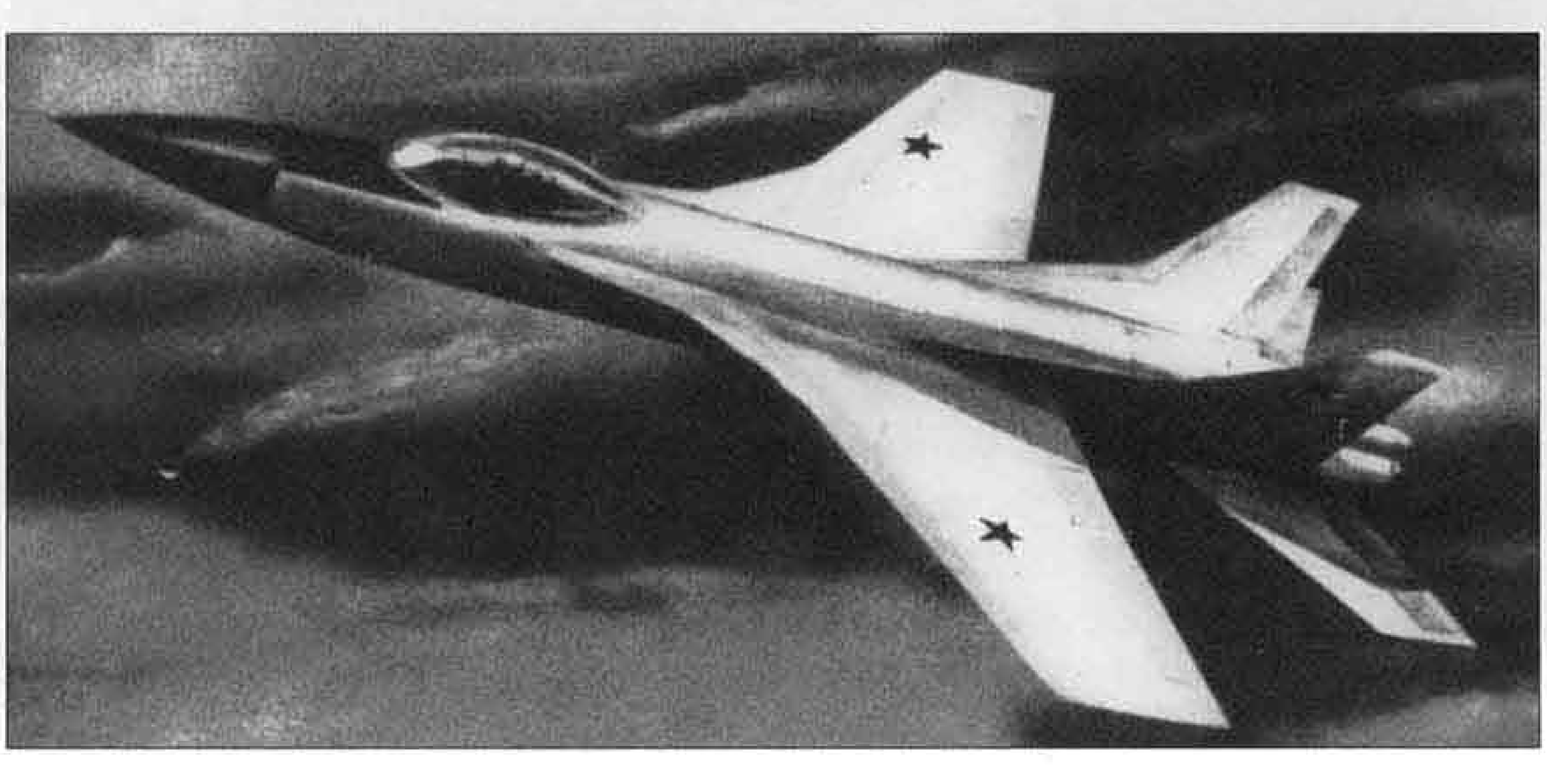
Yet the USA was reticent about its 'findings' at LII and not in a hurry to publish data on and photos of the MiG-29. The first information about the fighter's existence was released by the Pentagon two years later, in March 1979. As for the satellite imagery, it was not published until November 1983 when the *Fulcrum* had achieved IOC and the Central Intelligence Agency had a much better idea of the new fighter's design and combat potential. The photos released for publication were of extremely poor quality, showing only a blurred shape vaguely reminiscent of the F-15. There have been persistent rumours, however, that the photos had been *purposefully* 'coarsened' considerably and that the Pentagon had kept the good-quality originals to itself!

The Western world had its first good look at the MiG-29 on 1st July 1986 when six 234th GvIAP *Fulcrum-As* from Kubinka AB accompanied by an Antonov An-12BP *Cub* support aircraft came to Kuopio-Rissala AB in Finland, home to the 31st fighter squadron/Karelian air wing (31 HLeLv/*Karjalan Lennosto*) on a four-day friendly visit. The fighters ('01 Blue', '02 Blue', '03 Blue', '07 Blue', '08 Blue' and '12 Blue') were flown by Col. V. V. Longinenko (*sic*; this is how the name was spelled by *Air International* but the correct name was almost certainly Logvinenko) who headed the delegation, Col. V. Yashin, Maj. V. Solov'yov, Maj. V. Kravets, Maj. V. Chilin and Maj. A. Arastov. Finland was very probably chosen because the Finnish Air Force (*Ilmavoimat*) traditionally operated aircraft from East and West alike and could well order the MiG-29 as a MiG-21 replacement.

Such visits were nothing new; however, this was the first occasion when the latest Soviet military hardware was displayed in the West, and of course the interest generated by the visit was immense. Western specialists and photographers were not allowed to inspect the MiG-29 at close range, yet some good-quality photos were taken and the observers got the first taste of the fighter's high agility. This triggered a wave


AW&ST

Fantasies Unlimited. This is how the first artist's impression of the MiG-29 published in the Western press looked, envisaging variable-sweep wings! ▼


AW&ST

Fantasies Unlimited, Part 2. This later artist's impression was obviously based on satellite imagery of the 'Ram-L', but it was still a very poor resemblance. ▼▼

of publications whose authors conjectured on the *Fulcrum*'s design features, performance and combat potential.

Typically on such visits Soviet military aircraft had sensitive equipment items removed. The MiG-29s at Kuopio-Rissala were no exception, lacking pylons so as to avoid revealing how many missiles the aircraft could actually carry.

Despite the new Soviet policy of *glasnost'* (openness) and the fact that the MiG-29 had been displayed abroad, the Soviet media were tight as a clam about the fighter's existence. It was not until 19th March 1987 that *Krasnaya Zvezda* published a poor-quality photo of a four-ship formation of MiG-29s from Kubinka. By then, export sales had also begun; India took delivery of the first aircraft in December 1986, Iraq and Yugoslavia following in 1987. *Glasnost'* obviously still had a long way to go!

Since there was no point in keeping the fighter veiled in secrecy any more, the Soviet government made an unprecedented decision to demonstrate the MiG-29 at the 1988 SBAC airshow (Farnborough International '88). Until then, Soviet participation in international airshows had been strictly (one might say ostensibly) civilian. The Mikoyan OKB sent two *Fulcrums* to FI'88 – the ill-fated single-seater coded '10 Blue' (c/n 2960516767) and the third prototype MiG-29UB ('53 Blue', c/n 4029692486).

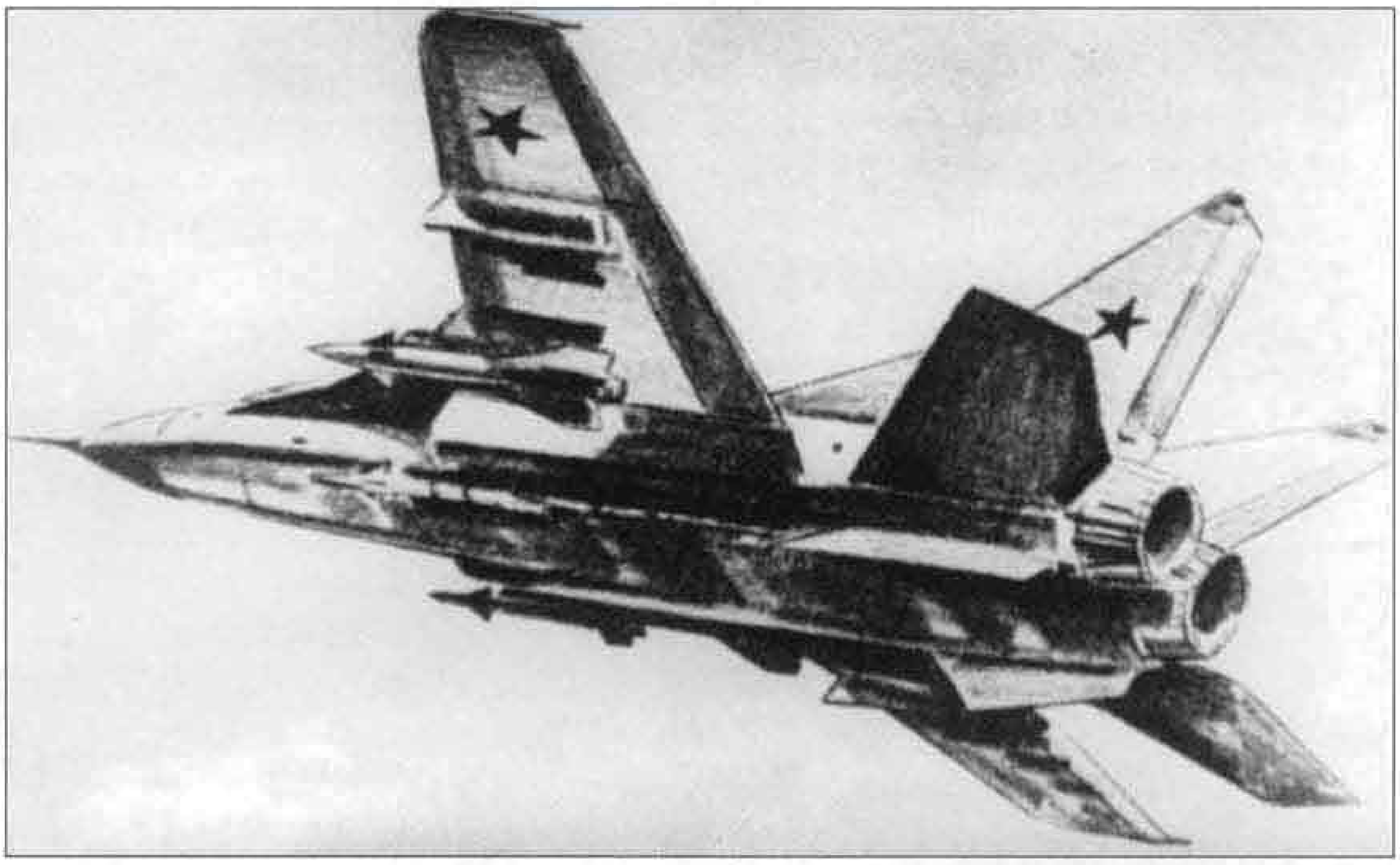
The single-seater was flown by Mikoyan test pilot Anatoliy N. Kvochur and the trainer by Roman P. Taskayev. The MiG-29s landed at Farnborough after making a refuelling stopover at Wittstock AB in Eat Germany. In British aerospace they were escorted by two RAF Panavia Tornado F.3 interceptors of No.5 Sqn (XT736/'CK' was one) and a BAe VC10 K.3 tanker acting as a camera ship for journalists.

Curiously, the fighters arrived without pylons but when the airshow opened on 4th September, '10 Blue' had four underwing pylons. These were delivered, along with other equipment and spares, by the An-124 Ruslan (*Condor*) widebody freighter registered CCCP-82007 which was one of the Soviet exhibits.

The appearance of two Soviet fighters at the Show created a veritable sensation; as David A. Brown (*Aviation Week & Space Technology*) put it, *'there also was a large dose of udivlenye* ('surprise' or 'amazement' in Russian – *Auth.*) – *with Western observers expressing amazement that Soviet air force* (sic) *MiG-29s and British Royal Air Force Tornado F.3s could be seen flying in a graceful formation at Farnborough'*. The *Fulcrum* quickly demonstrated its superiority to Western fighters present at the show; to quote Valeriy Ye. Menitskiy (the then Mikoyan OKB chief test pilot) who was present at the show, 'the joint practice sessions put everything into its proper place. The top of a loop executed on the MiG-29 is some 100 m [330 ft] lower than on the F-16C or [Dassault] Rafale.

Turning time is better than the Rafale's, to say nothing of the Mirage 2000. The F-16's time is very close, being only 0.8-1.5 seconds worse [than the MiG-29's]. The MiG-29 has an advantage during takeoff as well – it gets unstuck and starts climbing quicker than the others. The Rafale and Mirage 2000 have a slightly better roll rate but they don't have any advantage at high alpha and during the so-called 'special rolls' (a test manoeuvre developed to identify AOA limits – *Auth.*).'

The MiG-29's tailslide manoeuvre performed by Kvochur and Taskayev was a true show-stopper, as it had been performed previously on competition aerobatic aircraft only, not on fast jets. The tailslide was included in the display programme at Farnborough to give the spectators a better idea of the fighter's



AW&ST

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▲ **More artist's impressions; the upper drawing resembles a scaled-down MiG-25 with some F/A-18 features.**

Yefim Gordon archive

▲ **Mikoyan OKB test pilots (left to right) Valeriy Menitskiy, Anatoliy Kvochur and Roman Taskayev discuss the day's flying while technicians and support vehicles swarm around two MiG-29s.**

capabilities. Firstly, it showed that the controls remained effective at ultra-low speeds (trajectory control was retained at zero and even negative airspeed when the aircraft briefly moved tail-first before exiting the manoeuvre in a dive). Secondly, it demonstrated the fighter's high thrust-to-weight ratio and smooth engine operation throughout the flight envelope.

There have been discussions as to whether the tailslide could be used as an element of dogfight tactics. Some observers dismiss it as a flashy airshow stunt and nothing else but others believe this is not so. The fighter's unconventional trajectory may cause the enemy to lose target lock-on because the Doppler effect disappears when the MiG-29 literally stands still on its tail for a few seconds. Modern fire control radars have a memory feature, and if target lock-on is lost they will 'recall' the target's direction of flight and try to locate it in that direction. However, after making a tailslide the MiG-29 pops up where the enemy's radar least expects it to be.

On the other hand, pilots were wary of the manoeuvre because it implies a loss of speed; regaining speed would take a lot of time and any advantage gained by means of the tailslide could go to the dogs. The distrust of Western

The famous MiG-29 demonstrator shown at Farnborough (c/n 2960516767) is seen here at Zhukovskiy. Note the early version of the MiG logo. ▼

Dmitriy Grinyuk


RSK MiG

◄ **This photo of MiG-29 '10 Blue' carrying a full load of missiles was much used to promote the aircraft.**

observers was partly due to the fact that no other production fighter was capable of performing the tailslide at the time. The proof of the pudding is in the eating, as the saying goes, and new things are always treated warily.

Anyway, the MiG-29 overshadowed everything else at FI'88, including fighters traditionally in demand with weapons-importing countries. Features in aviation magazines describing the show appeared with such headlines as *Soviet MiG-29 Fighter Sparks Farnborough Opening* (*Aviation Week & Space Technology*), *Glasnost on the Wing* (*Flight International*), *The Show-Stopper: MiG-29 at Farnborough* (IDR) and so on.

While traditionally supplying combat aircraft to a number of 'friendly nations', the Soviet Union had been unwilling to be advertised as a weapons exporter. The *perestroika* and *glasnost'* policies, which were the beginning of democratic reforms in the country changed all that. The Soviet Union was becoming increasingly more open to the outside world; the Cold War and the arms race were winding down. Gradually people in the Western world began shedding the old 'Soviet threat' myth, albeit this took some time to accomplish. To quote the famous biologist Gerald Durrell, *'reputations, whether true or false, die hard, and for some reasons a bad reputation dies hardest of all.'*

Openly demonstrating the latest Soviet military hardware in the West was an important way of getting rid of the Cold War heritage. Besides, by entering the world weapons market the Soviet Union could earn sizeable profits. (In the past, Soviet weapons exports had been a purely political matter and usually did not generate any profits – indeed, many third-world countries never paid for the weapons or received them for the proverbial 10,000 goatskins!)

Participating in various international airshows and trade fairs would be the best way to advertise the aircraft. It so happened that the

Another high-altitude air-to-air of the same aircraft – this time in unarmed configuration. ▼


RSK MiG

via RART

via RART

▲
MiG-29 '10 Blue' and MiG-29UB '53 Blue' en route to Farnborough with their RAF escort – two Tornado F.3s and a VC10 K.2.

via RART

►
The pair of *Fulcrums* arrive in style, coming in to land on Farnborough's runway 27.

▶
MiG-29 '10 Blue' and MiG-29UB '53 Blue' in the static display at FI'88.

The *Fulcrums* immediately after arrival, with the escorting Tornados visible beyond and An-124 CCCP-82007 parked in the distance.
▶▼


Flight International


Flight International

MiG-29 was the first Soviet (Russian) combat aircraft openly demonstrated abroad with a view to attracting export orders. This was the beginning of Russia's cooperation with the outside world in the field of military technology.

FI'88 was but the first of the *Fulcrum*'s numerous airshow appearances and the fighter was invariably a success with the visitors. In June 1989 the same two aircraft – MiG-29 '10 Blue' and MiG-29UB '53 Blue' – were displayed at the Paris Air Show. They had been recoded '303 Blue' and '304 Blue' respectively for the occasion; the new codes were in fact Le Bourget exhibit numbers. The Soviet delegation included chief project engineer Mikhail R. Val'denberg, pilots Valeriy Ye. Menitskiy, Anatoliy N. Kvochur and Roman P. Taskayev, MiG-29 leading engineer V. N. Ootkin, flight operations engineer N. A. Belov, a ground crew and the chiefs of some Mikoyan divisions (for instance, flight test facility chief V. D. Troitskiy). As described in the preceding chapter, the single-seater was lost on 8th June when the starboard engine failed after a birdstrike.

In August 1989 MiG-29 '315 Blue' (c/n 2960525078, f/n 3315) and MiG-29UB '304 Blue' arrived in Abbotsford, British Columbia, via Elmendorf AFB, Alaska, for an airshow. Again they were flown by Menitskiy, Kvochur and Taskayev. A Royal Canadian Air Force CF-18A escorted the MiGs in Canadian airspace.

On 31st July – 3rd August 1989 a group of MiG-29s from Kubinka visited Kuopio-Rissala AB again. This time the *Fulcrums*' display was marred by an incident on 2nd August when '02 Blue' piloted by Col. Viktor Bytskov overran on landing after making a solo aerobatics display. The aircraft landed too fast and the brake parachute was torn off; the wheel brakes could not halt the aircraft in time and it entered the emergency barrier at the runway's end at about 18 km/h (12 mph), suffering minor damage. After the fighter had been towed back to the hardstand, the Soviet technicians washed the


Flight International

▶
Anatoliy N. Kvochur receives instructions from his crew chief before a demonstration flight at Farnborough.

Mikoyan OKB test pilot Anatoliy N. Kvochur. He subsequently left the OKB to work at LII, where he organised a display team flying Su-27s.

muddy wheels and declared the machine fit for flight. At a press conference the following day the pilot said he had seen many pretty girls waving their hands at him and that he had lost concentration because he was waving back!

The MiG-29 demonstrator takes off in full afterburner from runway 27 at Farnborough.

Robert J. Ruffle archive

Flight International

'315' Blue and '304 Blue' became Mikoyan's display hacks. 1990 was a busy year for them: piloted by Taskayev and Marat R. Alykov, the two *Fulcrums* participated in airshows in Hannover, Le Havre, and Geneva followed by a tour of Canada and the USA. During the latter Menitskiy flew as co-pilot of the IL-76MD support aircraft captained by test pilot V. G. Bliznyuk.

After leaving Zhukovskiy the fighters staged through Novyy Urengoy, Tiksi and Anadyr'. Thence the route of the North American tour went as follows: Elmendorf AFB (Alaska), Comox AB (British Columbia), Ottawa, Winnipeg, Kalamazoo (Michigan), Rockford (Illinois), Wright-Patterson AFB (Dayton, Ohio), Winnipeg, and then back to Zhukovskiy via Comox, Elmendorf, Anadyr', Tiksi and Novyy Urengoy. The MiGs performed in Ottawa, Kalamazoo, Rockford and Dayton; the other stops en route were just refuelling stops. On the return journey the group flew from Comox to Zhukovskiy in a single daylight period lasting 31 hours because it was 'chasing the sun'.

In 1991 the MiG-29S prototype ('407 Blue') and a MiG-29UB were demonstrated at airshows in the Philippines and China. The route of the tour went like this: Zhukovskiy, Omsk, Irkutsk, Peking, Guangzhou, Manila and back home. Again Taskayev and Alykov were flying the fighters; the group also included MiG-29 leading engineer S. V. Shal'nyov, flight operations engineer N. A. Belov, a ground crew and deputy project chief V. V. Novikov.

That year the MiG-29 participated in the airshows in Cleveland, Ohio, and Harrisburg, Pennsylvania. Marat Alykov and Aleksandr Yu. Garnayev did the flying. Both versions of the *Fulcrum* were also on display at the IDEX'90 international defence exhibition in Dubai (United Arab Emirates).

In 1992 a Russian Air Force An-124 airlifted a *Fulcrum-A* and a MiG-29UB to Malaysia for display and training purposes, since the Royal Malaysian Air Force had ordered the type. The Russian delegation demonstrating the fighters included pilots Valeriy Ye. Menitskiy and Vladimir M. Gorboonov, MiG-29 leading engineer S. P. Belyasnik, flight operations engineer N. A. Belov, a ground crew and deputy project chief Arkadiy B. Slobodskoy.

Also in 1992, MiG-29S '407 Blue' and the sixth MiG-29M prototype ('156 Blue') piloted by Pavel N. Vlasov and Roman P. Taskayev were on display at FI'92. In 1993 the same pilots demonstrated the Malaysian version of the *Fulcrum-A* and the MiG-29M at Le Bourget.

via RART

▲ **ZH200, the BAe Hawk 200 light fighter demonstrator, formates with MiG-29UB '304 Blue'**

In 1994 MiG-29S '299 Blue' (c/n 2960536581, f/n 5211) and a MiG-29UB were present at a defence exhibition in Santiago de Chile. Apart from Taskayev, the fighters were flown by MAPO test pilots A. P. Pelekh and S. N. Shaposhnikov. The Russian delegation also included S. P. Belyasnik, project chief G. A. Sedov and deputy project chief A. B. Slobodskoy.

In the summer of 1994 MiG-29 '506 Blue' (c/n 2960535121, f/n 4506) was demonstrated at the ILA'94 airshow at Berlin-Schönefeld by Taskayev and Vlasov. Shortly afterwards, in September 1994, another MiG-29M prototype ('155 Blue') put in an appearance at the Farnborough airshow along with a production MiG-29. By then the false dorsal auxiliary intakes originally painted on the LERXes of '155 Blue' had been painted out because this 'camouflage' was no longer needed. Taskayev and Alykov flew the *Fulcrums* at FI'94 and the Mikoyan delegation was headed by S. V. Shal'nyov who had been promoted to deputy project chief.

The static display at ILA'96 included '506 Blue' and MiG-29 '357 Blue' (c/n 2960536034, f/n 4808) fitted experimentally with the semi-retractable IFR probe designed to meet the Malaysian requirement. The same aircraft was presented at FI'96 as the MiG-29SM with an enhanced strike capability.

Of course the MiG-29 invariably participated in the airshows in Zhukovskiy. Besides the Strizhi aerobatic team, the flying display included LII's own MiG-29UB '86 Blue' (c/n N50903026539) and MiG-29 '506 Blue'; the latter (like '407 Blue') had thin stripes of Russia's national colours (white, blue and red) running across the fins above the tactical code.

Four MiG-29S (*izdeliye* 9.12S) fighters based at Lookhovitsy received a rather garish three-tone blue/grey camouflage with MAPO and Mikoyan logos for display purposes, including demonstration to foreign delegations. These

MiG-29 '315 Blue' (c/n 2960525078) became the OKB's display workhorse after the loss of '303 Blue'. ▼

via RART

via RART

Canadian Armed Forces

RSK MiG

▲▲ **One more view of '315 Blue' in maximum-range configuration with three drop tanks.**

▲ **Another Mikoyan demonstrator, '506 Blue' (c/n 2960535121, f/n 4506) with a full load of AAMs.**

aircraft coded '333 Silver' (c/n 2960536093), '555 Silver' (c/n 2960535400, f/n 4710), '777 Silver' (c/n 2960535403, f/n 4711) and '999 Silver' (c/n 2960536501) were sometimes referred to as MiG-29SEs or MiG-29SMs.

26th April 1995 is a big day in the MiG-29's biography. That day Roman P. Taskayev (who has been awarded the Hero of Russia title) set an altitude record in the 12-16-ton (26,455-35,270-lb) gross weight class, climbing to 27,460 m (90,091 ft) in a standard MiG-29. In May same year a *Fulcrum* set another record, climbing to an altitude in excess of 25,000 m (82,020 ft) with a 1,000-kg (2,204-lb) payload. These records were officially recognised by the FAI at the year's end, thus substantiating the MiG-29's excellent

USAF


USAF

Canadian Armed Forces

reputation and proving the potential of the Russian aerospace industry and the Mikoyan design bureau.

In keeping with the openness policy the Soviet Union offered foreign pilots a chance to fly the MiG-29, and many jumped at the opportunity. These included Maj. Robert Wade (an RCAF Hornet pilot), David M. North (managing editor of AW&ST), John Farley (former project test pilot of the Hawker Siddeley Harrier) and Benjamin Lambeth, a Sovietologist and tactical aircraft specialist with the Rand Corporation.

'I have piloted the MiG-29 and consider it an honour and good luck', Gen. Bernhard Norlain, commander of the French Air Force's Tactical Air Command, said in February 1992 after flying the *Fulcrum* at Kubinka AB. 'We are satisfied that the MiG-29 meets our requirements. We have compared it to other types and gave preference to the aircraft powered by two engines with reference to aircraft powered by one engine',

▲
'315 Blue' is escorted by RCAF CF-18A 188775 from 441 Sqn.

◄▲▲
MiG-29 '315 Blue' is escorted over Alaska by two 43rd TFS F-15Cs from Eielson AFB.

◄▲ ▼
'304 Blue' and '315 Blue' are escorted by Minnesota Air National Guard F-16As.

USAF

Robert J. Ruffle archive

said Lt. Gen. Haji Abdul Ghani Aziz, Royal Malaysian Air Force C-in-C, during his Moscow visit in November 1994.

'The MiG-29 is a very special aircraft. It is a superb fighter for close combat. In a lot of areas it is superior to a lot of jets in the West – it turns better in a dogfight', said Johann Köck, commander of 2/JG 73, the Luftwaffe unit operating the type, in an interview to *The Scotsman*. 'It is a pilot's aircraft. It is easily controllable and highly responsive. [...] In general the cockpit and ejection seat are comfortable, and the view from the cockpit is good as well. [...] The helmet-mounted target designation system is impressive', said Austrian Air Force C-in-C Gen. Erich Wolf after trying out the aircraft in Zhukovskiy.

Trade magazines were equally enthusiastic. *'The MiG-29 is one of the premier light tactical fighters having up-to-date weapons and a relatively low fly-away cost'*, wrote *Asian-Pacific Defence Reporter* No.3-4, 1995. *'The participation of the MiG-29 in the NATO Tactical Air Meet '95 caused something of a sensation... The main lesson stemming from the TAM'95 exercises has been the final confirmation (if such was needed) of the overwhelming superiority of*

▲ '506 Blue', now adorned with Russian flag tail stripes and wearing the ILA exhibit code 243, comes in to land at Farnborough.

Robert J. Ruffle archive

► The MiG-29S prototype, '407 Blue', shortly after arriving in Farnborough for the 1992 SBAC airshow.

Robert J. Ruffle archive

▲ '407 Blue' in the static park at FI'92.

Robert J. Ruffle archive

▲ MiG-29S (*izdeliye* 9.12S) '333 Silver' (c/n 2960536093) in a rather unlikely setting at the Krasnaya Presnya Exhibition Centre during the MAKS-93 airshow. Note the non-standard 'psychedelic' MiG logo.


via RART


T. Shia

◄
The MiG-29 gained publicity of a most unwelcome kind when '303 Blue' crashed at Le Bourget on 8th June 1989. Here Anatoliy Kvochur parts company with the K-36DM ejection seat as the doomed aircraft dives.

◄
This view emphasises the extremely low altitude at which Kvochur ejected.

The MiG-29 'cuts the cake', sinking halfway into the ground. Note the sheet of flame spewing from the port engine at the last moment.
◄▼ ▼


via RART


T. Shia


via RART


T. Shia

the Russian air-to-air weapon system installed on the MiG-29', wrote *Military Technology* No.12, 1995.

Moreover, in its 26th February 1990 issue AW&ST urged NATO to let Soviet pilots fly American fighters. *'The Soviet Union has now allowed three North American pilots to fly the Mikoyan MiG-29 and an Australian to fly the Sukhoi Su-27 from the front seat. It is time for reciprocity'*, the editorial said.

Speaking of comparisons between the *Fulcrum* and its Western counterparts, it has

◄▲
The fighter finally disintegrates, spewing up a huge mushroom of fire and smoke. Kvochur's parachute has just opened fully – a mere second before touchdown. Note the ejection seat impacting right next to the pilot, barely missing him.

MiG-29S (*izdeliye* 9.12S) '777 Silver' (c/n 2960535403, f/n 4711), a MAPO demonstrator, shows off its unusual blue camouflage as it flies above the countryside of the Moscow Region.

RSK MiG

'777 Silver' in company with a MiG-29UB demonstrator, '139 Silver', at Lookhovitsy-Tret'yakovo, with 'white-tail' MiG-29s visible in the background.

Yefim Gordon

Another MiG-29S (*izdeliye* 9.12S) demonstrator, '999 Silver' (c/n 2960536501), at Tret'yakovo, with MiG-23s visible in the background. The difference in the camouflage is clearly visible; not only are the colours darker but the Russian flag on the tails is much larger.

Victor Drushlyakov

MiG-29 *Fulcrum-A* '315 Blue' (c/n 2960525078, f/n 3315)
MiG OKB, 1990

MiG-29UB '53 Blue' (c/n 4029692486)
MiG OKB, 1988

MiG-29 *Fulcrum-A* '506 Blue' (c/n 2960535121, f/n 4506)
MAPO/ANPK MiG demonstrator, 1996

MiG-29S (*izdeliye* 9.12S) *Fulcrum-A* '999 Silver' (c/n 2960536501)
MAPO demonstrator, 1995

long been established that a well-trained MiG-29 driver can easily take on a seemingly more advanced adversary. This was demonstrated by dissimilar air combat training (DACT) sessions with the F-15. Though the F-15 can out-turn the MiG-29, generally the *Fulcrum* enjoys higher agility thanks to its better rate of climb, roll rate, acceleration and deceleration. The MiG-29 also has better 'dogfight weapons'; in spite of being repeatedly upgraded, the AIM-9 Sidewinder was handicapped by the old-fashioned aerodynamic layout of this 40-year-old design.

The F-15 supposedly had an advantage in the form of a more sophisticated radar with longer detection range and a pulse-Doppler main mode giving multiple track-while-scan capability. In theory, this would give a flight of F-15s 'first-shot, first-kill' capability, allowing them to destroy most of the opposing MiGs in one swipe and denying the survivors any chance

Artur Sarkisyan / RSK MiG

Yefim Gordon

Yefim Gordon

▲
MiG-29S (*izdeliye* 9.12S) '555 Silver' (c/n 2960535400, f/n 4710) initiates a climb, displaying its weapons for the camera.

►
Two views of MiG-29UB '139 Silver' in MAPO's blue demonstrator colours at Lookhovitsy-Tret'yakovo during an 'open house'. Note that Russian Air Force insignia have been added to the tails below the Russian flag.

An uncoded MiG-29 formates with an Ilyushin IL-103 light aircraft (RA-10303) for a low-speed pass during the Trey'yakovo air event. The IL-103 is produced by the same plant as the single-seat MiG-29s.
▼

A formation flypast by single-seat and two-seat *Fulcrums* and a MiG-23UB trainer; the latter is based at Lookhovitsy-Tret'yakovo.
▼▼

Yefim Gordon

Yefim Gordon

Yefim Gordon

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to engage in close combat. However, the Americans were in for a rude shock: a DACT session with Luftwaffe's MiG-29s in Germany revealed that the operating frequencies of the two fighters' radars were very similar. As a result, the N019 radar effectively jammed the opponent's radar, preventing a lock-on and missile launch, whereas the MiG-29 could still track the target and use its R-27 missiles. The USAF ordered an urgent (and costly) upgrade, but the problem persisted – the MiG-29's radar could still 'blind' the adversary when switched to full power.


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▲
MAPO test pilot A. P. Pelekh has just completed a demonstration flight in a MiG-29.

The Display Teams

From its first days of MiG-29 operations the 234th GvIAP started forming a display team flying the type. The team traced its origins back to Soviet times when the 234th GvIAP was still mastering the MiG-29. In mid-1984 four 1st Squadron pilots – S. Bezlyudnyy (some sources say N. Rozhkov), V. Solov'yov, V. Kravets and L. Spitsa – made the first display flight in diamond formation in their MiG-29s.

It was not until mid-1990, however, that the team was officially organised as the unit's Sqn 2 under the name Strizhi (Swifts; pronounced *stri***zhee**). It was (and is) staffed with the unit's best *Fulcrum* pilots; Lt. Col. (now Col.) Aleksandr N. Kutuzov, a distinguished military pilot, has led the team since its founding day. Note: Sqn 1 is the ***Roos****skiye* ***Vit****yazi* (Russian Knights) team flying the Su-27/Su-27UB *Flanker-B/C*. There was also Sqn 3, the *Ne***bes***nyye Goo***sa***ry* (Celestial Hussars) team flying the Su-25 *Frogfoot-A*, but this was disbanded in 1996 for financial reasons.

The team had ten single-seat *Fulcrum-As* coded '37 White' and '40 White' through '48 White', as well as four MiG-29UBs ('32 White' through '35 White'). Originally the fighters retained their grey factory finish. However, in 1991 Lt. Gen. N. Antoshkin (the author of the 'Strizhi' name) and the pilots jointly developed the team's original livery. All of them wore an eye-catching colour scheme with bright blue tails, blue/white wings, white engine nacelles and a white fuselage with a black spine and blue lightning flash punctuated by the Mikoyan logo below the windscreen. The tactical code was applied to the fins because its usual position on the air intakes was occupied by the team's badge, a stylised black swift on an orange disc.

On 6th May 1991 the team staged its first-ever performance. This display earned all of the team's pilots the Medal for Strengthening the International Brotherhood-in-Arms; the medals were handed to them by Air Marshal Ivan N. Kozhedoob.

Originally the Strizhi performed as a four-ship team comprising Lt. Col. Kutuzov (leader), Maj. Aleksandr Katashinskiy (left wingman), Maj. Andrey Makarenko (right wingman) and Lt. Col. Aleksandr Zakharov ('tail-end Charlie'). Later they were joined by Maj. Vladimir Galoonenko (left outer wingman), Maj. Aleksandr Sherstnyov (right outer wingman) and solo display pilot Maj. V. Yevdokimov. With this 'cast' the team perfected the six-aircraft display technique in close formation, the aircraft flying within 3 m (10 ft) of each other.

The team practises a scientific approach. Each new aerobatics element is checked on a computer by mathematical analysis and polished to perfection in training sorties before being included in the display programme. Sometimes even pilot error provided fresh ideas. On one occasion a pilot forgot to retract the landing gear before making a loop straight after takeoff as planned and was very surprised that the aircraft had let it pass. This led to the introduction of a new element when a six-aircraft formation made a loop with the gear down and landing lights on.

In 1991 the Strizhi made their international debut at Uppsala, Sweden. This was followed by a courtesy visit to France on 13th May 1991 when the team performed at Reims-Champagne air-base (BA112), home of the legendary ECTT2/30 'Normandie-Niémen'. The latter unit (which had flown Yak-3 fighters as part of the Soviet Air Force during the Second World War) had made a goodwill visit to Kubinka in 1990; now the 234th GvIAP repaid the visit on occasion of the 'Normandie-Niémen' squadron's 50th anniversary. Four single-seaters (including '43 White',

via RART

► 234th GvIAP airmen and their mounts at Kuopio-Rissala AB during a goodwill visit to Finland.

'44 White' and '46 White') and two MiG-29UBs ('32 White' and '34 White') went to Reims, accompanied by an IL-76MD *Candid-B* support aircraft ('01 Red', c/n 1003401024). The six fighters performed virtually every aerobatics element, constantly changing formation – echelon, diamond, wedge, star and so on. The show was concluded by an element known as the 'tulip' (similar to the Bomb Burst but initiated in level flight, not a vertical dive); the aircraft let loose a salvo of IRCM flares as they parted, making the finale very impressive indeed.

1993 turned out to be an even busier year for the team, with numerous shows in Russia (including the MAKS-93 airshow in Zhukovskiy) and abroad. The foreign tour included Belgium (Antwerp), Thailand (Bangkok), China (Changsha, Tianjin and Nanking), Mongolia (Nalaïkha AB), Vietnam (Da Nang AB) and Malaysia, where the team performed at the LIMA'93 airshow at Langkawi AB. In the latter case the fighters had been delivered to the base by a Russian Air Force transport aircraft and reassembled within an incredibly short time by the team's tech staff. The team's history includes a real overseas trip when the Strizhi performed at the US Air Force Flight Test Center (AFFTC) at Edwards AFB, California. As of now the Strizhi have displayed their skill around the world; apart from the places mentioned above, they have performed at air events in Germany, Finland, Sweden, Norway, Laos and the Philippines.

Of course, the team also performs actively on its home ground. This includes the open doors days at Kubinka AB, the grand military parade at Poklonnaya Gora in Moscow on 9th May 1995 marking the 50th anniversary of VE-Day and the performance above Moscow's Red Square on 9th May 2005 marking the 60th anniversary of VE-Day. On the latter occasion the Strizhi

234th GvIAP MiG-29s (mostly in the old livery of the Strizhi team) on the flight line at Kubinka AB, attended by an APA-5D ground power unit and two TZA-7.5-500A refuelling bowsers. The trainer has an incomplete livery, lacking tactical codes and wearing white stars instead of red ones. The grey-painted aircraft are all *Fulcrum-Cs*. ▼

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presented a spectacular joint diamond formation with the Roosskiye Vityazi consisting of four MiG-29s 'inserted' into a 'diamond five' of Su-27s. The Strizhi are regular participants in the Aviation Day flypasts at Moscow-Tushino airfield, the biennial international airshows in Zhukovskiy and the biennial hydro aviation shows in Ghelendjik on the Black Sea.

On 8th August 1997 the Strizhi excelled again at the Kubinka air fest staged to celebrate the 16th VA's 50th anniversary. First, four of the team's aircraft flown by Col. Aleksandr Dyatlov (leader), Lt. Col. Vladimir Chervinskiy, Lt. Col. Oleg Lazarev and Lt. Col. Andrey Makarenko performed group aerobatics, followed by a solo display by Nikolay Dyatel. After that, Col. Aleksandr Gornov and Lt. Col. Aleksandr Katashinskiy performed in a pair on *Fulcrum-Cs*. In September that year the team participated in the festivities on occasion of Moscow's 850th anniversary.

In 2002 the MiG-29s of the Strizhi team had their navigation suite and approach/landing system upgraded to permit flights along international airways. Additional fuel tanks were installed, too, to increase non-stop range to 1,800 km (1,118 miles).

In addition to its main capacity, the team operates as a training unit. The flying personnel of the Strizhi have assisted Russian and Hungarian MiG-29 pilots in learning to make the most of this excellent aircraft.

As the years passed, the problem of fleet renewal came up, and the *Fulcrum-As* were augmented by several *Fulcrum-Cs*. The 'fatbacks' wore a slightly different livery – the upper fuselage aft of the cockpit was red, not black. In early 2003, however, RSK MiG made a royal gift to the Strizhi team in the shape of an all-new and much more stylish livery. The basic

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▲▲
'44 White', '46 White' and '48 White' make a formation take-off at Kubinka AB.

▲
'37 White', '44 White', '46 White' and '48 White' in echelon port formation.

Views from the cockpit of a Strizhi team MiG-29UB during a practice session.
▼


Sergey Balakleyev


Yefim Gordon archive

Artur Sarkisyan

▲
Four *Fulcrum-As* and two MiG-29UBs of the Strizhi team fly in 'arrow six' formation over the suburbs of Moscow, practising for one of the MAKS airshows.

colours were now red and white, with a huge blue stylised swift applied to the upper and lower surfaces of the fuselage to accentuate the team's name and a blue zigzag across the outer faces of the fins forming the letters '*МиГ*' ('MiG'). The team's pilots and the squadron's senior political officer Lt. Col. Mikhail Loginov were actively involved in designing the new colours.

The new livery was applied only to the 'fatbacks' and the aircraft were resprayed by the Bykovo Air Services Co. (BASCO) at Moscow-Bykovo airport which, apart from refurbishing airliners and aero engines, occasionally does odd jobs like this. The team's *Fulcrum-Cs* made their first public performance at the MAKS-2003 airshow, and by 2005 the Strizhi had revamped

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►
The pilots of the Strizhi team pose in front of their aircraft at Kibinka AB before the VE-Day 50th anniversary parade.

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▲ **This view of MiG-29UB '33 White' shows how the undersides of the Strizhi team's aircraft looked in the original livery.**

▲ **The badge of the Strizhi team as applied to the aircraft. A more recent version is shown on the following page.**

their image completely, the old *Fulcrum-As* being disposed of and the two-seaters (except a few back-up aircraft) gaining the modern colours.

In addition, six 'fatbacks' operated by the 237th TsPAT's 3rd Squadron ('28 Red', '47 Blue', '52 Blue', '63 Blue', '66 Blue' and '68 Blue') were to be taken out of storage, returning to active status as the reborn Nebesnyye Goosary display/training team. However, these plans are still up in the air – or rather grounded. Apparently the Russian MoD finds it inadvisable to have two display teams flying the same aircraft type – a reasonable attitude in a situation when first-line units are less than 100% equipped due to funding shortfalls.

The Flight Research Institute named after Mikhail M. Gromov (LII) had its own display team (or rather pair) flying the MiG-29. It consisted of test pilots Sergey Tresvyatskiy and Aleksandr Beschastnov, whose mounts were *Fulcrum-Cs* in a black/yellow/blue display colour scheme coded '526 Black' (c/n 2960725887; f/n 3526?) and '926 Black' (c/n 2960715564; f/n 2925?). The team was sponsored by the Aviatika production association affiliated with MAPO (it manufactures the MAI-890 ultralight aircraft at MAPO's Moscow-Khodynka plant).

'33 White' taxies at Kubinka in a winter setting. The original livery was fairly smart but nowhere near as stylish as the current one. ▼

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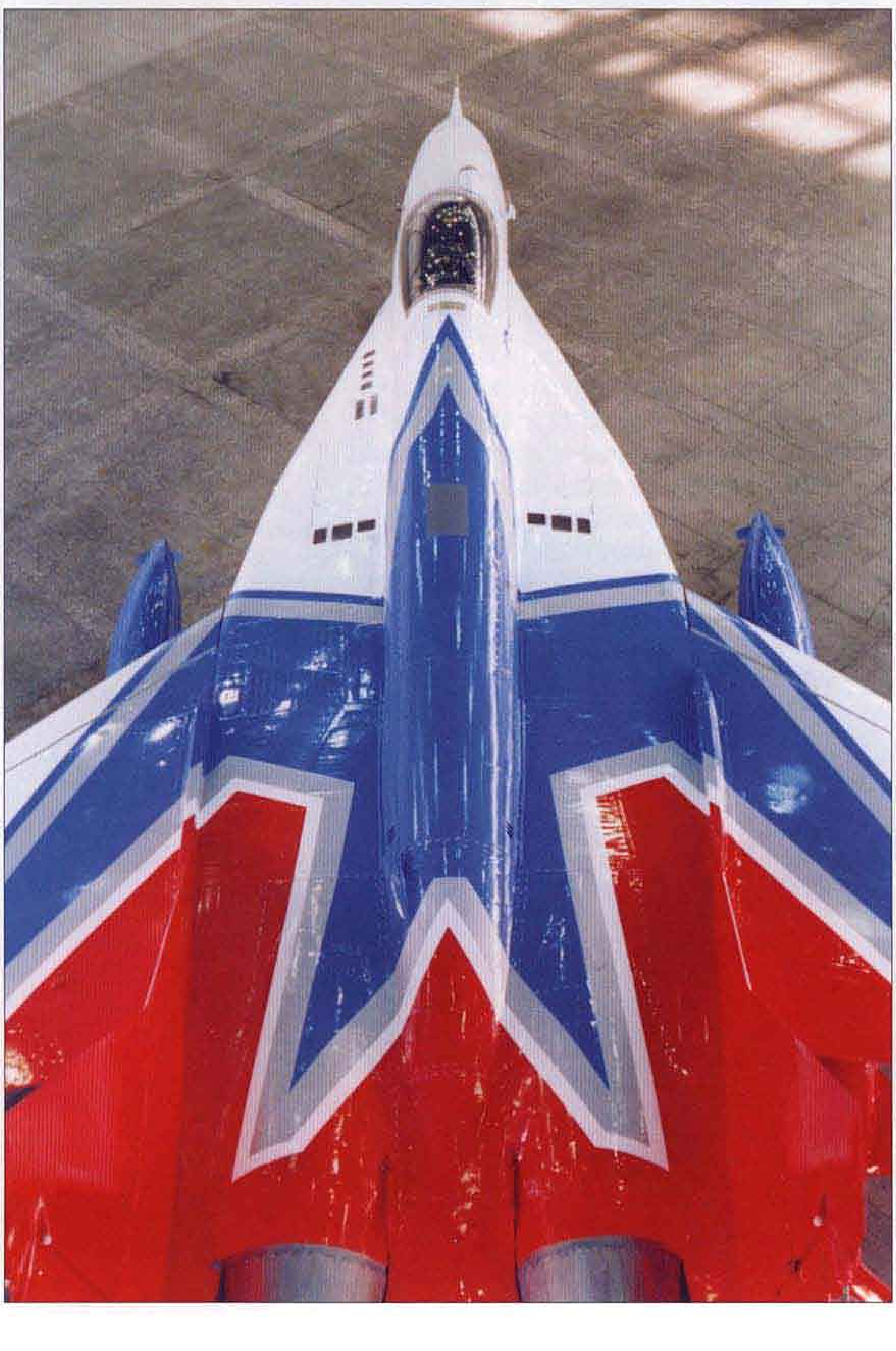
▲
The badge of the 237th Proskoorovskiy TsPAT. 1938 is the year when the unit was founded.

▲◄
Two MiG-29s of the Strizhi team escort a Tu-95MS.

Unfortunately the pair's participation in the 1993 Royal International Air Tattoo (RIAT) at RAF Fairford, where the Royal Air Force's 75th anniversary was celebrated, ended in a spectacular crash which wiped the team out. The MiGs had arrived on 21st July from Prague where they had performed at the Czech AF's 75th anniversary show.

For the next two days the pilots were busy practising. However, the 'real thing' on 24th July ended in a spectacular collision at 200-250 m (660-820 ft) in which Beschastnov's aircraft ('925 Black') was virtually cut in two aft of the cockpit and burst into flames. Incredibly, both pilots escaped without a scratch, even though one of them had to eject from an inverted position; a BBC announcer said that the pilots had 'jumped out from under the coffin's lid'.



Mikhail Nikol'skiy

Yefim Gordon

◄▲
In 2003 the Strizhi introduced a striking new livery in the Russian national colours featuring the team's name and a stylised swift as a key element. The aircraft were recoded concurrently from '01 Blue' up; as had been the case before, the two-seaters have the lowest codes.
▼►

Overleaf: The huge stylised swift is carried across the entire underside as well as on top.

Page 301: MiG-29UB '01 Blue' shows off its new livery during a practice session.

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via Yefim Gordon

Mikhail Nikol'skiy

►
A striking mixed formation of two top display teams – four Roosskiye Vityazi Su-27s and six Strizhi MiG-29s performing together.

Two *Fulcrum-Cs* and two MiG-29UBs in the new livery perform at the MAKS-2005 airshow.
▼

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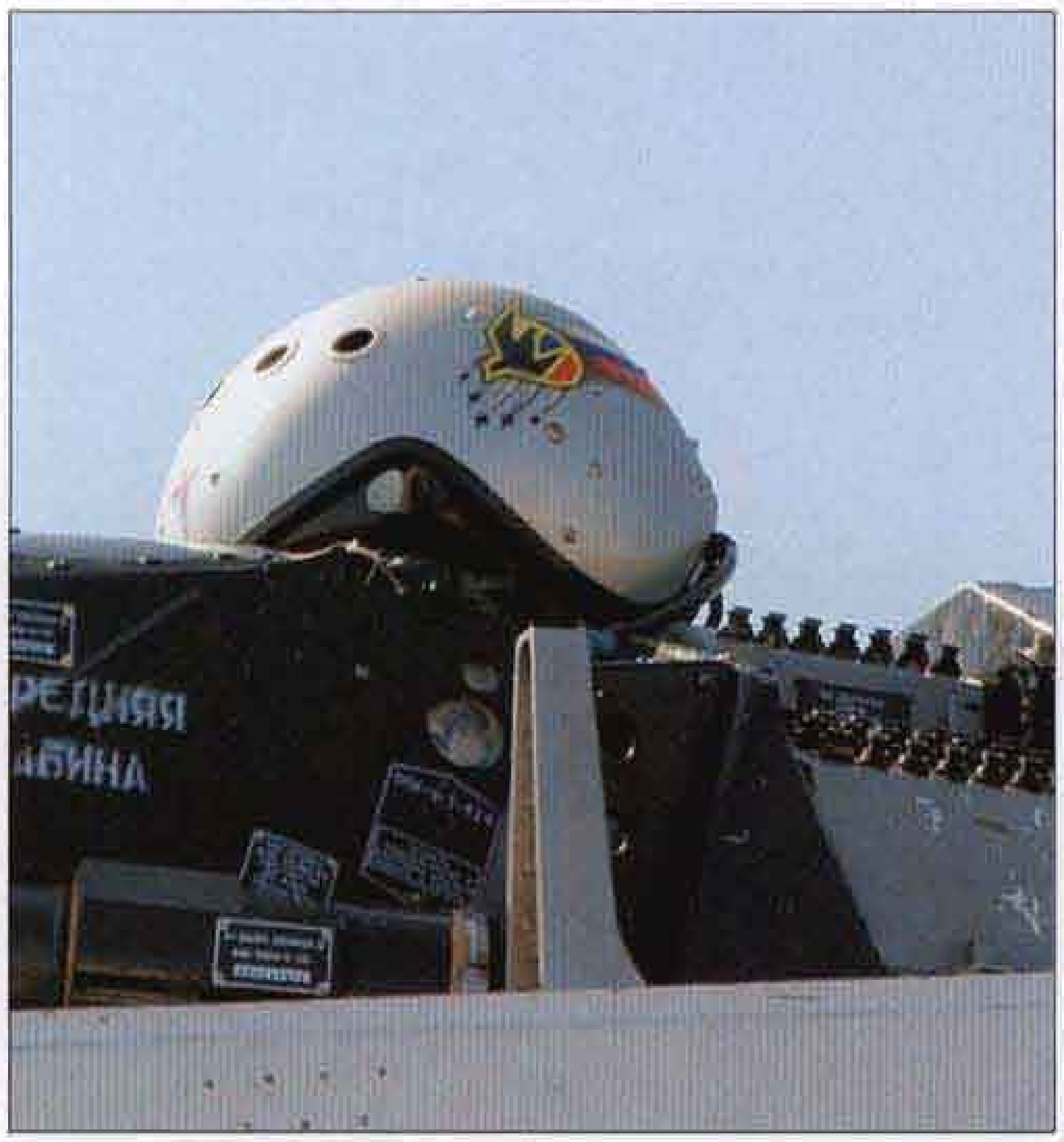
▲◄
A similar combo, but here the proportion is reversed. The Strizhi and the Roosskiye Vityazi gave this performance on the closing day of the MAKS-2005.

▲
The four Strizhi MiG-29s shown here appear to form a 'quadruplane', but actually they are flying in echelon port formation.

◄
Four Strizhi MiG-29s perform a slow loop in 'diamond four' formation with the gear down and landing lights on.



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◄
A Strizhi MiG-29 lets loose a salvo of IRCM flares. This is one of the highlights of the team's display programme.

◄◄
The pilots' flying helmets are adorned with the Strizhi logo.

◄▼
The team's aircraft are coated with modern polyurethane paint giving a high-gloss finish.

◄▼▼
The flight and ground crews of the Strizhi team and the engineering and flight test personnel of RSK MiG pose with the team's aircraft.

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▲
The aircraft of the Strizhi team perform the 'tulip' manoeuvre, fanning out in all directions.

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◄
The final preparations for the day's display routine.

MiG-29UB '02 Blue' taxies out for take-off.
▼

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MiG-29 *Fulcrum-A* '46 White' (c/n 2960530015, f/n 4003)
Russian Air Force, 237th TsPAT, Strizhi team, Kubinka AB

MiG-29 *Fulcrum-C* '06 Blue'
Russian Air Force, 237th TsPAT, Strizhi team, Kubinka AB

via RART

via RART

◄▲
Aleksandr Beschastnov's MiG-29 '925 Black' in LII/Aviatika team colours taxies out at RAF Fairford on 24th July 1993 and is seen during its last flight.

This sequence shows Sergey Tresvyatskiy's '526 Black' colliding with '925 Black' and continuing upward in a cloud of fuel mist and debris, its port wing demolished, while the other fighter explodes and Beschastnov ejects.

via RART

via RART

via RART

The accident information message released by the RAF Inspectorate of Flight Safety (IFS) went as follows:

'1. On 24 Jul 93 at 1527 hrs (local), a pair of MiG-29s of the Russian Flight Research Institute took off in close formation to commence their display at the RAF Fairford International Air Tattoo (IAT). The cloud was scattered at 3,000 ft [914 m], *visibility excellent and surface wind down runway at 8 kts* [4 m/sec]. *The display was normal until the final manoeuvre which was simultaneous loops commenced from long line astern, prior to a break to land. The leader, who pulled up first, carried out a normal loop. The aircraft entered cloud at the top. The Number 2 commenced his loop with some lead on the first aircraft, executed a slightly tighter loop and experienced difficulties with the cloud. At some stage during the manoeuvre, both pilots lost visual contact with each other and called it. As a result of the Number 2's tighter loop, the leader was lower and not as far in front of the Number 2 as he expected. Although still unsighted, the lead pilot decided to carry out his break to downwind, believing it would take him out of the flight path of the other aircraft. Shortly after commencing his break, the left wing of the lead aircraft impacted the fuselage of the number 2 aircraft. Both aircraft immediately became uncontrollable. Both pilots ejected successfully and were uninjured. The aircraft impacted to the NE of the airfield 700 m* [2,300 ft] *from the crowd line. One aircraft crashed on the perimeter fence and the other about 600 m* [1,970 ft] *beyond. Remarkably, only one person on the ground received minor injuries. A Belgian C-130, an Italian Air Force [Aeritalia] G222 and a French Air Force Alpha Jet were slightly damaged.*

2. An RAF BOI (board of investigation – *Auth.*) *was convened to investigate the circumstances of the accident. Preliminary assessment is that the cause of the collision involved the following factors: flight into cloud, the tighter loop by the Number 2, and the leader's break without visual*

'02 White', a smartly painted Ukrainian Air Force MiG-29UB finished in the national colours of blue and yellow, was operated by the UAF's first display team. ▼

Identically painted *Fulcrum-C* '01 White' is escorted by a pair of USAF F-16s en route to a Western airshow. ▼

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via Victor Markovsky

▲ Two UAF *Fulcrum-Cs*, '103 White' (c/n 2960731227, f/n 5327) and '104 White No.2' (ex-'108 Blue', c/n 2960731239, f/n 5420) in the late livery of the Ukrainian Falcons display team.

contact with his Number 2. Both pilots stated that their aircraft were serviceable prior to the impact.

3. Service and IAT orders and instructions appear valid. It is not clear whether the Russian Research Institute MiG-29s were civilian or military.

4. There are no recommendations at this stage.'

The British reaction to the crash was something like 'don't worry too much; you're not the first, you're not the last'. The RAF accepted the costs of recultivating the soil at the crash site

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► The pilots of the Ukrainian Falcons team pose with their aircraft, including '102 White' (c/n 2960731225, f/n 5326). Note the prize champagne.

while the Russian party paid for the damage to the parked aircraft. The pilots returned to active duty on 2nd August. Tragically, Beschastnov was later killed in the crash of a Myasishchev M-101T business aircraft he was testing.

Outside Russia, the only display team to fly the MiG-29 was the Ukrainian Air Force's *Ookraïns'ki* ***Sok****oly* (Ukrainian Falcons) outfit. The team's aircraft – *Fulcrum-Cs* coded '101 Blue', '102 Blue', '103 Blue', '106 Blue' and '108 Blue' plus MiG-29UBs '104 Blue' and '111 Blue' – sported a predominantly yellow/blue colour scheme (the Ukrainian national colours). Later the livery was changed while retaining the same basic colours and the aircraft were recoded (it is known that '101 Blue' and '108 Blue' became '105 White' and '104 White' No.2, and a new *Fulcrum-C* coded '101 White' was added). However, on 27th July 2002 a dreadful accident occurred at Sknilov AB near L'vov during an 'open house' when a Su-27UB clipped some trees in low-level flight and crashed into the crowd, killing 83 spectators – the worst-ever death toll at an air event. After that, the Ukrainian Air Force command reacted somewhat impulsively, banning display flying altogether, and the Ukrainian Falcons team, which had nothing to do with the accident, was disbanded.

via Victor Markovskiy

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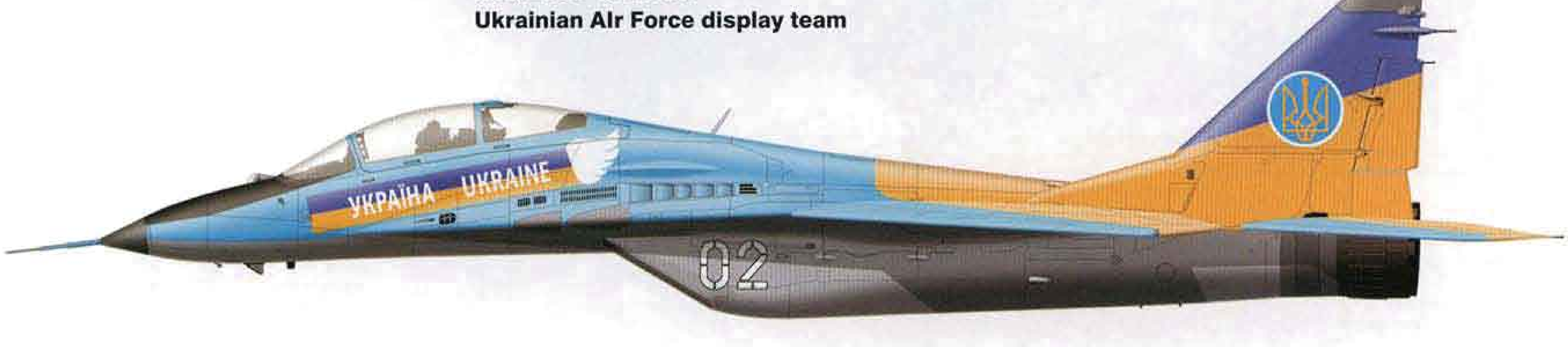
► These photos illustrate the original livery of the Ukrainian falcons team.

MiG-29 *Fulcrum-C* '925 Black' (c/n 2960715564; f/n 2925?)
Flight Research Institute display team

MiG-29UB '02 White'
Ukrainian Air Force display team



MiG-29 *Fulcrum-C* '102 Blue'
Ukrainian Air Force, Ukrainian Falcons team

PART TEN

THE MiG-29 IN DETAIL

RSK MiG

▲ The fuselage (lifting body) of a partly completed MiG-29 *Fulcrum-C* (*izdeliye* 9.13), showing the integrally built wing LERXes and fin root sections.

Type

Single-seat light tactical fighter or (MiG-29UB) combat trainer. The aircraft has a blended wing/body design; the fuselage (lifting body) generates 40% of the total lift, and the proportion of the lift generated by the fuselage and leading-edge root extensions is increased at AOAs above 17°. The airframe utilises large extruded panels, which reduces the number of stressed joints. Aluminium alloys (01420 aluminium-lithium alloy on the MiG-29K and MiG-29M) and high-strength steel are the main structural materials. Some airframe components subjected to high stress and/or temperature (for instance, the wing spars and aft fuselage structure) are made of titanium. Composites make up about 7% of the airframe weight.

The airframe incorporates numerous access panels for ease of maintenance.

Fuselage (Lifting Body)

Semi-monocoque stressed-skin structure with ten mainframes absorbing the main structural loads, interspersed with regular frames and bulkheads. Structurally the fuselage consists of three subassemblies: the forward fuselage (up to mainframe 4), centre fuselage (mainframes 4 through 7) and rear fuselage (mainframes No.7 through 10) incorporating the engine bays (mainframes 7 and 8) and aft bay.

The *forward fuselage* includes the ogival glassfibre radome, the forward equipment bay, the pressurised cockpit and canopy, two avionics bays aft of the cockpit and the nosewheel well. The radome mounts the PVD-18 main pitot (*pree**yom**nik voz**doosh**novo dav**len**iya* – air pressure sensor) with horizontal vortex generators; besides the radar scanner it houses the marker beacon receiver antenna.

The forward equipment bay houses the radar set and IRST/LR; the transparent sensor 'ball' of the latter is mounted dorsally, offset to starboard. The undersurface of the bay mounts IFF transponder, ATC, SHORAN and radio altimeter antennas and the air data system's yaw vane; AOA vanes are mounted on both sides. A PVD-7 backup pitot is mounted on the starboard side of the bay (the MiG-29K and MiG-29M have a third pitot head mounted ventrally beneath the cockpit). The IFF interrogator antenna is located ventrally or dorsally (ahead of the windscreen), depending on the version. On the MiG-29K the forward equipment bay also houses a retractable flight refuelling probe offset to port.

The pressurised cockpit is contained by frames No.1 and 2 and has an aft-hinged canopy. The one-piece curved windscreen is made of electrically de-iced Triplex glass and has a magnesium alloy frame mounting three rear-view mirrors. The aft section is hinged to fuselage frame No.3 and secured by four locks. The canopy is pneumatically actuated and has three positions, including partially open for taxying. Normally the canopy is operated by external and internal handles; a warning light and a voice information system warn the pilot if the canopy is not fully closed. In an emergency the canopy can be jettisoned manually; jettisoning prior to ejection is automatic.

The radome of a 'first-generation' MiG-29 (*Fulcrum-A/C*) tipped with a PVD-18 main pitot; note the double curvature. ▼

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◄ **The forward fuselage and cockpit canopy of a single-seat MiG-29. Note the heat-resistant blast plate and the venting apertures around the cannon muzzle. The fairing of the IRST/LR 'ball' is located entirely ahead of the one-piece curved windscreen.**

The pilot sits on a Zvezda K-36DM zero-zero ejection seat set at a 16° angle; the guide rails are attached to the aft cockpit bulkhead (frame 2). Seat height can be adjusted within ±85 mm ($3\frac{11}{32}$ in) to suit different pilots. Downward view over the nose is 14°.

A second equipment bay housing electrics is located between frames 2 and 3; it is accessible only when the canopy is fully open. An avionics bay further aft (between frames 3 and 3D) contains, among other things, the ARK-19 automatic direction finder. (Note: This is a transliteration of the Russian designation; the frames in this area are marked in Cyrillic alphabetical sequence as 3, 3A, 3B, 3V, 3G and 3D.) The ADF aerials are located dorsally (a blade aerial aft of the cockpit and a loop aerial beneath a dielectric panel between frames 5 and 6).

The nosewheel well is contained by frames No.2 and 4; the nose gear unit's hydraulic actuator is attached to the bottom of frame No.2 and the unit itself to frame 3.

The leading-edge root extensions (LERXes) built integrally with the fuselage begin at frame 1. Their area is 4.71 m^2 (50.64 sq ft); leading-edge sweep is 73°30'. The port LERX houses the

The forward fuselage and cockpits of a MiG-29UB. Note the blind flying hood in the front cockpit and the retractable forward vision periscope in the rear cockpit. ▼

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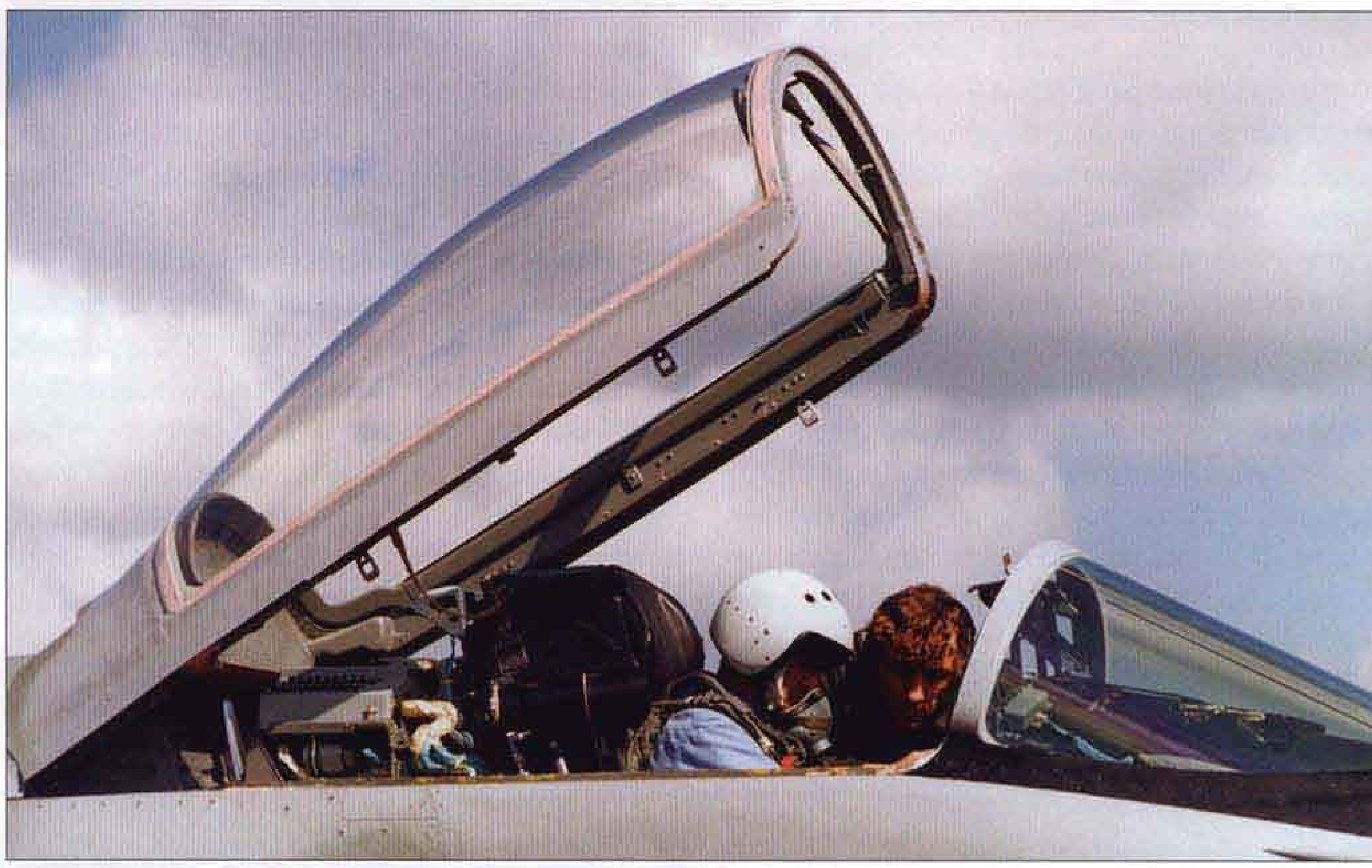
internal gun and its ammunition box (frames 1 through 3) while the starboard LERX accommodates air conditioning equipment; these are accessed from below via removable and opening panels. The port LERX features a gun blast panel made of heat-resistant steel near the gun muzzle and numerous cooling vents in the gun bay's upper skin between frames 2 and 3. Each LERX incorporates two dielectric panels over various aerials depending on the version (IFF, ATC, RHAWS and/or ECM).

The main engine air intakes are mounted ventrally on the LERXes between frames 3 and 4. On the *Fulcrum-A/B/C* the LERXes have a rounded leading edge and incorporate auxiliary dorsal air intakes between frames 3-D and 4; the MiG-29K and MiG-29M have sharp-edged LERXes with no dorsal air intakes.

▲
The open canopy of MiG-29 *Fulcrum-C* '29 Red'; note the triple rear view mirrors and the 'famous last five' of the c/n stencilled on the inside of the frame at the rear.

►
The open canopy of MiG-29SMT '917 Blue'. Avionics modules are located aft of the ejection seat.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Another view of the open canopy. Note the pink sealant around the perimeter of the transparency.
▼


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The MiG-29UB trainer differs markedly from the single-seaters in forward fuselage design. Mainframe No.1 is moved forward by 900 mm (2 ft 11⁷⁄₁₆ in), increasing the pressurised cockpit's length to some 3 m (9 ft 10 in). The trainee and instructor sit in tandem on identical K-36DM ejection seats enclosed by a common aft-hinged canopy; the latter incorporates a retractable periscope for the instructor improving his forward view on take-off and landing. All flight, engine and weapons controls, flight instruments and indicators are identical in the front and rear cockpits. The electric system's overload protection panel is moved forward from the No.2 equipment bay to a space between the front seat and rear instrument panel.

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◄ **The canopy of a MiG-29UB. Unlike single-seat versions, the canopy actuation pneumatic ram is exposed on the MiG-29UB. Note the folded blind flying hood over the front seat and the forward vision periscope built into the rear half of the transparency.**

Since the MiG-29UB lacks radar, the nosecone is made almost entirely of metal, incorporating only a small dielectric fairing over the marker beacon receiver antenna. The forward equipment bay houses the IRST/LR, automatic control system components and avionics. Thus Mikoyan have managed to make the trainer's airframe identical to the *Fulcrum-A*'s aft of mainframe 3 at the expense of only a 100-mm ($3\frac{15}{16}$ in) increase in overall length.

The *centre fuselage* of the MiG-29, MiG-29S/MiG-29SD/MiG-29SE/MiG-29SM and MiG-29UB incorporates three main integral fuel tanks and the mainwheel wells. The No.1 tank is limited by frames 4 and 5, the No.2 tank by frames 5 and 6, and the No.3 tank by frames 6 and 7. The latter tank is the main structural element of the fuselage, absorbing the vertical loads from the wings, engines and main gear units. Frame 6 incorporates the forward fitting of the centreline drop tank and frame 7 carries the engines' forward mounting brackets. The main gear units are attached to special boxy structures fitting in between frames 6 and 7.

Frames 7 and 8 delimit the engine bays. The No.3-A integral fuel tank split into two sections is located between frames 7 and 7-Zh (again in Cyrillic alphabetical sequence – A-B-V-G-D-Ye-Zh). A bay in the aft fuselage houses the auxiliary power unit and the engine accessory gearbox with associated generators, fuel, oil and hydraulic pumps (the MiG-29 is probably unique among twin-engined fighters in having a common accessory gearbox for both engines).

The aft fitting of the centreline drop tank is located at frame 8. Further aft is the rear bay

The canopy of the MiG-29M2, while having the same shape as the MiG-29UB's, lacks the trainer's blind flying hood and periscope. ▼

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mounting the tail unit and afterburners. Frame No.9 incorporates attachment points for the split airbrakes and brake parachute canister, as well as the engines' rear mounting brackets. The airbrakes are hydraulically actuated; the upper airbrake with an area of 0.75 m^2 (8.06 sq ft) is deflected 56° and the lower airbrake with an area of 0.55 m^2 (5.91 sq ft) is deflected 60°.

The MiG-29K and MiG-29M have a different aft fuselage structure with a single large airbrake between frames 8 and 9 and a strap-on fuel tank (No.3-B) added between frames No.7 and 8. The MiG-29K is also equipped with an arrester hook attached to frame 8.

▲
The centre fuselage and port air intake trunk of MiG-29UB '102 White'.

►
Rear view of a *Fulcrum-C*, showing the bulged fuselage spine, the APU air intake offset to port, the bulged engine housings and the airbrake.

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This view shows the bulged upper fuselage of a red-coded *Fulcrum-C*.
▼

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Wings

Cantilever all-metal mid-wing monoplane of trapezoidal planform. Leading-edge sweep 42°, anhedral 3°, taper 4.41, aspect ratio 3.5. The wings utilise a TsAGI P-177 airfoil. Area of the wings proper (excluding LERXes) is 38.056 m^2 (409.2 sq ft); chord is 5.6 m (18 ft $4\frac{15}{32}$ in) at the root and 1.27 m (4 ft 2.00 in) at the tip.

The wings have a three-spar structure with two false spars ahead of the wing torsion box and a third false spar aft of it, 16 ribs and upper and lower skins reinforced by stringers. The wing panels are attached to the fuselage by five fittings each at frames 6, 6-V and 7. The wing torsion box doubles as an integral fuel tank.

The wings have three-section leading-edge flaps, one-piece trailing-edge flaps and ailerons

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▲ The port LERX of a MiG-29M.

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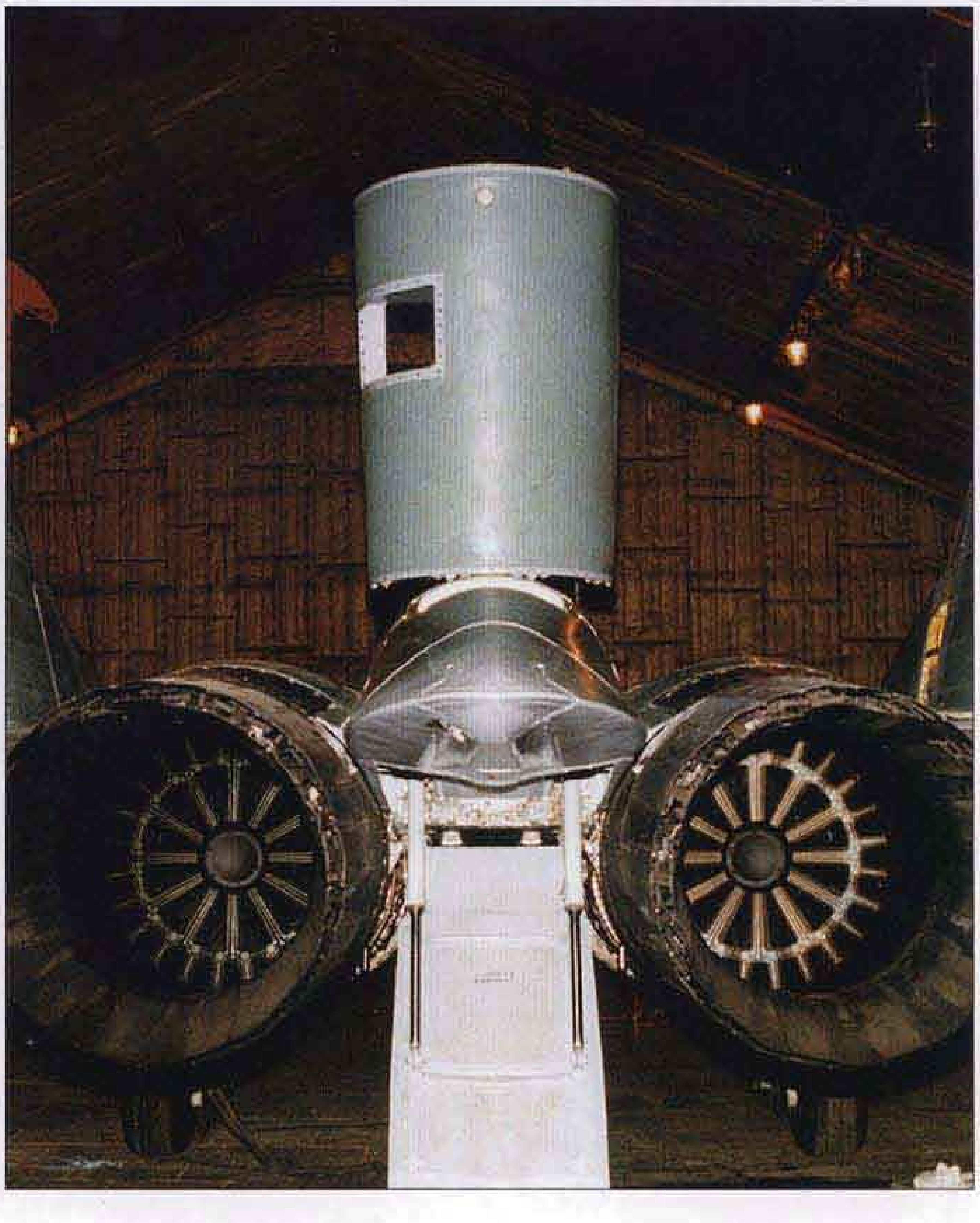
► The lower airbrake segment of a *Fulcrum-C* operated by the Ukrainian Falcons team. Note the APU exhaust door and the drop tank attachment fittings.

This rear view of a MiG-29M undergoing maintenance shows the 'beaver tail' rear fairing, the open ventral airbrake with its twin actuators (the dorsal airbrake is closed) and the strap-on fuel tank tilted up to give access to the systems located underneath. Note also the flame holders of the engine afterburners. ►



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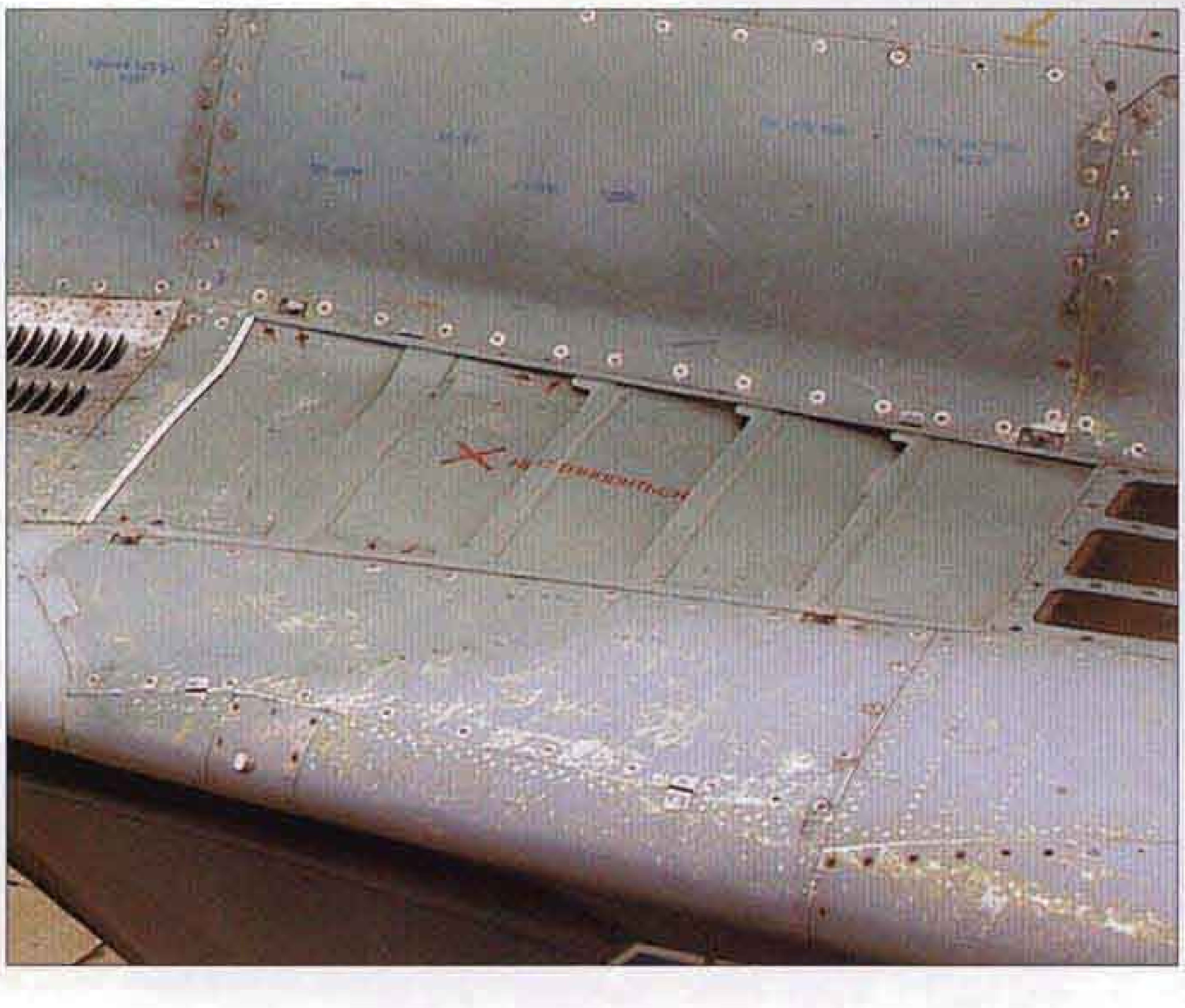
The spring-loaded auxiliary blow-in doors and excess air spill outlets in the port LERX of a MiG-29. ▼



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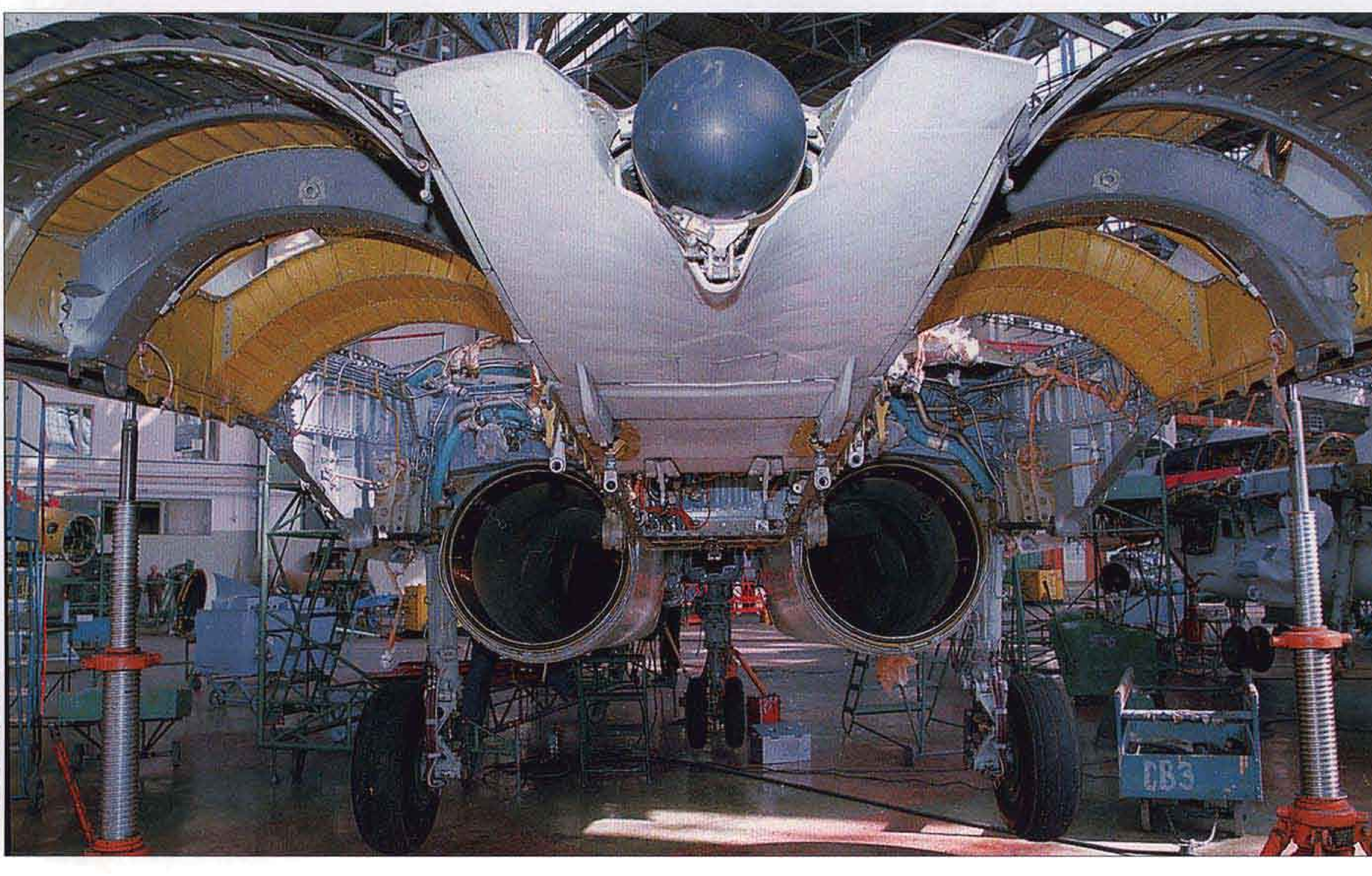
▲
The upper airbrake segment of a MiG-29 *Fulcrum-A*; note the hefty external hinges.

via Internet

▲
The lower airbrake segment. Note the fixtures holding the rear end of the drop tank in place. The arrow on the brake parachute container points to the cover retention lock.

This view of a stripped-down MiG-29 shows the engine inlet ducts and the insides of the engine bays. Note the position of the jacking points.
▼



Artur Sarkisyan / RSK MiG

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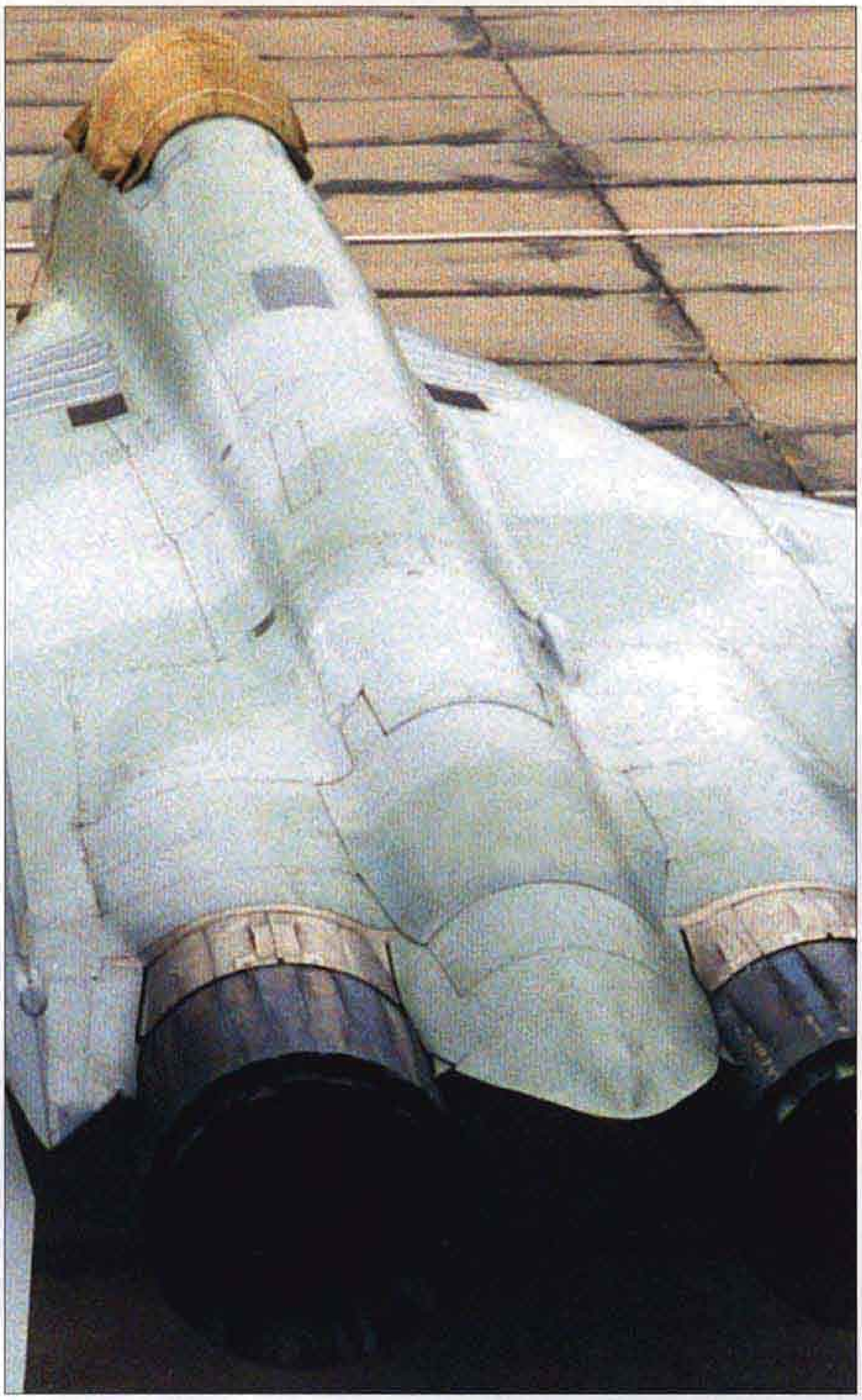
▲
The dorsal and ventral airbrakes of MiG-29SMT (*izdeliye* 9.17) '51 White' (c/n 2960518051) photographed in the process of conversion at ARZ No.121.

◄
Three views of the dorsal airbrake of a MiG-29K prototype. The shape is different from that of the MiG-29SMT's airbrake.



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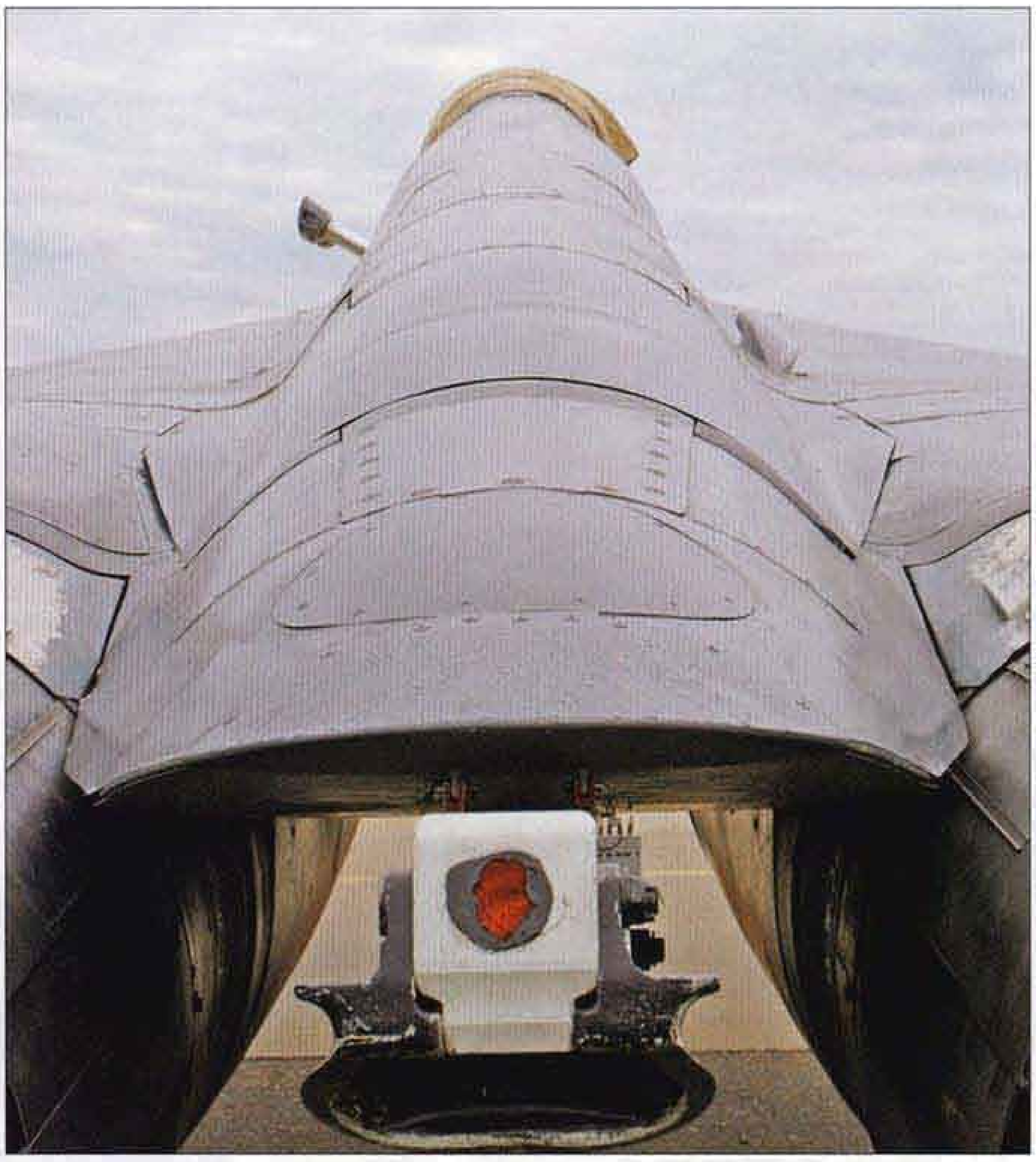

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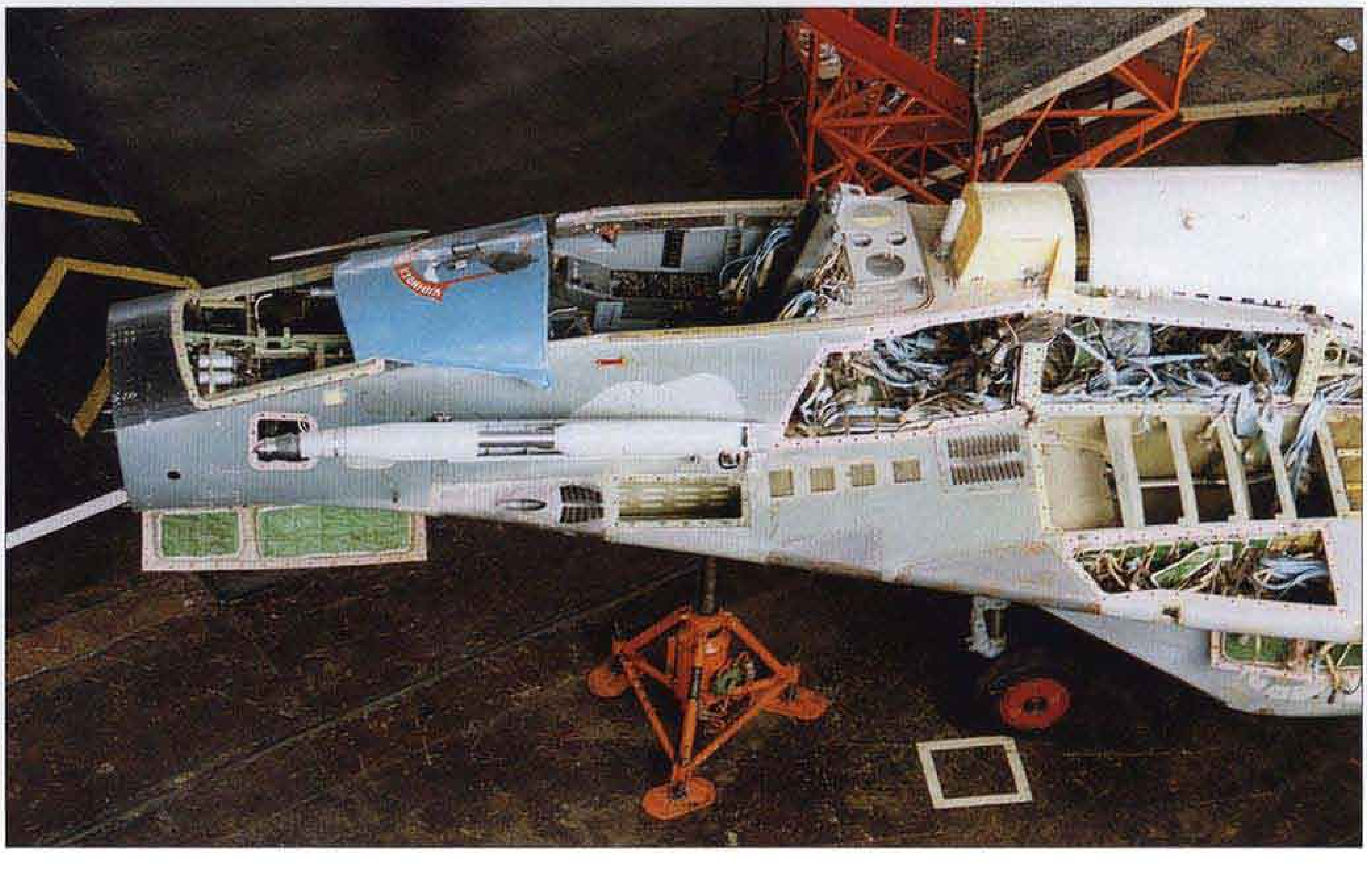
▲
The rear fuselage of a MiG-29K, showing the arrester hook.

◄
The centre and rear fuselage of MiG-29M '155 Blue', showing the location of the airbrake, the starboard-side APU air intake and the smaller, square-shaped spill air outlets on top of the LERXes.



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►
The nose of MiG-29SMT '51 White', showing the uncowled semi-retractable IFR probe and the forward strap-on fuel tank. The piping and wiring bundles are visible through the access hatches.

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▲
Another view of MiG-29SMT (*izdeliye* 9.17) '51 White' in the process of conversion, showing the two strap-on dorsal tanks and the open dorsal airbrake. Note the engine bay access hatches.

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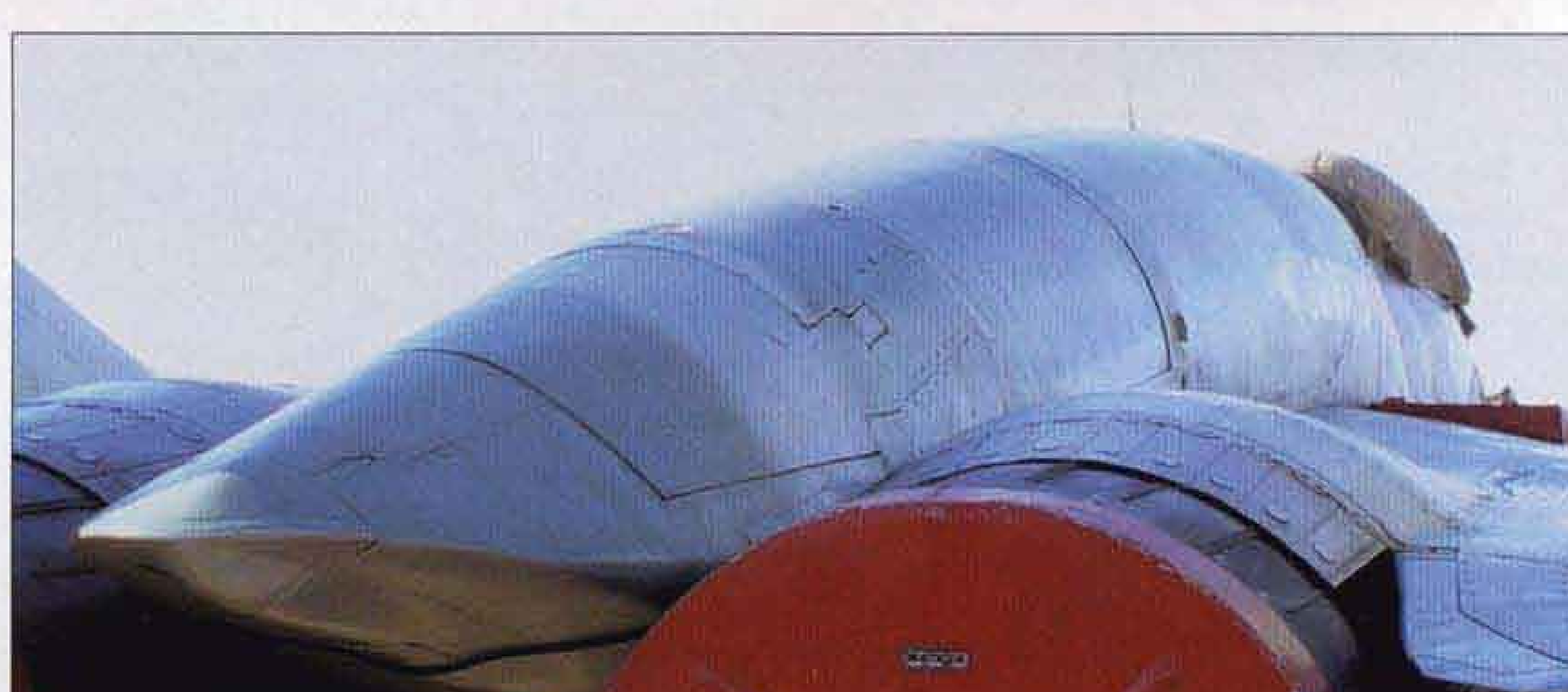
► ►▲
The centre and rear fuselage of the MiG-29SMT (*izdeliye* 9.17). The APU air intake is on the port side. Note the subcontractors' logos.



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►
The tip of the 'beaver tail' fairing on the MiG-29SMT (*izdeliye* 9.17) hinges upward when the brake parachute is deployed.

▶ The starboard wing of a MiG-29UB; the wing/fuselage joint is visible in line with the fin fillet. Note how the aileron stops short of the wingtip.

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▶ The starboard wingtip of a MiG-29UB, showing the navigation light, the RHAWS antenna and the static discharge wicks.

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(see Control system). The LE flaps are deflected 20° by six hydraulic actuators each (one inboard, two on the central section and three outboard). The TE flaps are deflected 25° for takeoff and landing by single hydraulic actuators equipped with uplocks; the high-lift devices move in concert. LE and TE flap area is 2.35 m² (25.26 sq ft) and 2.84 m² (30.53 sq ft) respectively. The ailerons have an area of 1.45 m² (15.59 sq ft).

Each wing incorporates attachment points for three external stores pylons. The innermost pylons are attached to the spars in three places, the others in two places. The wingtips carry navigation lights, static discharge wicks, RHAWS and (on some versions) ECM antennas.

The MiG-29M features two-section LE flaps. The MiG-29K has a very different wing design featuring a TsAGI P-177M airfoil; the wings are

▶ The port wing of a MiG-29UB, showing the aileron bellcrank and push-pull rod. Note how the missile rails are attached.

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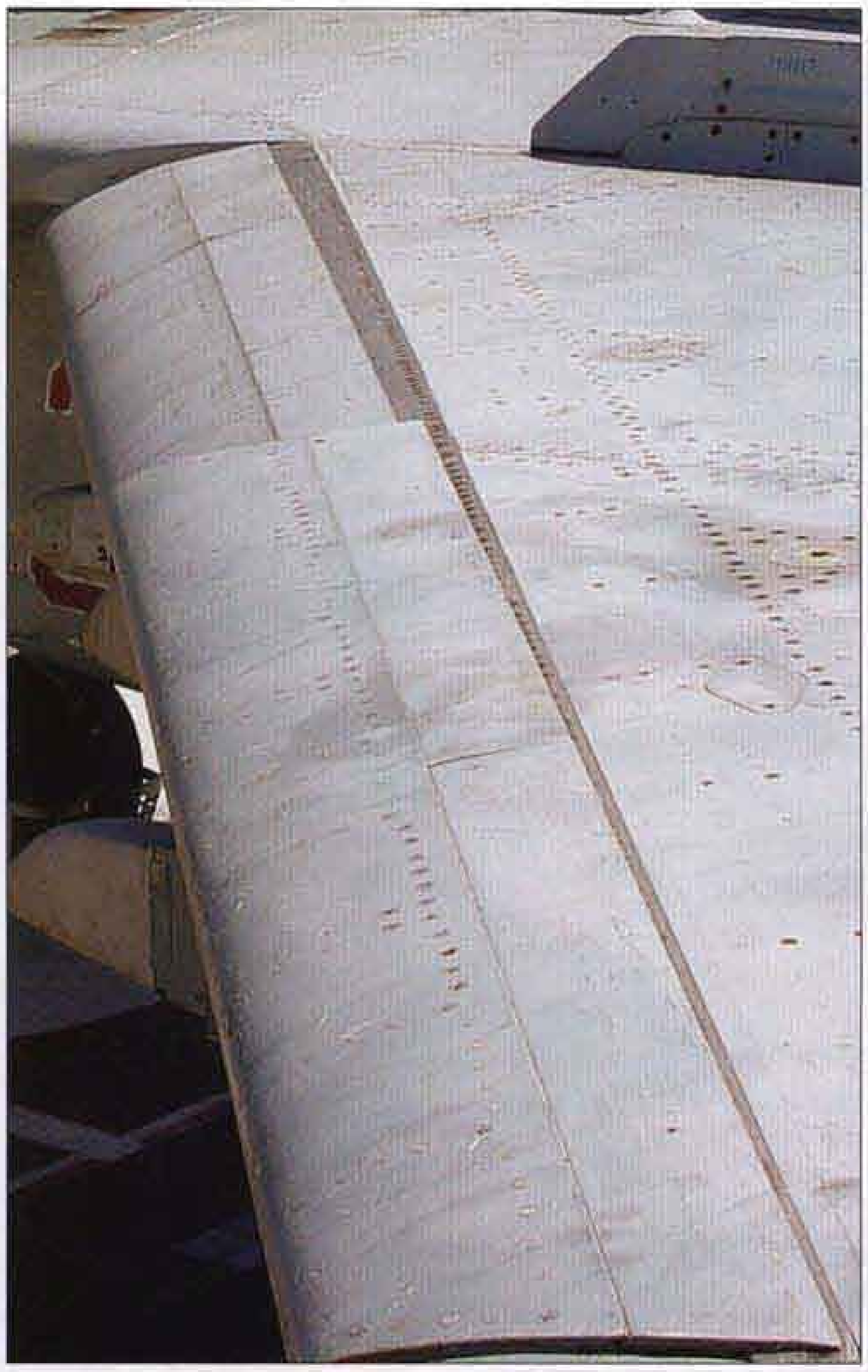
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▲◄ ▲▲▲
The port leading-edge flaps of *Fulcrum-Cs*.

▲▲
This view of MiG-29SMT '917 Blue' shows that the LE flap sections can be deflected independently.

▲
The port trailing-edge flap of a MiG-29UB.

made of steel, not 01420 Al-Li alloy as on the MiG-29M, and fold upwards for carrier stowage. Wing span is increased by 630 mm (2 ft $0\frac{51}{64}$ in) to 11.99 m (39 ft $4\frac{3}{64}$ in), slightly increasing wing area; span with wings folded is 7.8 m (25 ft $7\frac{3}{32}$ in). Two-section LE flaps are fitted, and the trailing edge has double-slotted flaps inboard and flaperons of slightly increased area outboard. The capacity of the wing integral tanks is identical to that of the *Fulcrum-A/B/C*. The MiG-29K and MiG-29M have two additional wing hardpoints.

Tail Unit

The *horizontal tail* comprises slab stabilisers (stabilators) or tailerons mounted on the outer sides of the engine nacelles. Leading-edge sweep 50°, anhedral 3° 30', span 7.78 m (25 ft $6\frac{19}{64}$ in), total area 7.05 m^2 (75.80 sq ft). The stabilators utilise a TsAGI S-11S symmetrical airfoil. They move symmetrically for pitch control and differentially for roll control. The MiG-29K and MiG-29M have increased-area stabilators with a characteristic leading-edge 'dogtooth'.

Each stabilator is a single-spar structure with a false spar, 16 ribs, upper and lower skins and a honeycomb core composite trailing edge. The stabilators are controlled by RP-280A hydraulic actuators (*roole**voy** pri**vod***) mounted on aft fuselage frame 10 (see Control system); the skewed axles are rigidly attached to the

On the *Fulcrum-A/C* the fin fillets feature strake-like extensions accommodating BVP-30-26 IRCM flare dispensers. ▶

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▶ When not in use the flare dispensers are closed by protective covers.

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▶ The MiG-29K has folding wings with redesigned high-lift devices and reshaped wingtips.

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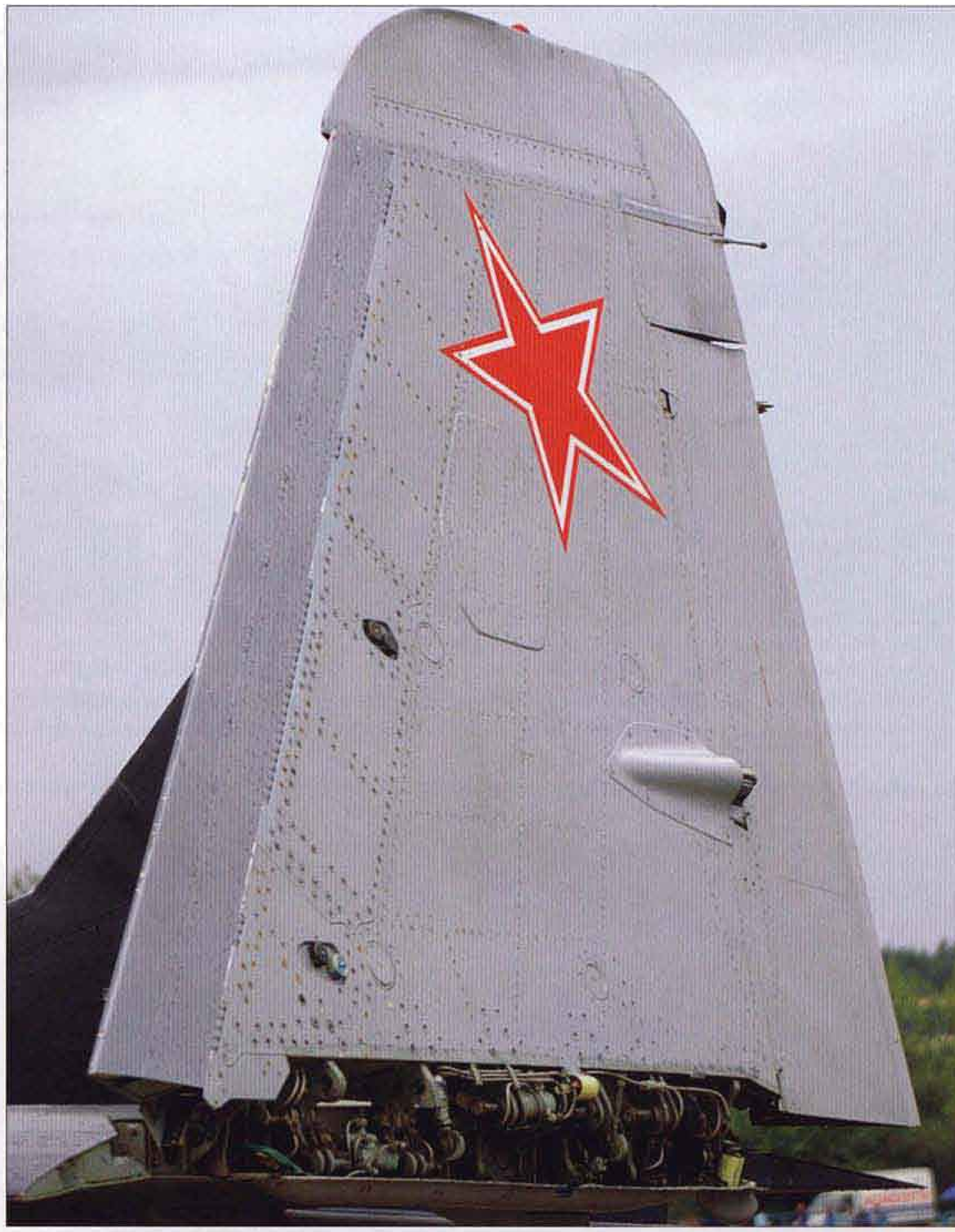
▲ **The wingtips of the MiG-29 *Fulcrum-C* (*izdeliye* 9.13) incorporate antennas for the Gardeniya-1FU (L-203B) self-protection active jammer and have a slightly different shape as compared to those of the *Fulcrum-A* and MiG-29UB.**

stabilators, turning in bearings mounted on frames 9 and 10.

The *vertical tail* comprises twin fins with fillets and inset rudders attached to the aft fuselage bay outboard of the engine nacelles. The fins are canted 6° outboard; leading-edge sweep 47°50', total fin area 10.1 m² (108.6 sq ft) and total rudder area 1.25 m² (13.44 sq ft).

Each fin is a two-spar structure with front and rear false spars, nine ribs, skins and a honeycomb core trailing edge. Structurally the fins consist of rectangular metal root sections



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▲ **The MiG-29K's outer wings go past the vertical when folded.**

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◄ **The starboard wing folding mechanism and flaperon of the MiG-29K.**

Anton Pavlov

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▲
The vertical tails of MiG-29 *Fulcrum-As* with and without ventral fins. The red paint on the insignia has weathered away completely, creating this 'low-visibility' version. Note that the rudder bellcranks are located to port and the actuator access panels to starboard on each fin.

The MiG-29's vertical tails bear *Ostorozhno! Oogleplastik!* (Caution: CFRP) and *Ostorozhno! Soty!* (Caution: honeycomb structure) stencils.
▼

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rigidly attached to the aft fuselage, detachable trapezoidal upper sections made of carbon fibre reinforced plastic (CFRP) and metal root fillets with 75° leading-edge sweep. Each rudder is mounted on three brackets and has a nose section and a honeycomb core trailing edge. All aircraft manufactured from 1984 onwards have rudders with 21% longer chord extending beyond the fin trailing edge. The rudder actuators are mounted in the root sections and accessed via removable panels to starboard.

The fins have glassfibre tips housing communications radio and ATC/SIF aerials (port fin) and IFF and GCI command link aerials (starboard fin). A SHORAN antenna and the tail navigation light are located on the port fin trailing edge and backup IFF and ATC/SIF aerials on the starboard fin trailing edge. RHAWS and ECM are mounted on the outer surfaces of the fins. The number and placement of the aerials may vary between versions.

Fulcrum-As built from 1984 onwards, *Fulcrum-Cs* and the MiG-29S/SD/SE/SM have strake-like structures ahead of the fin fillets housing BVP-30-26 chaff/flare dispensers. These are absent on early-production *Fulcrum-As*, the MiG-29UB, and MiG-29K and MiG-29M prototypes.

Fulcrum-A prototypes and the first 70 production fighters featured trapezoidal ventral fins outboard of the engine nacelles. These were deleted on later aircraft, as directional stability was found to be adequate without them.

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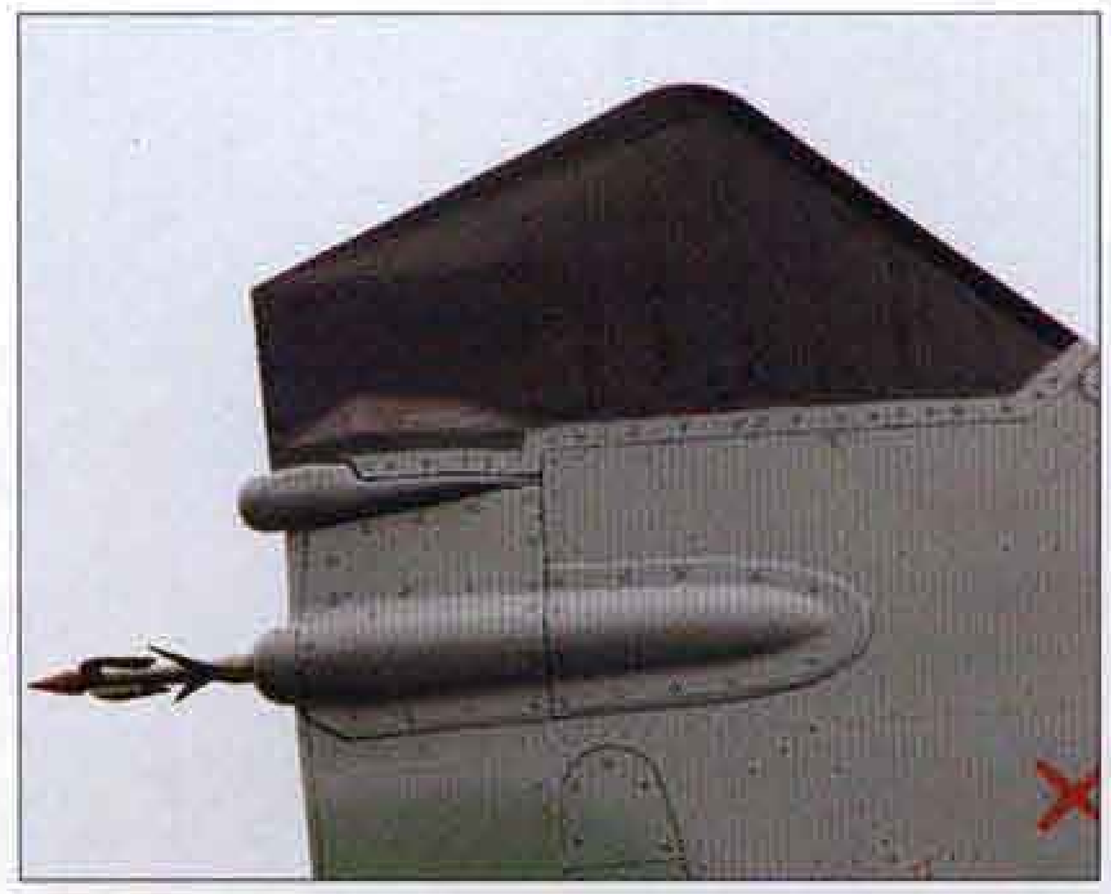

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◄▲
The starboard fin of a 'first-generation' MiG-29 with backup IFF and ATC/SIF aerials on the trailing edge below the GRP fin cap enclosing more antennas.

►▲
The port fin carries the tail navigation light and a SHORAN aerial below the fin cap.

The port fin of a MiG-29M. Note the increased fin chord below the rudder (in line with the latter's trailing edge) and the relocation of the backup IFF aerial to a position below the rudder.
◄▼

The port fin of the second prototype MiG-29K; this version featured the same changes.
▼

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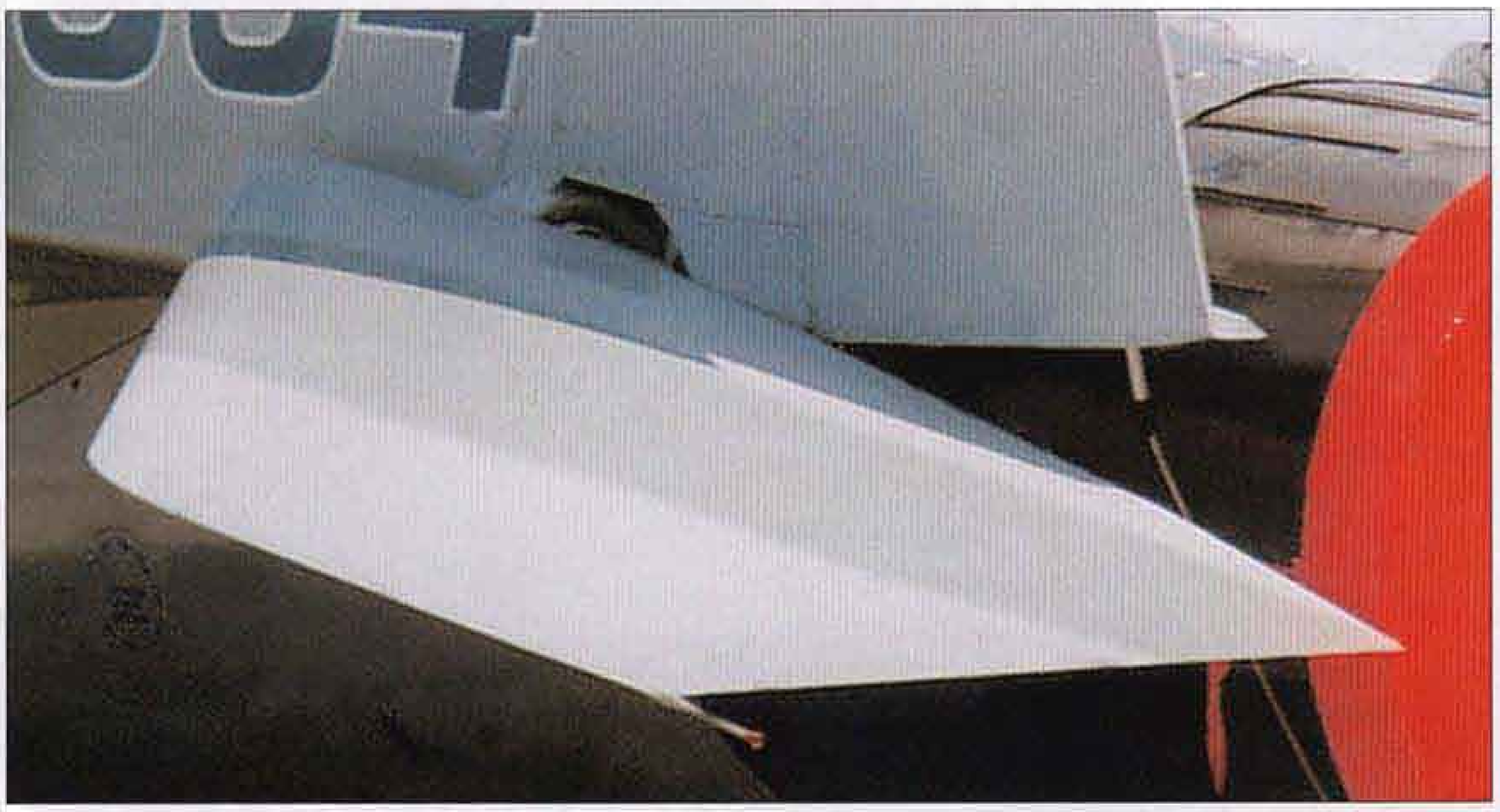
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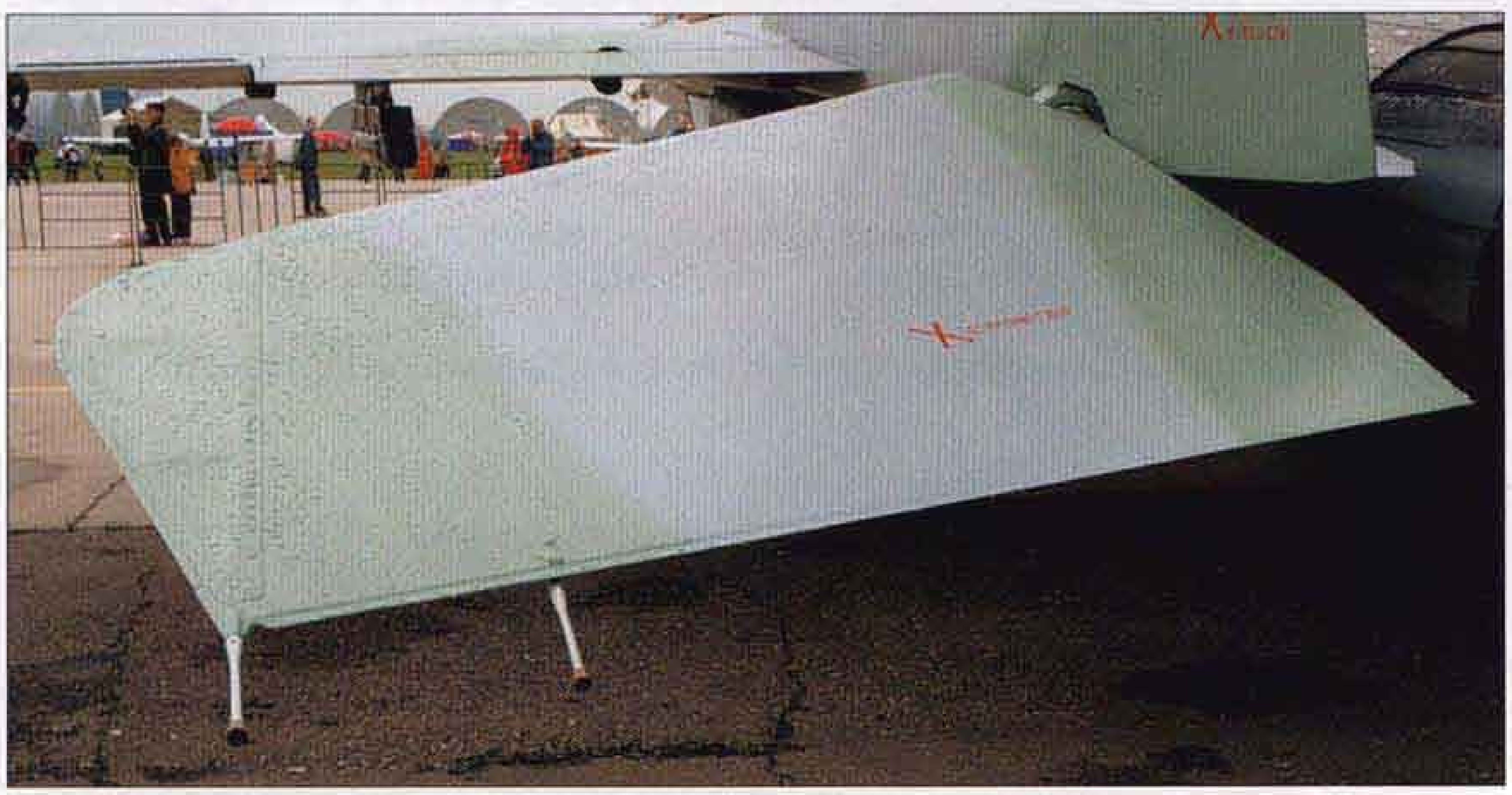
◄
The port stabilator of a MiG-29UB with a single static discharge wick on the trailing edge.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The port stabilator of a late-production single-seater with twin static discharge wicks and 'caution, honeycomb structure' stencils.
◄▼


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The stabilator leading edges are encased in heat-resistant sheaths to protect them from the flames when the missiles or rockets are fired.
◄▼▼

Landing Gear

Hydraulically retractable tricycle type; wheel track 3.09 m (10 ft $1\frac{21}{32}$ in), wheelbase 3.645 m (11 ft 11 ½ in). All three units are equipped with oleo-pneumatic shock absorbers.

The semi-levered suspension nose unit is equipped with twin 570 x 140 mm (22.4 x 5.5 in) KT-100 wheels (KT = *koleso tormoznoye* – wheel, brake-equipped) and retracts aft into the tunnel between the air intakes. The combined steering mechanism/shimmy damper allows the nosewheels to turn ±31° for taxying and ±8° for evasive action during an aborted take-off or landing. The nosewheels are fitted with a scraper-type mud/snow/slush guard for FOD protection. On the first *Fulcrum-A* prototype ('aircraft 901') the wheelbase was approximately 5.2 m (17 ft $0\frac{23}{32}$ in). The much longer nose gear strut was attached to mainframe 2 and the nosewheels were semi-enclosed by a MiG-23-style mudguard.

Each main unit is equipped with a single 840 x 290 mm (33.0 x 11.4 in) KT-150 wheel; the


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►
The stabilator tips are raked to increase the critical flutter speed.

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◄ The stabilators of the MiG-29M and its derivatives feature a leading-edge dogtooth energising the airflow at high angles of attack.

Front view of the MiG-29's landing gear (exemplified by MiG-29SMT '917 Blue'). The nose gear unit has sway braces and a retraction ram offset to starboard. Note the taxi light. ▼

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◄▲
The nose gear unit (note the mudguard design).

The starboard main gear unit of MiG-29BM '06 Black'; note the skewed position of the fulcrum making the wheel rotate into horizontal position during retraction.
▼

The port mainwheel well houses the refuelling connector.
▼

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▲
The large mainwheel well doors carry the landing lights.

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▲▲
All wheel well doors remain open when the gear is down. The larger mainwheel well doors have their own actuation rams.

▲
This view shows the inside of the starboard mainwheel well and the aft-mounted actuation ram.

MiG-29M has KT-209 wheels. The main units retract forward; the main gear fulcrums (axles) are inclined upward and aft so that the mainwheels rotate through 90° during retraction to lie horizontally in the wing centre section. The MiG-29K has a reinforced landing gear with longer-stroke oleos which are shortened by special links during retraction.

On production aircraft each wheel well is closed by three doors, one of which is attached to the retraction jack. On *Fulcrum-A* prototypes and initial production aircraft the nosewheel well was closed by four doors (the fourth door segment was attached to the strut ahead of the nosewheels). All doors remain open when the gear is down.

The retracted struts are secured by mechanical uplocks. There are no downlocks as such, their role being played by shut-off valves trapping hydraulic fluid in the retraction rams. The landing gear is normally operated by the main hydraulic system, with pneumatic emergency extension for the nose unit and free-fall emergency extension for the main units.

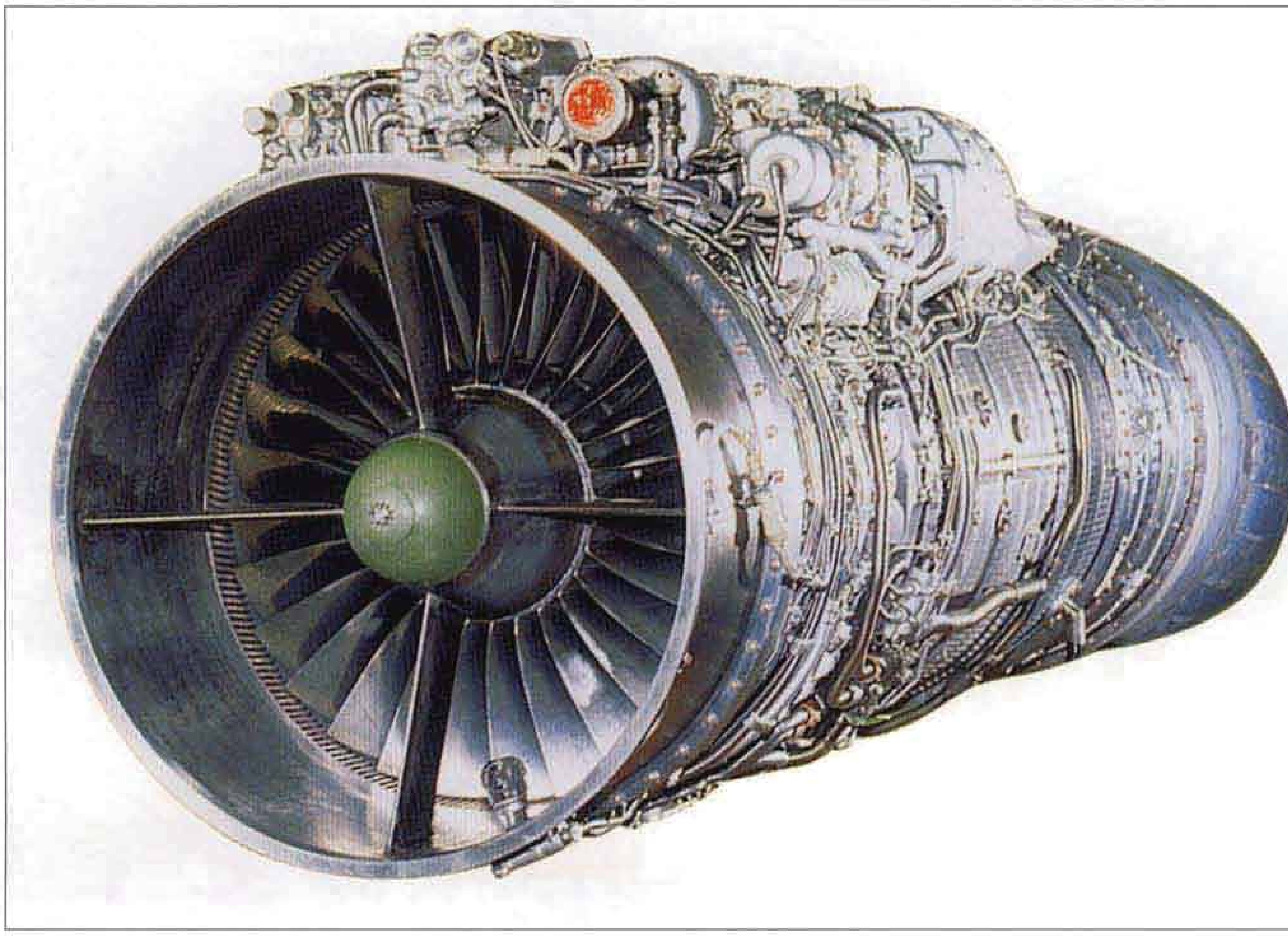
The wheel brakes are pneumatically operated by two systems (normal and backup); the nosewheel brakes can be selected off. An electromechanical anti-skid system is provided, operating only in normal braking mode.

The wheel brakes are augmented by a cruciform brake parachute with an area of 17 m^2 (182.79 sq ft). The parachute is deployed and released electropneumatically.

Powerplant

All versions except the MiG-29M and MiG-29K are powered by two NPP Klimov (Izotov) RD-33 afterburning turbofans delivering 5,040 kgp (11,110 lbst) at full military power, 5,600 kgp (12,345 lbst) at minimum afterburner rating and 8,300 kgp (18,300 lbst) in full afterburner.

The RD-33 is a two-shaft turbofan with a bypass ratio (BPR) of 0.475, a four-stage axial low-pressure (LP) compressor, an adjustable nine-stage high-pressure (HP) compressor, an annular combustion chamber, a single-stage air-cooled HP turbine, a single-stage air-cooled LP



The NPP Klimov (Izotov) RD-33 afterburning turbofan.

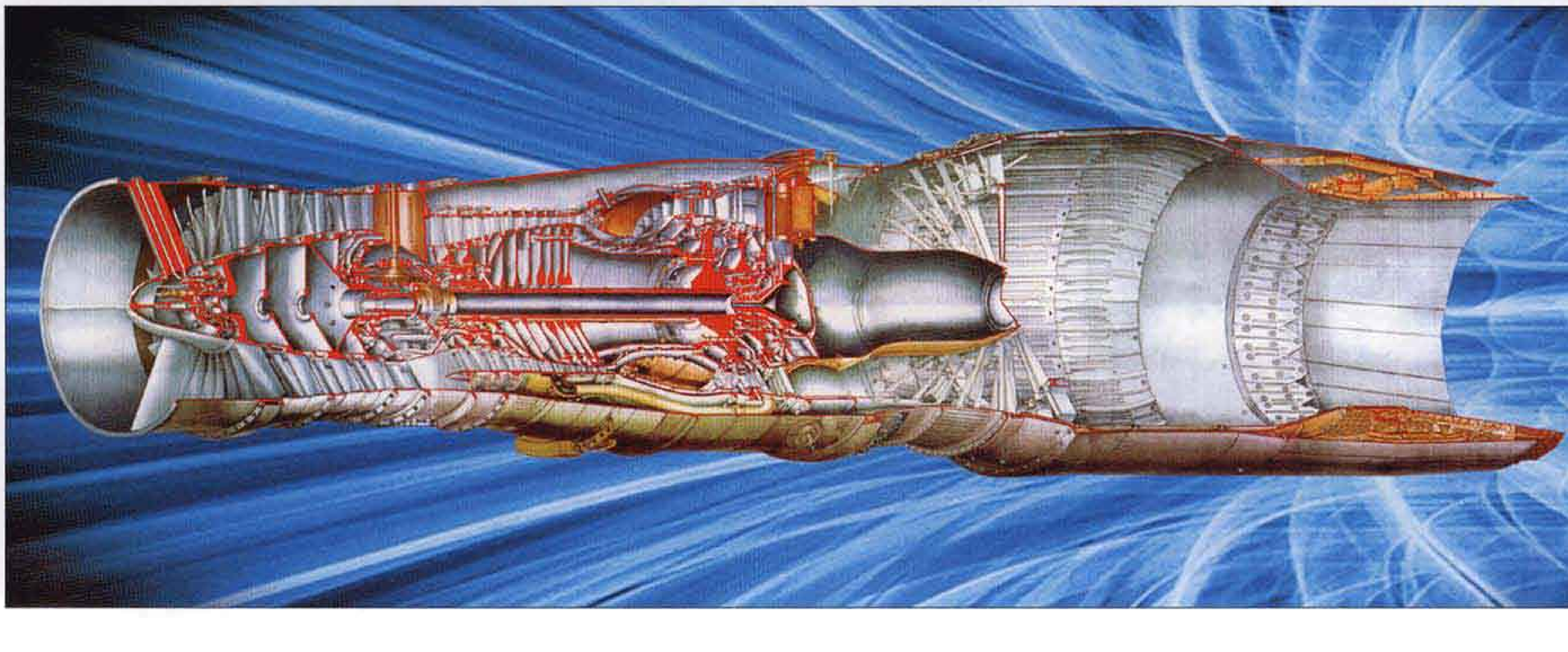
NPP Klimov

turbine, an afterburner and a convergent-divergent axisymmetric supersonic nozzle. Core and bypass flows are mixed aft of the turbine.

For greater reliability the combustion chamber is equipped with an oxygen feed system. It increases the chances of a successful relight at high altitude where the air is thin and prevents flameouts caused by gas ingestion during gun firing and missile launches. The RD-33 has proved to be virtually immune to surge during violent manoeuvres – even at negative airspeed during a tailslide. On the ground the engine runs steadily at ambient temperatures between –60°C and +60°C (–76 to +140°F); in the air it runs at inlet temperatures up to +200°C (392°F) which are reached in Mach 2.35 cruise.

Specific fuel consumption (SFC) is 2.05 kg/kgp·hr (lb/lbst·hr) in full afterburner and 0.77 kg/kgp·hr at full military power. The two compressors provide an overall engine pressure ratio (EPR) of 21.5 and a mass flow of 76.9 kg/sec (169.5 lb/sec). Turbine temperature is fairly high – 1,525°K at idling RPM and 1,650°K in flight. Idling thrust is a mere 200 kgp (440 lbst). The engine accelerates from idling RPM to full military power in three or four seconds and another two seconds is needed to engage full afterburner; in case of need, however, the RD-33 can go from idling RPM to full afterburner in just four seconds.

A cutaway drawing of the RD-33.



NPP Klimov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▲ **Once removed, the one-piece cowlings provide almost unrestricted access to the engines. Note the rear engine attachment point.**

The engine is 4.26 m (13 ft 11$\frac{23}{32}$ in) long, with a maximum overall diameter of 1.0 m (3 ft 3$\frac{3}{8}$ in) and an inlet diameter of 0.75 m (2 ft 5$\frac{33}{64}$ in). Dry weight is 1,050 kg (2,310 lb), which amounts to a weight/thrust ratio of 0.126. Engine life is 1,400 hrs (RD-33 Srs 2) or 2,000 hrs (RD-33 Srs 3); time between overhauls (TBO) is 700 and 1,400 hrs respectively.

The RD-33 has a hydroelectronic control system featuring a BPR-88 analogue RPM limiter, an NR-59A variable delivery fuel pump (*na**sos**-regoo**lya**tor*), an RSF-59A nozzle and afterburner regulator (*regoo**lya**tor **sop**la i for**sa**zha*), an RT-59I main fuel distributor (*rasprede**li**tel' **top**liva*) and an RTF-59 afterburner fuel distributor (*rasprede**li**tel' **top**liva for**sa**zha*). The engines are controlled by throttles located on the port cockpit console via mechanical linkages.

The MiG-29K is powered by RD-33K engines uprated to 5,500 kgp (12,125 lbst) at full military power and 8,800 kgp (19,400 lbst) in full afterburner, with a 9,400-kgp (20,720-lbst) contingency rating for high gross weight carrier takeoffs. A modified version of the RD-33K without this contingency rating powers the

Another view of the RD-33 engine minus cowling. ▼


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The convergent-divergent nozzles of the RD-33 engines have outer and inner petals. Note the shades of burnt metal on the outer ones.


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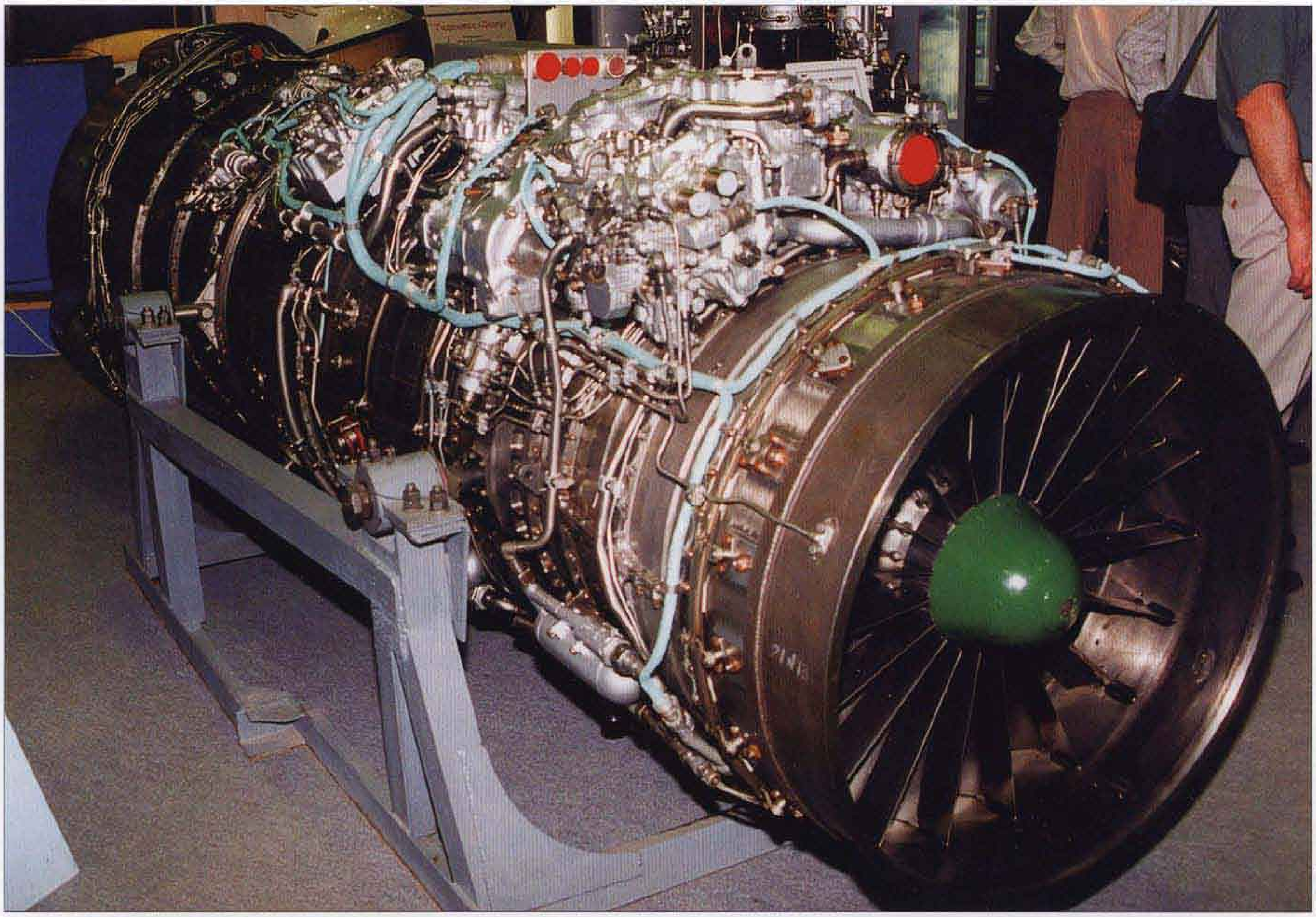
The RD-33K engines of the naval MiG-29K are outwardly identical to the standard version.

MiG-29M. The RD-33K is equipped with a full authority digital engine control (FADEC) system featuring the NR-59A fuel pump, the RSF-59A nozzle/afterburner regulator and the ESU-21 digital control unit (*elek**tron**naya sis**tem**a oopravl**en**iya*). Afterburner SFC is improved to 1.97 kg/kgp·hr and weight/thrust ratio to 0.119.

The engines are inclined 4° upwards and set at 1°30' 'toe-in' in spaced nacelles. The adjustable supersonic air intakes are raked and have rectangular cross section at the inlets changing to circular at the compressor faces. To prevent boundary layer ingestion the intakes are set apart from the wing undersurface, the upper lip acting as a boundary layer splitter plate. A vee-shaped fairing spilling the boundary layer connects the intake lip to the wing.

The horizontal airflow control ramps create four shock waves, optimising the airflow for various flight modes (subsonic, transonic and supersonic). The ramps consist of four segments; the first of these (that is, the splitter plate) is fixed at a 6° angle, the others are hydraulically-actuated. The rearmost segment is perforated to spill the boundary layer via triple dorsal windows closed by metal mesh.

To prevent foreign object ingestion during taxying, take-off and landing the forward movable segments of the intake ramps double as FOD protection doors which block the intakes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▲
A thrust-vectoring version of the RD-33 engine (originally known as the RD-133) at the NPP Klimov stand at one of the MAKS airshows in Zhukovskiy.

◄
This view illustrates how the KLIVT all-axis vectoring nozzle of the RD-133 works. This version powers the MiG-29OVT and is to be fitted to future versions for India, including the MiG-35.

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▲ **Two RD-33 engines with as-yet non-functional KLIVT nozzles fitted to the MiG-29OVT in 2001. The nozzle actuator fairings are clearly visible.**

completely. When these are closed the engines breathe via the dorsal air intakes mentioned earlier (five rows of spring-loaded blow-in doors). The FOD protection doors close automatically during engine starting when hydraulic pressure reaches nominal and open when the aircraft accelerates to 200 km/h (124 mph) IAS during take-off, that is, past rotation speed. They close again when the airspeed drops below 200 km/h, reopening after engine shutdown. The dorsal blow-in doors may open to admit additional air in low-speed flight, even when the FOD protection doors are fully open.

Each intake has an individual ARV-29D ramp control system (*avtoma**ti**cheskiy regoo**lya**tor* ***voz**dukhoza**bor**nika* – automatic air intake regulator) with three preset programmes which adjusts the ramp depending on engine RPM and operates the FOD protection door. (D = *dora**bot**annyy* – revised; early-production aircraft had the earlier ARV-29 version.) The ARV-29D includes two airspeed sensors (triggered when the aircraft reaches Mach 1.15 and Mach 1.5) and two pressure relays triggered by altitude in excess of 3,000 m (9,840 ft) and airspeed in excess of 200 km/h. If the system fails the pilot can adjust the intakes manually.

Operational RD-33 engines with KLIVT nozzles on the MiG-29OVT in 2003. ▼

Victor Drushlyakov

The MiG-29K, MiG-29M and MiG-29SMT have redesigned air intakes with movable lower lips and no dorsal blow-in doors. FOD protection is offered by hinged grilles which retract after take-off to lie flat against the bottom of the inlet ducts, trapping any foreign objects retained by them. The mainwheel well walls are perforated to admit additional air at low speed. Besides, the MiG-29K and MiG-29M have reprofiled inlet ducts to cater for the higher mass flow of the uprated RD-33K engines.

On the ground the engines can be started singly or simultaneously by means of an NPP Klimov (Izotov) GTDE-117 auxiliary power unit located in a bay in the aft fuselage between the engine nacelles. The APU's 'elephant's ear' air intake offset to port on most versions (or to starboard on the MiG-29K/MiG-29M), is located at frame 7; the exhaust is located on the fuselage underside near the starboard nacelle and closed by a door to reduce drag when the APU is off. In flight the engines are restarted by windmilling at speeds down to 300 km/h (186 mph).

The GTDE-117 itself is started by an ST-115B starter-generator, using ground power or batteries. It weighs only 40 kg (88 lb) and delivers 90 eshp. The APU provides electric and hydraulic power when the engines are shut down, allowing the aircraft's systems to be checked without using ground power – an undoubted asset on tactical airstrips where support equipment may be unavailable.

The same bay houses the remotely located engine accessory gearbox (common for both engines) which conveys torque to the generators, fuel, oil and hydraulic pumps and allows the APU to spin up the engines by direct drive via couplings. The basic *Fulcrum-A*, MiG-29SD and MiG-29UB have a KSA-2 gearbox (*ko**rob**ka* [*pri**vo**da*] *samo**lyot**nykh agre**gah**tov*); this was replaced by the KSA-3 on 'fatback' versions (*izdeliye* 9.13 and MiG-29SE/SM). The engines, accessory gearbox and APU all use IPM-10 grade mineral oil.

Separating the engine accessories from the engines minimises disconnecting operations during an engine change. The engines are extracted downwards and enclosed by one-piece cowlings with quick-release fasteners; this allows a team of four technicians to change an engine in just 2 hours 15 minutes.

Control System

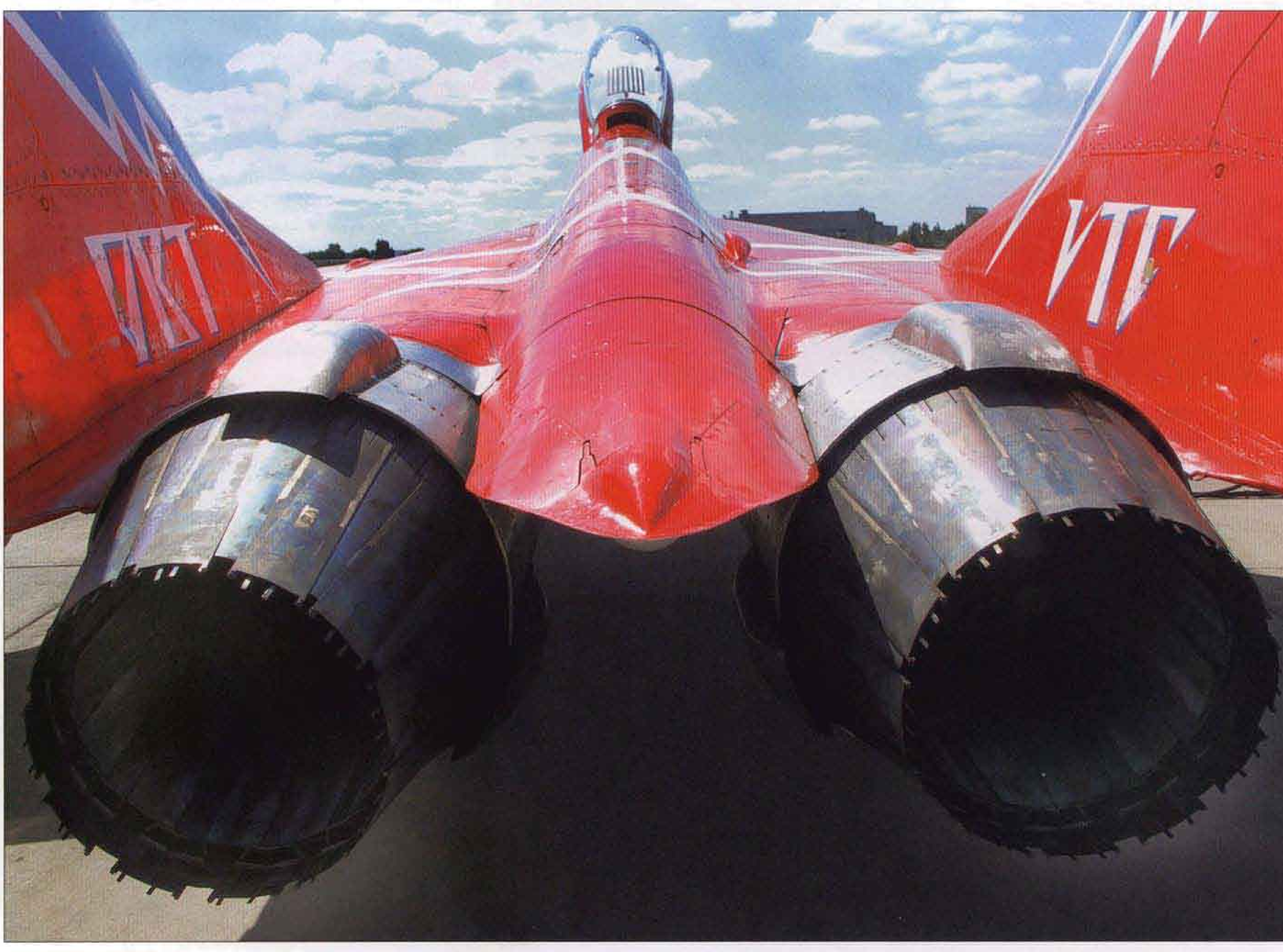
All versions except the MiG-29M and MiG-29K have a conventional mechanical flight control system with rod linkages and irreversible hydraulic actuators. The control system features an artificial-feel mechanism and trimming in all three control channels.

Pitch and roll control is provided by simultaneous or differential movement of the stabilators (tailerons) with separate RP-260A actuators. Maximum deflection is 25° up/15° down on take-off/landing and 17°45' up/5°45' down in cruise flight. Roll control is also provided by ailerons with RP-280A actuators; maximum deflection is 15° up/25° down. Directional control is provided by inset rudders with RP-270 actuators deflected ±25°. The actuators have twin chambers and are powered by two different hydraulic systems for greater reliability.

The aircraft can be controlled manually or automatically – in the latter case by the SAU-451 automatic control system (*sis**tem**a avtoma-**tich**eskovo oopravl**en**iya*). The system acts as a yaw, roll and pitch damper, enhancing stability and control, especially at high alpha. It also stabilises heading, AOA and bank angle, brings the aircraft into straight and level flight from any attitude at the push of a button on the stick (the so-called 'panic button'), stabilises barometric altitude, enables automatic climbout from dangerously low altitude (when the gear is up) and automatic landing approach down to 50-60 m (165-200 ft).

The *Fulcrum-A* and *-C* (*izdeliye* 9.12 and 9.13) have the SAU-451-03 and SAU-451-04 versions respectively. The MiG-29S/MiG-29SE features the SAU-451-05 version featuring a critical AOA warning horn, a bank angle limiter and bigger rudder deflection at high alpha; the MiG-29SD's SAU-451-06 is similar, except for the latter feature. The MiG-29UB has the SAU-451-02 version with changes associated

Close-up of the engine nozzles of the MiG-29OVT.



Yefim Gordon

with the trainer's dual controls. The system has twin ARM-150M servos in the pitch channel and ARM-150K servos in the yaw and roll channels (*avto**nom**naya roole**va**ya ma**shin**ka* – self-contained servo).

To prevent stalling and inform the pilot that he is about to exceed prescribed AOA and G limits the MiG-29 is equipped with an SOS-3M alpha and G limiter (*sis**tem**a ograni**chi**tel'nykh sig**na**lov* – 'limiting signals system') which also controls the LE flaps to expand the AOA envelope. As the aircraft approaches critical AOAs the system engages a stick-pusher with a force of up to 17 kg (37.5 lb). On the MiG-29 (*izdeliye* 9.12) and MiG-29UB the alpha limit is 26°; the MiG-29S/SD/SE/SM is equipped with an SOS-3M-3 system with a 28° limit.

The MiG-29M and MiG-29K have a KSU-915 control system (***kom**pleksnaya sis**tem**a ooprav-**len**iya* – integrated control system for *izdeliye*

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◄▲
The semi-retractable in-flight refuelling probe developed for the MiG-29SD in stowed position.

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◄
The IFR probe in deployed position; note the telescopic design

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Front view of the semi-retractable IFR in stowed position...
▼◄

Yefim Gordon

...and in deployed position.
▼

9.15). The system has a quadruplex analogue fly-by-wire pitch control channel with no mechanical backup and triplex FBW roll and yaw control channels with mechanical backup enabling 50% control surface deflection. It enhances manoeuvrability by making the aircraft statically unstable.

Fuel System

Apart from its obvious purpose, the fuel system maintains the aircraft's CG and cools the engine oil, the bleed air for the air conditioning system (MiG-29S/SE only) and the radar set (in the latter case by means of a fuel/glycol heat exchanger). Fuel system components and hydraulic tanks are located inside the fuel tanks for better survivability.

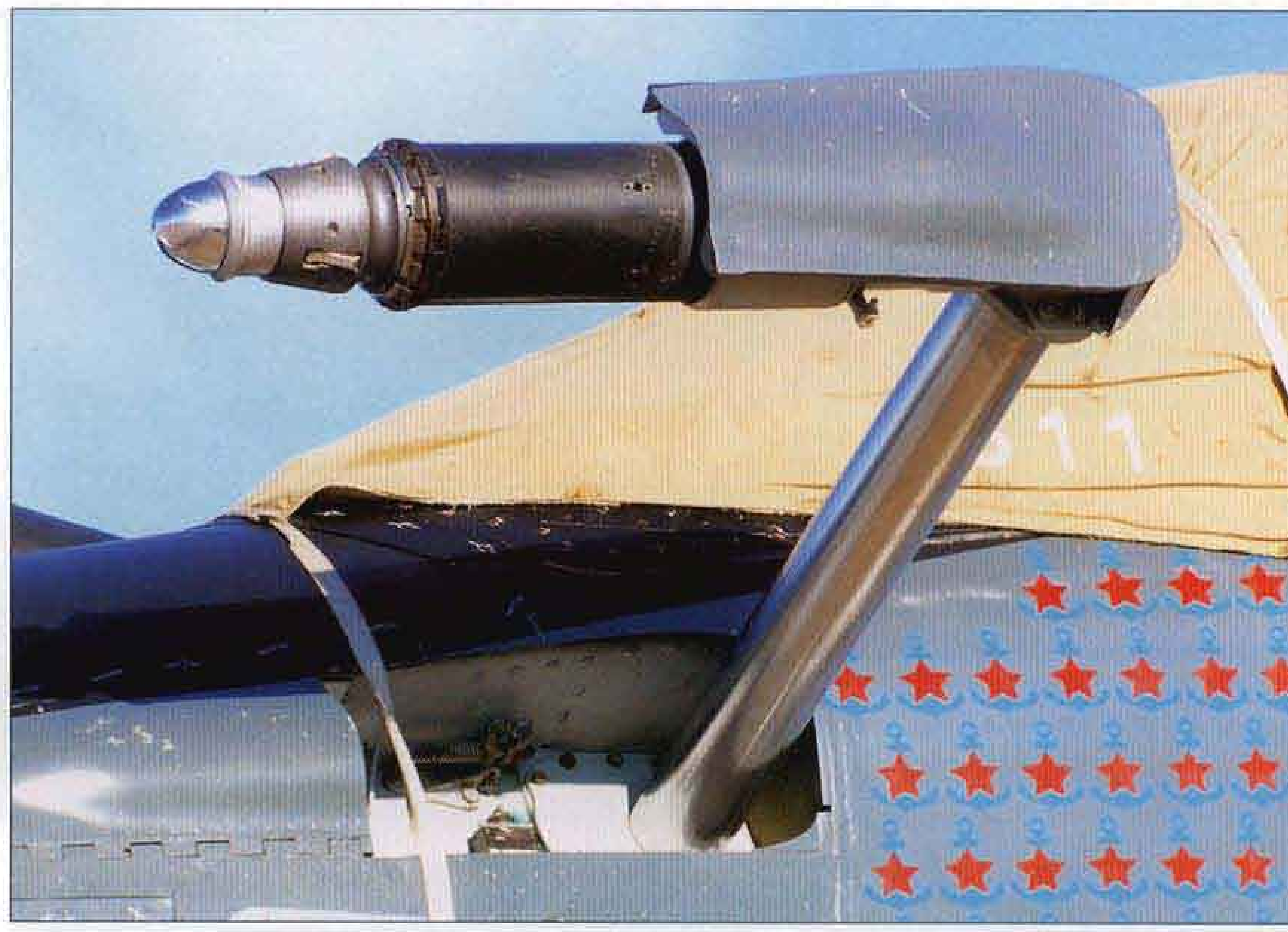
On the *Fulcrum-A* (including the MiG-29SD) and MiG-29UB internal fuel is carried in four fuselage integral tanks and two wing tanks. The fuselage tanks hold 650 litres/143 Imp gal (No.1), 870 litres/191.4 Imp gal (No.2), 1,810 litres / 398.2 Imp gal (No.3) and 310 litres/68.2 Imp gal (No.3A); each of the wing tanks holds 330 litres (72.6 Imp gal). The No.2 fuselage tank feeds the engines via a fuel accumulator in the No.3 tank. Total internal fuel capacity is 4,300 litres (946 Imp gal), which amounts to 3,200 kg (7,050 lb) of usable fuel at a specific gravity of 0.785 g/cm³.

On the *Fulcrum-C* the capacity of the No.1 fuselage tank is increased by 240 litres (52.8 Imp gal) to 890 litres (195.8 Imp gal), resulting in a characteristically bulged fuselage spine. This brings the total internal fuel capacity to 4,540 litres (998.8 Imp gal) or 3,400 kg (7,495 lb) of usable fuel.

A 1,500-litre (330 Imp gal) long-range tank can be carried on the centreline. It obstructs the APU exhaust and hence incorporates a unique sloping duct enabling the APU to exhaust straight through it. The *Fulcrum-C* introduced 'wet' inner wing pylons allowing the carriage of two 1,150-litre (253 Imp gal) drop tanks; this feature was added to many *Fulcrum-As* as a mid-life update. With three drop tanks the 'fatback' versions have a total fuel capacity of 8,340 litres (1,834.8 Imp gal) or 6,250 kg (13,780 lb). Latest Mikoyan data state drop tank capacity as 1,440 litres (316.8 Imp gal) and 1,200 litres (264 Imp gal) for the centreline and underwing tanks respectively.

Structural changes have increased internal fuel capacity to 5,810 litres (1,278.2 Imp gal) on the MiG-29M and 5,670 litres (1,247.4 Imp gal) on the MiG-29K. These versions feature a new 1,710-litre (376.2 Imp gal) No.1 fuselage fuel tank whose capacity is almost doubled by using the space in the LERXes formerly occupied by the dorsal auxiliary intakes. The capacity of the No.3A tank is enlarged by 70% to 530 litres (116.6 Imp gal), and a new No.3A strap-on tank holding 130 litres (28.6 Imp gal) is added. The Nos. 2 and 3 tanks hold 840 litres (184.8 Imp gal) and 1,800 litres (396 Imp gal) respectively.

The MiG-29K and MiG-29M have an internal fuel capacity of 5,720 litres (1,258.4 Imp gal) or 4,460 kg (9,830 lb) of usable fuel. This is distributed as follows: 1,700 litres/374 Imp gal (No.1 fuselage tank), 840 litres/184.8 Imp gal (No.2 tank), 1,800 litres/396 Imp gal (No.3 tank), 480 litres/105.6 Imp gal (No.3A tank), 100 litres/22 Imp gal (No.3B tank) and 400 litres (88 Imp gal) in each wing tank. The MiG-29K and


Yefim Gordon

▲▲
The fully retractable L-shaped IFR probe of the MiG-29K in deployed position. Note the hinged cover enclosing the tip when retracted.

Yefim Gordon

▲
The very similar IFR probe of the MiG-29M2. In this case the tip remains exposed.

▶
The 1,500-litre (330 Imp gal) centreline tank belonging to a MiG-29 coded '23'. The connector for the aircraft's fuel system is in the 'pylon' at the front end. Note the pressurisation line and the offset duct at the rear for the APU exhaust.

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Rear view of a MiG-29 with the centreline tank fitted, complete with restraining fixtures at the rear end. The APU exhaust outlet in the tank is just visible.
▼

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▲▶
Front view of the centreline tank in place.

Yefim Gordon

▶
Two 1,150-litre (253 Imp gal) PTB-1150 drop tanks belonging to MiG-29S '506 Blue'. Note the small negative-incidence canards at the front end assisting separation when the drop tanks are jettisoned.

MiG-29M also have provisions for three drop tanks.

The MiG-29K features a refuelling probe enabling it to receive fuel from hose-and-drogue tankers (IL-78, Su-24M with a UPAZ-1A 'buddy' refuelling pack and so on). The fully retractable L-shaped probe is located ahead of the windscreen on the port side.

The MiG-29SMT has an internal fuel capacity of approximately 5,300 litres (1,166 Imp gal) thanks to a new No.1 fuselage fuel tank similar to that of the MiG-29K and MiG-29M. This version and other export *Fulcrums* can be fitted with the optional semi-retractable refuelling probe on the port side of the forward fuselage. The faired probe is attached to frames No.1 and 2 and can be removed if necessary; it has a delivery rate of 900 litres/min (198 Imp gal/min). Enlarged new 1,800-litre (396 Imp gal) underwing drop tanks are also offered.

The Nos. 1 and 3 fuselage tanks each have one GTN-7 turbine pump, with three more in the No.2 tank. The wing tanks each have one fuel jet pump; so do fuselage tanks Nos. 3 and 3A. The turbine pumps and fuel jet pumps are powered by a DTsN-80 centrifugal pump connected to the engine accessory gearbox. The fuel tanks are pressurised by bottled nitrogen for explosion suppression or by engine bleed air.

The MiG-29 uses RT, T-1 or TS-1 grade jet fuel or Western equivalents (JP-1, Jet A-1, AVTUR and the like). Normal procedure is single-point pressure refuelling through a standardised connector in the port mainwheel well; gravity refuelling is also possible through filler caps in the Nos. 1 and 3 fuselage tanks. The drop tanks are filled independently through filler caps.

Refuelling options include 50% internal fuel, 100% internal fuel and 100% internal fuel plus one, two or three drop tanks. The STR-6-2(A) or STR-6-5(A) fuel metering system automatically calculates fuel quantity and range on remaining fuel, indicates empty tanks and alerts the pilot when he is down to 'bingo fuel', that is, reserves (550 litres/121 Imp gal).

To maintain CG position the tanks are emptied in a certain sequence. On the *Fulcrum-A* fuel is used as follows: centreline tank; 250 kg (551 lb) from No.2 tank; 200 kg (440 lb) from No.3 tank; wing tanks, No.3A tank; 600 kg (1,322 lb) from No.3 tank; 280 kg (617 lb) from No.1 tank; Nos. 3 and 1 tanks completely, No.2 tank completely and fuel accumulator. On the *Fulcrum-C* the sequence is as follows: centreline tank, No.1 tank (partially), No.3 tank (partially), wing tanks (partially), underwing drop tanks, wing tanks (completely), No.3 tank (some more), No.3A tank, No.3 tank (some more), No.1 tank (some more), Nos. 3, 1 and 2 tanks completely and fuel accumulator.

Victor Drushlyakov

▲ **A set of external tanks belonging to a *Fulcrum-C* coded '26 Yellow' and wearing a tactical camouflage scheme. The centreline tank, showing considerable wear and tear, rests on a wooden cradle when not in use.**

Electrics

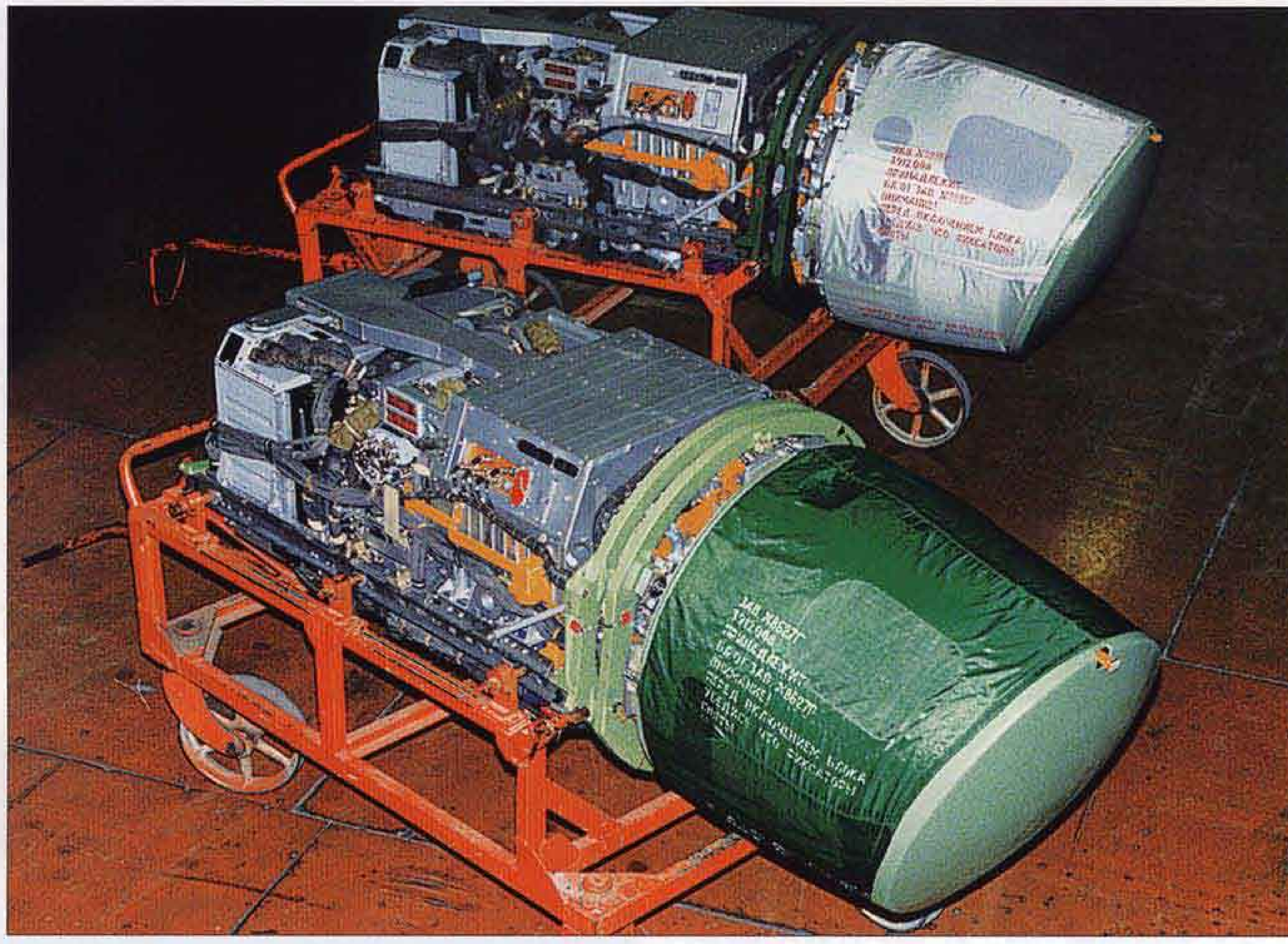
Three subsystems: 28.5 V DC, 115 V/400 Hz AC (three-phase) and 36 V/400 Hz AC (single-phase). Main power sources are a 30-kW GSR-ST-12/40A DC generator (peak output 83.3 A, 208/120 V) and a 12-kW GT30NZhCh12 AC generator (400 A, 28.5 V); both are driven by the accessories gearbox. Reserve DC power is supplied by two 15STsS-45B silver-zinc batteries (28 V, 45 A·h) located in the starboard LERX which are also used for APU starting if ground power is unavailable. Reserve AC power is supplied by a PTO-1000/1500M converter (*preobrazo**vah**tel' tryokh**fahz**no-odno**fahz**nyy* – single-/three-phase converter) providing 1.5 kW, single-phase/1 kW, three-phase; peak current 13 or 16 A respectively).

The electric system includes an AZU-400A overload protection and control unit (*avto**maht** za**shchi**ty i oo**prav**le**niya*). Two ground power receptacles are located on the port side of the forward fuselage.

This view clearly shows two PTB-1150 drop tanks on the inboard pylons of a *Fulcrum-C*. ▼

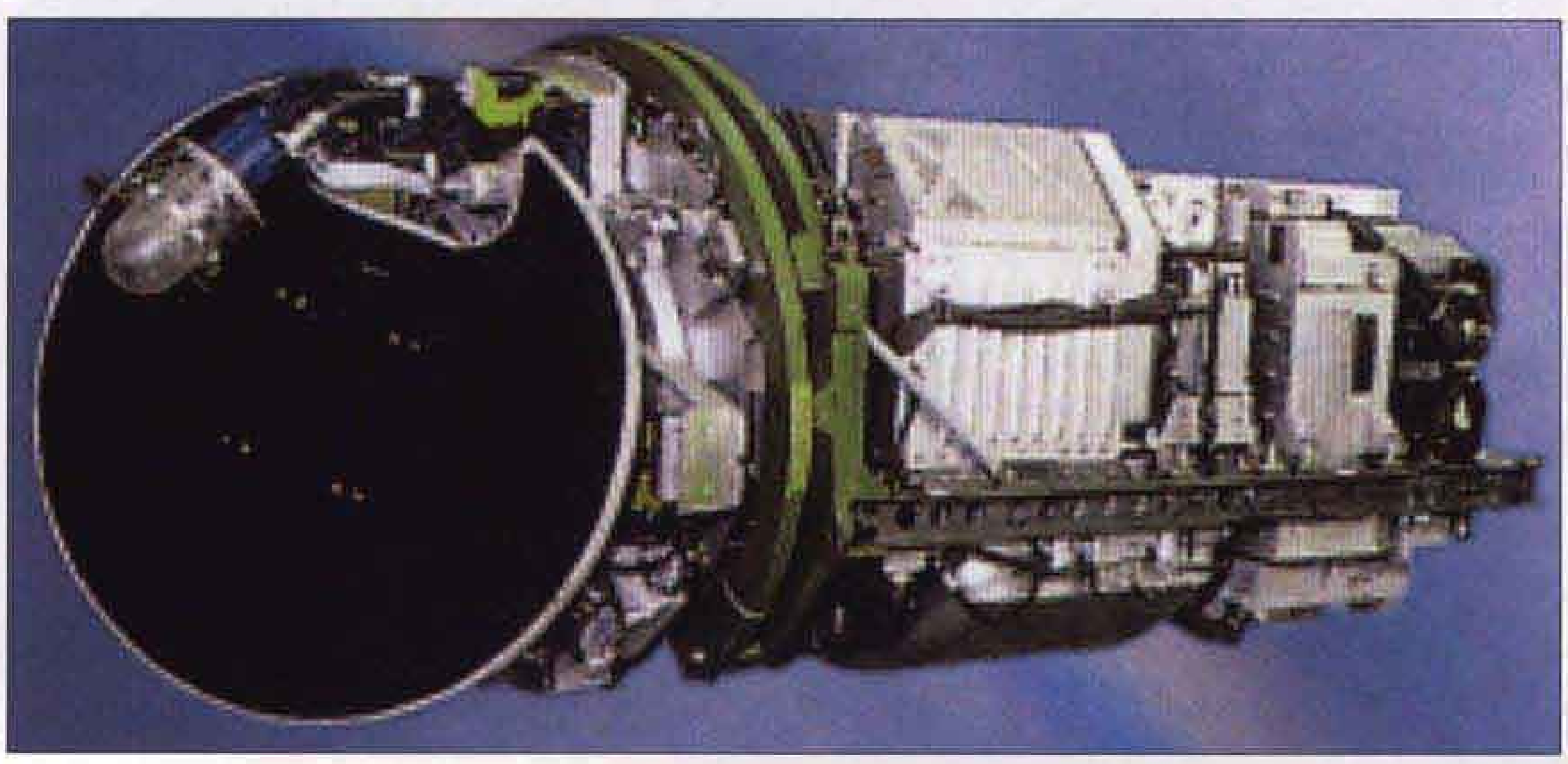
R. Simon

Two Phazotron N019 Rubin fire control radars on ground handling dollies at ARZ No.121; the radars have been removed from MiG-29s undergoing refurbishment. Note the cloth cover of the twist-cassegrain antenna bin.



Artur Sarkisyan

An N019 radar with the protective antenna housing removed, showing the xenon lamp pulse emitter.

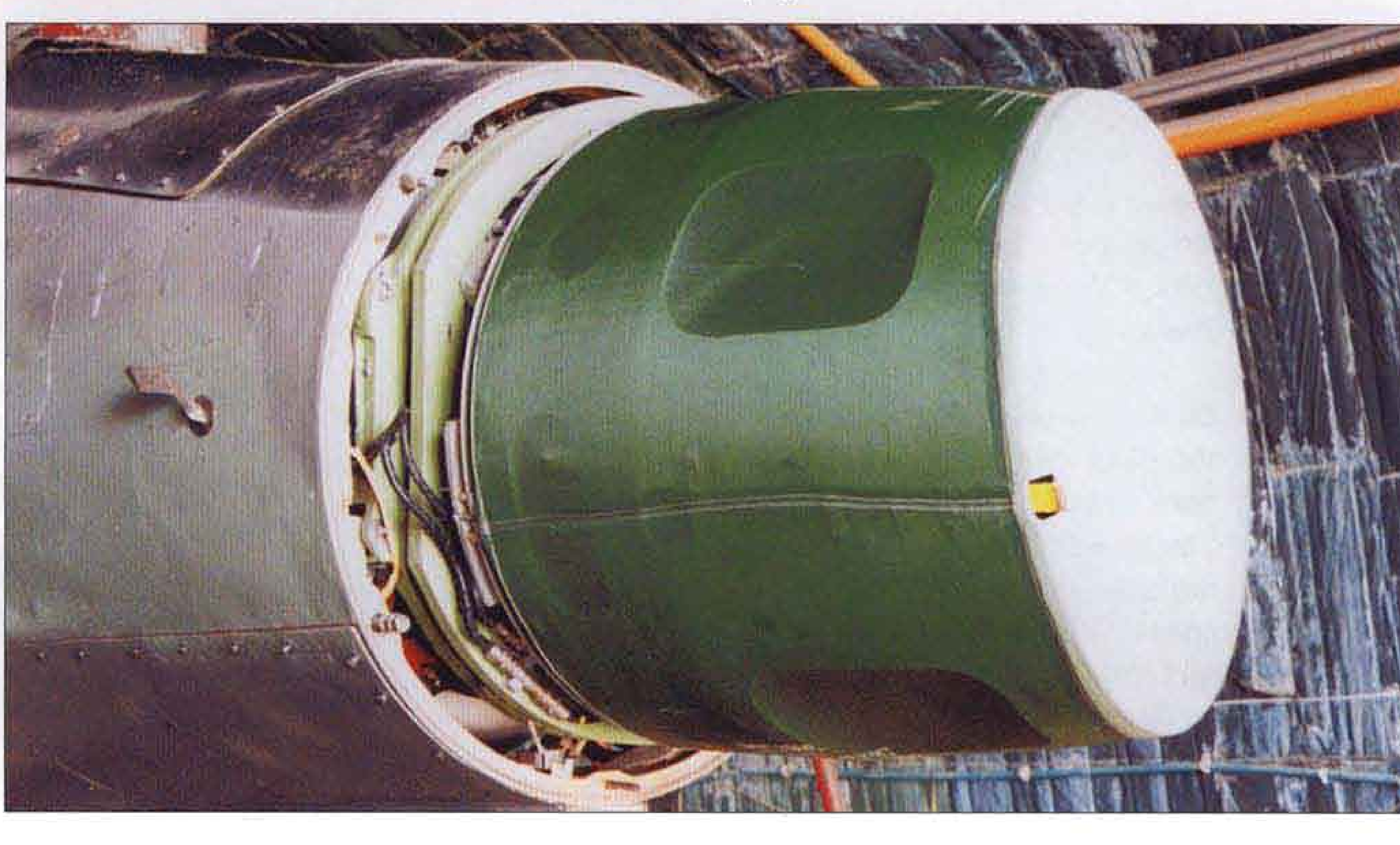


Phozotron-NIIR

Hydraulics

Two independent hydraulic systems. The main system powers one chamber of each control surface actuator and the stick pusher, the artificial feel unit, operates the landing gear, airbrakes, LE and TE flaps, air intake ramps, nosewheel steering mechanism and APU exhaust door. The backup system (or 'actuator hydraulic system') powers the other chamber of each control surface actuator and the stick pusher. The two systems have separate hydraulic tanks pressurised to 2.8 kg/cm^2 (40 psi).

The removed radome of *Fulcrum-C* '53 White' reveals the antenna bin of the N019 radar. Note the open ventral hatch of the forward avionics bay giving access to the radar set.



Yefim Gordon

Hydraulic power is supplied by NP-103A variable-displacement pumps driven by the engine accessory gearbox. In an emergency the backup hydraulic system is powered by an NS-58 self-contained pump (*nasosnaya* ***stahn****tsiya*). The systems use AMG-10 oil-type hydraulic fluid (*aviatsi****on****noye* ***mahs****lo ghidrav-****lich****eskoye*) and have a nominal pressure of 210 kg/cm² (3,000 psi); safety valves prevent the pressure from exceeding 240 kg/cm² (3,428 psi). If hydraulic pressure falls to 130 kg/cm² (1,857 psi) all hydraulically-powered equipment except the control actuators, LE and TE flap actuators and stick pusher are automatically disengaged; when the pressure falls to 100 kg/cm² (1,428 psi) the emergency pump is automatically engaged.

Pneumatic System

Three separate systems. The main pneumatic system powers the wheel brakes, canopy actuator, fuel shut-off cocks and operates brake parachute deployment and jettisoning. The emergency system operates the mainwheel brakes and enables emergency gear extension. The third system pressurises the hydraulic tanks and avionics bays. Air is supplied by bottles charged to 150 kg/cm² (2,143 psi); the pressure is reduced to 63 kg/cm² (900 psi) for operation.

Air Conditioning System

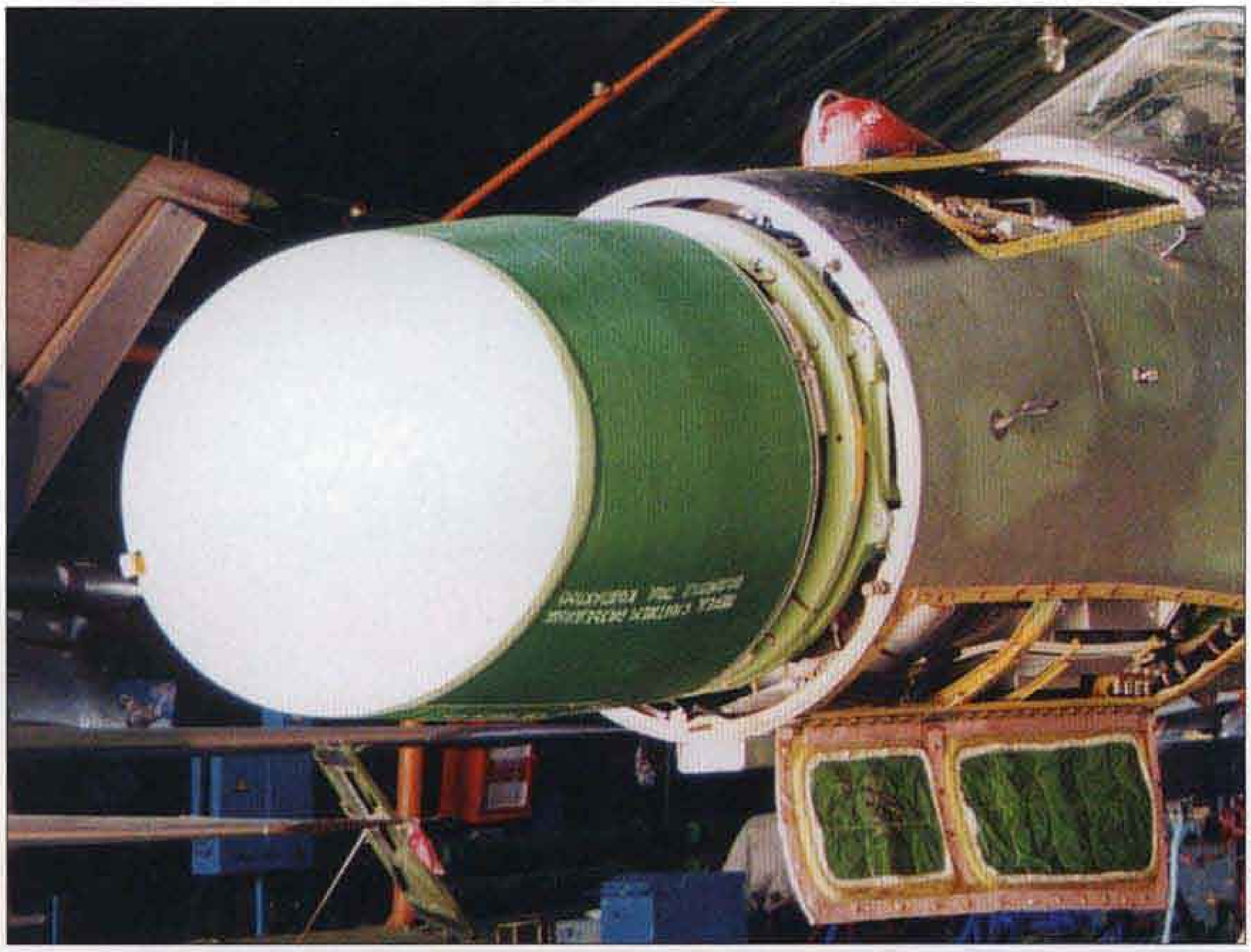
The cockpit is air conditioned by engine bleed air cooled by air/air heat exchangers and a cooling turbine. The cockpit temperature is automatically maintained at +15-25°C (+59-77°F). The system also pressurises the pilot's pressure suit, demists the windscreen and cools the cannon bay.

Fire Suppression System

One 3-litre (0.66 Imp gal) fire extinguisher filled with Khladon-114V$_2$ grade chlorofluorocarbon (CFC) in the fuselage spine for extinguishing fires in the engine bays and the APU/accessory gearbox bay. The system is activated by flame sensors within 3 seconds when fire breaks out.

Avionics and Equipment

Weapons control system: The MiG-29's weapons control system comprises a fire control radar for medium-range targeting and a short-range optoelectronic targeting system. It enables the aircraft to complete its mission (long-range intercept, dogfight or strike) in any weather conditions, day or night, and in an ECM environment, operating singly or in a group. The functions of the WCS are:

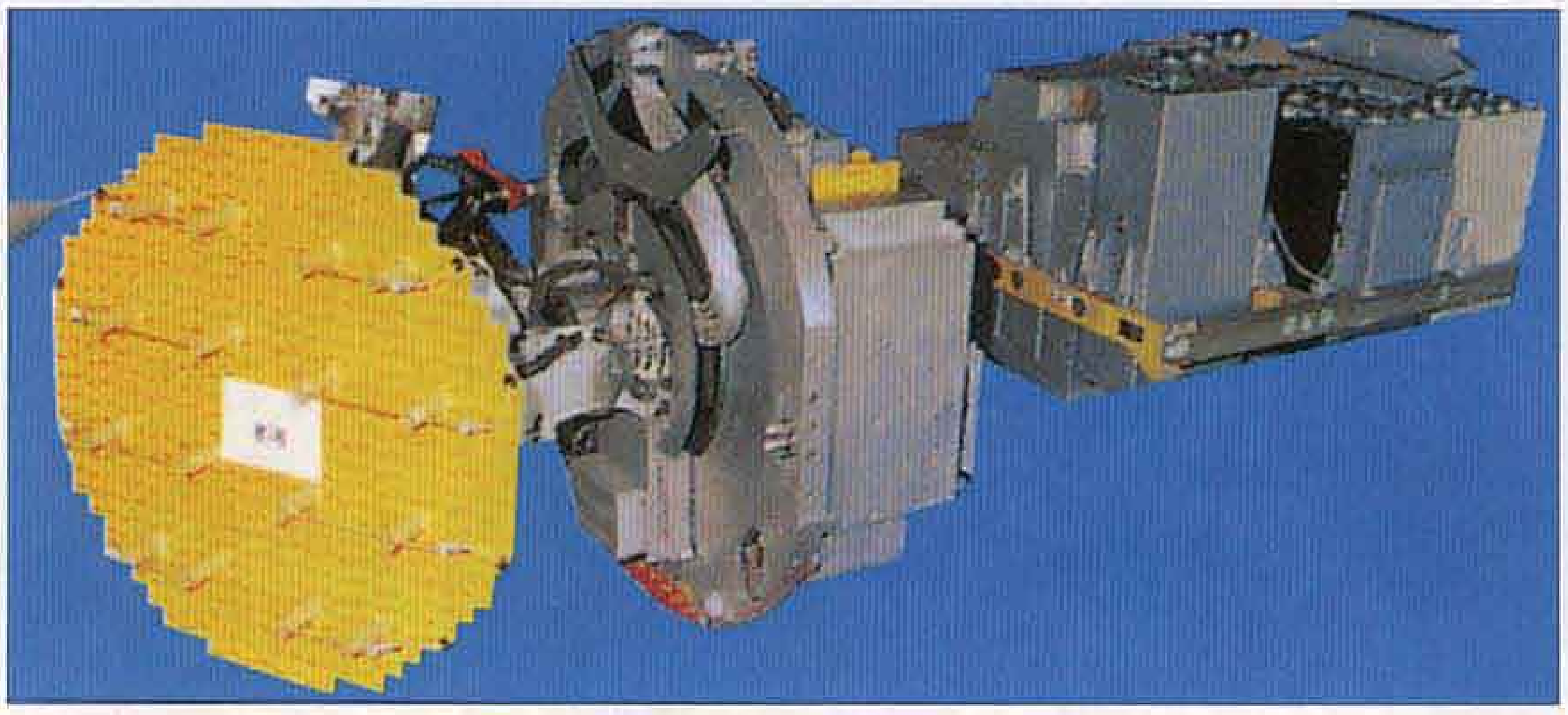


▲ **One more view of the exposed radar antenna. Other hinged and removable access panels on the port side provide access to the radar**

- to seek and detect aerial targets and identify them jointly with the IFF system;
- to target aerial targets and ground targets within visual range;
- to determine whether the conditions are OK for missile launch, download target data and illuminate targets for SARH missiles;
- to display and record targeting, flight and navigation data and weapons control commands.

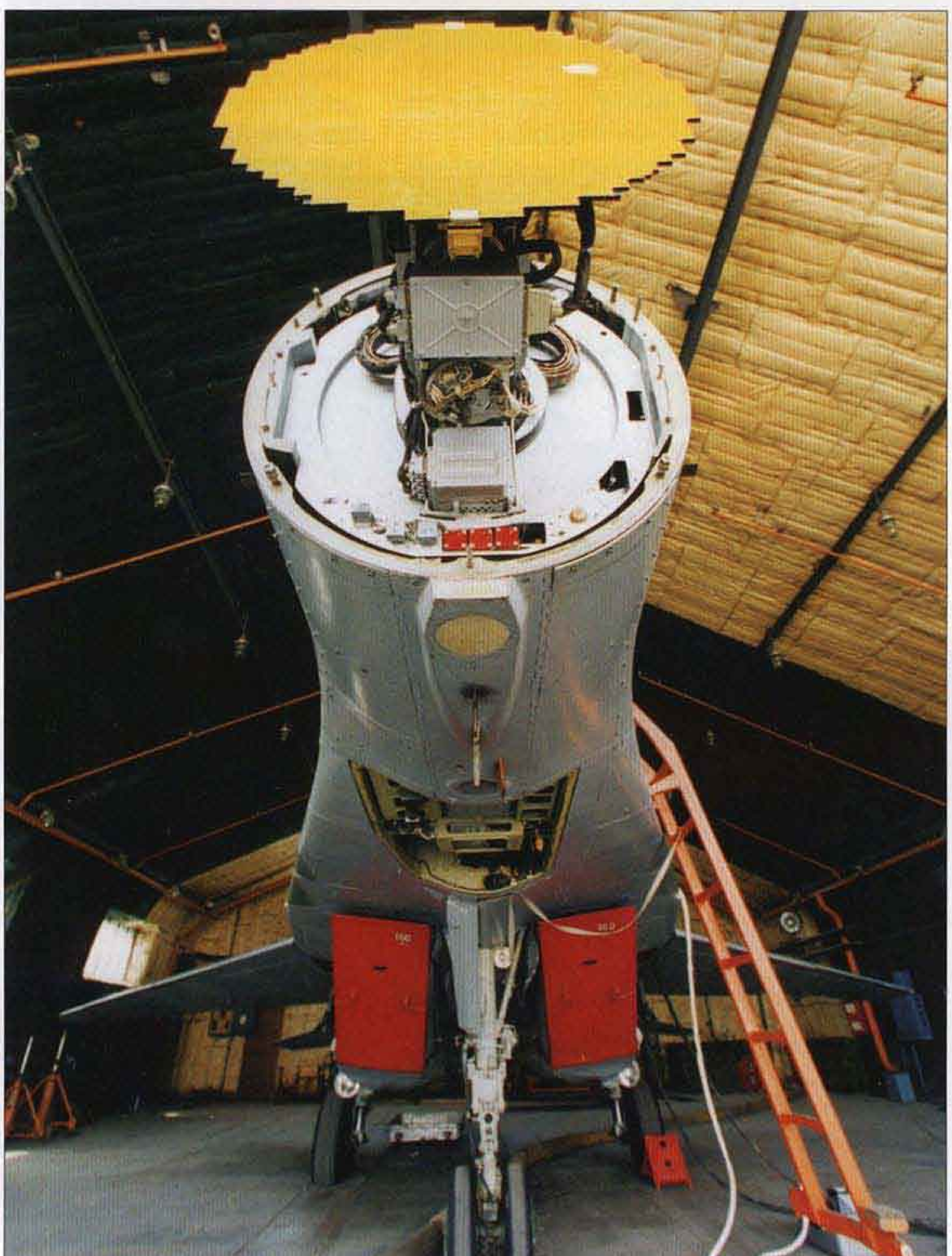
The MiG-29 *Fulcrum-A/C* is equipped with the SUV-29 (Sh-104) combined WCS comprising the RLPK-29 radar targeting suite (based on the Phazotron N019 Rubin fire control radar) and the OEPrNK-29 (S-31) optoelectronic targeting/navigation suite. Export aircraft (*izdeliye* 9.12A and 9.12B) have a downgraded RLPK-29E radar targeting suite (based on the N019EA or N019EB radar respectively) and an OEPrNK-29E2 (S-31E) optoelectronic targeting/navigation suite. The MiG-29UB lacks radar, featuring only the OEPrNK-29UB suite.

The MiG-29S has an SUV-29S WCS comprising the RLPK-29M radar targeting suite (based on the Phazotron N019M Topaz radar) and the OEPrNK-29-1 optoelectronic targeting/navigation complex. Export versions (MiG-29SD/MiG-29SE) have a downgraded RLPK-29ME radar targeting suite (based on the N019ME radar) and an OEPrNK-29-1E optoelectronic targeting/navigation suite. These are compatible with R-27T1/RE1/TE1 and R-77 AAMs and multiple ejector racks increasing the bomb load to 4,000 kg (8,820 lb). Additionally, the RLPK-29ME and OEPrNK-29-1E are integrated


Phazotron-NIIR

▲ The Phazotron N010 Zhuk fire control radar with a flat-plate mechanically scanned antenna; note the multiple dipole antennas on the scanner.

The *izdeliye* 9.16 testbed with the radome removed, showing the N010M Zhuk-M radar. ▼


Phozotron-NIIR

with the aircraft's automatic control system and have an enhanced self-test capability and a training mode helping pilots to master the WCS.

The MiG-29M has a SUV-29M (Sh-103) WCS and the MiG-29K has a SUV-29K WCS. Both comprise the Phazotron N010 Zhuk radar and the OEPrNK-29M (K-048) optoelectronic targeting/navigation suite. The SUV-29M/K features a 'dogfight mode' – the radar or IRST automatically engages a target within 1.5 seconds after it enters a preset area marked on the HUD.

The RLPK-29 can track up to ten targets at a time, automatically selecting a priority threat; the pilot can also designate a priority target manually. The radar determines the exact coordinates of the priority target as it is tracked. On the MiG-29SD/SE the system can engage two priority threats at a time and has a training mode emulating the target's evasive manoeuvres and countermeasures. The system has an automatic built-in test feature.

The RLPK-29 comprises the N019 Rubin radar and a Ts100 series digital processor; the 'third-world' MiG-29 (*izdeliye* 9.12B) has a Ts100.02.06 processor. The radar has 'look-down/shoot-down' capability and is virtually jam-proof. Detection range for a fighter-type target in open airspace is more than 100 km (62 miles) and target lock-on range is 70 km (43.4 miles). Target tracking angles are +60°/–38° in elevation and ±67° in azimuth.

The RLPK-29M/ME comprises the N019M/ME Topaz radar and a Ts101M digital processor. It can guide missiles to two targets at a time, is compatible with R-77 AAMs and has increased ECM resistance.

The RLPK-29UM comprises the N010 Zhuk radar and a Ts100 series digital processor. The radar has a flat-plate slotted array; the beam is electronically scanned in elevation and mechanically in azimuth. The N010 can guide missiles to four aerial targets at a time, determine the coordinates of ground targets and track moving ground targets. It has three ground mapping modes with different resolution and supports automatic terrain following.

The optoelectronic targeting/navigation suite has the following functions:

• day and night passive ('stealthy') detection and tracking of targets with a high heat signature at short range or aerial targets within visual range in a dogfight;

• determining whether the conditions are OK for unguided rocket or IR-homing AAM launch, designating targets for rockets and missiles, targeting during gun firing, and bomb-aiming;

• navigation;

• presentation of target, flight, navigation and tactical information and;

• supporting the helmet-mounted sight (HMS);

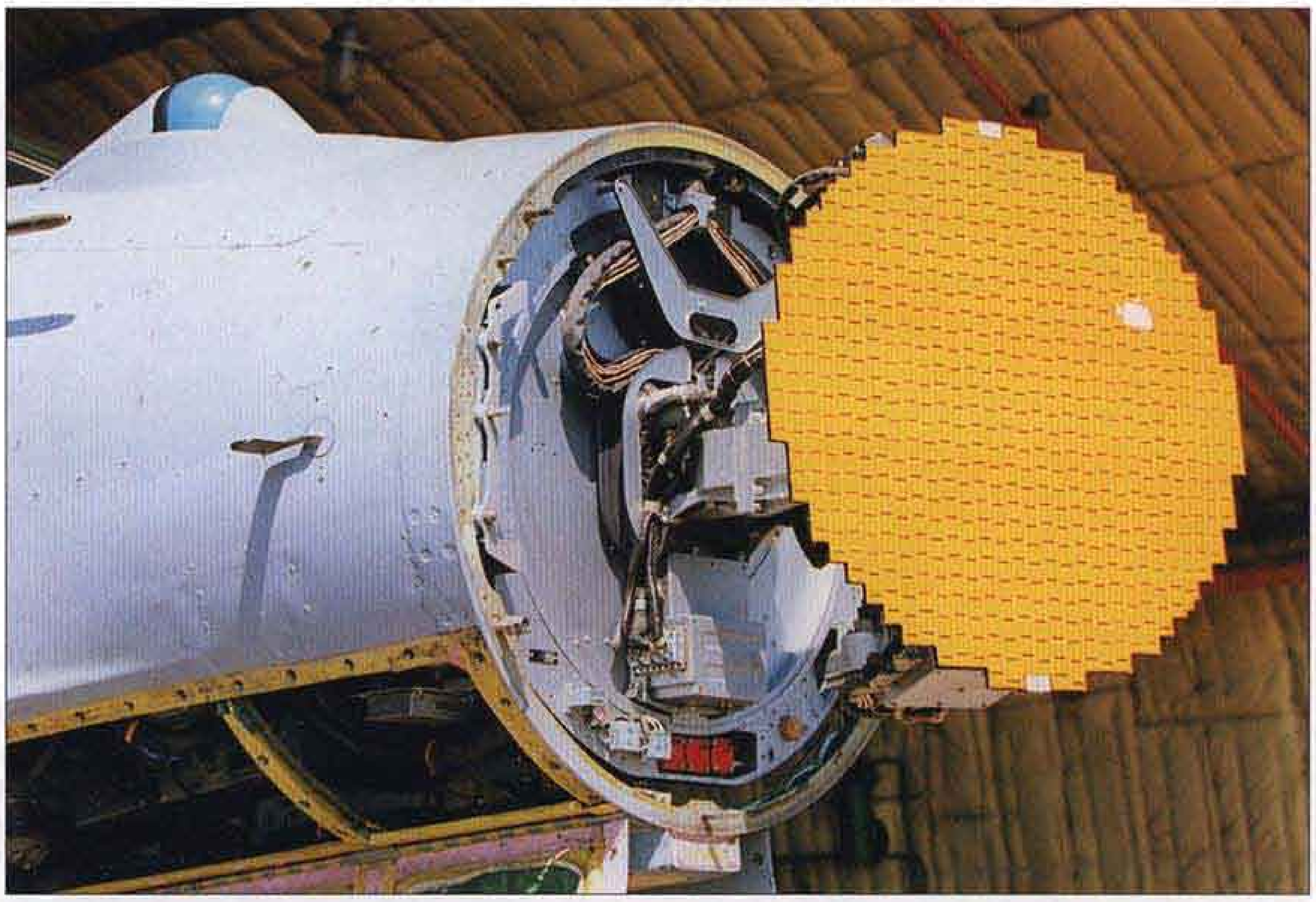
• photographic registration of the attack's results;

• pre-flight testing of the WCS.

On the MiG-29SD/SE the suite again has a training mode emulating the target's evasive manoeuvres and countermeasures and displays WCS test results.

The OEPrNK-29 consists of an OEPS-29 optoelectronic targeting system, an SN-29 navigation system, a Ts100 series digital processor, an SUO-29M weapons selection system, an SEI-31 joint indication system (JIS) featuring the ILS-31 HUD, an FKP-EU gun camera and multi-function control panels. The MiG-29 (*izdeliye* 9.12B) features a Ts100.02.02 processor and an SEI-31-E2 JIS; the MiG-29SD/ MiG-29SE has a Ts100.02.07 processor and an SEI-31-1E JIS.

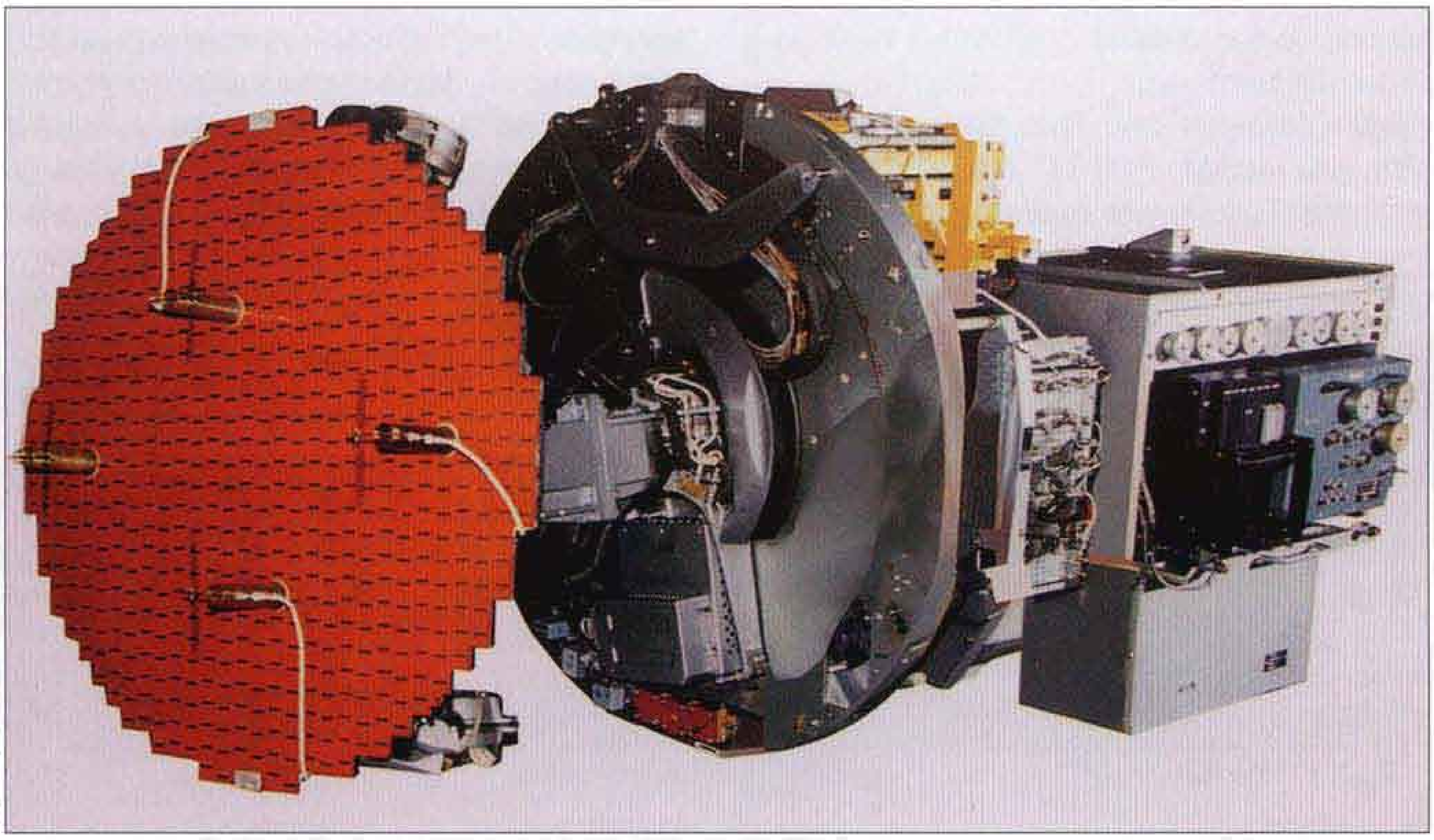
The OEPS-29 targeting system includes the KOLS (*izdeliye* 13S) infrared search&track/laser ranger designed by NPO Gheofizika and the Schchel'-3UM HMS (Schchel'-3UM-1 for export). The IRST/LR, which can acquire targets independently or with data input from the radar, can determine the target's coordinates and range with greater accuracy than the radar. Since the IRST/LR does not emit electromagnetic pulse, it enables the fighter to attack covertly without switching on the radar. Some performance figures are given in the table on the following page.



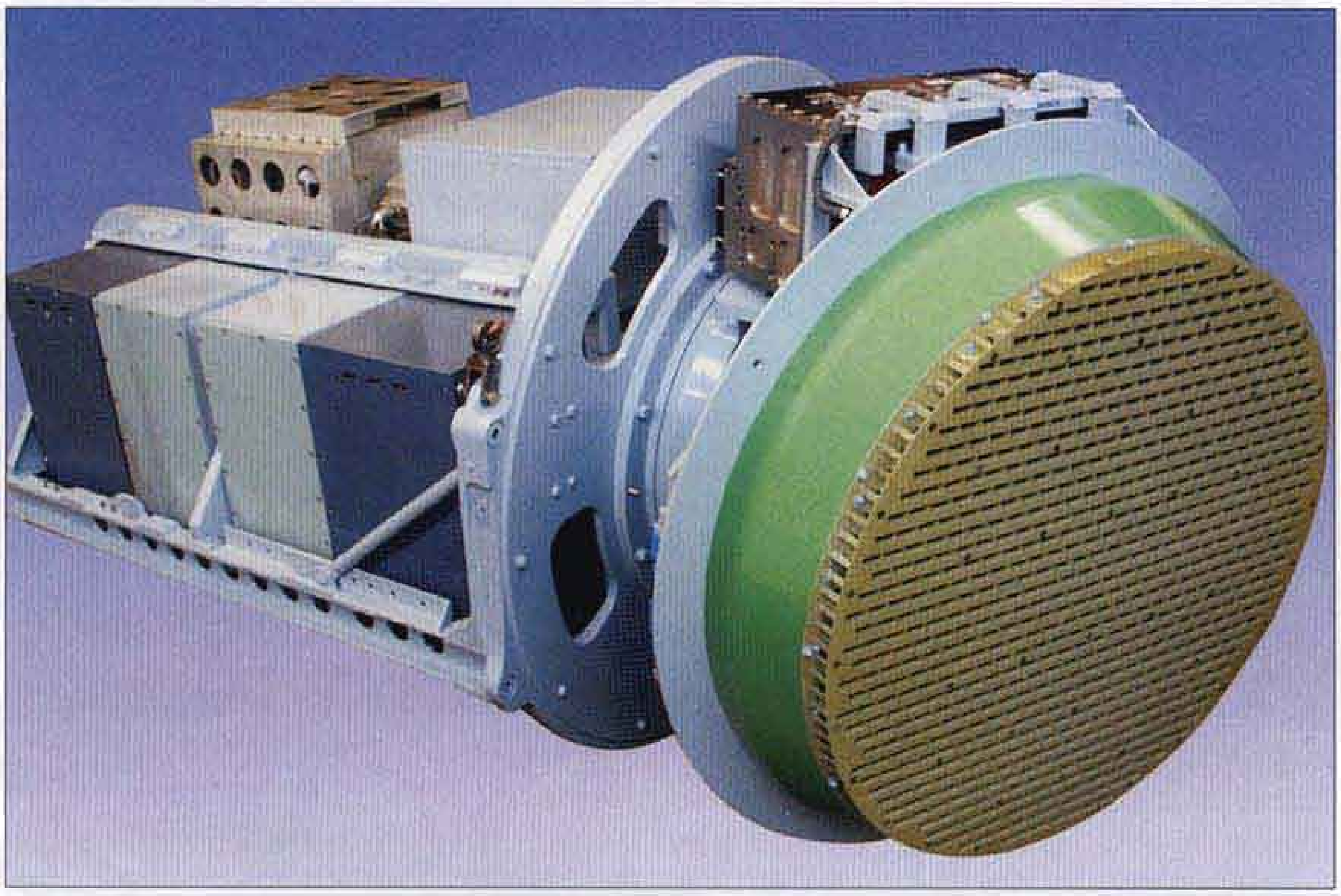
▲ **One more view of the same aircraft with the avionics bay access panels open. Unlike the original N010 model, the scanner of the N010M radar lacks the dipole antennas.**

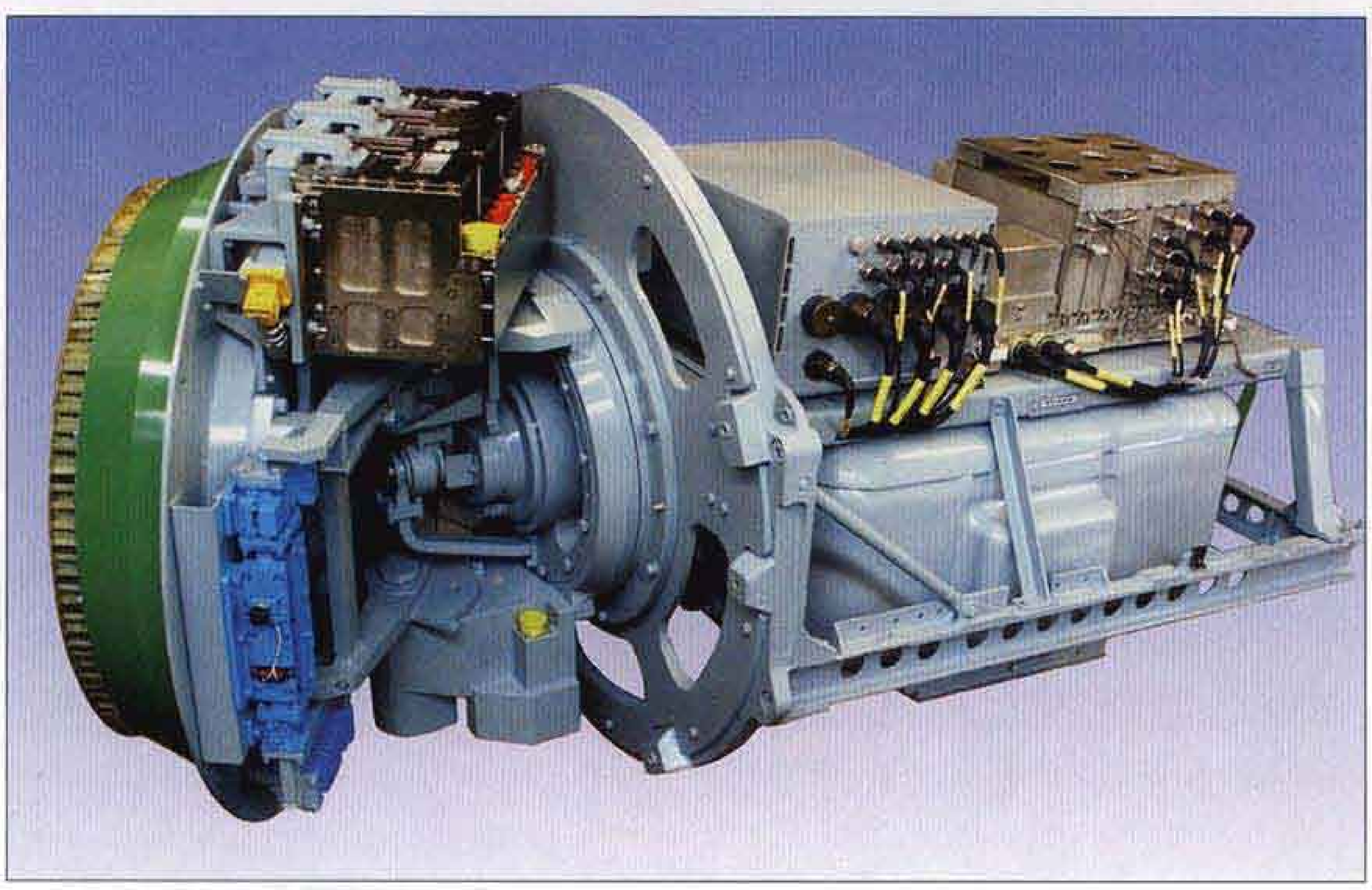
The high-precision channel of the IRST/LR is used for targeting when firing the cannon. The so-called asynchronous aiming method is the main one. When the target is plainly visible (that is, in VMC conditions) a gunsight reticle is projected on the HUD and must be placed over the target. In IMC conditions the HUD displays targeting error values calculated by the computer; these increase or decrease as the aircraft manoeuvres. When the error values drop to zero the pilot knows that the reticle is over the unseen target and it's time to fire.

If autotracking is impossible an enhanced optical mode – the so-called 'forecast mode' – is used. If targeting data is unavailable it is possible to launch missiles with the IRST sighting line in neutral position and fire the



◄ **The N010ME Zhuk-ME export version of the radar.**


NIIP


NIIP

▲ **The Bars-29M phased-array radar was developed for the MiG-29M/M2 as a direct competitor of the N010ME. It is a derivative of the N011M (which, despite the similar designation, was developed by NIIP, not Phazotron) and features both electronic and mechanical beam scanning in azimuth (±40° and ±30° respectively).**

cannon, using a fixed grid in the HUD as a reference point.

The MiG-29M and MiG-29K are equipped with an OLS-M IRST/LR featuring a more sensitive IR sensor with cooling, a more powerful laser ranger and a TV channel for long-range target identification. The IRST's detection range is 35 km (21.7 miles) in pursuit mode and 10 km (6.2 miles) in head-on mode. The TV channel's detection range and identification range is 10 km and 6 km (3.72 miles) respectively; the LR's maximum range is 8 km (5 miles).

The Shchel'-3UM HMS with NVU-2M goggles (*na**shlem**noye vi**zeer**noye oo**stroy**stvo* – helmet-mounted viewing device) increases targeting efficiency in a dogfight, offering the 'point and shoot' targeting mode. By turning his head towards the target the pilot supplies targeting data both to the IRST/LR and to the R-73 IR-homing AAMs. If the R-73 gets a lock-on the pilot can fire missiles without waiting for target data from other systems to become available.

The SN-29 navigation system has the following functions:

• providing input to flight instruments, the automatic control system and JIS;

• determining the aircraft's heading, airspeed, altitude, pitch and bank angles, azimuth and range to waypoints and feeding airspeed information to targeting systems;

• computing the aircraft's coordinates (independently or by using ATC beacons).

The SN-29 navigation system includes the A-323 short-range radio navigation/instrument landing system, the IK-VK-80 (Ts-050) attitude & heading reference system, the SVS-II-72-3-2I air data system (*sis**tem**a voz**doosh**nykh sig**nah**lov*) and the BK-55 connector module (*blok kommu**tah**tsii*). The A-323 SHORAN/ILS enables the aircraft to follow a predetermined route, return to a preprogrammed airfield equipped with landing aids and land in manual, automatic or flight director mode, executing a landing pattern down to 50 m (164 ft) and making a go-around if necessary. The SHORAN works in conjunction with various tactical navigation systems: RSBN-2N, RSBN-4N, RSBN-6N, Pole-N (Field-N; pronounced like the 'poly-' prefix), Udar-M (Blow-M; pronounced ***oo**dar*) and PRMG. Navigation signals are received by the Pion-NM-02 (Peony; pronounced like 'pee on') antenna and feeder

Performance of the OEPS-29 Optoelectronic Targeting System

Detection range (fighter-type target)	15 km (9.3 miles)
Steady tracking range	12 km (7.45 miles)
Laser ranger operating range	200-6,500 m (660-21,325 ft)
Large field of view	±30° in azimuth, ±15° in elevation
Small field of view	±15° in azimuth, ±15° in elevation
Scanning time:	
large field of view	3.5 sec
small field of view	2.0 sec

system located under the nose and on the starboard fin. Early-production MiG-29s were fitted with an A-312 Radikal-NP SHORAN.

The MiG-29M has an upgraded navigation suite featuring an INS-84 inertial navigation system, an SVS-2Ts-U air data system, an A-331 SHORAN/ILS with a *Po**tok*** (Stream) antenna and feeder system, an Uragan (Hurricane; pronounced *oora**gahn***) long-range radio navigation (LORAN) system and a Ts080 digital processor. The MiG-29M has a slightly different SN-K Oozel (Knot) navigation suite featuring a Resistor-K-42 SHORAN/ILS optimised for carrier operations instead of the A-331.

The SUO-29M (*izdeliye* 20PN) weapons selection system (*sis**tem**a oopravl**en**iya o**roo**zhiyem*) performs the following functions:

• delivering and interrupting electrical power to all weapons as required;

• issuing commands to arm and fire the weapons as required by the mission;

• indicating available weapons, the currently active weapon and its condition;

• jettisoning the external stores in an emergency (in USAF terms, the 'panic button' function);

• self-test.

The system includes a BTsL-10P-20P central processing unit (*blok tsen**trahl'**nyy lo**gich**eskiy*), BUR-20PR-I and BUR-20PR-II missile control modules (*blok oopravl**en**iya ra**ket**ami*), a BAP-20 automatic cannon control module (*blok avto**mah**tiki **push**ki*), four BNO unguided weapons automatic control modules (*blok [avto**mah**tiki] ne'upravl**ya**yemovo o**roo**zhiya*) and, on *Fulcrum-Cs* only, two BUT multiple bomb rack (MER) control units (*blok oopravl**en**iya tan**dem**nymi pod**ves**kami* – tandem stores control unit). The MiG-29 (*izdeliye* 9.12B) has an SUO-29M2 weapons selection system. The MiG-29S/SD/SE has an SUO-29M4 system enabling the fighter to carry R-27T/T1, R-27RE/RE1, R-27TE/TE1 and R-77 AAMs and four MERs. The weapons selection system of the MiG-29SM/SMT/M/K has provisions for Kh-29L, Kh-31A/P air-to-surface missiles and KAB-500Kr guided bombs.

The SEI-31 joint indication system (*sis**tem**a ye**din**oy indi**kah**tsii*; SEI-31-01 on the MiG-29S) presents targeting, flight and navigation data. It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◄ **The characteristic transparency of the MiG-29's OEPS-29 infrared search & track/laser ranging system. The conical metal fairing in front reduces drag and gives a measure of protection in the event of a birdstrike.**

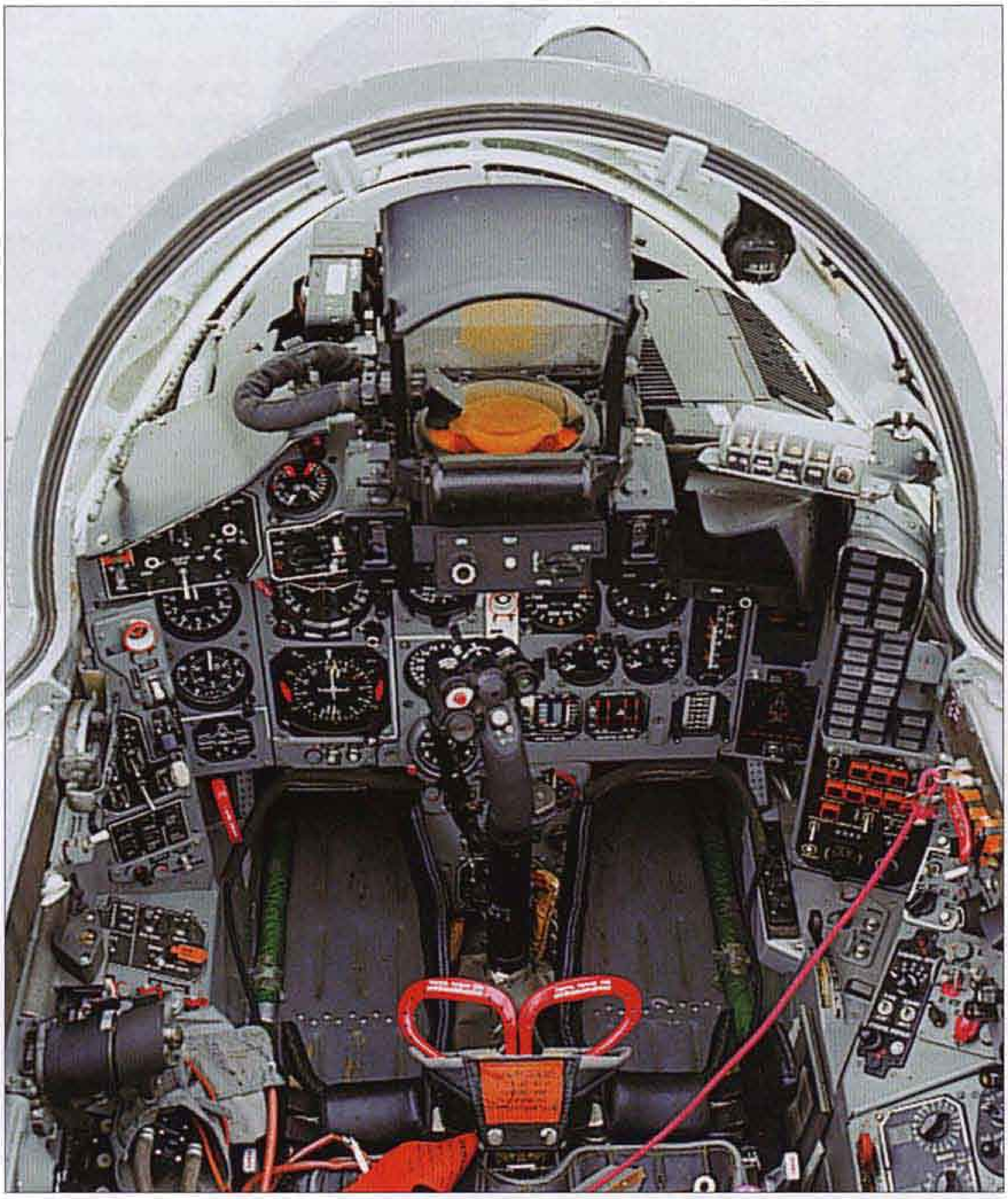

Yefim Gordon

◄ **When the aircraft is parked the IRST/LR transparency is protected by a cover.**

The SN-29 System's Navigation Error Margins

Parameter		Error Margin (normal computation)	(express computation)
Bank and pitch angle	0.5°	1°	
Heading:	true	±0.5°	±1°
	magnetic	±1°	±1.5°
Coordinates:	in autonomous mode	±8 km (4.4 nm)	±4% of distance covered since last correction
	in radio correction mode	±0.04 D±300 m (984 ft)	±0.04 D±300 m (984 ft)

Note: D = distance to beacon


via Yefim Gordon

comprises the ILS-31 HUD (*indikahtor na lobovom stekle*) and the IPV direct vision CRT display (*indikahtor pryamoy vidimosti*). On the MiG-29M and MiG-29K this is replaced by the SOI-29 data presentation system (*sistema otobrazheniya informahtsii*) featuring a more sophisticated collimator HUD and two monochrome multi-function CRT displays. The latter is replaced by colour liquid-crystal multi-function displays (MFDs) on the MiG-29SMT.

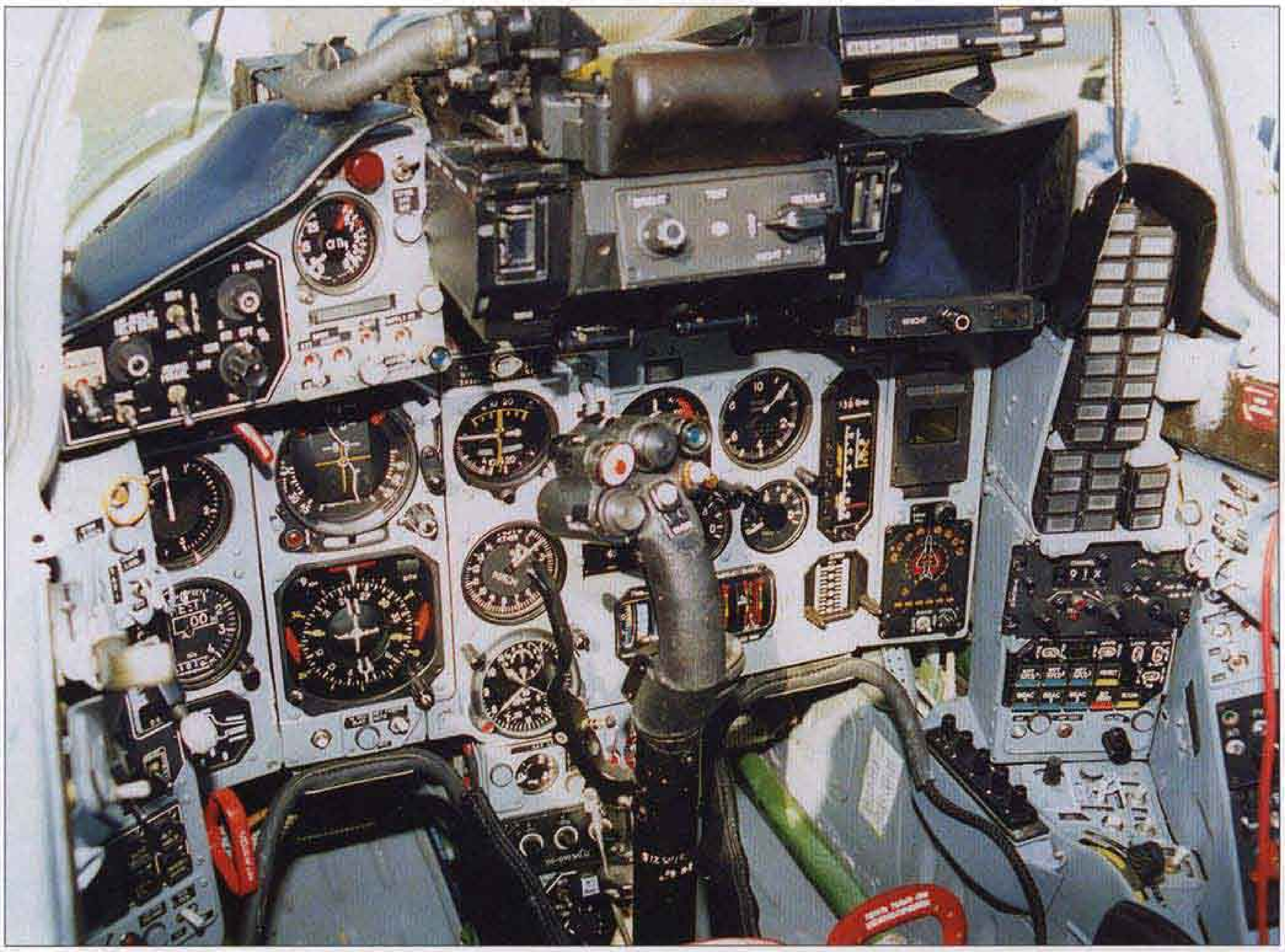
The attack results are documented by the FKP-EU gun camera (*fotokontrol'nyy pribor*) which can photograph targets within 3 km (1.86 miles). The gun camera 'fires' through the HUD glass and uses 35-mm film up to 30 m (98 ft) long; maximum camera speed is 10 frames per second.

Radio navigation equipment: The MiG-29's radio navigation suite comprises the ARK-19 ADF (*avtomaticheskiy rahdiokompas*), the A-037 radio altimeter, the A-611 (RPM-76) marker beacon receiver and the SO-69 ATC transponder. The ADF consists of a receiver, a control panel and two aerials on the fuselage spine (an omnidirectional blade aerial and a directional loop aerial). It enables navigation by means of ground VHF omnidirectional range (VOR) beacons by determining the angle between the aircraft's longitudinal axis and the beacon's bearing. The ADF's range depends on the aircraft's flight level and the power of the VOR (for instance, a 500-watt beacon can be detected

▲ **The cockpit of a production MiG-29 *Fulcrum-A*. The instrument panel is dominated by the ILS-31 HUD. The instruments are strictly electromechanical.**


Yefim Gordon

► **Interestingly, the instrument panel and the side consoles are painted neutral grey instead of the lurid turquoise colour which was typical of earlier Soviet aircraft and which is said to reduce pilot fatigue. The thick white line down the middle is for aligning the control stick during spin recovery.**



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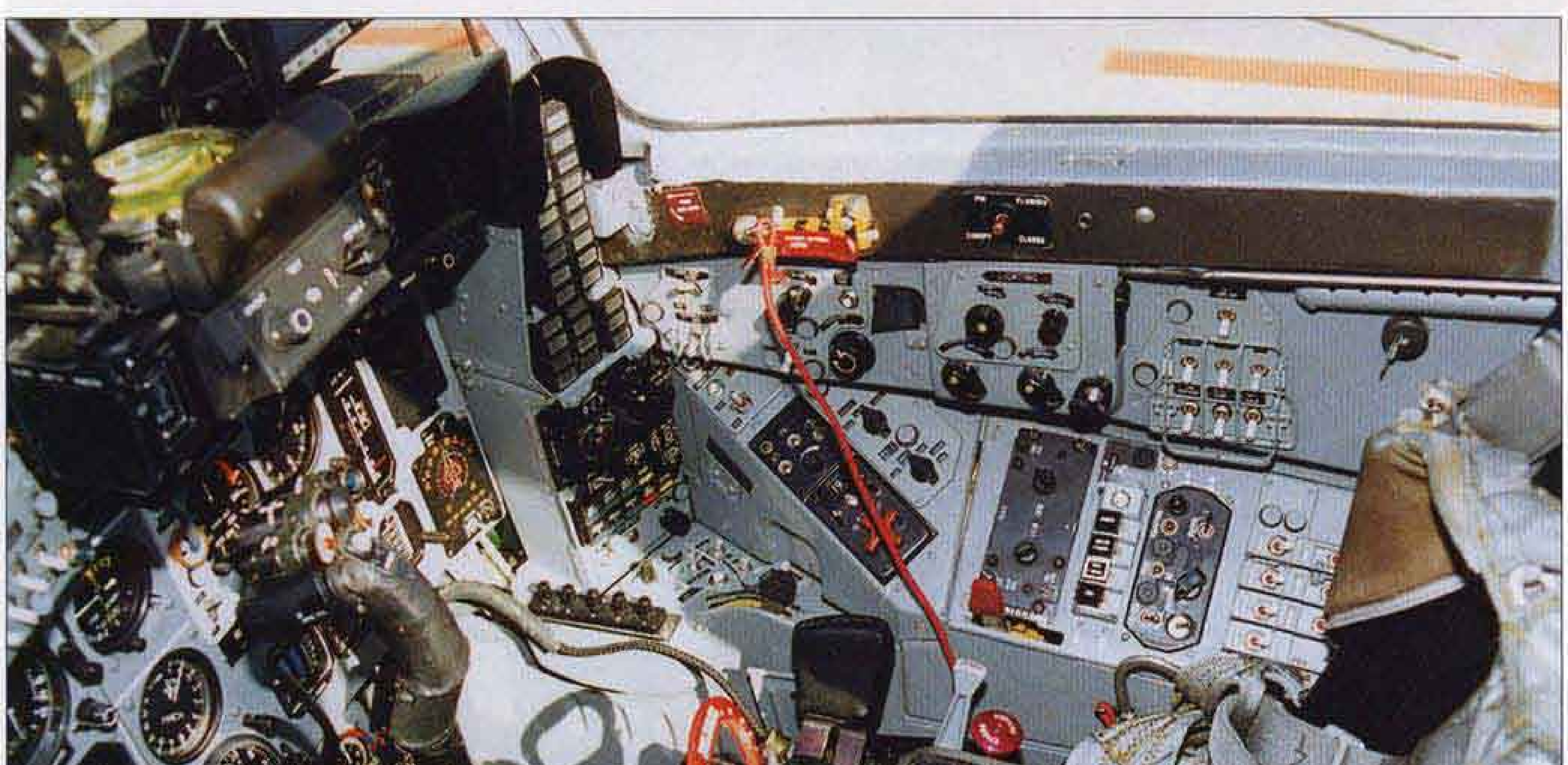
The right-hand side of the instrument panel is dominated by the IPV display and a bank of caution/warning lights. The red handle in the lower left-hand corner is for emergency landing gear extension; directly above it is the landing gear/flap/airbrake position indicator. This example is an export aircraft with English-language cockpit labels and instruments calibrated in Imperial units.



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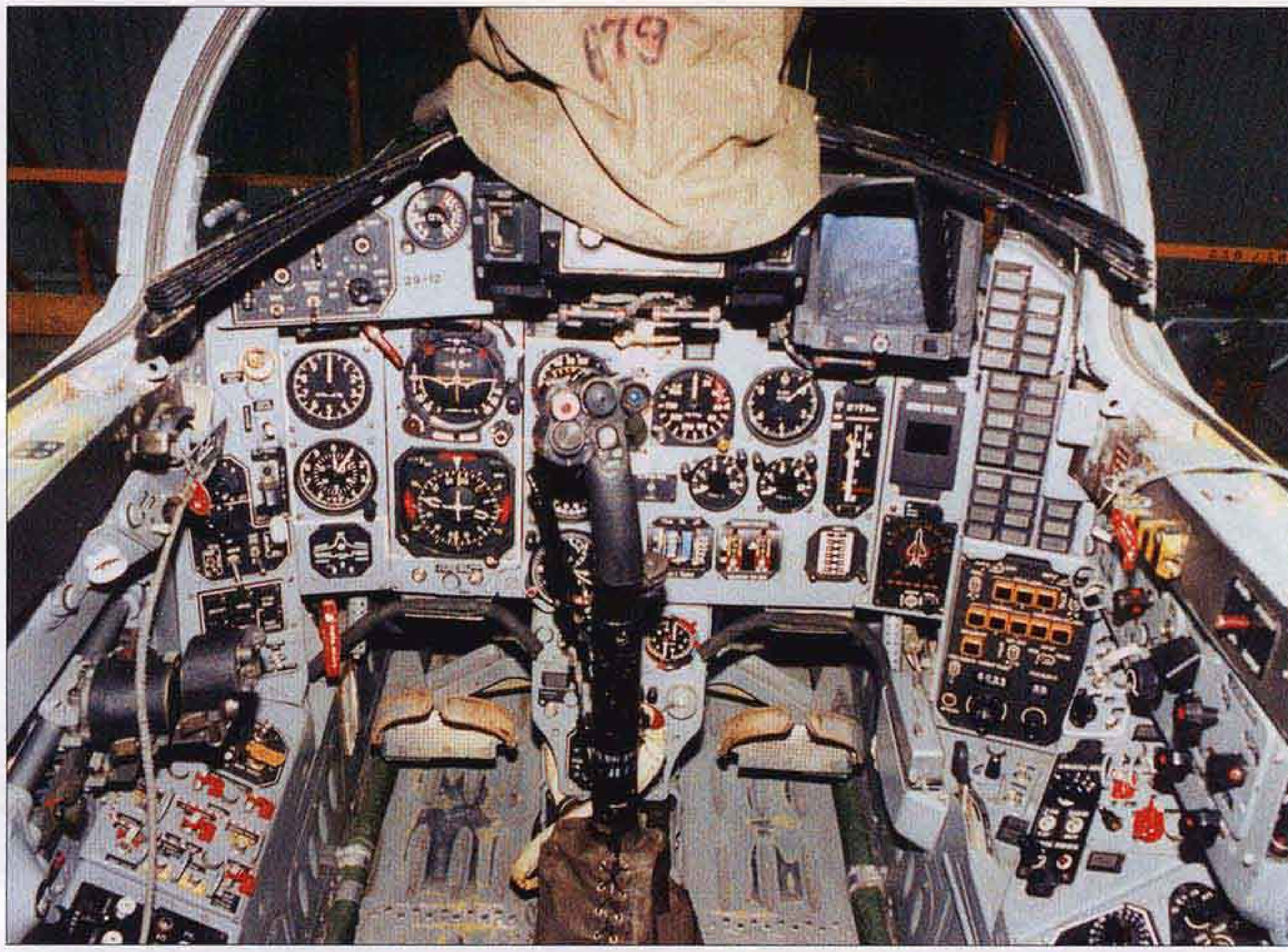
The starboard console of the same aircraft's cockpit with navigation system, lighting and ATC/SIF transponder controls.

at 200-300 km/124-186 miles). The error margin is 3-5°.

The A-037 Doppler altimeter doubles as a ground proximity warning system (GPWS) when the gear and flaps are up. It comprises a transceiver, two aerials under the fuselage nose and an electromechanical indicator. Measurement range is 0-1,000 m (3,280 ft). Early-production aircraft were equipped with the RV-15 (A-031) altimeter; the MiG-29M and MiG-29K have the RV-21 (A-035) Impul's altimeter.

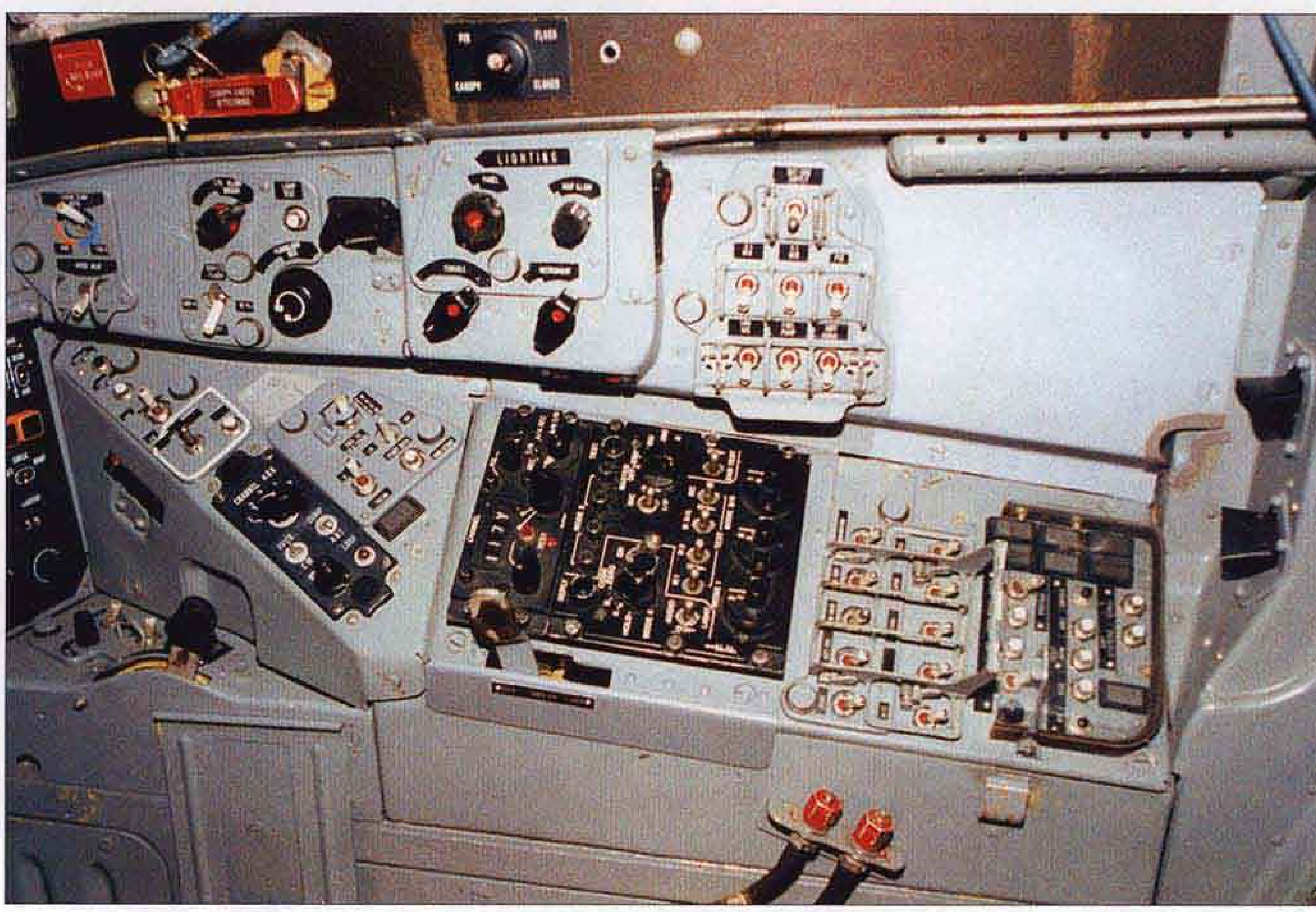
The A-611 receiver informs the pilot with a beep tone when the aircraft passes the outer and inner marker beacons during the landing approach. The receiver's aerial is located inside the radome.

The SO-69 ATC transponder (*samo**lyot**nyy ot**vet**chik*) transmits the aircraft's callsign, true



The cockpit of Luftwaffe MiG-29G 29+12 (the old East German serial '679 Red' is still carried on the canvas cover of the HUD).

Thomas Girke

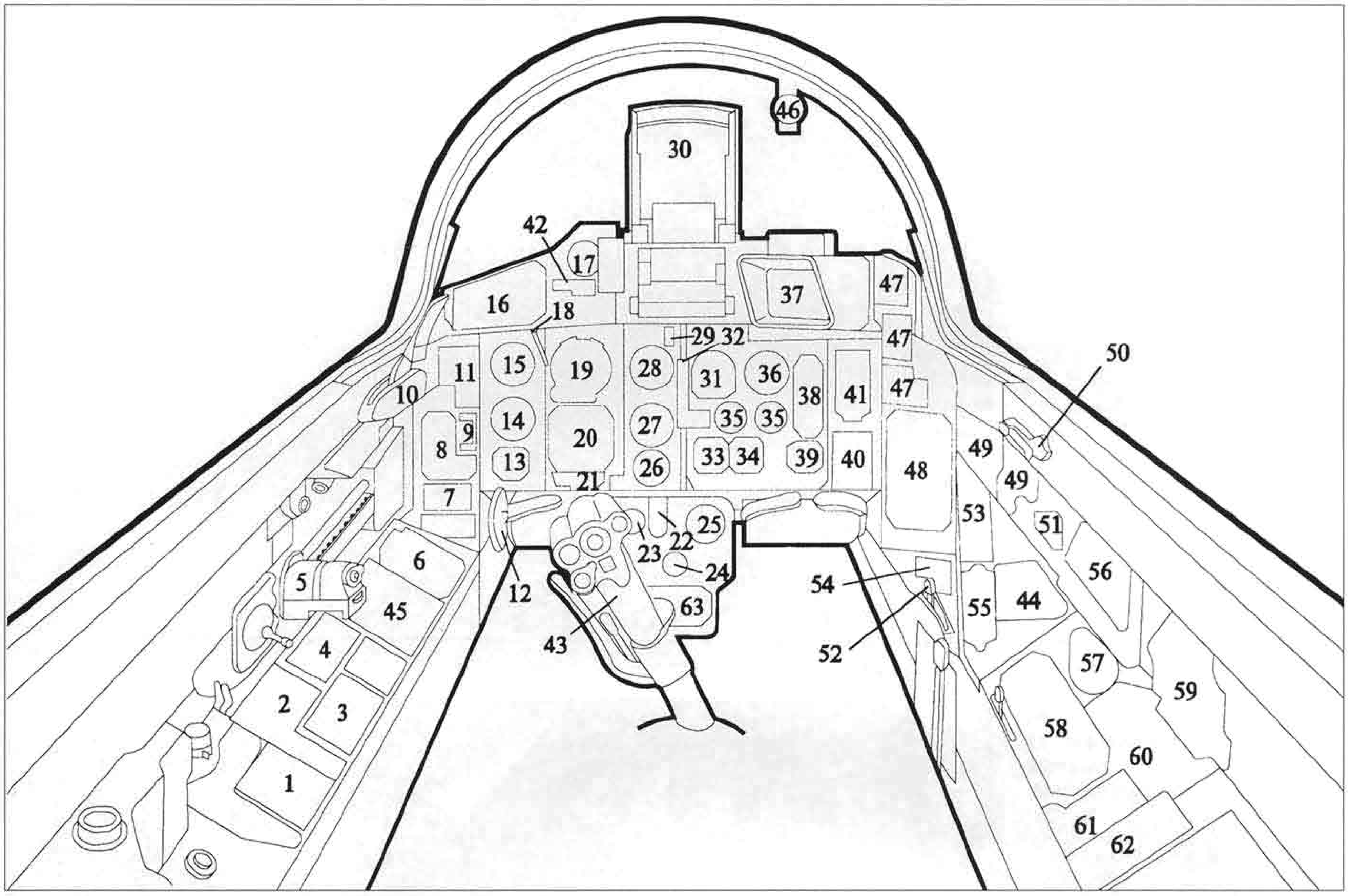


The starboard side console of MiG-29G 29+12; the difference from the aircraft on the preceding page is obvious.

Thomas Girke

airspeed and altitude. These are displayed beside the aircraft's 'blip' on the ATC radar screen, allowing better air traffic control and flight safety, especially in an ECM environment in combat. The ATC transponder aerials are located under the nose, in the port LERX and on both fins. The MiG-29M and MiG-29K are equipped with an improved SO-72 (A-511) ATC transponder.

Communications equipment: The comms suite comprises an R-862 *Zhoo**ravl'**-30* (Crane, the bird) UHF radio, an SPU-9 intercom (*samo-**lyot**noye perego**vor**noye oo**stroy**stvo*) and an R-855UM *Ko**mar-2**M* (Mosquito-2M) emergency radio. The R-862 radio is used for communication with other aircraft and ground control. It is frequency-stabilised and operates in the metre and decimetre wavebands, with working



▲
Key to the MiG-29's controls.

1 Oxygen control panel
2 AFCS panel
3 Communications control panel
4 Flaps control panel
5 Throttle levers
6 Aiming control panel
7 AFCS controller
8 Radar control panel
9 Landing gear control valve
10 Canopy manual operating handle
11 Landing lights control panel
12 Landing gear emergency extension handle
13 Pilot approach display
14 Altimeter
15 Airspeed indicator
16 Optical and electronic aiming and navigation control panel
17 AOA indicator and accelerometer
18 Emergency braking valve handle
19 Flight director indicator
20 Navigation instruments
21 Heading setting panel for AHRS
22 Pitot/static tube selector switch
23 Voltmeter
24 Cockpit air temperature selector
25 Braking system pressure gauge
26 Clock
27 Machmeter
28 Vertical speed and turn-and-slip indicator
29 Nosewheel braking handle
30 ILS-31 HUD and its control panel
31 Radio altimeter indicator
32 Chaff/flare release control panel
33 Oxygen supply indicator
34 Hydraulic and pneumatic system pressure indicator
35 Exhaust gas temperature indicator
36 Tachometer
37 IPV radar screen
38 Fuel quantity and flow meter
39 Air intake ramp position indicator
40 Master caution/warning panel
41 Ekran BITE display
42 ECM control panel (MiG-29SE)
43 Control stick
44 IFF panel
45 Powerplant emergency modes control panel
46 Standby compass
47 Annunciators
48 SHORAN and ILS control panel
49 Cabin, glass and probe heating control panel
50 Canopy emergency jettison handle
51 Internal and external lighting panel
52 Ventilation selector switch (canopy or pilot)
53 Communications radio control panel
54 RHAWS display/control panel
55 Radio compass controls
56 Lighting selector panel
57 IFF system panel
58 Guidance system controls
59 Electic system control panel
60 Engine starting control panel
61 Aircraft systems switchboard
62 Aircraft systems control panel
63 Combined armament-control system control panel


The cockpit of MiG-29M '155 Blue'. Note the new HUD.

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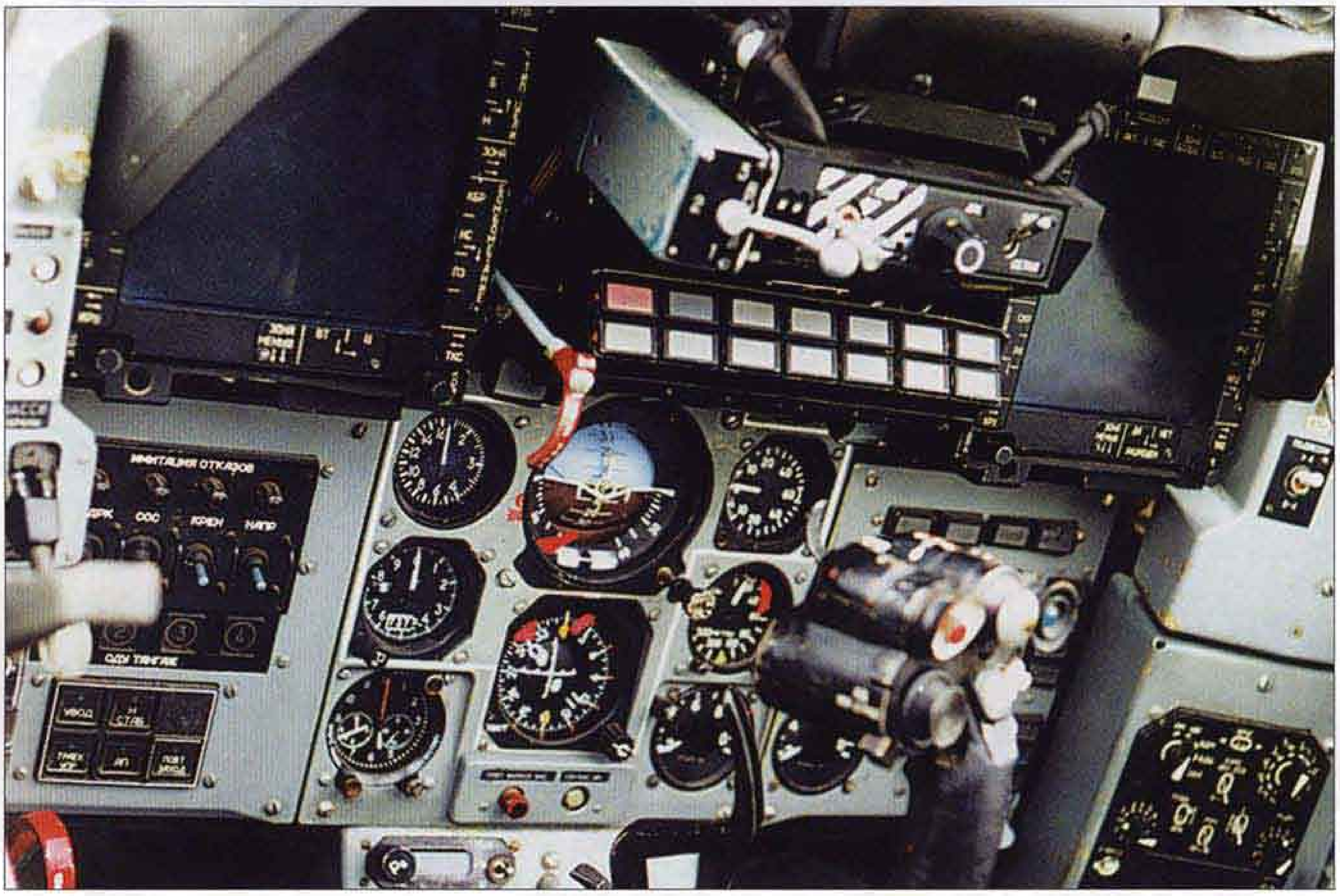
Close-up of the HUD control panel and the two CRT displays in the cockpit of the MiG-29M.

Yefim Gordon

frequencies changing in 25-kHz increments. The R-862 has 2,000 preset channels in the metre waveband (100-149.975 MHz) and 7,200 preset channels in the decimetre waveband (220-399.975 MHz). Minimum operating range for communication ground control is 120 km (74.5 miles) at 1,000 m (3,280 ft), 250 km (155 miles) at 5,000 m (16,400 ft) and 350 km (217 miles) at 10,000 m (32,810 ft).

The SPU-9 intercom enables the pilot to use the radio, listen to VOR identification signals, warning and caution messages given by the *Almaz-UP* (Diamond-UP) voice information module and informing and warning 'beeps' from various systems ('marker beacon passed', 'GCI data link on', 'target lock-on' from the IRST/LR, 'enemy radar detected' from the RHAWS and so on). On the ground it can be used for communication with ground crew who plug into a connector on the forward fuselage. Finally, on the MiG-29UB the intercom can be used for communication between trainee and instructor.

The R-855UM emergency UHF radio is part of the survival kit and is used in the event of an ejection or forced landing. It uses the 121.5 MHz emergency frequency, enabling two-way voice communication within a 50-km (31-mile) radius with search and rescue aircraft flying at up to 3,000 m (9,842 ft) and acting as a beacon to assist in the location of the downed pilot within a 60-70-km (37.2-43.5-mile) radius. The radio's batteries permit 55 hours of continuous operation in transceiver mode (with reception 75% of the time) or at least 24 hours in beacon mode.

On the MiG-29M and MiG-29K the comms equipment is integrated into the TKS-2-29 suite.

IFF equipment: The IFF system identifies aerial targets detected by the fire control radar as 'friendly', 'identity unknown' or 'hostile' and responds to 'identify yourself' queries from other aircraft. The MiG-29's IFF system comprises the SRZ-1P (*izdeliye* 6231) interrogator (*samo**lyot**nyy **rah**diolokatsi**on**nyy za**pros**chik*) and the SRO-1P (*izdeliye* 6201) transponder (*samo**lyot**nyy **rah**diolokatsi**on**nyy ot**vet**chik*) which constitute the *Pa**rol**'-2D* (Password) system.

Both parts of the system are programmed with the current identification code. The pilot makes a query by pushing a button on the stick; the interrogator sends a coded signal and gets a coded response from the other aircraft's transponder. A 'friendly' tag then appears beside the target's blip on the JIS display if the other aircraft is a 'good guy'. In an emergency the IFF transponder can transmit a 'Mayday' signal.

The MiG-29 (*izdeliye* 9.12B) features the SRZ-15 interrogator and SRO-2 (NATO *Odd Rods*) and SO-69 (version K-42E) transponders. The MiG-29SD/SE is equipped with the *izdeliye* 6231R interrogator (with the interchangeable *izdeliye* 035MR as an option) and *izdeliye* 6201R and SO-69 (version K-11E) transponders which utilise modern electronics components making them more reliable.

The interrogator aerial is located dorsally or ventrally ahead of the cockpit. The transponder aerials are under the nose, in the LERXes, on the port fin and (SRO-2 only) on the wingtips.

Electronic support measures suite: The ESM suite warns the pilot that he is under attack,

The front cockpit of the MiG-29M2 ('154 White') as it looked in 2001, featuring two small square-shaped MFDs. These are 'leftovers' from the days when the aircraft was a single-seat MiG-29M ('154 Blue'); they were eventually replaced by larger MFDs (see page 359). ▼

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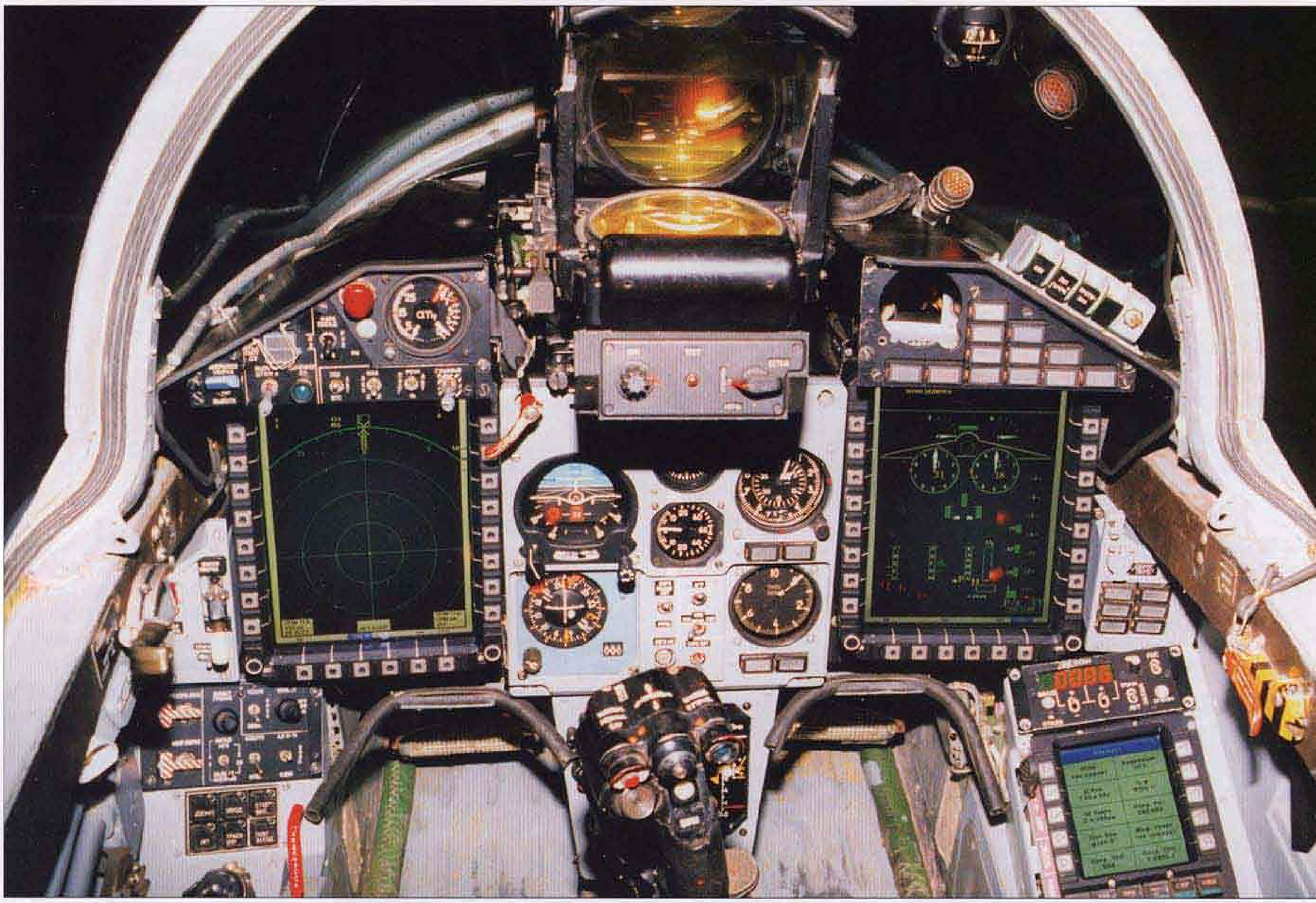

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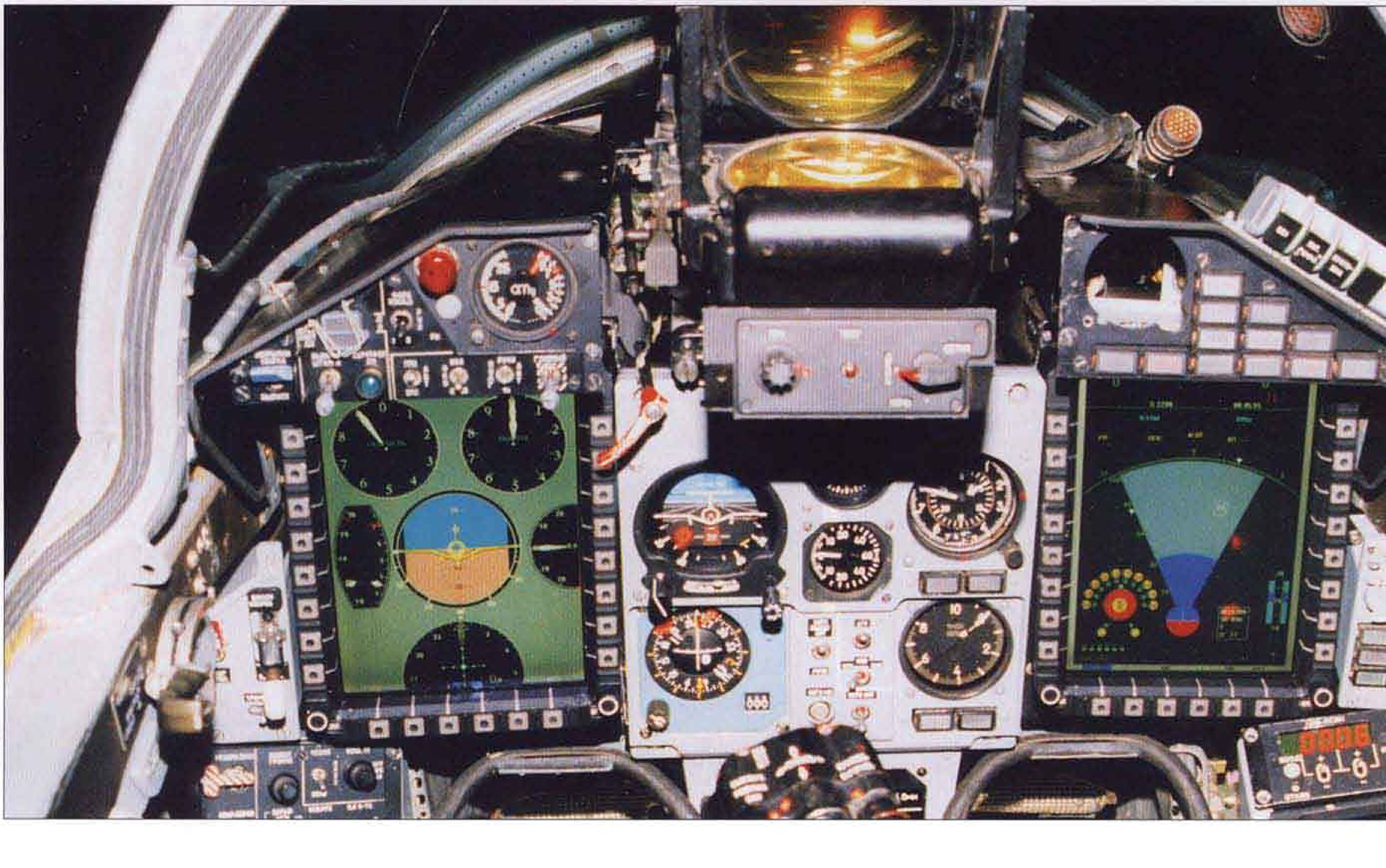

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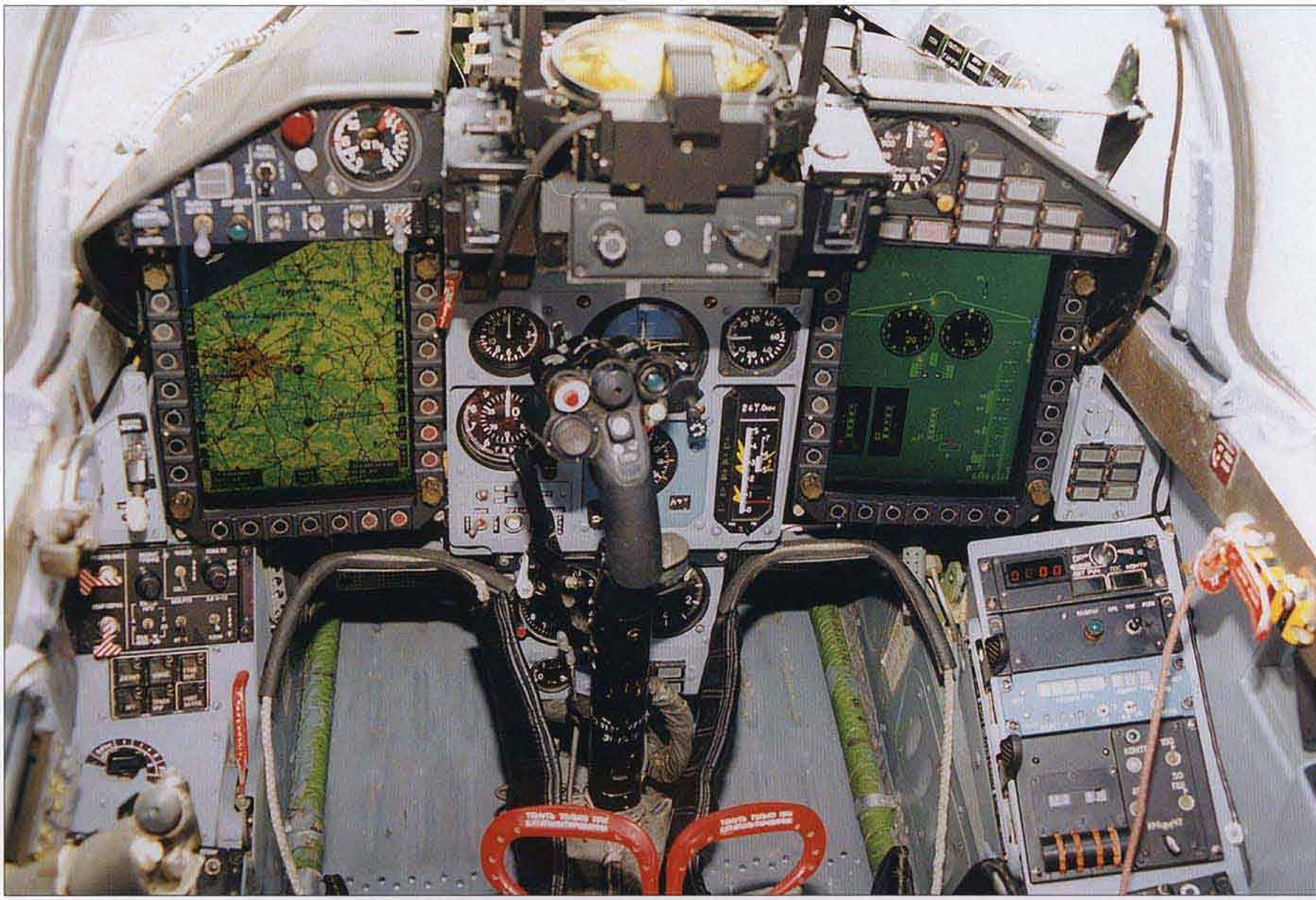

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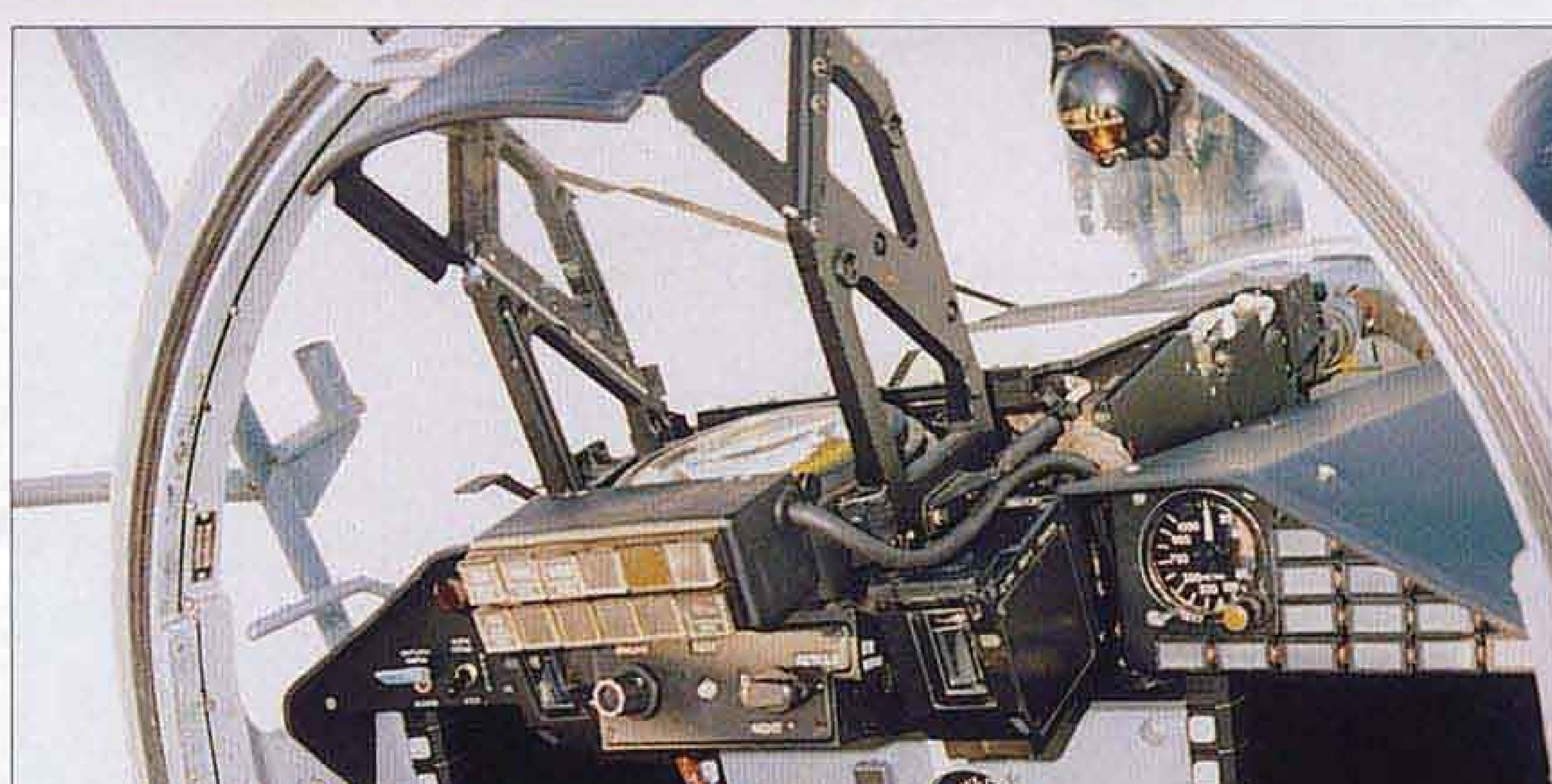
▲
The cockpit of the MiG-29SMT with an EFIS supplied by RPKB. Two 6x8" liquid-crystal MFDs rimmed with function keys replace most of the electromechanical instruments (those in the centre of the instrument panel are retained as a backup). This has caused the bank of warning lights on the right to be rearranged. The left-hand MFD is in moving-map display mode and the right-hand one is in engine instrumentation mode.

▲◄
Another MiG-29SMT with an earlier 'glass cockpit' supplied by Roosskaya Avionika. The two MFDs are augmented by an input/output module with a small display on the right-hand console. The HUD is slightly different, so is the placement of the backup electromechanical instruments, and a small bank of switches is added on the instrument panel shroud. Here again the left-hand MFD is in navigation mode and the right-hand one is in engine instrumentation mode.

◄
The same cockpit, now with the left-hand MFD in primary flight display mode and the right-hand one in radar display mode.

►
The front cockpit of MiG-29UBT '304 Blue'. The instrument panel is similar to the old 'SMT.



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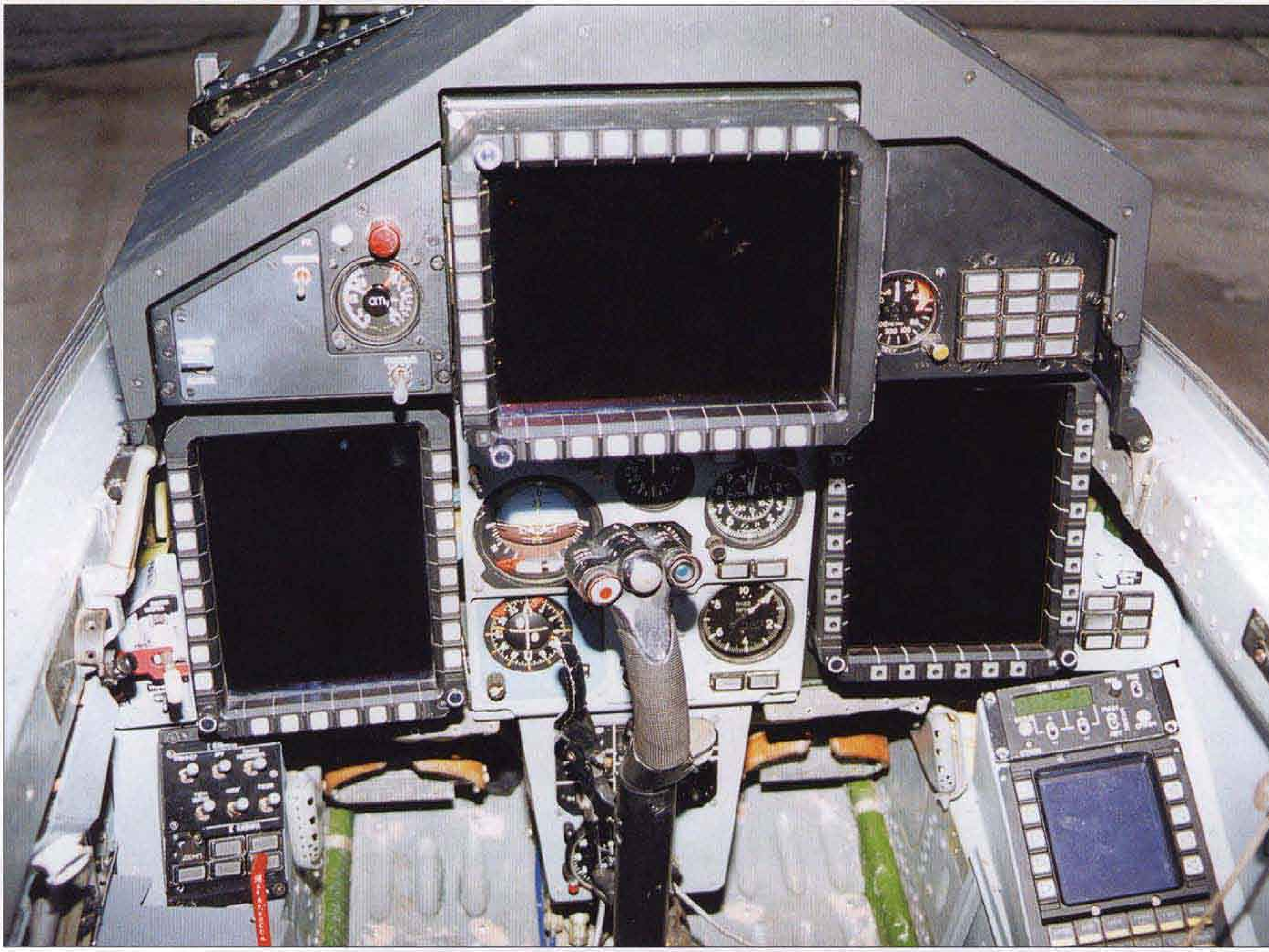
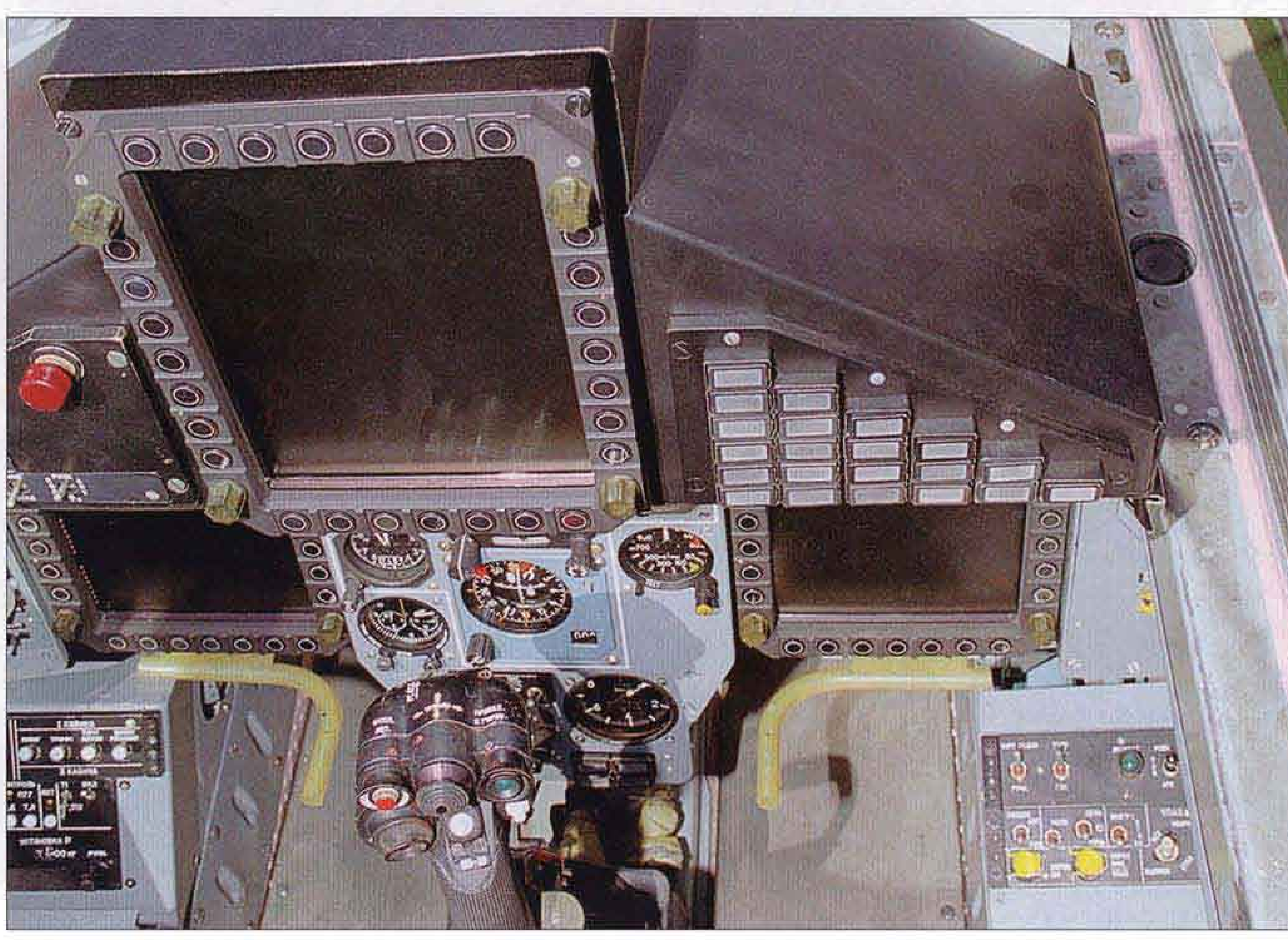


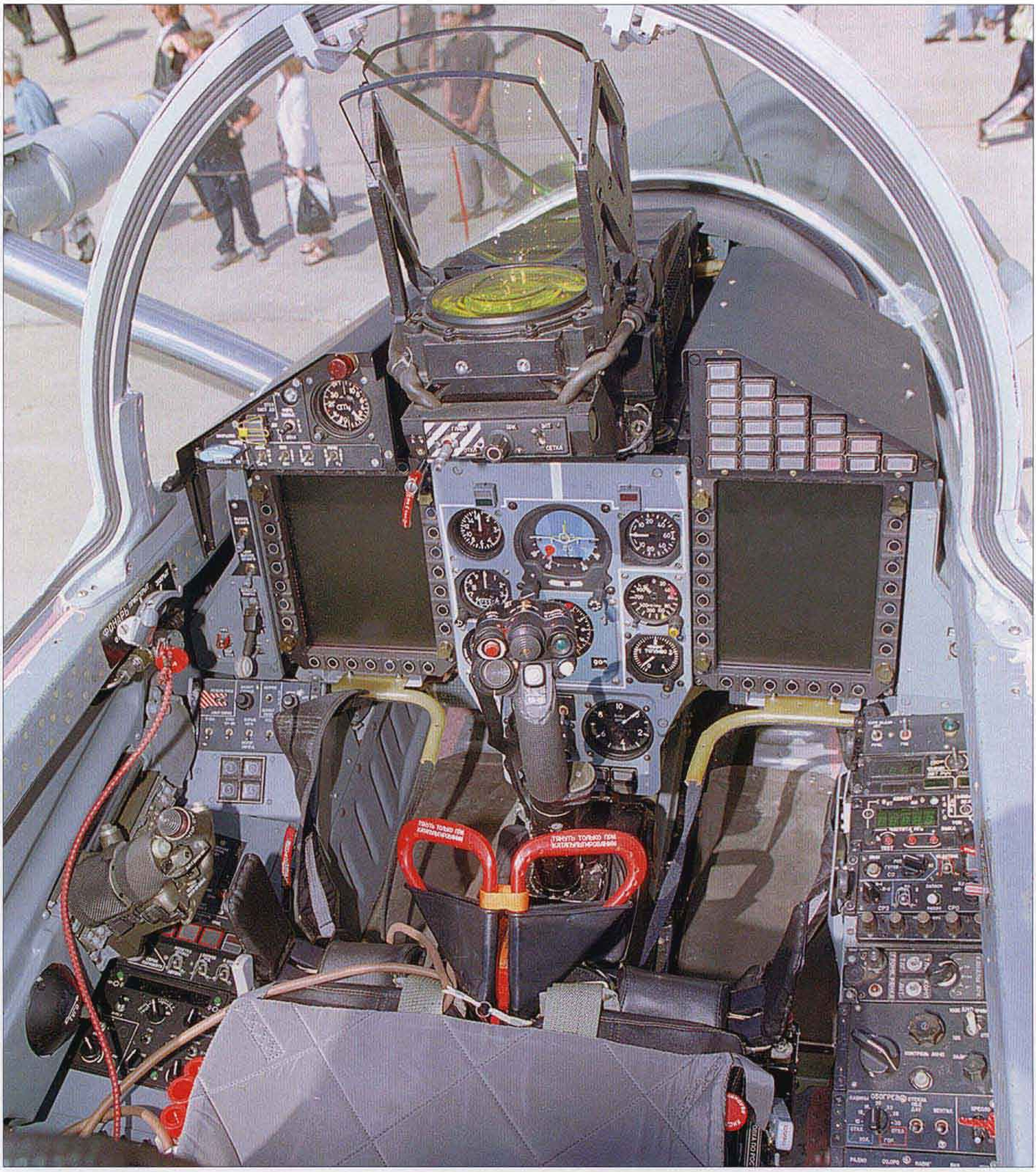
Yefim Gordon

▲ The rear cockpit of the MiG-29UBT features three 6x8" MFD and an I/O unit. Again, the set of back-up electromechanical instruments represents the Roosskaya Avionika version (th artificial horizon is on the left).



Sergey Popsuevich

► Here, for comparison, is the rear cockpit of the MiG-29M2 featuring different MFD, a different and no I/O unit.



indicates possible directions from which he could be attacked and diverts enemy missiles from the aircraft. The core of the MiG-29's ESM suite is the SPO-15LM (L006LM) *Beryoza* (Birch) radar homing and warning system (RHAWS; SPO = *sis**tem**a predooprezh**den**iya ob oblooche**n**ii* – 'irradiation warning system'). With a warning 'beep' the system informs the pilot that he is being 'painted' by enemy radars; the joint indication system display shows the direction and type of the enemy radar and the signal's intensity.

▲ **The front cockpit of the MiG-29M2 as it looked in 2003 – an intermediate configuration.**

Pavel Novikov

Sergey Krivchikov

A slightly different RHAWS is fitted to export aircraft – L006LM/version 101 on the MiG-29 (*izdeliye* 9.12B) and L006LM/version 108 on the MiG-29SE. On the MiG-29M and MiG-29K the Beryoza is replaced by a more efficient *Pastel'* (Pastel) RHAWS which can download target data to Kh-31P anti-radiation missiles. The RHAWS aerials are located in the LERXes, at the wingtips and the outer surfaces of the fins to give complete 360° coverage.

To disrupt the operation of land-based and shipboard air defence radars and sidetrack

◄
The modified MiG-29K '312 Blue'. will be the pattern for the MiG-29K/KUB and MiG-29M/M2.

▲
Cockpit of MiG-29SMT '777 Green'.

Victor Drushlyakov

▲ **The cockpit of MiG-29BM '06 Black'.**

radar-homing AAMs and SAMs the *Fulcrum-C*, MiG-29M and MiG-29K are equipped with a Gardeniya-1FU (L203B) active jammer; the export version, Gardeniya-1FUE (L203BE), is fitted to the MiG-29SE. On the *Fulcrum-C* the jammer works in concert with the Beryoza RHAWS, using an L138 commutation module.

Depending on the type of enemy radar illuminating the aircraft the jammer can emit high-frequency noise, low-frequency Doppler noise or flashing interference signals. This allows it to neutralise at least two radars operating in continuous, quasi-continuous or pulse-Doppler emission mode. The jammer covers a sector of the aircraft's rear hemisphere measuring ±60° in azimuth and ±30° in elevation.

The *Fulcrum-A/C* is equipped with two BVP-30-26M chaff/flare dispensers (*blok* ***vyb**rosa po**mekh***) located on the wing upper surface ahead of the fin fillets and canted towards the aircraft's centreline. These are loaded with sixty 26-mm (1.02-in) PPI-26 IRCM flares (*peeropa**tron** infra**krahs**nyy* – infrared cartridge) for protection against IR-homing missiles or PPR-26 chaff bundles (*peeropa**tron** [**pro**tivo]**rah**dio-lokatsi**on**nyy* – radar suppression cartridge) for passive radar jamming, though the latter are seldom used. The flares or chaff are fired by the SUVP-29 (*izdeliye* 20SP) control unit (*sis**tema** oopravl**en**iya **vyb**rosom po**mekh***) determining the firing sequence and duration. These depend on the aircraft's speed, altitude and direction of the attack; on the *Fulcrum-C* fitted with the L138 commutation module the launch is programmed automatically as directed by the RHAWS.

On the MiG-29M and MiG-29K the chaff/flare capacity is doubled, with two BVP-60-26 dispensers buried in the aft fuselage upper surface.

Command link equipment: The E502-20 *Biryu**za*** (Turquoise) command link system receives guidance signals, target coordinates, tactical and interaction data from ground controlled intercept (GCI) centres. The commands prepared by the GCI computer are transmitted as modulated HF signals and received by the *Be**kas**-R* (Snipe-R) system, then converted into standard digital or analogue form and fed to the radar, automatic control system, JIS, intercom and other equipment. The main parameters transmitted via the command link system are the target's altitude and speed, range to the target, closing speed, and required heading and elevation.

By customer request all export versions of the MiG-29 may be fitted with flight instruments calibrated in Imperial units, Western TACAN tactical radio navigation, IFF and VOR/ILS equipment, an SO-69M ATC transponder using internationally-accepted frequencies (or a Cossor IFF transponder), GPS and an extra Western communications radio.

Built-in test equipment/crew alerting system and data recording equipment: The MiG-29 has an Ekran-03M (Screen) built-in test and crew alerting system (BITE/CAS) or, alternatively, the Ekran-03ME version on the MiG-29 (*izdeliye* 9.12B) and Ekran-13ME on the MiG-29SE). The BITE/CAS is built around a programmable data collection and processing module which diagnoses systems down to subsystem level, informs the pilot of critical systems failures and records these for ground personnel to deal with later. It enables automated pre-flight systems check and monitors the aircraft's systems in flight. Malfunctions are memorised in priority order and automatically recorded on tape 20 seconds after touchdown along with the time of failure (that is, time elapsed from system startup). 64 malfunction messages can be memorised and recorded and 256 alpha-numeric messages displayed in priority order.

The BITE/CAS and self-test modules of certain systems monitor more than 80% of the aircraft's systems and equipment, including the engine controls, intake ramp controls, landing gear, hydraulics, electrics, automatic flight control, fuel and fire suppression systems, WCS, IFF and other avionics.

The VSS-1-4K indication system (*vnootri-ka**bin**naya sveto**va**ya signali**zah**tsiya*) informs the pilot of the various systems' operating modes and malfunctions by means of green advisory lights, yellow caution lights and red warning lights.

The Almaz-UP (P-591B) audio warning module plays back 47 pre-recorded caution and warning messages, alerting the pilot of dangerous flight modes and malfunctions ('engine fire', 'accessory gearbox fire', 'exhaust gas temperature critical' and so on). The most critical warning messages are also transmitted to the ATC controller by radio. The messages are triggered by sensors in the engines, intake ramp

Aerial Configurations for MiG-29 Variants

Antenna / Aerial	MiG-29 (*izdeliye* 9.12B)	MiG-29SD	MiG-29SE
1 Fire control radar antenna	+	+	+
2 SRZ-15 IFF interrogator aerial	+	–	–
Izdeliye 035MR IFF interrogator aerial	–	+	+
3 Marker beacon receiver antenna	+	+	+
4 Forward navigation antenna	+	+	+
5 Radio altimeter transmitting antenna	+	+	+
6 SRO-2 IFF transponder waveband III aerial *	+	–	–
Izdeliye 6201R IFF transponder waveband II, III and VII aerials	–	+	+
7 Radio altimeter receiving antenna	+	+	+
8 IFF transponder waveband III aerial	+	+	+
9 ECM receiving antenna symmetrically to starboard	–	–	+
10 IFF transponder waveband I and II aerial	+	+	+
11 SRO-2 IFF transponder waveband I aerial symmetrically to starboard	+	–	–
Izdeliye 6201R IFF transponder waveband I aerial symmetrically to starboard	–	+	+
12 RHAWS azimuth antenna symmetrically to starboard	+	+	+
13 SRO-2 IFF transponder waveband II aerial	+	–	–
14 ECM antennas	–	–	+
15 RHAWS wide-angle azimuth and elevation antennas	+	+	–
16 ADF blade aerial	+	+	+
17 ADF loop aerial	+	+	+
18 SRO-2 IFF transponder waveband II aerial	+	–	–
19 ECM antennas	–	–	+
20 ECM receiving antennas	–	–	+
21 RHAWS wide-angle azimuth antennas	–	–	+
22 UHF communications blade aerial	+	+	+
23 Aft navigation antenna	+	+	+
24 Command link aerial	+	+	+
25 SRO-2 IFF transponder waveband I aerial	+	–	–
Izdeliye 6201R IFF transponder waveband I aerial	–	+	+

* Note: IFF operating frequencies are divided into several arbitrary wavebands which cannot be disclosed here – for obvious reasons.

control, hydraulic, electric, life support and air data systems and by the BITE/CAS.

The Tester-UZLK flight data recorder (FDR) tapes coded information about flight modes and systems operation to be used in normal mission evaluation or accident investigation. It is housed in a crashworthy capsule in the aft fuselage and is activated manually or automatically at the moment of unstick. The FDR records the engines' operating mode, RPM and exhaust gas temperature, fuel flow, intake ramp and landing gear position, G loads and pitch/roll/yaw rates, heading and vertical speed, operation of the WCS, automatic flight control, hydraulic, fire suppression and crew escape systems, marker beacon receiver and comms radio.

External lighting: Two FP-8 (*Fulcrum-A/B*) or FP-15 (*Fulcrum-C*) landing lights on the main gear doors (***fah**ra po**sah**dochnaya*); one FPK-250 or, on early-production aircraft, FR-9 (***fah**ra roo**lyozh**naya*) taxi light on the nose gear strut. ANO-15 navigation light (***ae**ronavigatsi-**on**nyy **ogon'***) at the wingtips (port, red; starboard, green) and on the port fin trailing edge (white).

All versions are armed with a 30-mm Gryazev/Shipoonov GSh-301 cannon. ▼

The cannon muzzle opening in the port LERX, with the associated blast gas vents and blast plate made of heat-resistant steel. ▼▼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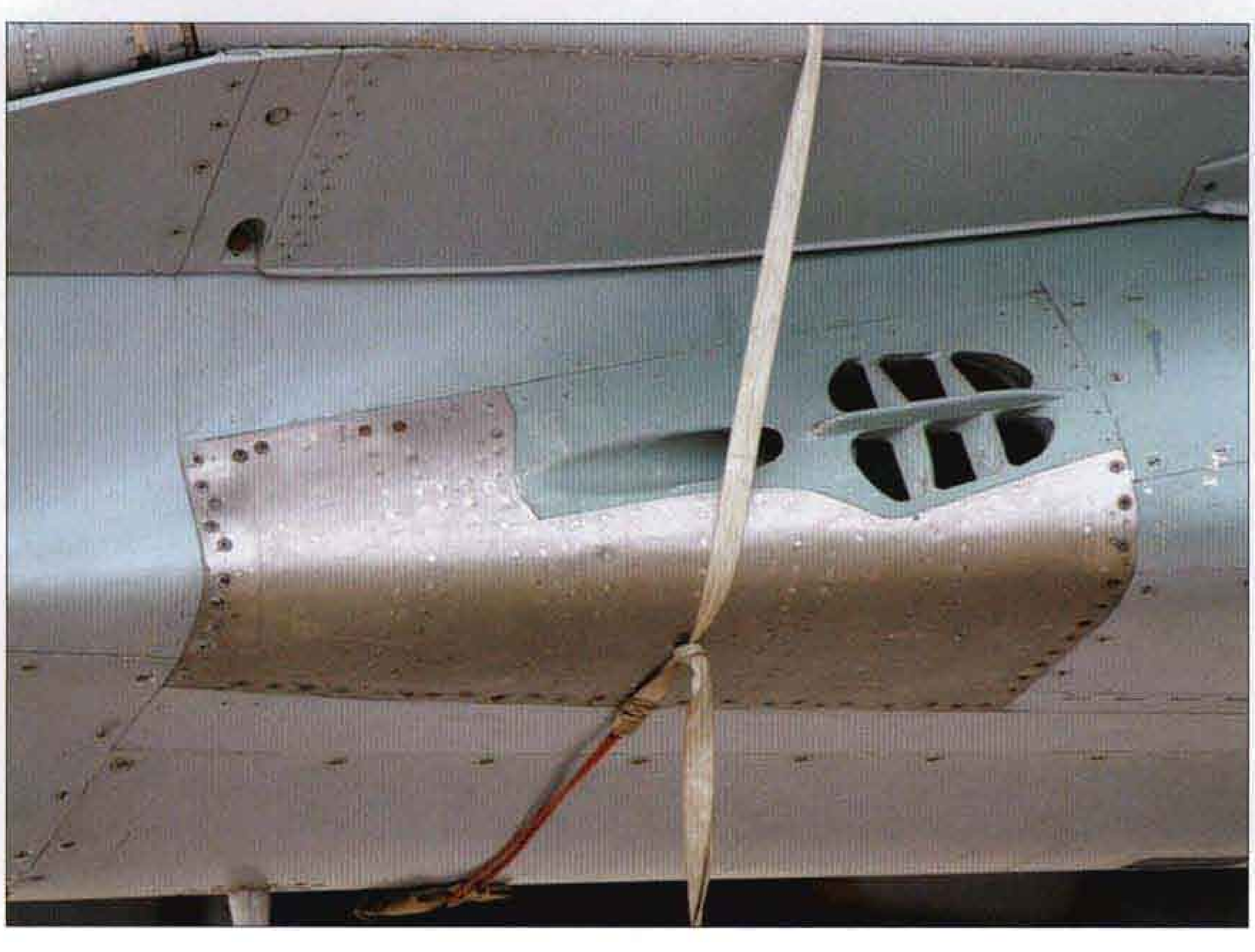
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Armament

The MiG-29's weapons range allows it to fill the counter-air and strike roles, comprising an internal cannon, short- and medium-range air-to-air missiles, unguided rockets and free-fall bombs. The MiG-29K, MiG-29M and MiG-29SM/MiG-29SMT can also carry guided air-to-surface missiles and guided bombs. The guided and unguided weapons are carried on four (MiG-29UB), six (*Fulcrum-A/C*) or eight (MiG-29K and MiG-29M) wing hardpoints equipped with launch rails or ejector racks. The maximum ordnance load is 2,200 kg (4,850 lb) for the MiG-29 (*izdeliye* 9.12) and MiG-29UB, 3,200 kg (7,050 lb) for the MiG-29 (*izdeliye* 9.13), 4,000 kg (8,820 lb) for the MiG-29S/SD/SE/SM/SMT and 4,500 kg (9,920 lb) for the MiG-29K and MiG-29M.

The TKB-687 (9A4071K) internal cannon installation is housed in the port LERX and consists of a Gryazev/Shipoonov GSh-301 single-barrel 30-mm (1.18 calibre) automatic cannon and associated ammunition box for 150 AO-18 rounds. On the MiG-29K and MiG-29M the ammunition capacity is reduced to 100 rounds. Rate of fire is 1,500-1,800 rounds per minute, muzzle velocity 860 m/sec (2,821.5 ft/sec) and recoil force 6,000-7,500 kg (13,230-16,530 lb).

The cannon is belt-fed and fires high explosive/fragmentation/incendiary (HEFI), HE/fragmentation/incendiary/traced (HEFI-T) and armour-piercing/explosive (APE) rounds. The latter type can penetrate armour up to 40 mm (1.57 in) thick. An HEFI round weighs 836 g (29.5 oz) and an APE round weighs 860 g (30.36 oz), including belt link.

Firing is electrically controlled by a trigger on the stick. The cannon can fire continuously, expending the entire ammunition supply in a single six-second burst (applies to the *Fulcrum-A/B/C* with 150 rounds), or in short bursts. Alternative firing modes are 'automatic fire' (three quarters of the ammunition supply), 'automatic fire with cutoff' (firing 25 rounds in a one-second burst each time the trigger is squeezed) and 'training mode' (a 7-round burst each time the trigger is squeezed). Effective range is 800-200 m (2,620-660 ft) in air-to-air mode and 1,800-1,200 m (5,905-3,940 ft) in strafing mode.

The GSh-301 is water-cooled, with additional air cooling through vents in the cannon bay to extend its service life. The gun can tolerate 2,000 shots; it is 1,978 mm (6 ft 5⅞ in) long and weighs 45 kg (99.2 lb).

The MiG-29 (*izdeliye* 9.12 and 9.13) is armed with two Vympel R-27R medium-range AAMs and/or two, four or six Vympel R-73 or Molniya R-60M short-range AAMs.

The R-27R (*izdeliye* 470) can destroy all types of aerial targets, including RPVs and cruise missiles, in any weather conditions, day or night, over land and sea, even though the target manoeuvres violently, returns fire, uses ECM and generally misbehaves. Target flight level is 20-27,000 m (65-88,580 ft) and maximum target speed is 3,500 km/h (2,174 mph). The missile can be launched when the aircraft is pulling up to 5 Gs and the target is up to 10,000 m (32,810 ft) higher or lower.

The missile utilises the tail-first configuration with large forward-swept cruciform canards and cruciform wings. It features an inertial navigation system with mid-course radio correction and a model 9B-1101K semi-active radar homing (SARH) seeker head with a 100° field of view. The R-27R is compatible with all versions of the *Fulcrum* except the MiG-29UB which has no radar for target illumination; export aircraft (*izdeliye* 9.12A and 9.12B) are armed with export R-27R1 missiles. R-27Rs are carried on APU-27 (APU-470) missile rails (*aviatsi**on**naya poos-kovaya oosta**nov**ka* – aircraft-mounted launcher) on the inboard pylons.

The R-73 (*izdeliye* 72) is designed to destroy highly agile aircraft and RPVs during close-range air-to-air combat in any weather conditions, day or night and in an ECM environment. It is likewise a tail-first missile with cruciform canards and wings but has a mixed jet/aerodynamic control system. The jet control (thrust vectoring) feature makes the missile extremely manoeuvrable, enabling it to score a 'kill' on a target pulling up to 12 Gs. The R-73 is equipped with a *Ma**yak*** (Beacon) high-sensitivity passive IR seeker head with a cooling system, which makes it one of the world's first all-aspect 'dogfight AAMs' capable of destroying targets in both head-on and pursuit mode.

Target flight level is 20-20,000 m (65-65,620 ft) and maximum target speed is 2,500 km/h (1,552 mph). The IR seeker has a 90° field of view and can track targets at a speed of up to 60°/sec. The pilot can aim the missile in 'point and shoot' mode by using a helmet-mounted sight. The R-73 is compatible with all versions of the MiG-29; export aircraft are armed with R-73E missiles. R-73s are carried on APU-73-1D (P-72-1D) missile rails which can be fitted to any pylon.

The R-60M (*izdeliye* 62M) with a IR seeker head is designed to destroy highly agile aircraft and RPVs within visual range. This again is a tail-first missile with purely aerodynamic controls. The wings incorporate so-called 'rollerons' for roll stabilisation. The R-60M is a uniquely light and compact weapon in its class. Its low launch weight and refined aerodynamics make the missile extremely agile, enabling it to score a 'kill' on a target pulling up to 12 Gs.

Target flight level is 30-20,000 m (98-65,616 ft) and maximum target speed is 2,500 km/h (1,388 kts). The Komar-M passive IR seeker has a 40° field of view and can track targets at a speed of up to 35°/sec. It has a cooling system, enabling attacks in head-on mode. The missile can be launched when the aircraft is pulling up

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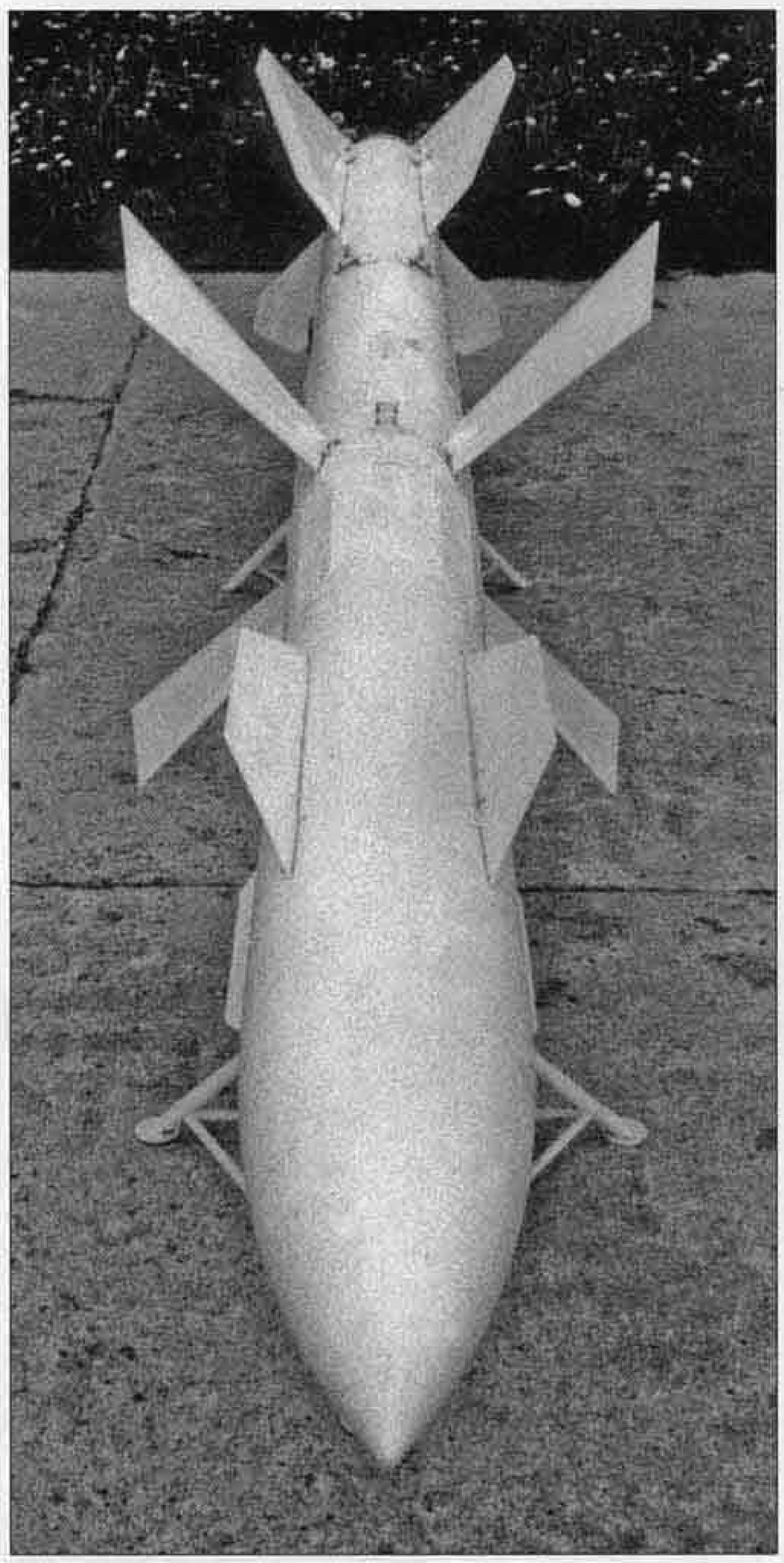
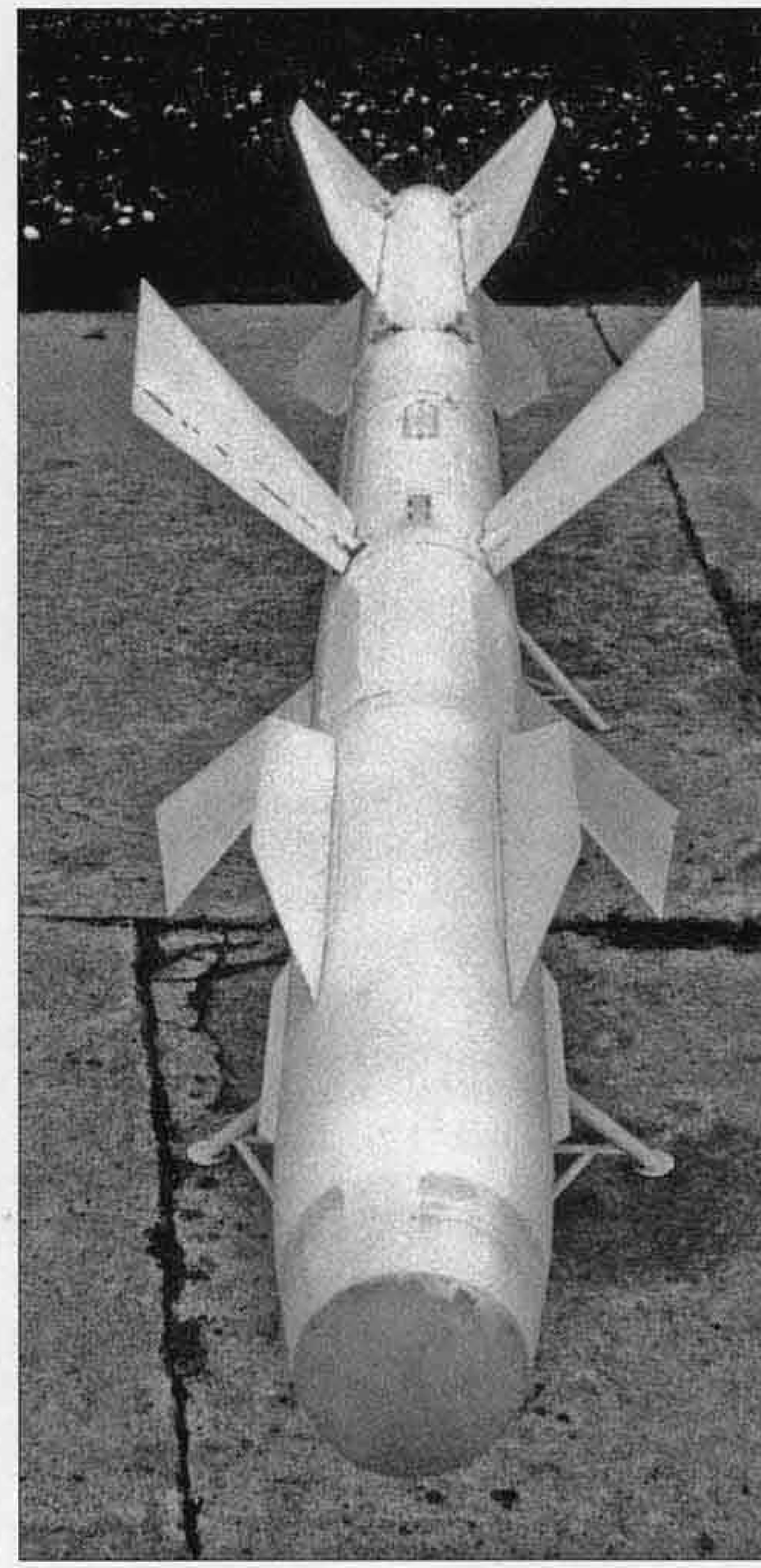
▲ **Four P-12-1D missile rails and two APU-470 ejector racks under the wings of MiG-29BM '06 Black'. The two types carry R-73 and R-27 missiles respectively.**

An MBD3-U2T-1 tandem bomb rack and a single bomb rack under the starboard wing of *Fulcrum-C* '38 White' (c/n 2960707701). ▼

Victor Drushlyakov



►
The Vympel R-27R semi-active radar homing medium-range AAM.



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►►
The Vympel R-27T IR-homing medium-range AAM.

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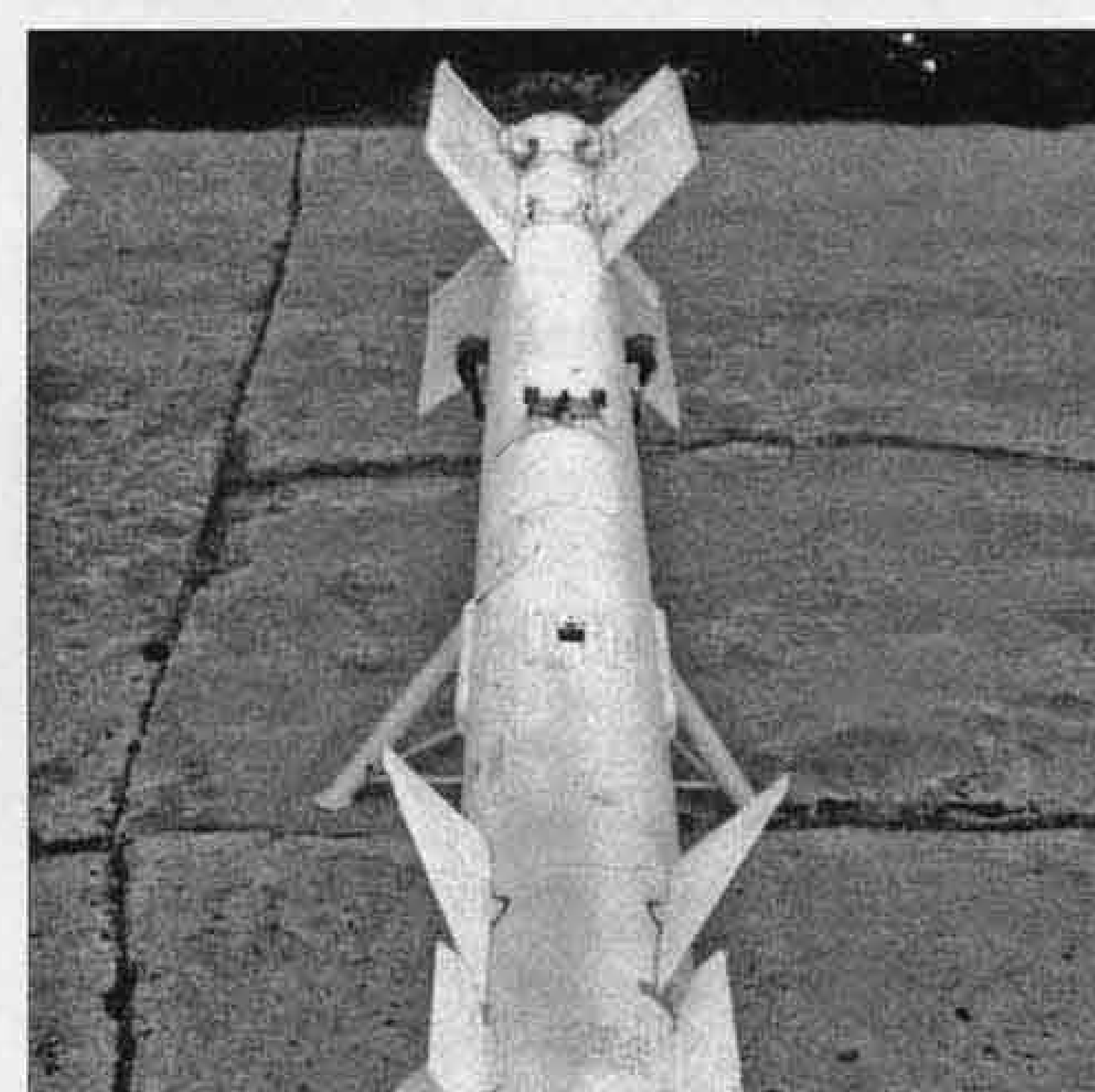
▲
This view shows the double-kinked fin leading edge and the reverse-tapered canards of the R-27 missile.



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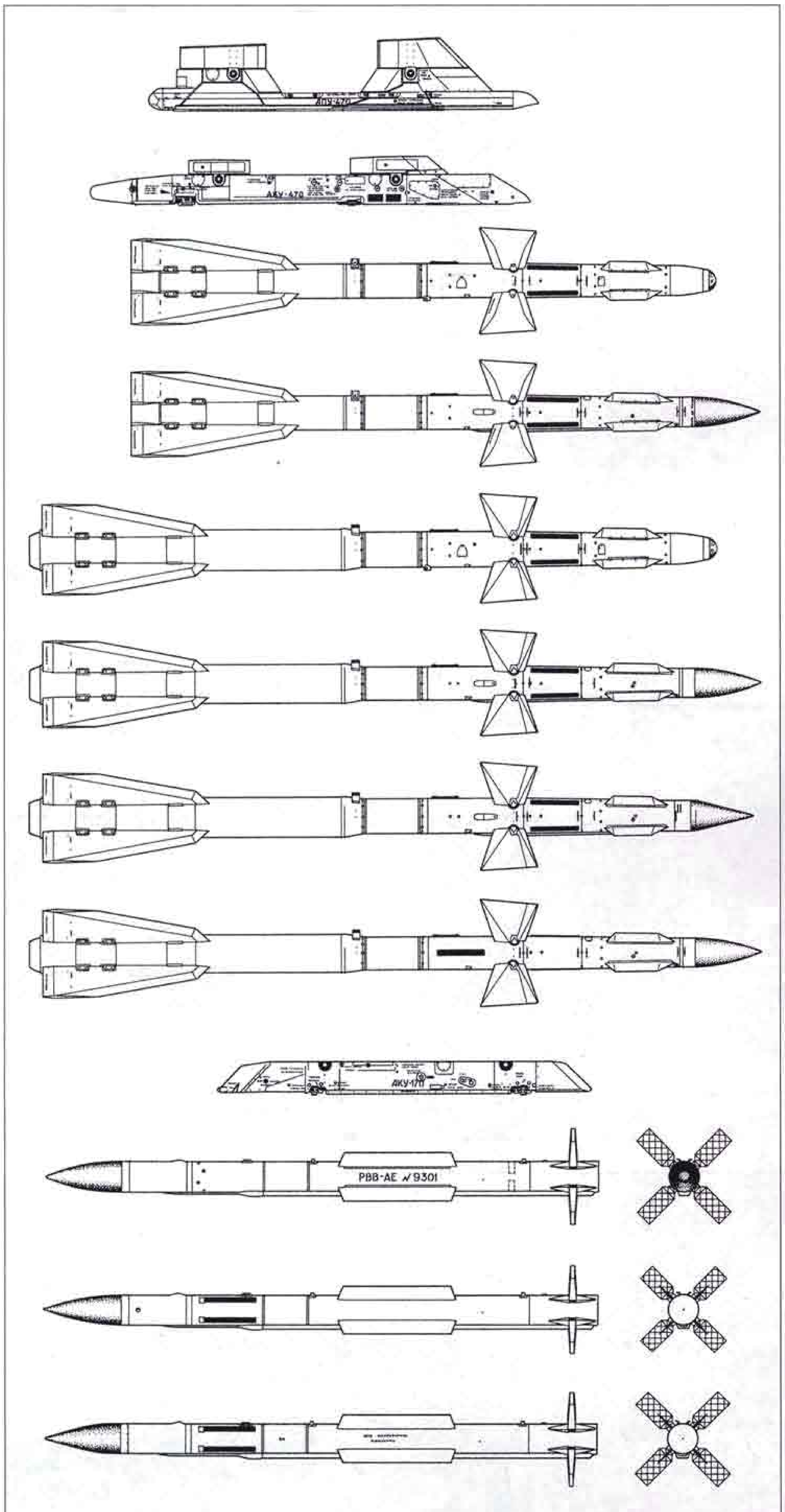
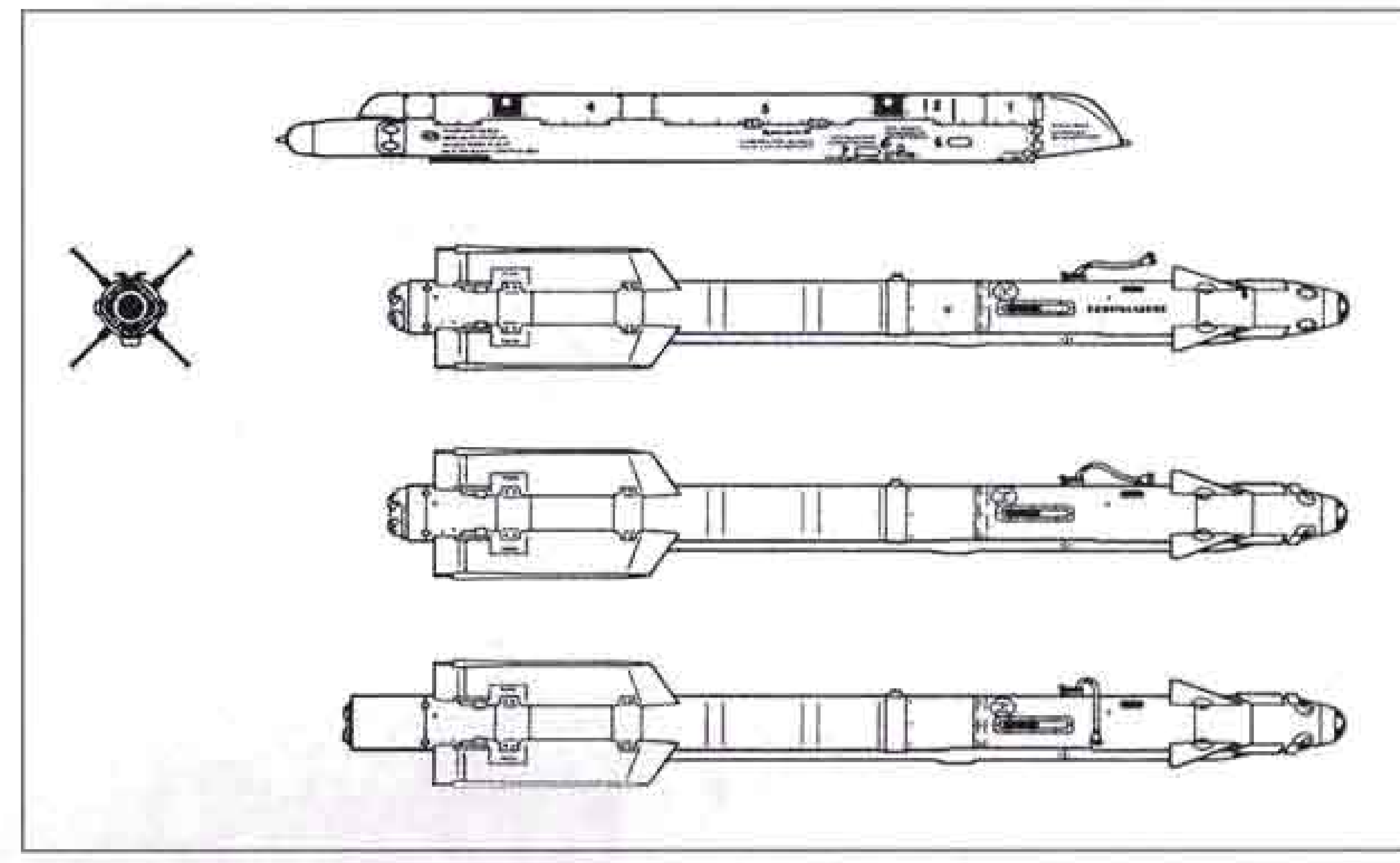
►
The Vympel R-73 IR-homing agile short-range AAM. Note the attitude vanes immediately aft of the IR seeker head.



▲
Top to bottom: the APU-470 missile rail, the AKU-470 ejector rack, the R-27T, the R-27R, the R-27ET, the R-27ER, the R-27AE, the R-27EM, the AKU-170 ejector rack, the RVV-AE, and the R-77 with small and large rudders.

▶
An R-60M (outboard) and an R-73 under the port wing of the first prototype MiG-29UBT.

▶
Two R-27Rs on APU-470 launch rails under the port wing of a MiG-29.



▲
Top to bottom: the P-12-1D launch rail, the R-73, the R-73RMD with attitude vanes and the longer-range R-73E.

An R-73 on a P-12-1D launch rail under the port wing of *Fulcrum-C* '331 Blue'.
▼

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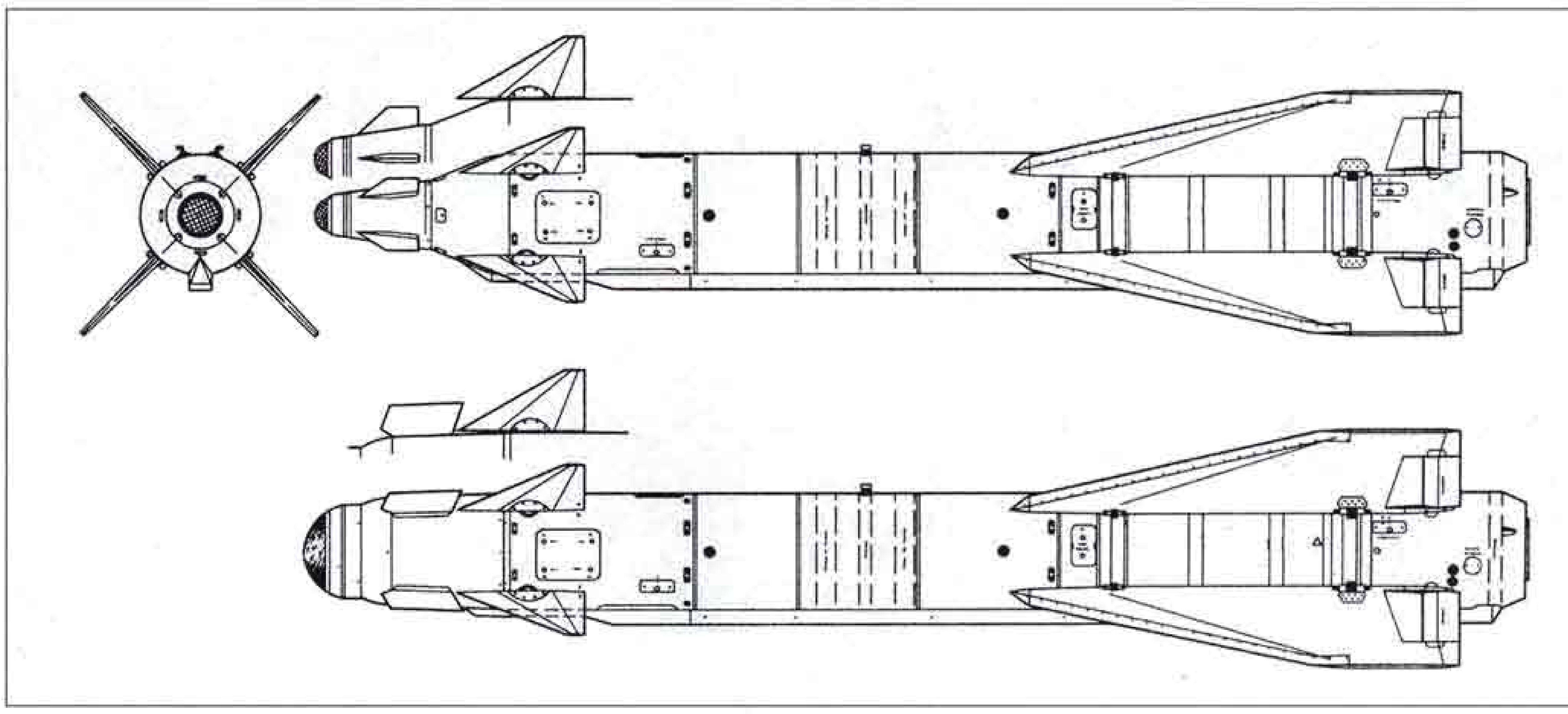
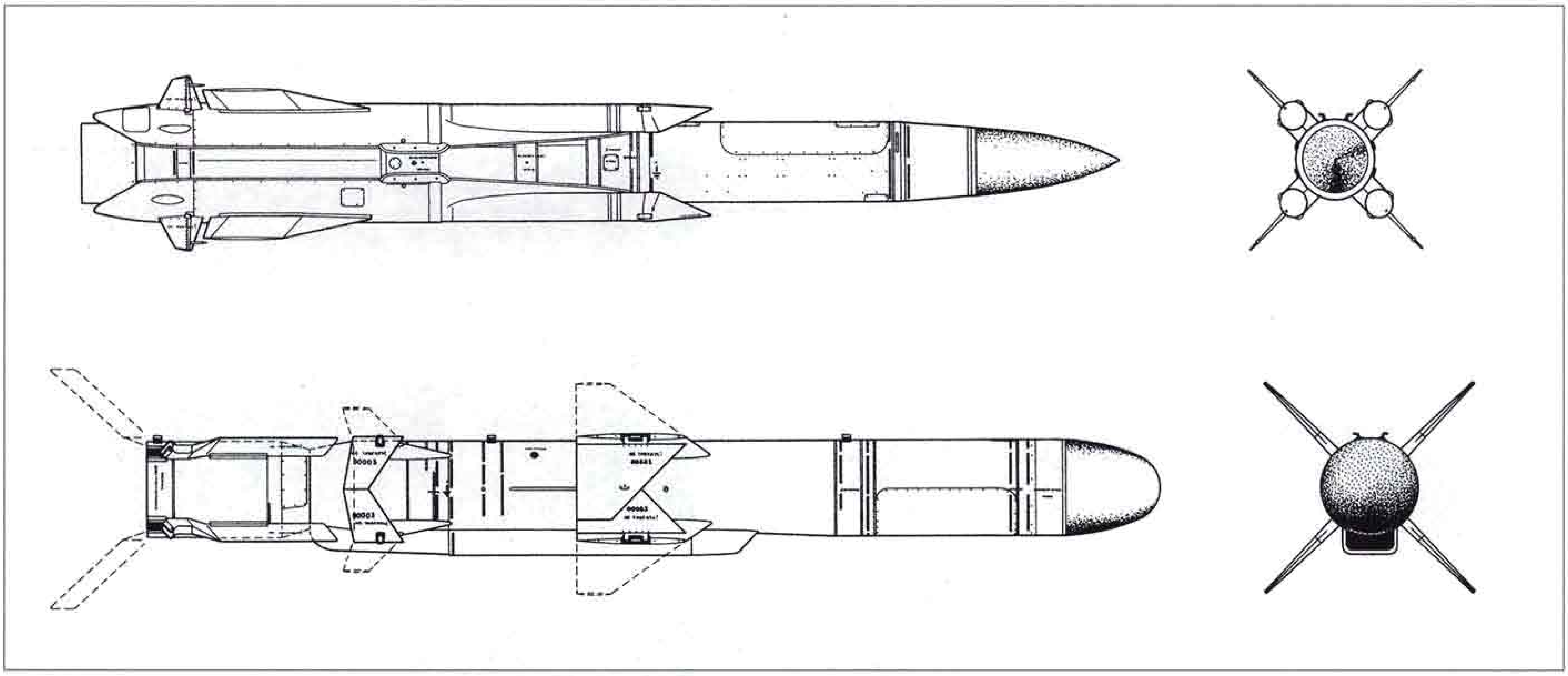


► The Kh-29L (above) and Kh-29T air-to-surface missiles, with scrap views showing the planform of the canards.

The Kh-31 air-to-surface missile with intake covers and booster motor. ▼

The Kh-35 anti-shipping missile with booster motor. ▼▼



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► Inert versions of (left to right) the Kh-29T ASM (on an AKU-58 ejector rack), the KAB-500Kr TV-guided bomb and the R-77 AAM under the port wing of MiG-29SMT '917 Blue'.

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◄ **Unguided air-to-ground weapons (an FAB-100M54 HE bomb, B-7L and B-8M1 FFAR pods, a UPK-23-250 cannon pod and an FAB-250M62 low-drag HE bomb) arrayed in front of MiG-29SMT '918 White'. Note also the Sapsan-E laser designator pod in front of the fighter.**

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◄ **An inert Kh-31P anti-radiation missile under the starboard wing of MiG-29SMT '917 Blue'.**

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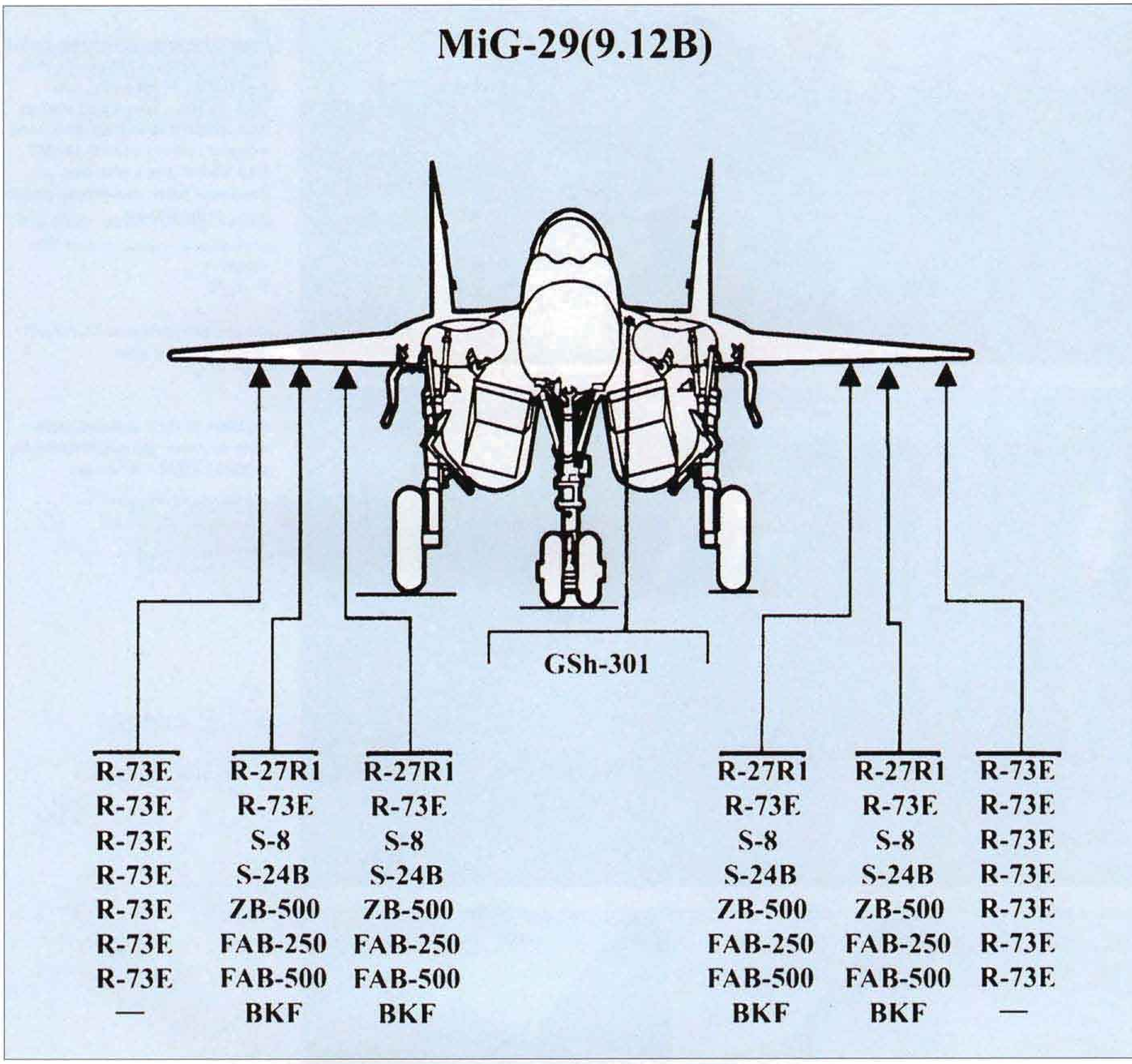
◄ **Wingless Kh-29T missiles on the two inboard starboard pylons of MiG-29M '155 Blue'.**



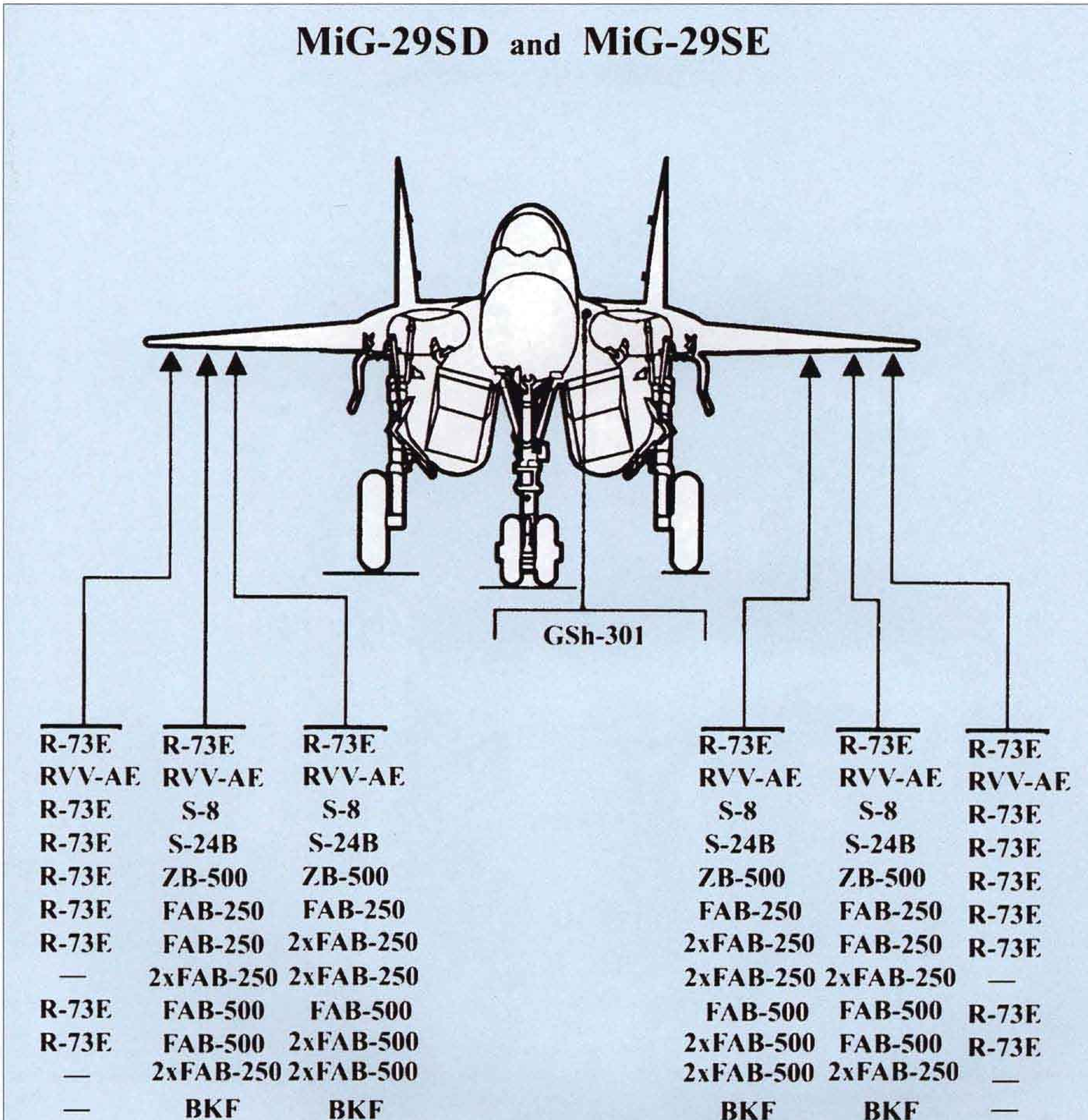
▲ **A diagram from Mikoyan export documents showing the weapons options of the MiG-29 *Fulcrum-A* (*izdeliye* 9.12B).**

►► **A diagram from Mikoyan export documents showing the weapons options of the MiG-29SD and MiG-29SE.**

to 7 Gs. Export aircraft are armed with export R-60MK missiles. The R-60s are carried on APU-60-1DB-1 (P-62-1D) missile rails which can be fitted to any pylon.

The air-to-air weapons range of the MiG-29S/MiG-29SD/MiG-29SE/MiG-29SM and MiG-29SMT includes two Vympel R-27R/T/RE/TE medium-range AAMs (R-27R1/T1/RE1/TE1 for export), two, four or six Vympel R-77 (RVV-AE) medium-range AAMs and a like number of Vympel R-73 (R-73E) short-range AAMs. The R-27T is a passive IR-homing version of the R-27R; its IR seeker head has a 110° field of view. The R-27RE and R-27TE are extended-range versions with longer-burn rocket motors. A mix of R-27s with different guidance systems can be used to increase resistance to countermeasures and improve the chances of a 'kill'.

The R-77 is designed to destroy enemy fighters, bombers, attack and transport aircraft and helicopters in all weather conditions, over land and sea, day or night and in an ECM environment. It is a wingless missile with aft-mounted cruciform lattice-type rudders. The R-77 is a 'fire and forget' weapon featuring an inertial navigation system with mid-course radio correction and an active radar homing seeker head which allows the missile to go for another target if the original one manages to break target lock-on.



Target flight level is 20-25,000 m (65-82,020 ft) and maximum target speed is 3,600 km/h (2,236 mph). The missile can be launched at up to the aircraft's G limit and destroy targets flying up to 10,000 m (32,810 ft) above or below the aircraft's own altitude. The R-77s are carried on AKU-170 ejector racks (*aviatsi**on**naya kata-**pool't**naya oosta**nov**ka*) which propel them clear of the aircraft before the rocket motor ignites.

The MiG-29K and MiG-29M can carry two R-27RE/TE AAMs, two or four R-27R/T AAMs, two, four, six or eight R-77s and/or a like number of R-73s.

In the attack role all versions of the MiG-29 can carry a range of unguided rockets, including two or four B-8M1 rocket pods with twenty 80-mm (3.15-in) S-8 folding-fin aircraft rockets (FFARs) each and two or four 240-mm (9.44-in) S-24B heavy unguided rockets on APU-68-85

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launchers. Early *Fulcrum-As* also used four UB-32A-73 rocket pods with thirty-two 57-mm (2.24-in) S-5 FFARs each. On the MiG-29K and MiG-29M the S-24s were replaced by two 266-mm (10.47-in) S-25 rockets on PU-O-25 disposable launchers (*poosko**va**ya oosta**nov**ka odno**rah**zovaya*) and/or two or four B-13L missile pods with five 122-mm (4.8-in) S-13 FFARs each.

The unguided rockets are mainly used against enemy personnel and small single armoured, hardened and soft-skinned targets but may also be used against aerial targets. They have several types of warheads. The 57-mm FFAR comes in high-explosive (S-5M), HE/fragmentation (S-5MO), shaped-charge armour-piercing (S-5K) and SCAP/frag (S-5KO/KP) versions. The 80-mm FFAR comes in AP/frag (S-8A/M/KO/KOM/T), concrete-piercing (S-8B/BM), HEF (S-8-OF), fuel/air (S-8D/DM) and anti-personnel dart-filled (S-8AS/ASM) versions. The warhead of the S-8D/DM is similar to the fuel/air bomb filled with liquid explosive which forms an aerosol and is then ignited. The resulting fireball burns up all oxygen inside, creating a vacuum, and the outside air rushing in flattens everything in the centre of the explosion.

The 122-mm FFAR comes in concrete-piercing (S-13 and S-13T), HE (S-13D) and HE/frag (S-13-OF) versions. The S-24B has an HEF warhead, while the 266-mm rockets are equipped with outsize warheads – fragmentation (S-25-O) or HEF (S-25-OF/OFM) of 420 mm (16.53 in) and 340 mm (13.38 mm) diameter.

The weapons range of all versions includes 250-kg (551-lb) and 500-kg (1,102-lb) free-fall bombs. Typically these are HE bombs (including FAB-250M54 and FAB-500M54 high-drag bombs, FAB-250M62 and FAB-500M62 low-drag bombs, and FAB-500ShN parachute-retarded bombs) and HE/frag bombs (such as the OFAB-250-270). The MiG-29 (*izdeliye* 9.12) and MiG-29UB can carry two or four bombs on BD3-UMK or BD3-UMK-2/-2B bomb racks fitted to Nos. 1 through 4 pylons (the inner and centre wing pylons). The MiG-29 (*izdeliye* 9.13) can be fitted with MBD3-U2T-1 multiple ejector racks on the inboard pylons, permitting the carriage of two bombs in tandem and increasing the total to six; the MiG-29S/SD/SE/SM/SMT/M/K can carry up to eight bombs on four MERs.

Other air-to-ground weapons include ZB-500ShM, ZB-500ASM and ZB-500GD napalm tanks for strikes against personnel and large-

◄◄
The external stores options of the MiG-29S (*izdeliye* 9.12S). Front to back: B-8M1 FFAR pods; PTB-1150 and PTB-1500 drop tanks interspersed with KMGU-1 submunitions dispensers; MBD3-U2T-1 tandem racks with 100- and 250-kg bombs; ZB-500 napalm tanks, and various AAMs.

The MiG-29UBT with its weapons options – IR-homing R-27ER and R-73 AAMs, Kh-31P ARMs, laser-guided Kh-25ML AGMs and KAB-500L bombs, and TV-guided Kh-29T AGMs and KAB-500Kr bombs. The 'smart' weapons require the use of appropriate target designator pods.
▼

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▲
The MiG-29SMT (*izdeliye* 9.17) with its assorted air-to-air and air-to-surface weapons.

►▲
The same aircraft ('917 Blue') in its current guise with a slightly amended range of weapons.

►►
The MiG-29M2 has a broadly similar range of weapons. Note the radar-tipped Kh-35M anti-shipping missile in the front row.

area targets such as railyards and warehouses; two or four of these can be carried on BD3-UMK racks. Another option is KMGU-1 or KMGU-2 submunitions pods used for bomblets without attachment lugs and for anti-tank or anti-personnel mines. The submunitions are packed into BKF cassettes (= *blok kon**tey**nernyy dlya fronto**voy** avi**ah**tsii* – containerised [submunitions] pack for tactical aviation), eight per pod. The KMGU pod has pneumatically-operated doors and can be programmed to release the cassettes at 0.05-, 0.2-, 1- or 1.5-second intervals.

For MiG-29 operations the KMGU pods are usually loaded with twelve 2.5-kg (5.5-lb) AO-2.5RT fragmentation bomblets, twelve 1.6-kg (3.5-lb) PTM-1 anti-tank mines or 156 800-g (1.76-lb) anti-personnel mines. Two or four pods are carried on BD3-UMK racks, giving a total of 384 bomblets or anti-tank mines and no fewer than 4,992 anti-personnel mines. 100-kg (220-lb) OFAB-100-120 HE/fragmentation bombs and 50-kg (110-lb) P-50-75 practice bombs can also be loaded.

Radar Cooling System

The radar set has a liquid cooling system filled with OZh-65 glycol antifreeze (*okhlazh**da**yushchaya **zhid**kost'* – coolant); it features a pump, an expansion tank, an air separator and a fuel/glycol heat exchanger. The radar is switched off automatically if the coolant temperature exceeds 70°C (158°F) or glycol pressure exceeds 8.8 kg/cm² (125 psi).

Oxygen System and Crew Gear

The oxygen system provides life support to the pilot(s) at high altitude, during high-G manoeuvres and in the event of an ejection. It also ensures reliable engine restarting in flight and APU start-up on the ground.

The pilot's main oxygen supply consists of three 4-litre (0.88 Imp gal) oxygen bottles charged to 150 kg/cm² (2,143 psi); the pressure is reduced to 8-12 kg/cm² (114-171 psi) for operation. An air/oxygen mix is supplied to the pilot's face mask up to 8,000 m (26,250 ft); at higher altitude the system switches to pure oxygen.

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▲ **Dummy R-73 AAMs on the outer wing pylons of the MiG-29K.**

The KSKK-2M emergency oxygen system located in the ejection seat consists of a 0.7-litre (0.15 Imp gal) oxygen bottle; the supply lasts four minutes. MiG-29 pilots can use the KKO-15LP breathing apparatus (*kom**plekt** kis-lo**rod**novo obo**roo**dovaniya* – oxygen equipment set) enabling the pilot to eject at up to 20,000 m (65,620 ft) and stay underwater for up to five minutes if he is unlucky enough to ditch in so doing. The engine and APU oxygen feed system has one 4-litre bottle.

Pilot gear includes a VKK-15K pressure suit (*vy**sot**no-kompen**see**ruyushchiy kos**tyum***), a ZSh-7A flying helmet (*zaschchitnyy shlem* – protective helmet) and a KM-35 oxygen mask. If the mission does not involve climbing above 12,000 m (39,370 ft), the lighter PPK-3 G suit (***pro**tivopere**groo**zochnyy kos**tyum***) may be used at the expense of a slight reduction in the pilot's G limits. For overwater sorties the VMSK-4-15 maritime pressure/rescue suit (*vy**sot**nyy mor**skoy** spa**sah**tel'nyy kos**tyum***) with added heat insulation in case of ditching is used.

Crew Escape System

Current versions have a Zvezda K-36DM Srs 2 zero-zero ejection seat (or seats) and a canopy jettisoning system activated by external and internal handles. The seat guarantees safe ejection in horizontal flight at 0-1,400 km/h (777 kts) IAS or Mach 2.5, during manoeuvres with –2 to +4 Gs, at AOAs up to 30°, sideslip angles up to 20° and any bank angles right up to the inverted position, roll rates up to 3 sec-1. On the ground safe ejection is guaranteed at speeds down to 75 km/h (46.5 mph). Minimum ejection altitude is 85 m (278 ft) in a 30° dive and 55 m (180 ft) in inverted flight; airspeed is 400 km/h (248 mph) in both cases. Maximum G load during ejection is 18 Gs.

The seat is equipped with a KSMU-36 two-stage combined ejection gun, a parachute deployment mechanism, a PSU-36 parachute system with a 28-line parachute (canopy area is 60 m^2; 645 sq ft) and a stabilisation system with two drogue parachutes and automatic and semi-automatic deployment devices. It also houses the NAZ-8 survival kit (*no**sim**yy ava**reey**nyy za**pahs*** – portable emergency supply) comprising the R-855UM Komar-2M UHF radio, the PSN-1 one-man inflatable rescue raft (*plot spa**sah**tel'nyy nadoov**noy***), a food supply, camping gear, signal flares and a first-aid kit. The seat weighs 123 kg (271 lb) complete with oxygen system and survival kit.

MiG-29 (*izdeliye* 9.12) Specifications

Length overall	17.32 m (56 ft $9\frac{7}{8}$ in)
Length less pitot boom	16.28 m (53 ft 4.$\frac{15}{16}$ in)
Fuselage length	14.875 m (48 ft $9\frac{5}{8}$ in)
Wing span	11.36 m (37 ft $3\frac{15}{64}$ in)
Wing area	38.056 m^2 (409.2 sq ft)
Height on ground	4.73 m (15 ft $6\frac{7}{32}$ in)
Landing gear track	3.09 m (10 ft $1\frac{21}{32}$ in)
Landing gear wheelbase	3.645 m (11 ft $11\frac{1}{2}$ in)
Empty operating weight	10,900 kg (24,030 lb)
Take-off weight:	
normal	15,000-15,200 kg (33,070-33,510 lb)
maximum	18,480 kg (40,740 lb)
Fuel load:	
with one drop tank	4,640 kg (10,230 lb)
with three drop tanks	6,480 kg (14,285 lb)
Usable fuel (depending on specific gravity):	
RSK MiG data:	
with 100% internal fuel	3,150-3,800 kg (6,940-8,380 lb)
with 50% internal fuel	1,200-1,500 kg (2,645-3,310 lb)
with one drop tank	4,350-5,000 kg (9,590-11,020 lb)
with two drop tanks	5,000-5,600 kg (11,020-12,345 lb)
with three drop tanks	6,150-6,800 kg (13,560-14,990 lb)

MiG-29 TACTICS

The MiG-29's main combat modes in the counter-air role are:

• maximum-range intercept, GCI-controlled or independent (using the fire control radar);

• beyond visual range (BVR) air combat using R-27R/RE, R-27T/TE and R-77 AAMs;

• close-range air combat (dogfight mode) using R-73 AAMs;

• close-range air combat using the internal cannon.

In all kinds of air-to-air combat the fighter's WCS enables:

• automatic target detection by means of the radar or IRST/LR, possibly with guidance from GCI centres or AWACS aircraft via command link;

• covert target detection by means of the radar (in passive tracking mode) at 70-80 km (43.4-49.6 miles) range or by the IRST/LR at 15-30 km (9.3-18.6 miles) range; in search mode the radar can track up to 10 targets;

• target lock-on and autotracking by the radar at up to 40 km (24.8 miles) range or by the IRST/LR at up to 12 km (7.45 miles) range with radar or laser ranging; the N019M and N010 radars can guide missiles to two or four priority targets respectively.

The IRST/LR is the main targeting system used in gunnery mode. Targeting is possible in visual reference mode (by placing the gunsight reticle on the HUD over the target in VMC) or error computation mode (in IMC). A fixed grid on the HUD can be used as a reference point for gunnery and missile launch if no targeting information is available.

In strike mode the versions having no provisions for precision-guided munitions (*izdeliye* 9.12, 9.12A/B and 9.13, MiG-29S, MiG-29SD and MiG-29SE) can use the following tactics:

• diving attack (dive-bombing, firing FFARs and strafing);

• dropping bombs at the moment of recovery from a dive;

• dropping bombs and submunitions in level flight.

Targeting mode is selected automatically, depending on the flight mode. The WCS continuously measures target range with the laser ranger or, if this is impossible, computes the target range based on altitude and attitude; this is then used to calculate the weapon impact point, commence and cease fire. Once again a fixed grid on the HUD can be used as a reference point for gunnery and rocket firing if no targeting information is available.

VVS data:	
with 100% internal fuel	3,150-3,700 kg (6,940-8,160 lb)
with one drop tank	4,250-4,950 kg (9,370-10,910 lb)
with two drop tanks	4,950-5,500 kg (10,910-12,125 lb)
with three drop tanks	6,050-6,750 kg (13,340-14,880 lb)
Fuel remaining after landing (with reserves)	550 kg (1,210 lb)
Maximum ordnance load:	
Fulcrum-A	2,000 kg (4,410 lb)
MiG-29SE	4,000 kg (8,820 lb)
Top speed:	
at sea level	1,480 km/h (919 mph)
at 11,000 m (36,090 ft)	2,450 km/h (1,521 mph)
Unstick speed	260-280 km/h (161-174 mph)
Landing speed	250-260 km/h (155-161 mph)
Maximum Mach number	2.3
Service ceiling with 800 kg (1,760 lb) of fuel	18,000 m (59,055 ft)
Service ceiling at subsonic speed	
(900 km/h; 559 mph)	14,500 m (47,572 ft)
Rate of climb	330-335 m/sec (64,940-65,930 ft/min)
Take-off thrust-to-weight ratio	1.1
G limits:	
up to Mach 0.85	+9 to -2.5
above Mach 0.85	+7 to -1.5
Range/combat radius:	
with 2 R-27s, 4 R-73s, internal fuel:	
at 200 m (660 ft)	455/134 km (282/83.2 miles)
at 10,000-13,000 m (32,810-42,650 ft)	900/180 km (559/111 miles)
with 2 R-27s, 4 R-73s, 1 drop tank:	
at 200 m (ft)	670 km (416 miles)
at 10,000-13,000 m	1,380 km (857 miles)
clean:	
at 200 m (ft)	535 km (332 miles)
at 10,000-13,000 m	1,250 km (776 miles)
Endurance:	
with 2 R-27s, 4 R-73s, internal fuel:	
at 200 m	0 hr 50 min
at 10,000-13,000 m	1 hr 10 min
with 2 R-27s, 4 R-73s, 1 drop tank:	
at 200 m	1 hr 11 min
at 10,000-13,000 m	1 hr 38 min
clean:	
at 200 m	0 hr 57 min
at 10,000-13,000 m	1 hr 22 min
Take-off run:	
in full afterburner	250 m (820 ft)
at full military power	600-700 m (1,970-2,300 ft)
Time to unstick (in full afterburner)	6-7 sec
Landing run with brake parachute	600-700 m (1,970-2,300 ft)

Note: Range, combat radius and endurance figures are stated as per VVS documents. ANPK MiG state that the MiG-29 (*izdeliye* 9.12) has a maximum range of 1,430-1,500 km (794-833 nm) on internal fuel, 2,100 km (1,166 nm) with one drop tank at S/L and 2,900 km (1,611 nm) with three drop tanks.

MiG-29 Versions: Comparative Specifications

	MiG-29 (*izdeliye* 9.12)	MiG-29 (*izdeliye* 9.13)	MiG-29UB (*izdeliye* 9.51)	MiG-29S (*izdeliye* 9.13S)	MiG-29SD (*izdeliye* 9.12SD)
First flight	1977	1984	1981	1990	1995
Powerplant	2 x RD-33	2 x RD-33	2 x RD-33	2 x RD-33	2 x RD-33
Rating in full a/b, kgp (lbst)	2 x 8,340 (2 x 18,390)	2 x 8,340 (2 x 18,390)	2 x 8,340 (2 x 18,390)	2 x 8,340 (2 x 18,390)	2 x 8,340 (2 x 18,390)
Length with pitot	17.32 m (56 ft 9$\frac{7}{8}$ in)	17.32 m (56 ft 9$\frac{7}{8}$ in)	17.42 m (57 ft 1$\frac{53}{64}$ in)	17.32 m (56 ft 9$\frac{7}{8}$ in)	17.32 m (56 ft 9$\frac{7}{8}$ in)
Wing span	11.36 m (37 ft 3$\frac{15}{64}$ in)	11.36 m (37 ft 3$\frac{15}{64}$ in)	11.36 m (37 ft 3$\frac{15}{64}$ in)	11.36 m (37 ft 3$\frac{15}{64}$ in)	11.36 m (37 ft 3$\frac{15}{64}$ in)
Height on ground	4.73 (15 ft 6$\frac{7}{32}$ in)	4.73 (15 ft 6$\frac{7}{32}$ in)	4.73 (15 ft 6$\frac{7}{32}$ in)	4.73 (15 ft 6$\frac{7}{32}$ in)	4.73] (15 ft 6$\frac{7}{32}$ in)
Wing area, m^2 (sq ft)	38.056 (409.2)	38.056 (409.2)	38.056 (409.2)	38.056 (409.2)	38.056 (409.2)
Normal TOW, kg (lb)	15,000 (33,070)	15,300 (33,730)	14,600 (33,730)	15,300 (33,730)	15,300 (33,730)
MTOW, kg (lb)	18,480 (40,740)	n/a	n/a	19,700 (43,430)	18,480 (40,740)
Ordnance load, kg (lb)	3,200 (7,050)	3,200 (7,050)	n/a	3,200 (7,050)	3,200 (7,050)
Internal fuel, kg (lb)	3,630 (8,000)	3,850 (8,490)	n/a	3,850 (8,490)	3,630 (8,000)
Thrust/weight ratio [1]	1.11	n/a	n/a	1.09	1.11
Top speed, km/h (mph):					
at 11,000 m (36,090 ft)	2,450 (1,521)	2,450 (1,521)	2,230 (1,385)	2,450 (1,521)	2,450 (1,521)
at sea level	1,480 (919)	1,480 (919)	1,400 (869)	1,480 (919)	1,480 (919)
Landing speed, km/h (mph)	260 (161)	260 (161)	260 (161)	260 (161)	260 (161)
Service ceiling, m (ft)	17,500 (57,410)	17,000 (55,770)	17,500 (57,410)	17,000 (55,770)	17,500 (57,410)
Rate of climb, m/sec (ft/min) [2]	330 (64,940)	300 (59,040)	330 (64,940)	300 (59,040)	330 (64,940)
Effective range, km (miles):					
on internal fuel at sea level	710 (441)	n/a	680 (422)	n/a	710 (441)
on internal fuel at altitude	1,500 (931)	n/a	1,410 (875)	1,500 (931)	n/a
with 1 drop tank	2,100 (1,304)	n/a	n/a	n/a	2,100 (1,304)
with 3 drop tanks	2,900 (1,801) [10]	3,600 (2,236)	n/a	3,600 (2,236)	2,900 (1,801)
Subsonic G limit	9.0	9.0	9.0	9.0	9.0
Air-to-air missiles:					
long-range	–	–	–	R-27ET/ER	R-27ET/ER
medium-range	R-27R1/T1	R-27R1/T1	–	R-27R1/T1 R-77	R-27R1/T1 R-77
short-range	R-60M R-73	R-60M R-73	R-60M R-73	R-60M R-73	R-60M R-73
Air-to-surface missiles	–	–	–	–	–

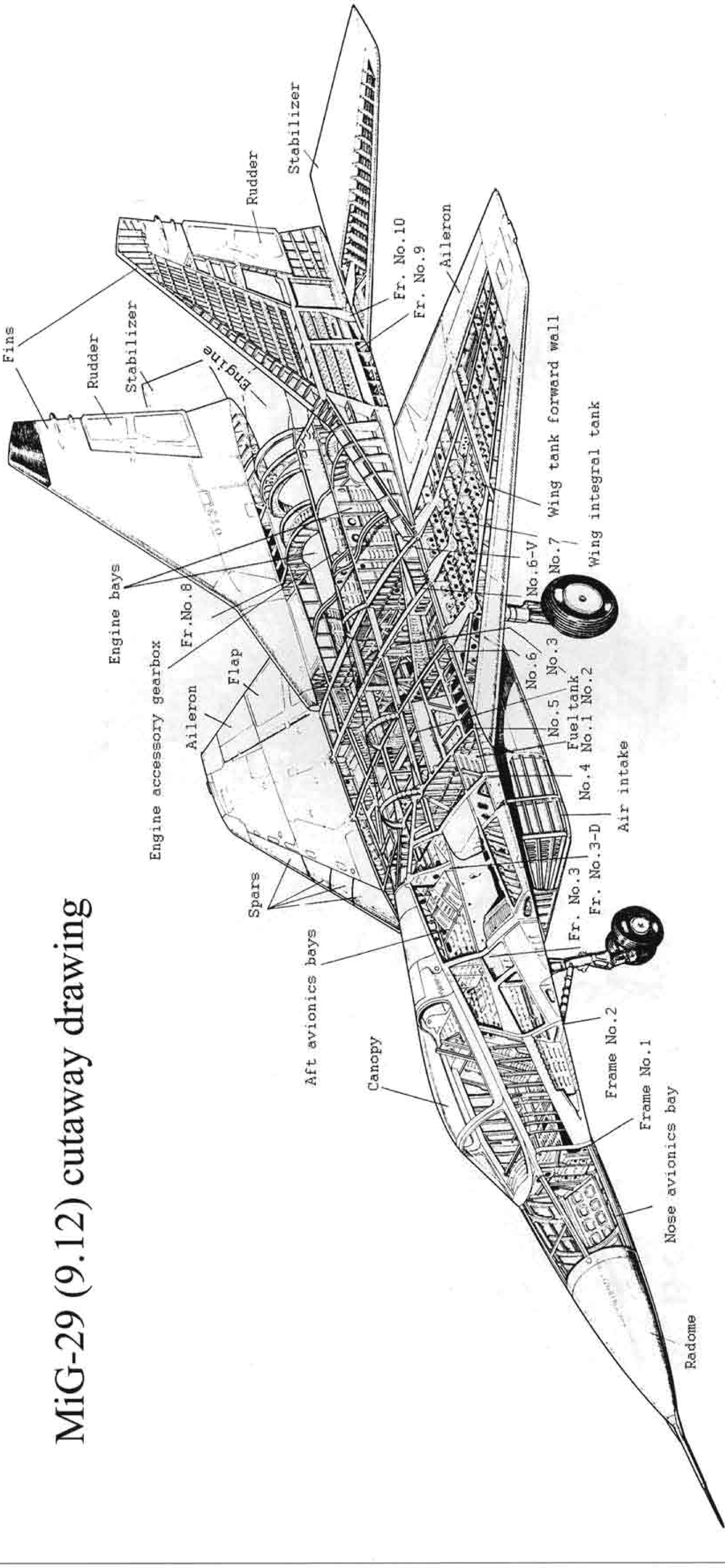
	MiG-29SE (*izdeliye* 9.13SE)	MiG-29SM (*izdeliye* 9.12SM)	MiG-29SMT (*izdeliye* 9.17)	MiG-29M (*izdeliye* 9.15)	MiG-29K (*izdeliye* 9.31)
First flight	1992	1990 [3]	1998	1986	1988
Powerplant	2 x RD-33	2 x RD-33	2 x RD-33	2 x RD-33K [4]	2 x RD-33K
Rating in full a/b, kgp (lbst)	2 x 8,340 (2 x 18,390)	2 x 8,340 (2 x 18,390)	2 x 8,340 (2 x 18,390)	2 x 8,800 (2 x 19,400)	2 x 9,400 (2 x 20,720)
Length with pitot	17.32 m (56 ft 9 7/8 in)	17.32 m (56 ft 9 7/8 in)	17.32 m (56 ft 9 7/8 in)	17.32 m (56 ft 9 7/8 in)	17.27 m (56 ft 7 59/64 in)
Wing span	11.36 m (37 ft 3 15/64 in)	11.36 m (37 ft 3 15/64 in)	11.36 m (37 ft 3 15/64 in)	11.36 m (37 ft 3 15/64 in)	11.99/7.85 m (39 ft 4 3/64 in/25 ft 7 3/32 in) [5]
Height on ground	4.73 (15 ft 6 7/32 in)	4.73 (15 ft 6 7/32 in)	4.73 (15 ft 6 7/32 in)	4.73 (15 ft 6 7/32 in)	4.73 (15 ft 6 7/32 in)
Wing area, m^2 (sq ft)	38.056 (409.2)	38.056 (409.2)	38.056 (409.2)	38.056 (409.2)	43.0 (462.36)
Normal TOW, kg (lb)	15,300 (33,730)	n/a	16,850 (37,150)	15,800 (34,830)	15,570 (34,325) [6]
MTOW, kg (lb)	19,700 (43,430)	n/a	n/a	n/a	18,210 (40,145) [7]
Ordnance load, kg (lb)	3,200 (7,050)	n/a	4,000 (8,820)	4,500 (9,920)	4,500 (9,920)
Internal fuel, kg (lb)	3,850 (8,490)	3,630 (8,000)	4,835 (10,660)	4,460 (9,830)	4,460 (9,830) [8]
Thrust/weight ratio [1]	n/a	n/a	n/a	1.11	1.06
Top speed, km/h (mph):					
at 11,000 m (36,090 ft)	2,450 (1,521)	2,450 (1,521)	2,450 (1,521)	2,500 (1,552)	2,300 (1,428)
at sea level	1,480 (919)	1,480 (919)	1,480 (919)	1,480 (919)	1,400 (919)
Landing speed, km/h (mph)	260 (161)	260 (161)	260 (161)	260 (161)	230-240 (142-149)
Service ceiling, m (ft)	17,000 (55,770)	n/a	n/a	17,000 (55,770)	17,400 (57,090)
Rate of climb, m/sec (ft/min) [2]	300 (59,040)	n/a	n/a	320 (62,980)	260 (51,170)
Effective range, km (miles):					
on internal fuel at sea level	n/a	n/a	n/a	900 (559)	n/a
on internal fuel at altitude	n/a	n/a	2,100 (1,304)	2,000-2,200 (1,242-1,366)	n/a
with 1 drop tank	n/a	n/a	2,700 (1,677)	3,200 (1,987)	2,600 (1,615)
with 3 drop tanks	n/a	n/a	3,300 (2,050)	n/a	3,000 (1,863)
Subsonic G limit	9.0	9.0	9.0	9.0	8.5/6.09
Air-to-air missiles:					
long-range	R-27ET/ER	R-27ET/ER	R-27ET/ER	R-27ET/ER	R-27ET/ER
medium-range	R-27R1/T1 R-77	R-27R1/T1 R-77	R-27R1/T1 R-77	R-27R1/T1 R-77	R-27R1/T1 R-77
short-range	R-60M R-73	R-60M R-73	R-60M R-73	R-60M R-73	R-60M R-73
Air-to-surface missiles	–	Kh-29T/TD	Kh-29T/TD Kh-31A/P	Kh-29T/TD Kh-31A/P Kh-25ML/MP	Kh-29T/TD Kh-31A/P Kh-25ML/MP

Notes:

1. With normal TOW; 2 At 1,000 m (3,280 ft); 3. Design date, as the aircraft has not flown yet; 4. Without 9,400-kgp contingency rating;
5. With wings deployed and folded respectively; 6. With four AAMs; 7. With four AAMs and three drop tanks;
8. Normally limited to 4,000 kg (8,820 lb) because of weight restrictions during carrier operations; 9. Subsonic/supersonic; 10. Modified aircraft only (with 'wet' wing pylons)

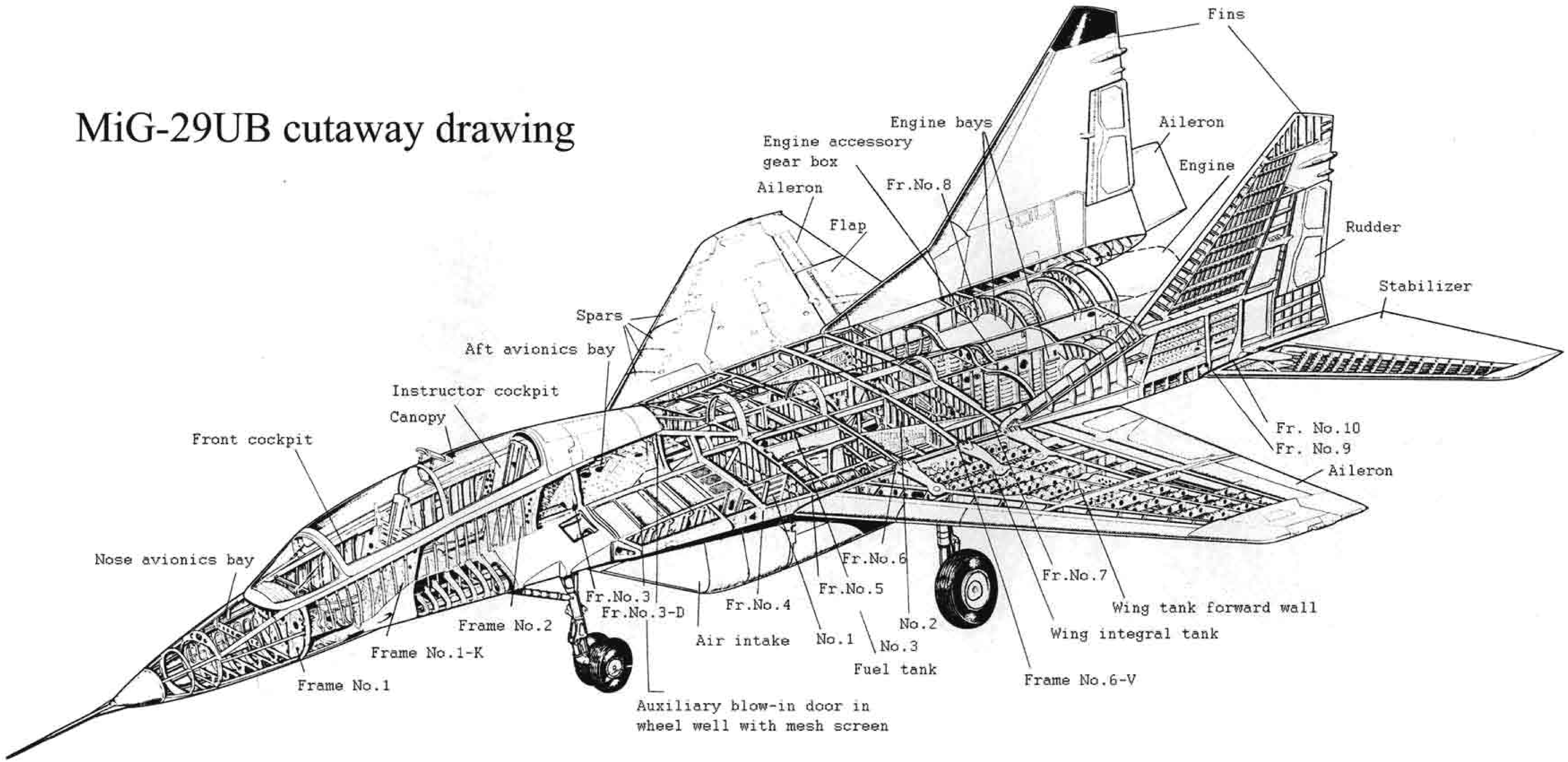
MiG-29 New Versions: Comparative Specifications				
	MiG-29SMT **(*izdeliye* 9.18)**	**MiG-29M2** **(*izdeliye* 9.67)**	**MiG-29K** **(*izdeliye* 9.41)**	**MiG-29KUB** **(*izdeliye* 9.47)**
Crew	1	2	1	2
Powerplant	2 x RD-33 Srs 3	2 x RD-33 Srs 3M [11]	2 x RD-33MK	2 x RD-33MK
Rating in full a/b, kgp (lbst)	2 x 8,300 (2 x 18,300)	2 x 8,700 (2 x 19,180)	2 x 9,000 (2 x 19,840)	2 x 9,000 (2 x 19,840)
Length with pitot	17.161 m (56 ft 3⅜ in)	17.32 m (56 ft 9⅞ in)	17.317 m (56 ft 9 49/64 in)	17.317 m (56 ft 9 49/64 in)
Wing span	11.41 m (37 ft 5 7/32 in)	11.42 m (37 ft 5 19/64 in)	11.99 m (39 ft 4 in)	11.99 m (39 ft 4 in)
Height on ground (with normal ordnance load)	4.357 m (14 ft 3 17/32 in)	4.73 m (15 ft 6 7/32 in)	4.406 m (14 ft 5 15/32 in)	4.406 m (14 ft 5 15/32 in)
Width with wings folded (without pylons)	–	–	7.46 m (24 ft 5 45/64 in)	7.46 m (24 ft 5 45/64 in)
Stabilator span	n.a.	n.a.	7.695 m (25 ft 2 61/64 in)	7.695 m (25 ft 2 61/64 in)
Landing gear track	3.09 m (10 ft 1 21/32 in)	3.09 m (10 ft 1 21/32 in)	3.12 m (10 ft 2 53/64 in)	3.12 m (10 ft 2 53/64 in)
Landing gear wheelbase	n.a.	n.a.	4.115 m (13 ft 6 in)	4.115 m (13 ft 6 in)
Empty weight, kg (lb)	n.a.	n.a.	12,400 (27,340)	12,400 (27,340)
Normal TOW, kg (lb)	15,800 (34,830)	17,700 (39,020)	18,550 (40,895)	18,650 (41,115)
MTOW, kg (lb)	20,300 (44,750)	23,700 (52,250)	24,500 (54,010)	24,500 (54,010)
Ordnance load, kg (lb)	5,000 (11,020)	6,500 (14,330)	5,500 (12,125)	5,500 (12,125)
Internal fuel load, kg (lb)	n.a.	n.a.	5,200 (11,460)	5,200 (11,460)
Top speed, km/h (mph):				
at sea level	1,500 (931)	1,400 (869)	1,400 (869)	1,400 (869)
at medium/high altitude	2,400 (1,490)	2,200 (1,366)	2,100 (1,304)	2,100 (1,304)
Mach limit	n.a.	n.a.	2.0	2.0
Service ceiling, m (ft)	17,000 (55,770)	17,500 (57,410)	17,500 (57,410)	17,500 (57,410)
Rate of climb, m/sec (ft/min)	n.a.	n.a.	300 (59,040)	300 (59,040)
G limit	9.0	9.0	8.0	8.0
Effective range, km (miles):				
on internal fuel	1,800 (1,118)	1,800 (1,118)	1,850 (1,149)	1,600 (993)
with three drop tanks	3,000+ (1,860+)	3,000 (1,860)	3,000 (1,860)	3,000 (1,860)
with three drop tanks and one fuel top-up	6,000+ (3,720+)	6,000+ (3,720+)	5,500 (3,416)	5,500 (3,416)

11. The RD-33 Srs 3M engines are fitted to the MiG-29M2 prototype (demonstrator). Production examples will be powered by RD-33MK thrust-vectoring engines.

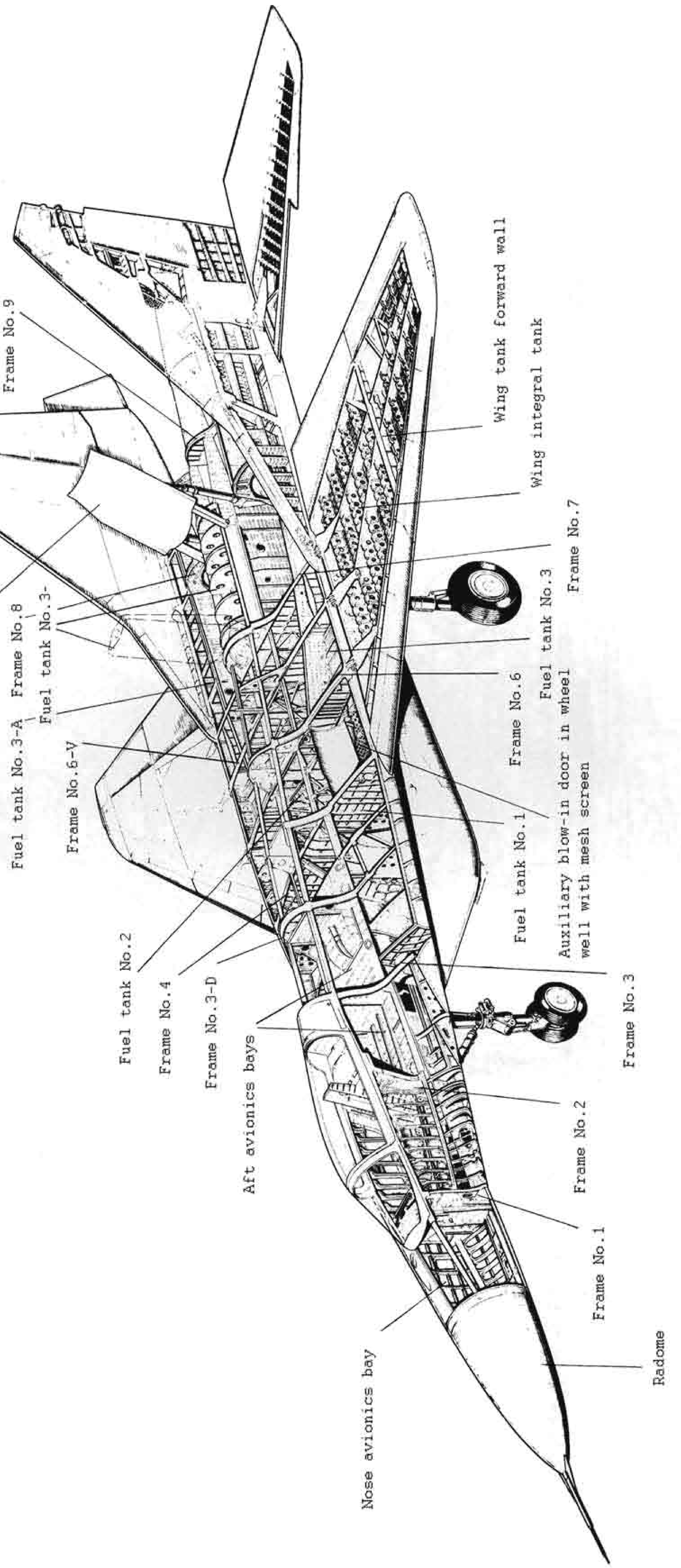


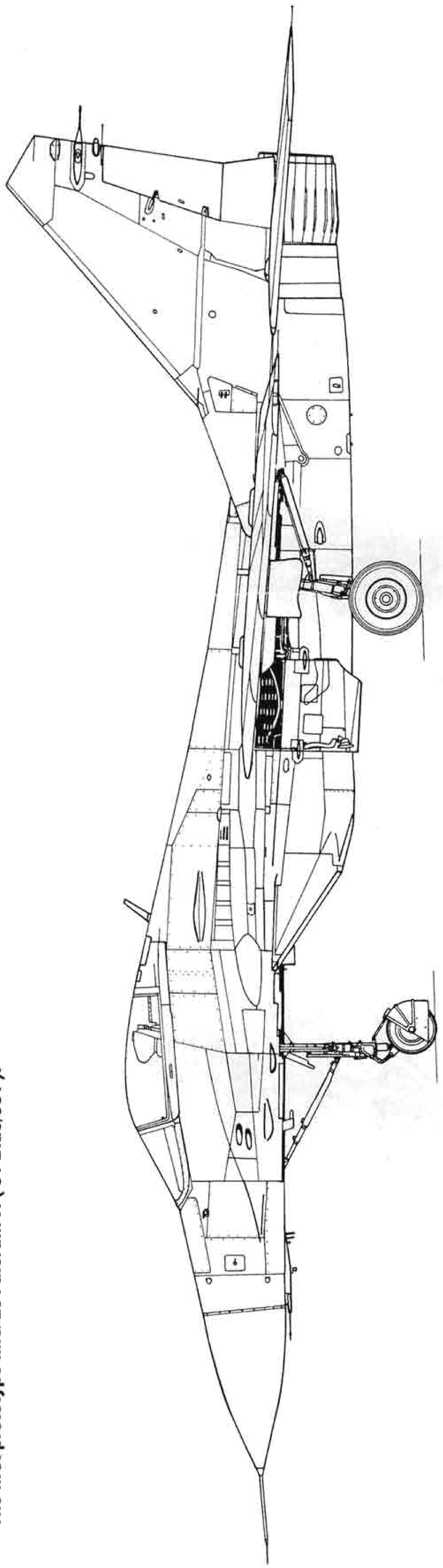
MiG-29 (9.12) cutaway drawing

MiG-29UB cutaway drawing

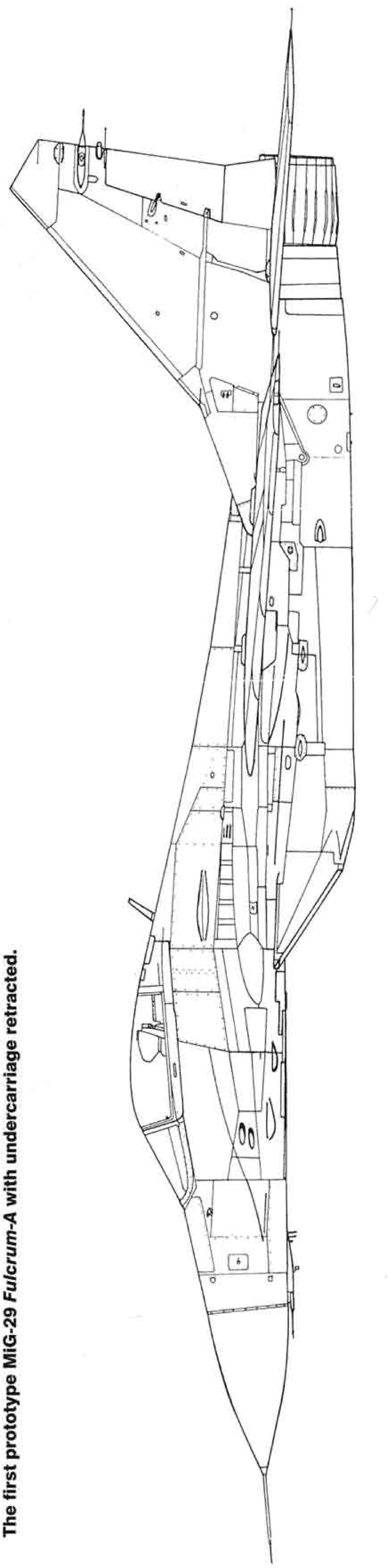


MiG-29M cutaway drawing

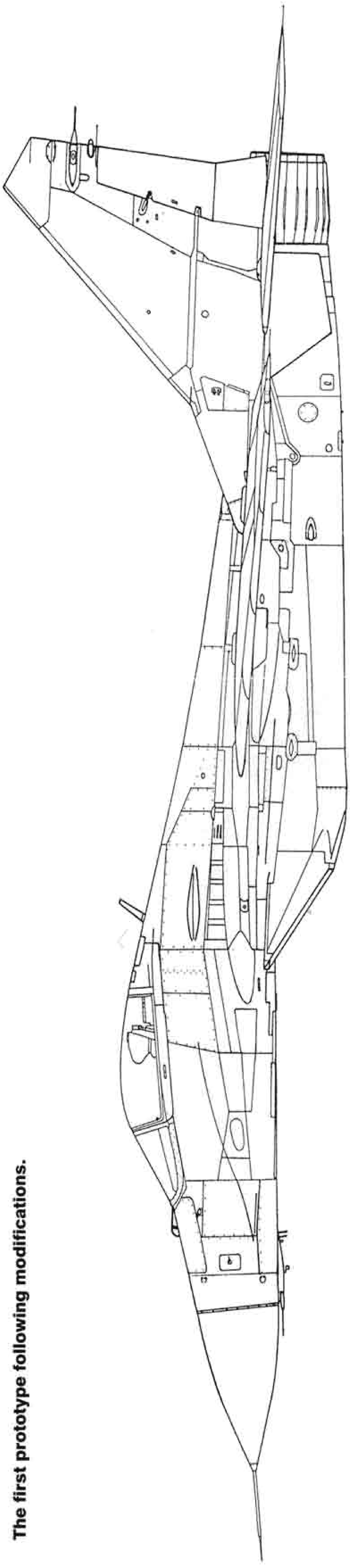




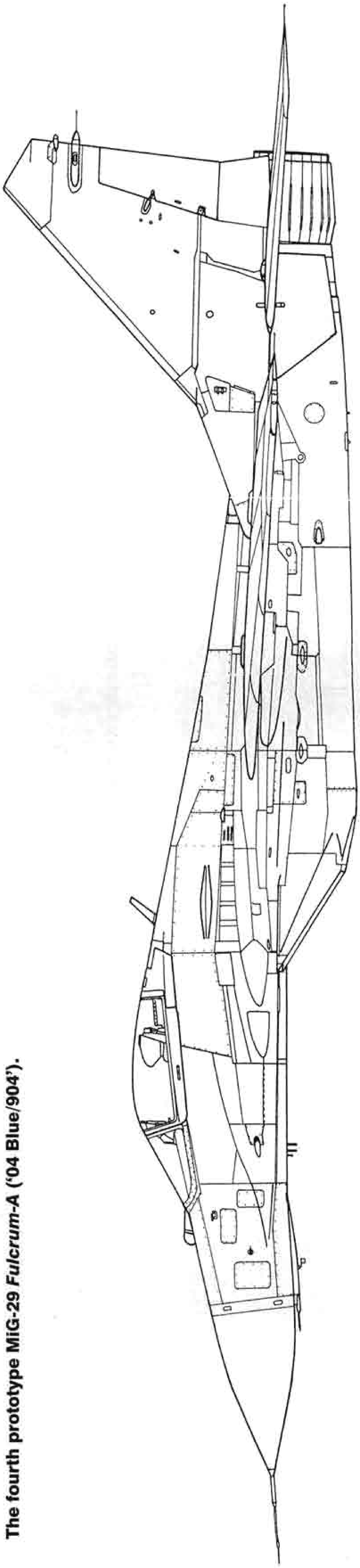
The first prototype MiG-29 *Fulcrum-A* ('01 Blue/901').



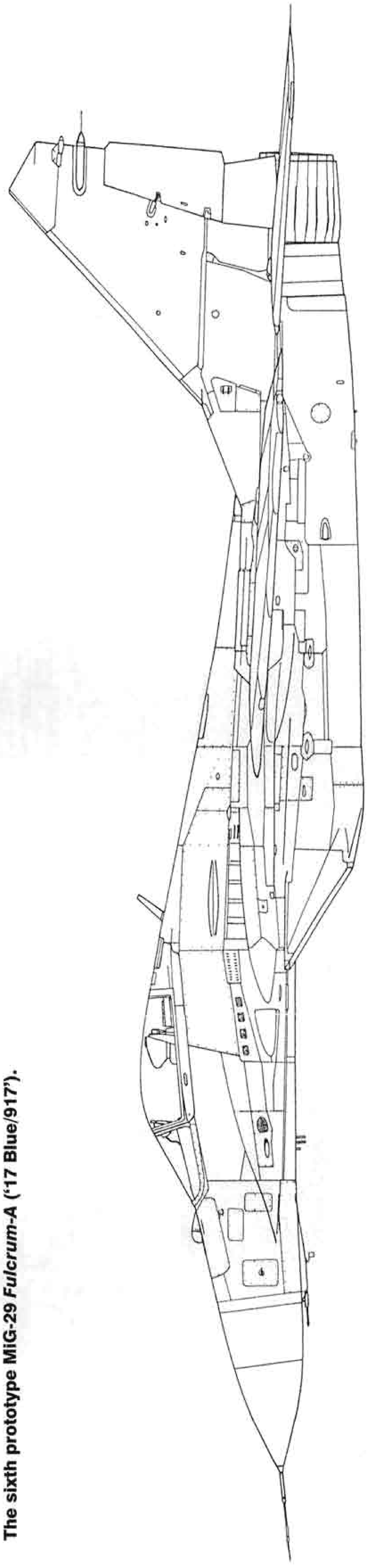
The first prototype MiG-29 *Fulcrum-A* with undercarriage retracted.



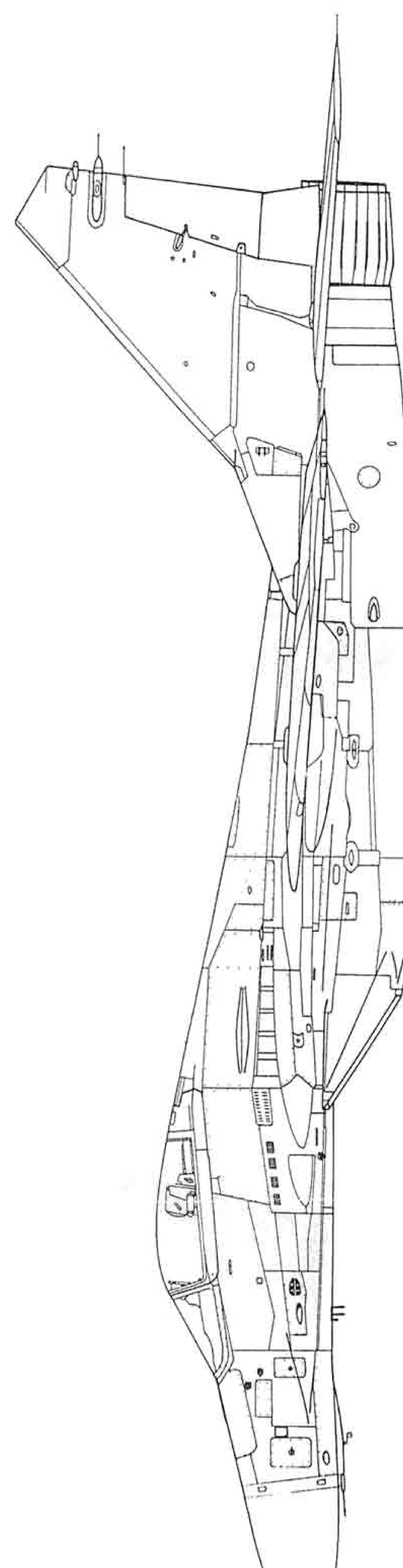
The first prototype following modifications.



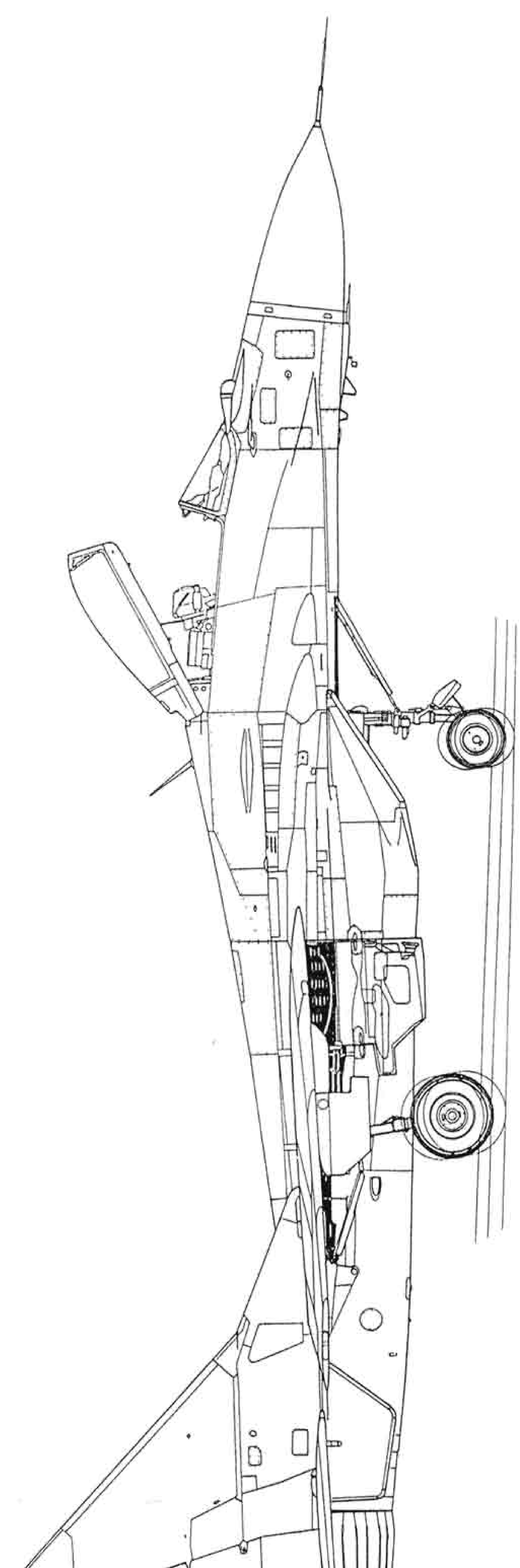
The fourth prototype MiG-29 *Fulcrum-A* ('04 Blue/904').



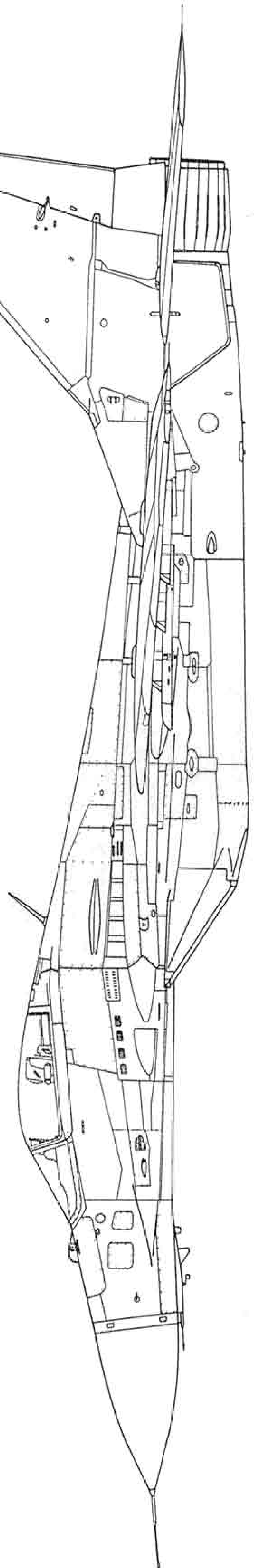
The sixth prototype MiG-29 *Fulcrum-A* ('17 Blue/917').



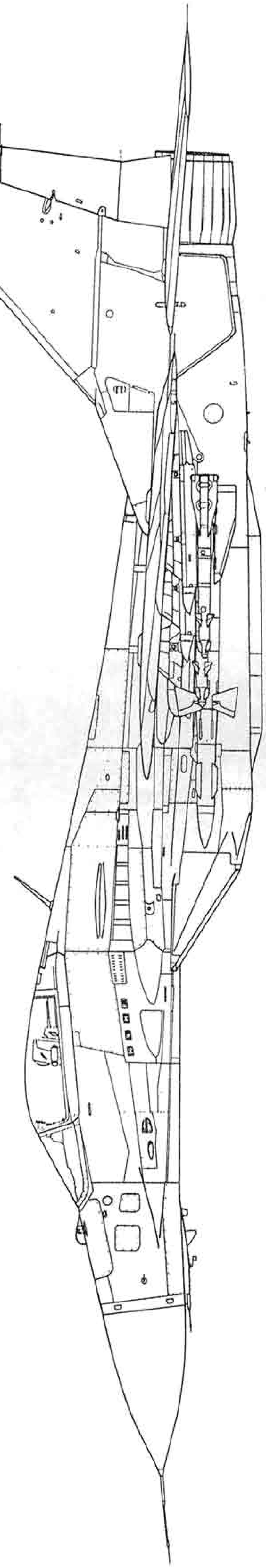
The eighth prototype MiG-29 *Fulcrum-A* ('18 Blue/918').



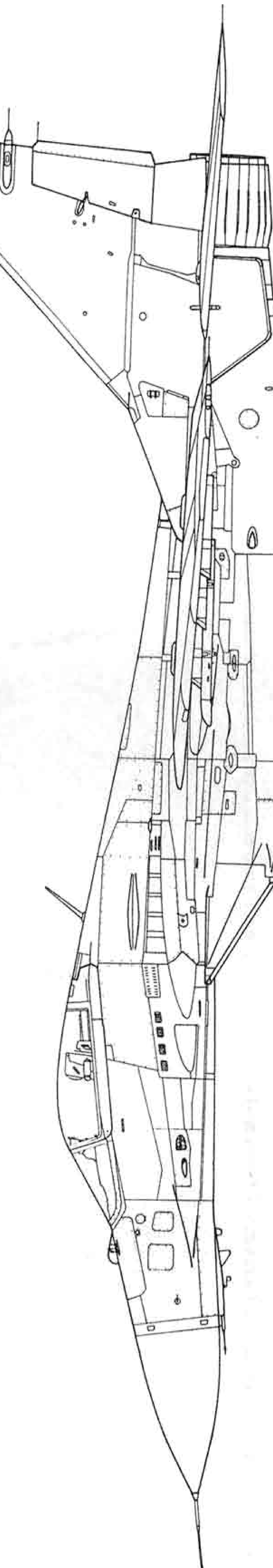
The first production MiG-29 *Fulcrum-A* ('24 Blue/924', c/n 0390501625, f/n 0101).



The first production MiG-29 *Fulcrum-A*.

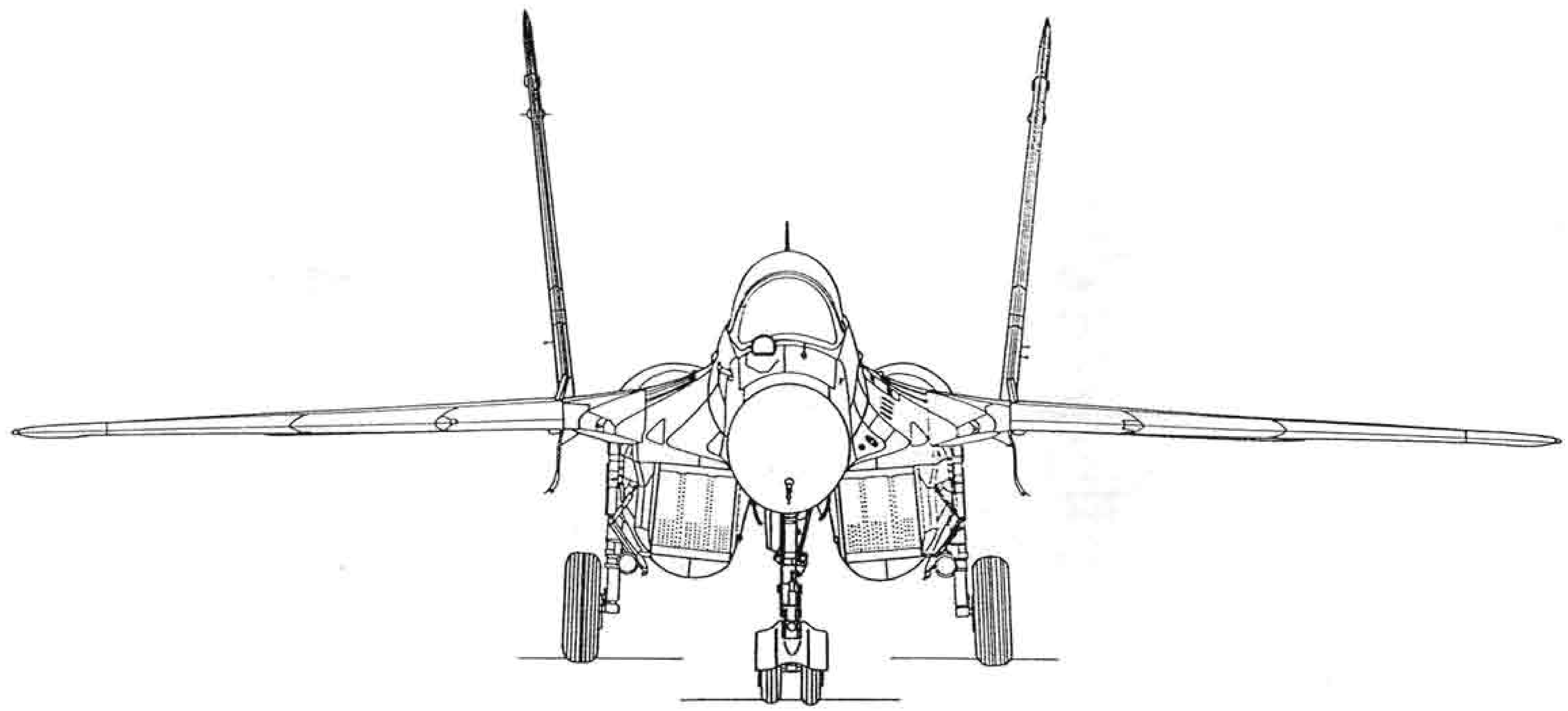


The same aircraft with R-27R and R-60 missiles

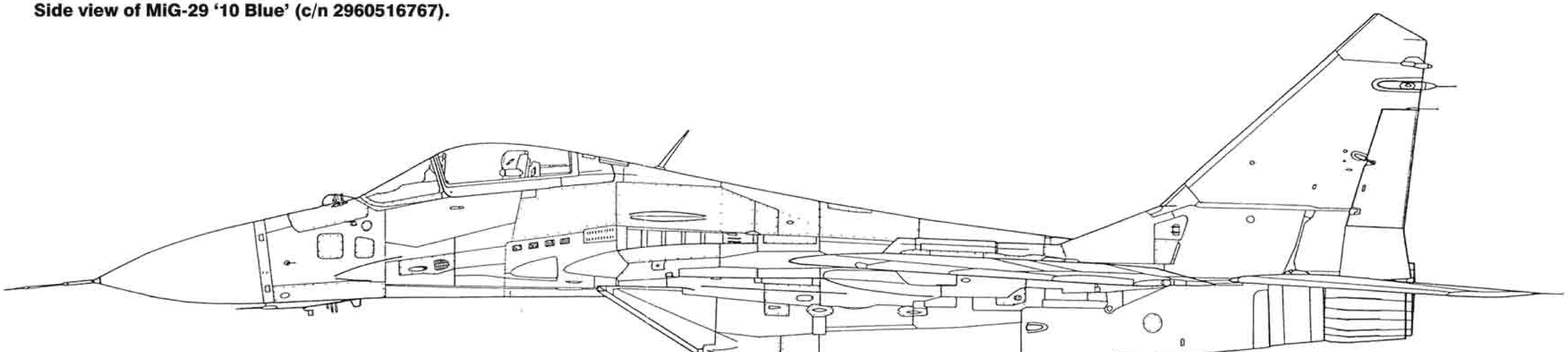


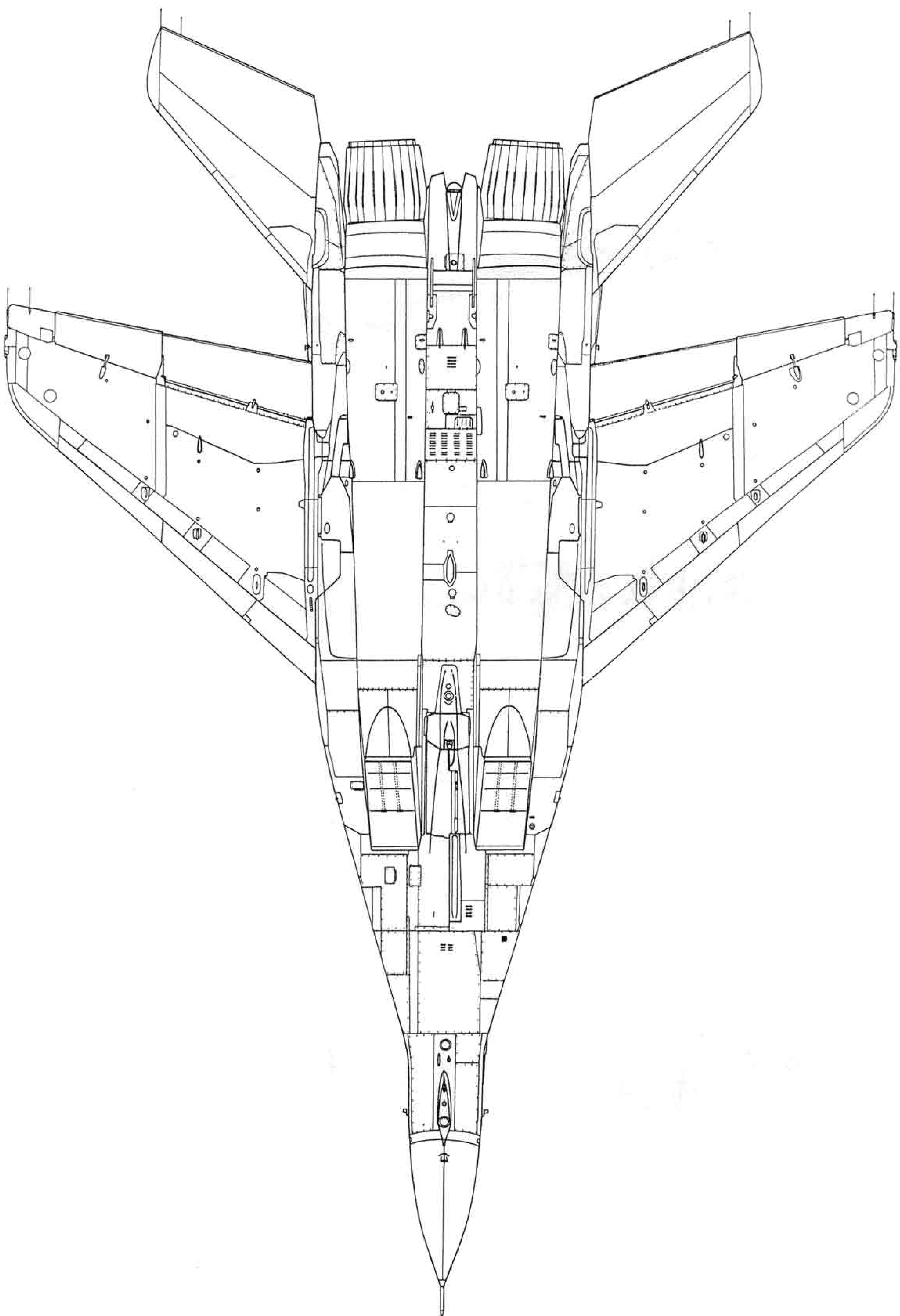
The same aircraft following modifications (with extended-chord rudders).

Front view of an early-production MiG-29 *Fulcrum-A* with a 'butterfly' nose gear door ('10 Blue', c/n 2960516767).

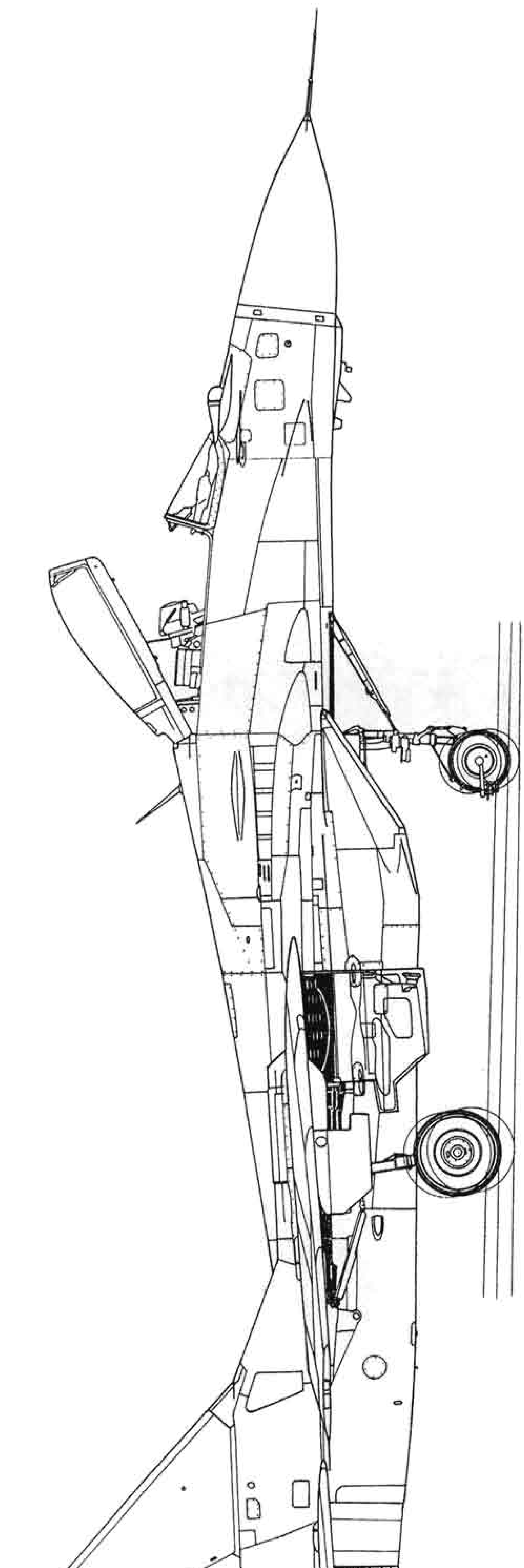


Side view of MiG-29 '10 Blue' (c/n 2960516767).

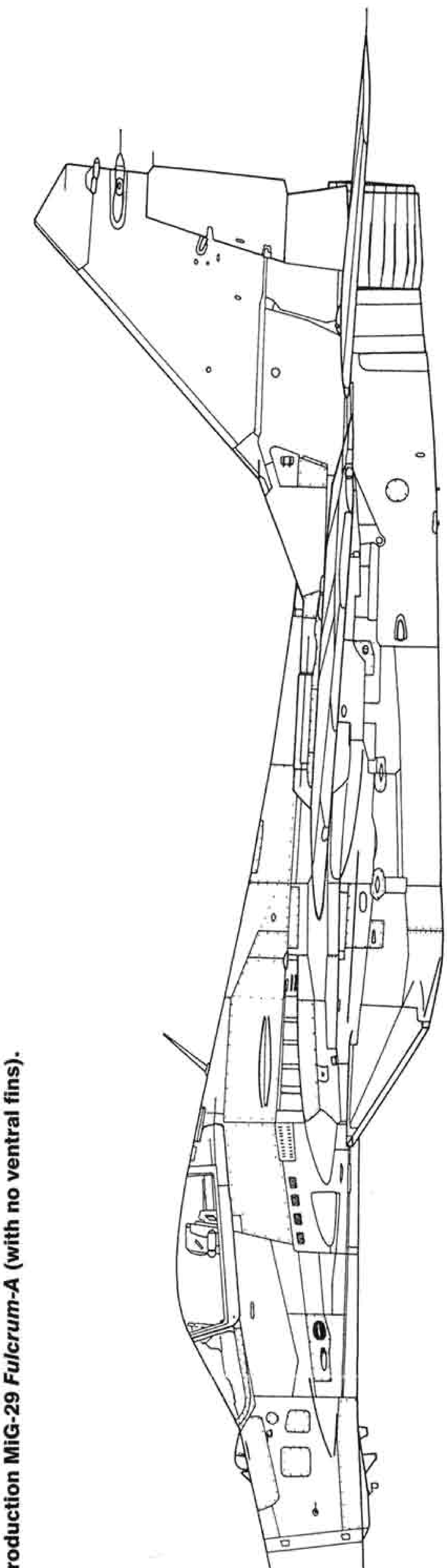




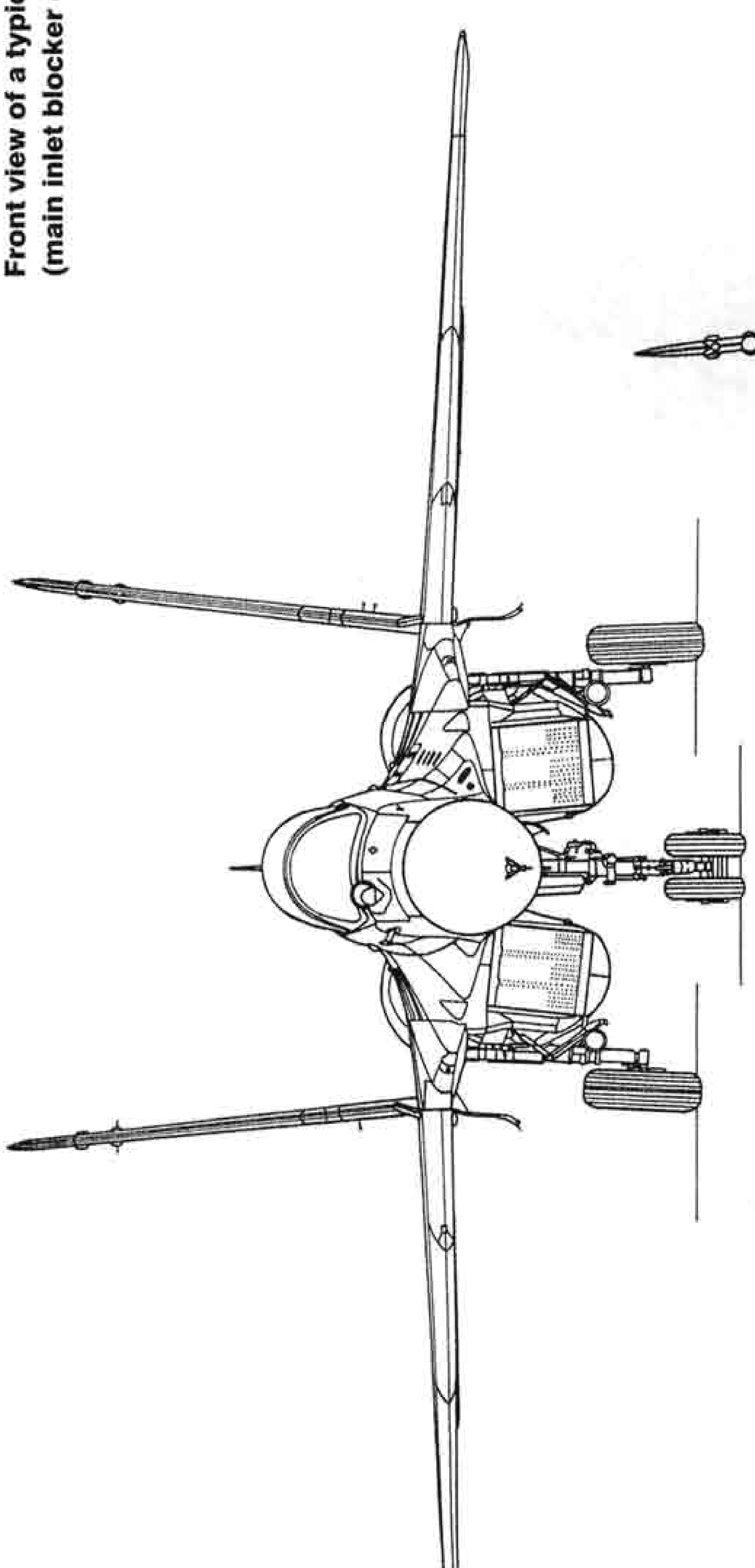
Underside view of the same aircraft.



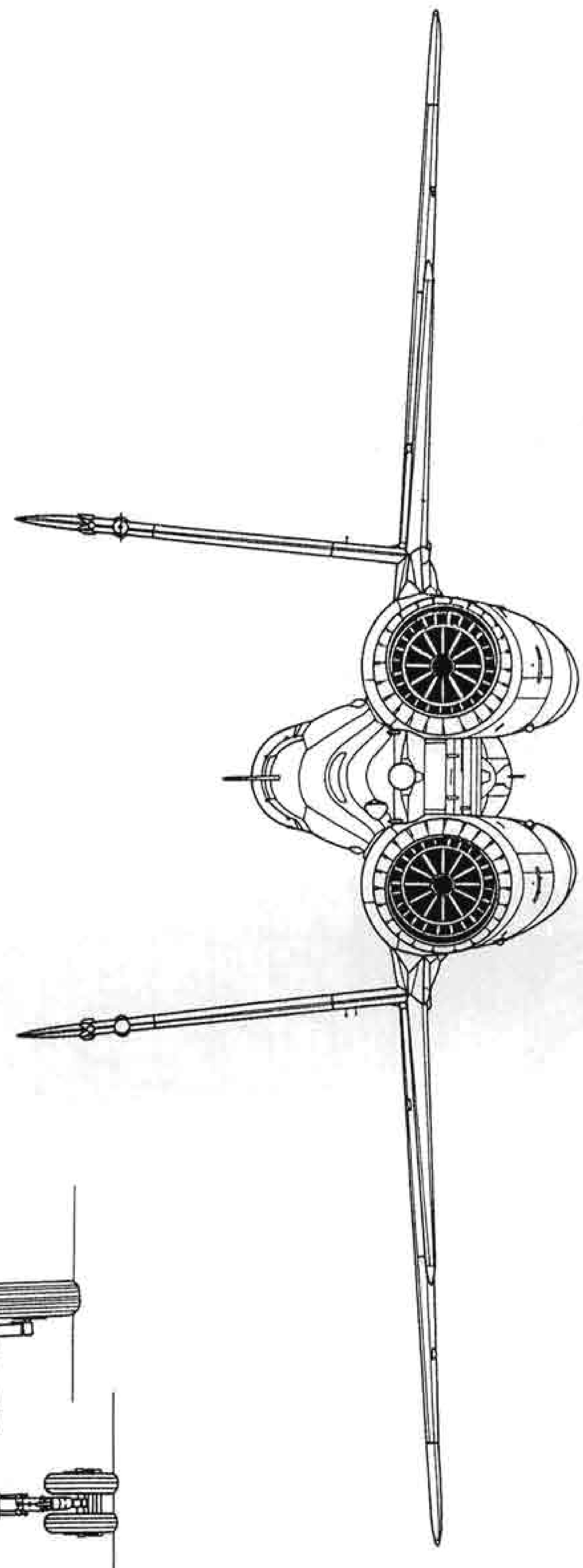
Starboard side view of a typical production MiG-29 *Fulcrum-A* (with no ventral fins).



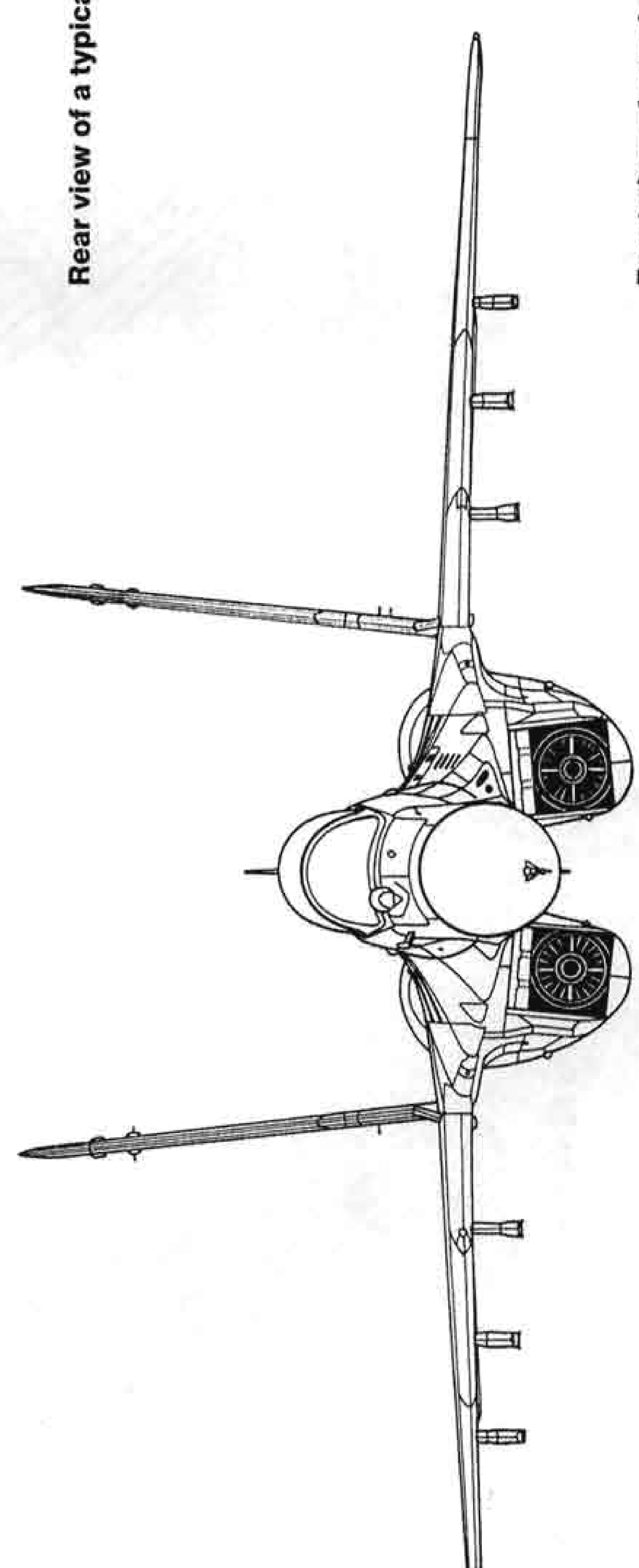
Port side view of a typical production MiG-29 *Fulcrum-A* (with no ventral fins).



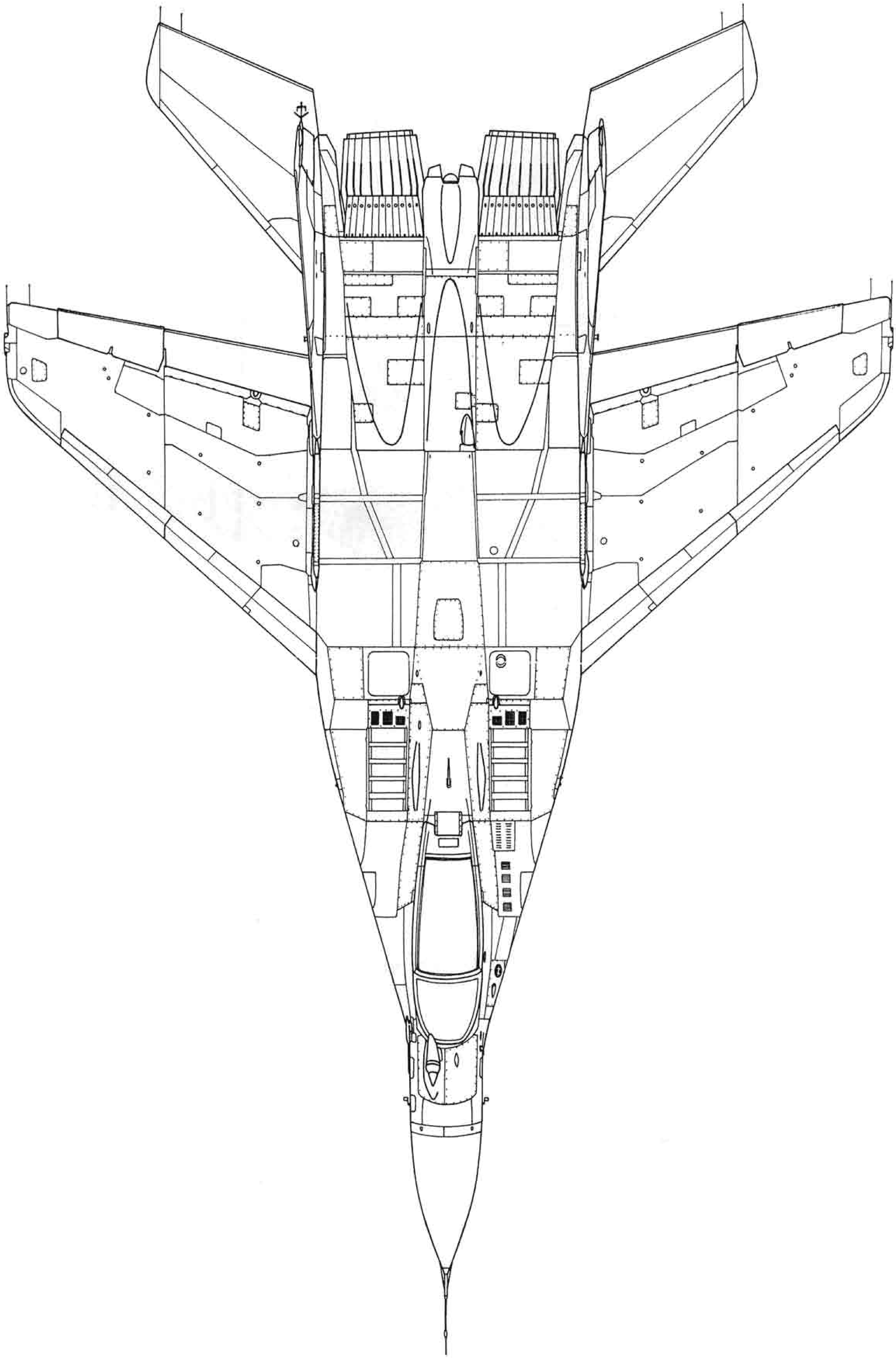
Front view of a typical production MiG-29 *Fulcrum-A* (main inlet blocker doors closed).



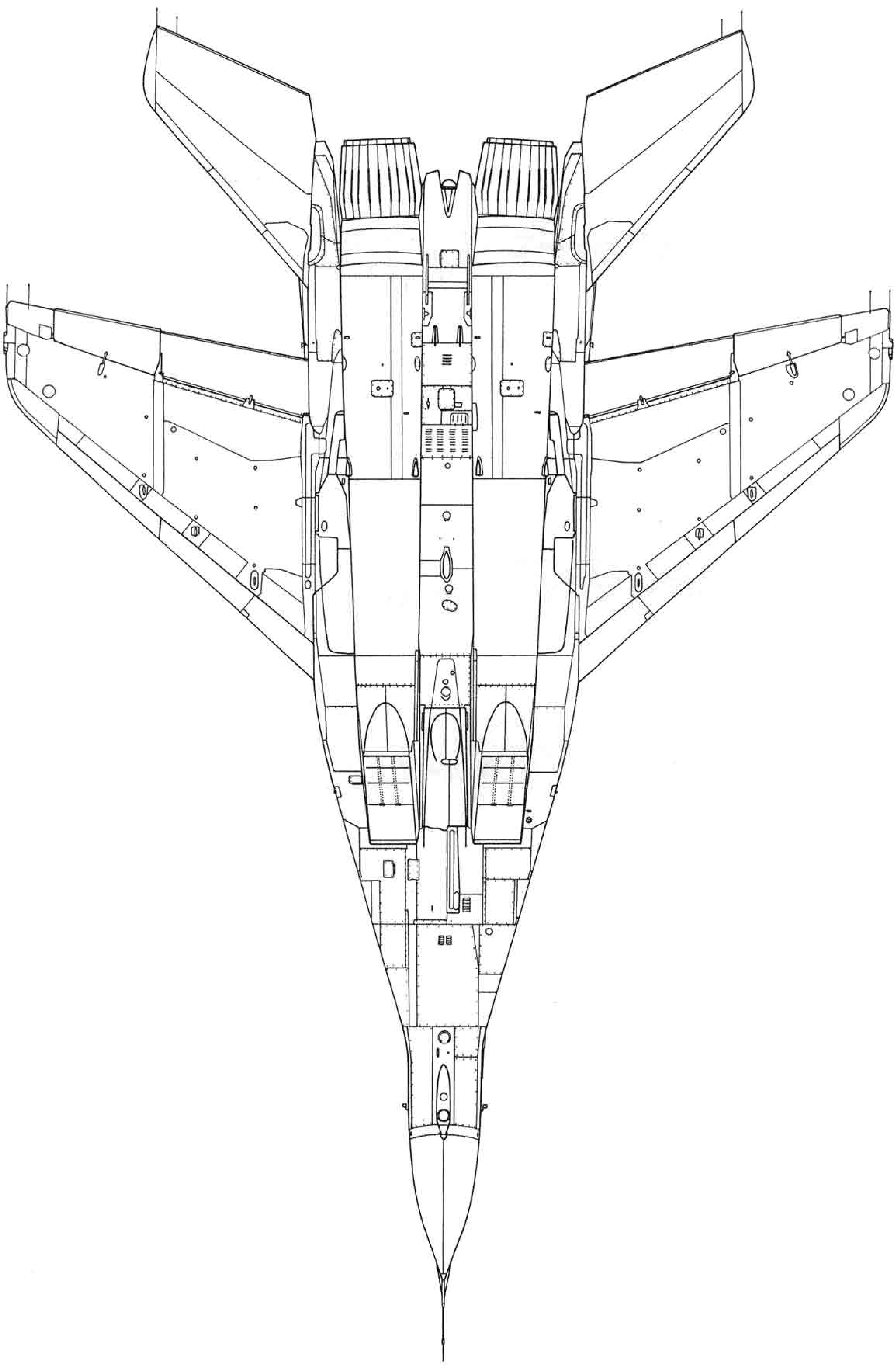
Rear view of a typical production MiG-29 *Fulcrum-A*.



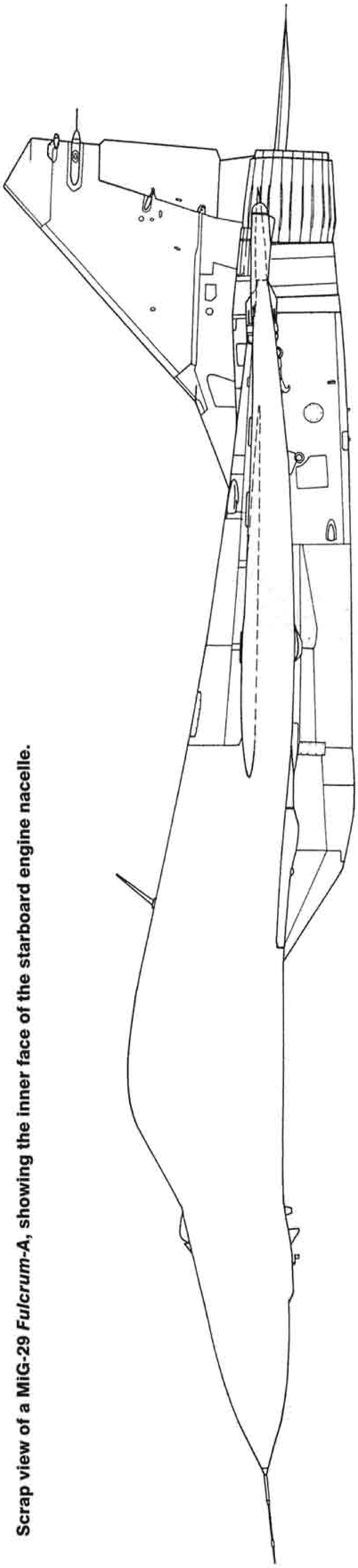
Front view of a typical production MiG-29 *Fulcrum-A* (main inlet blocker doors open).



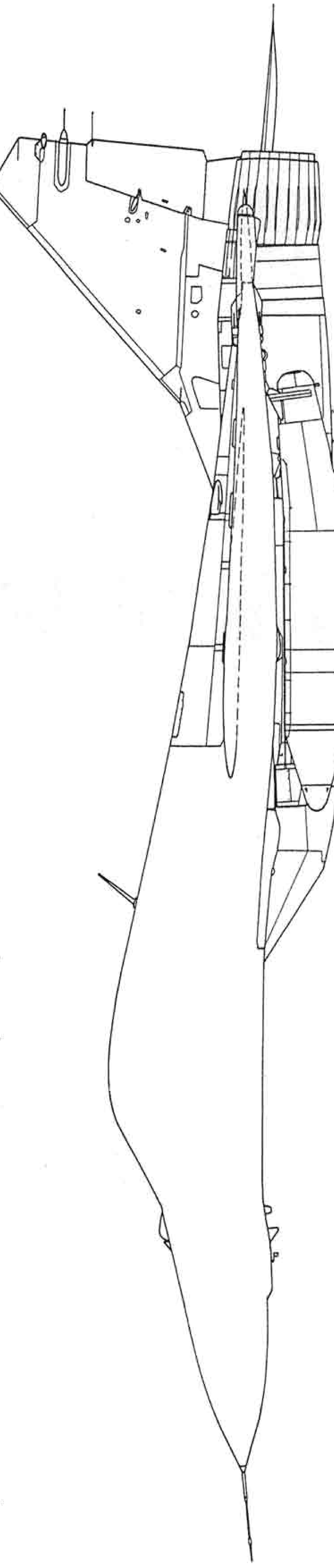
Upper view of a typical production MiG-29 *Fulcrum-A*.



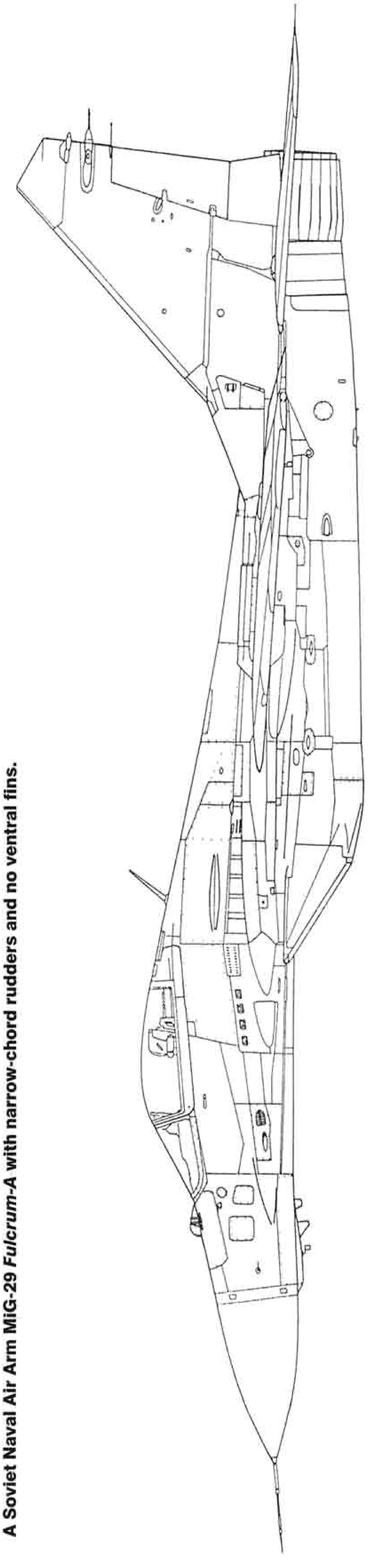
Lower view of a typical production MiG-29 *Fulcrum-A*.



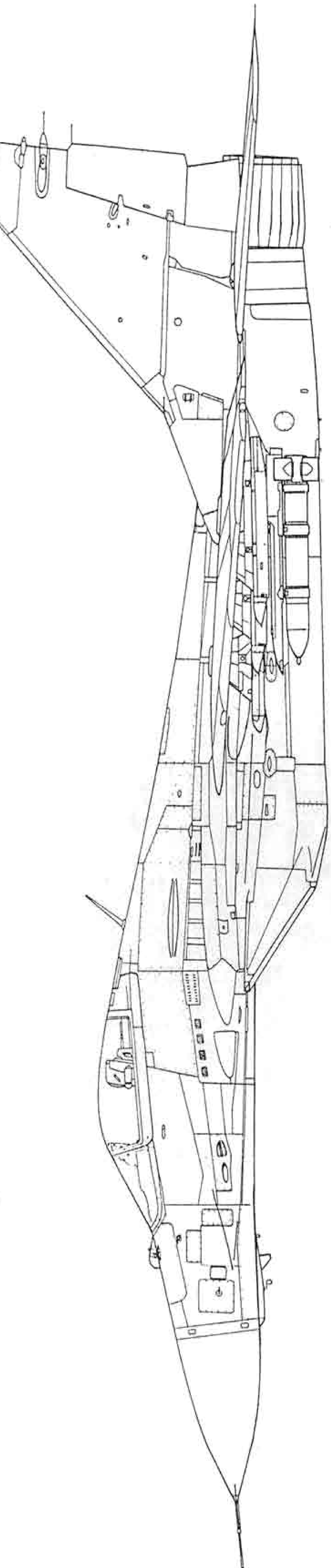
Scrap view of a MiG-29 *Fulcrum-A*, showing the inner face of the starboard engine nacelle.



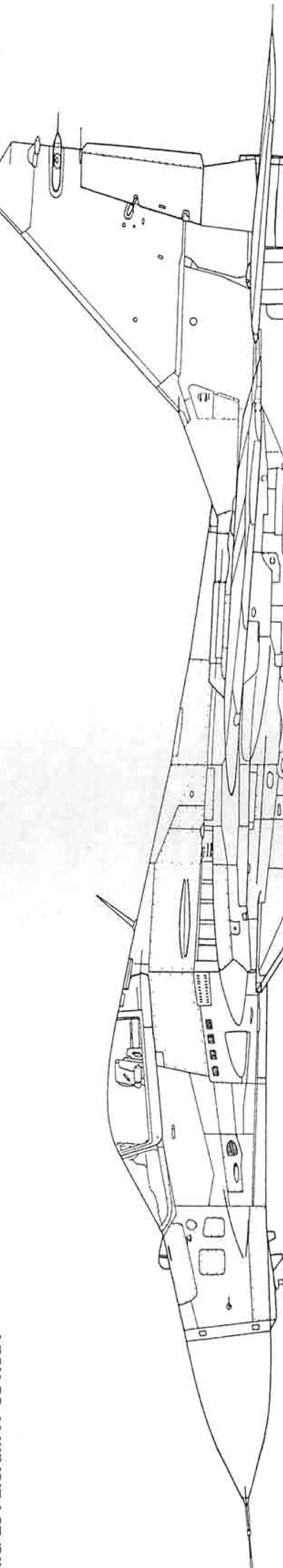
Scrap view of a MiG-29 *Fulcrum-A* with the centreline drop tank in place.



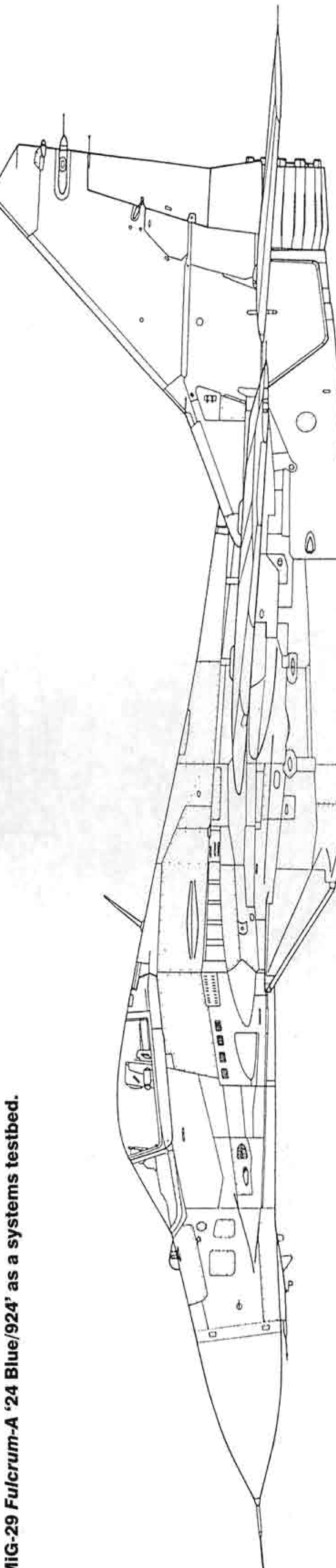
A Soviet Naval Air Arm MiG-29 *Fulcrum-A* with narrow-chord rudders and no ventral fins.



MiG-29 *Fulcrum-A* '48 Blue' with S-24B unguided rockets.

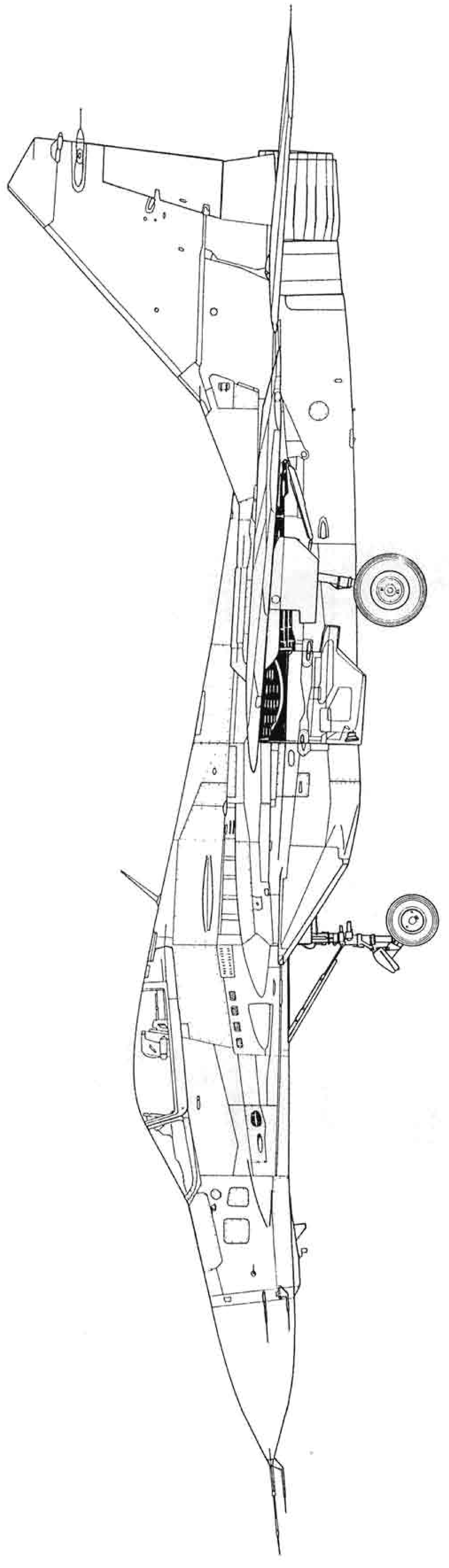


MiG-29 *Fulcrum-A* '33 Red'.

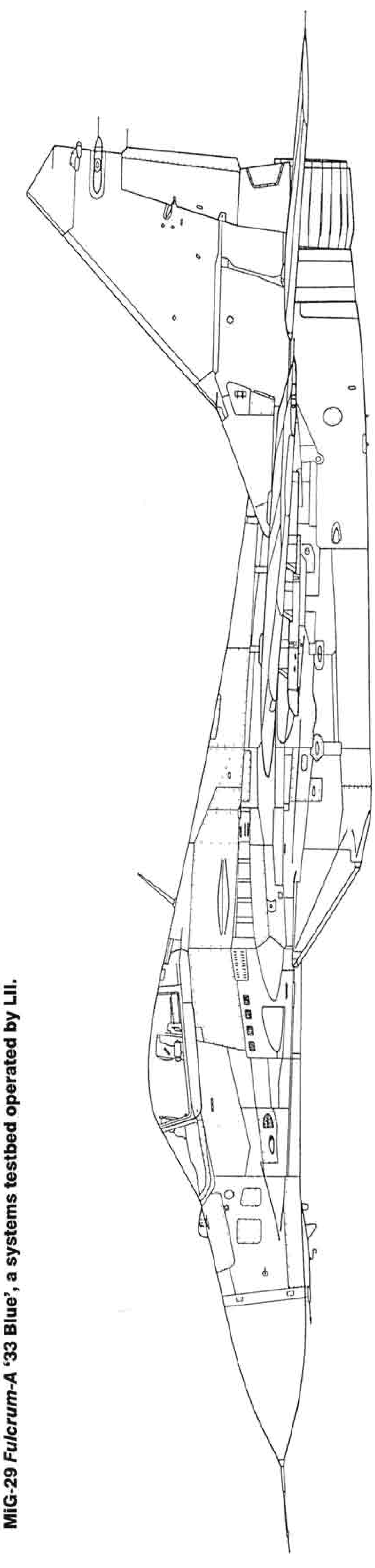


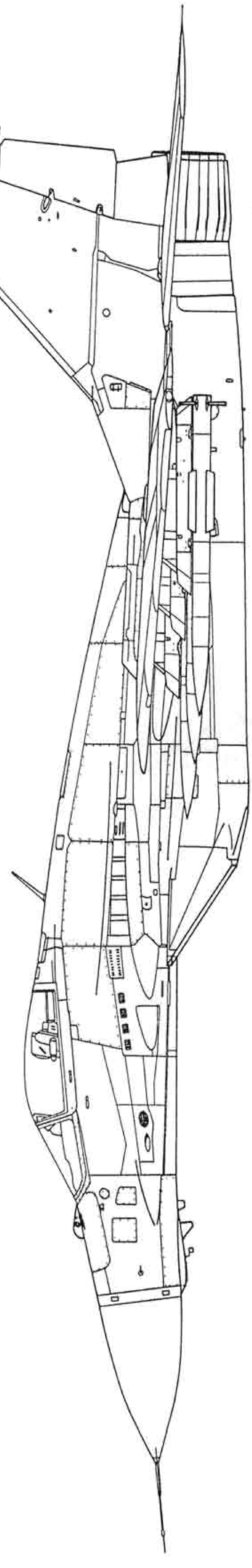
MiG-29 *Fulcrum-A* '24 Blue/924' as a systems testbed.

The MiG-29E Skif (*izdeliye 9.21*) avionics testbed ('11 Blue/211', f/n 1601)

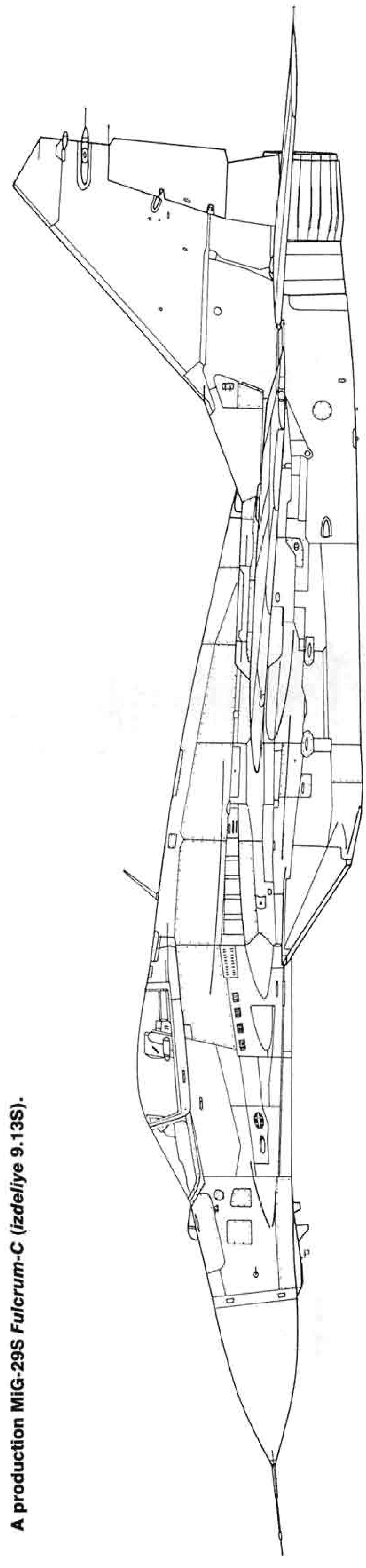


MiG-29 *Fulcrum-A* '33 Blue', a systems testbed operated by LII.

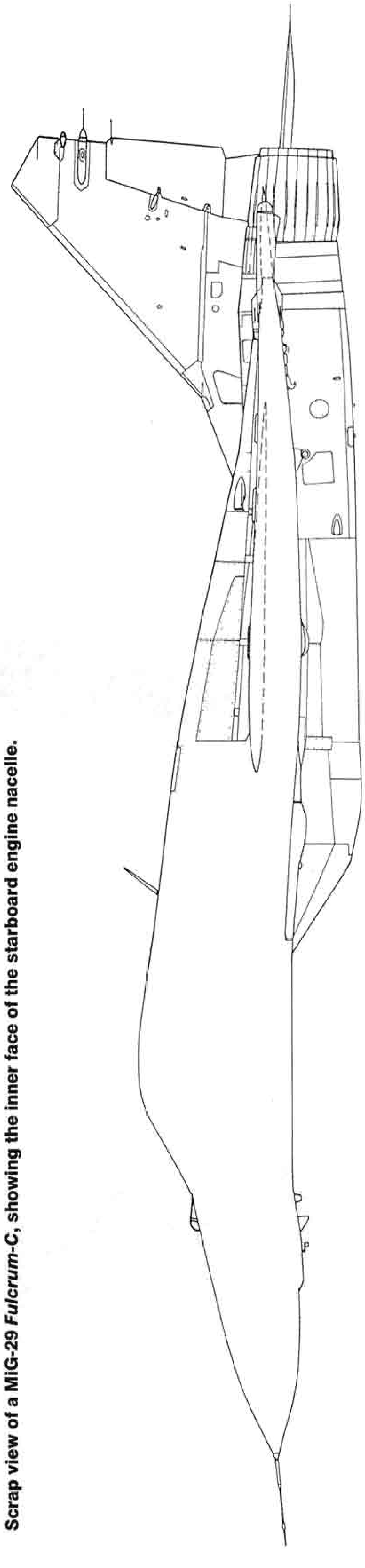




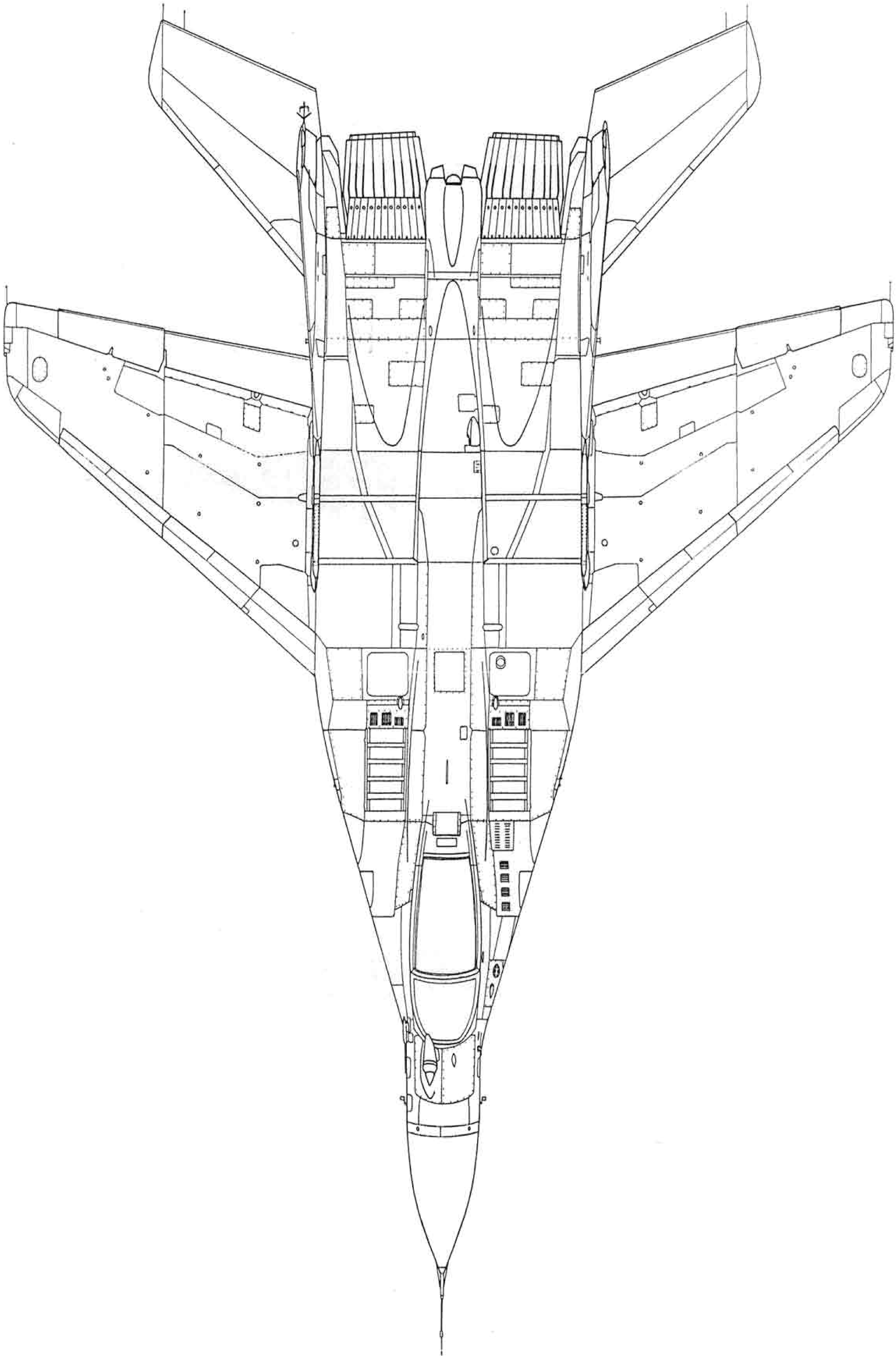
The MiG-29S *Fulcrum-C* (*izdeliye* 9.13) prototype, '407 Blue' (converted *Fulcrum-A* c/n 2960507682, f/n 0707).



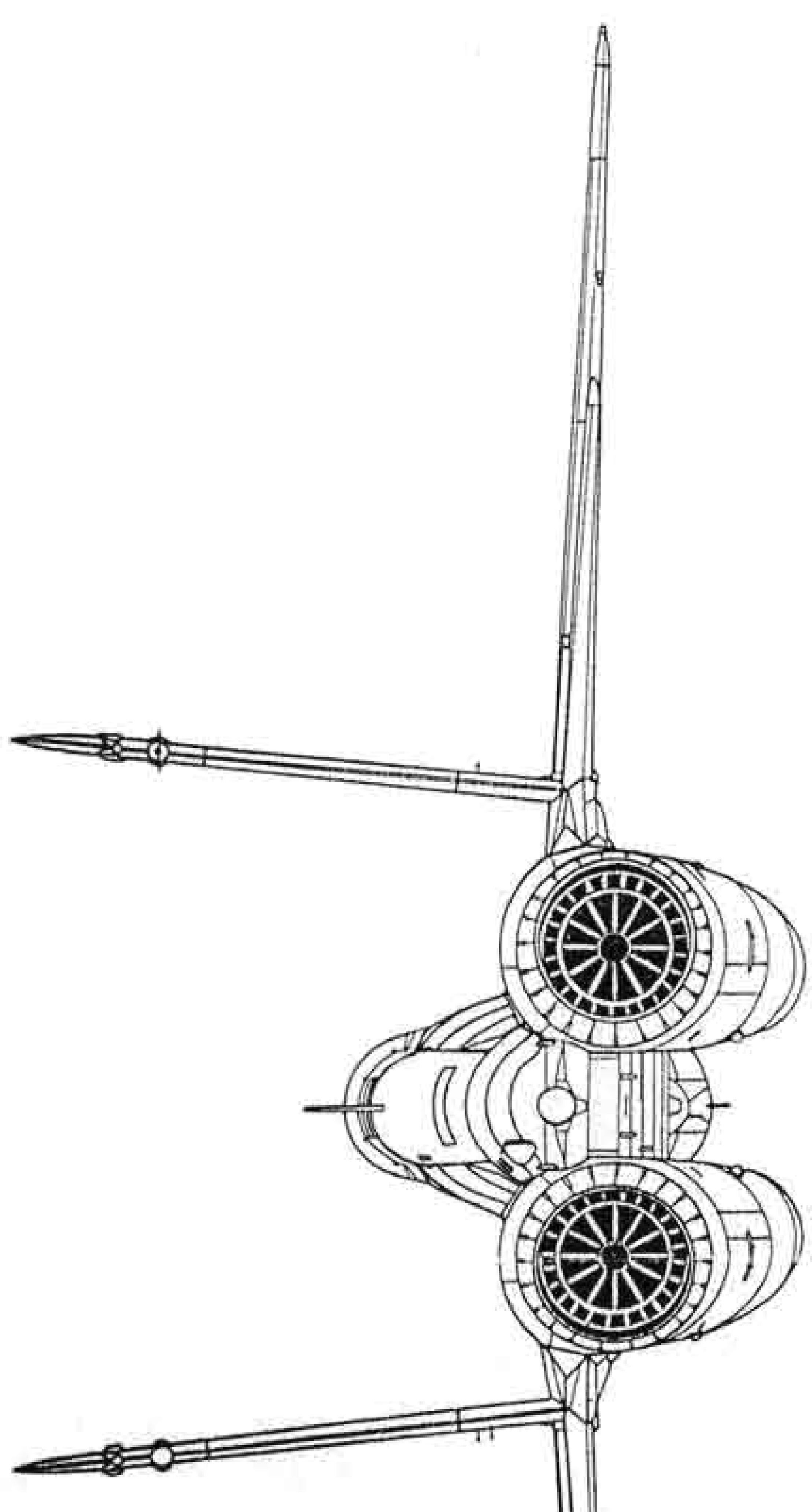
A production MiG-29S *Fulcrum-C* (*izdeliye* 9.13S).



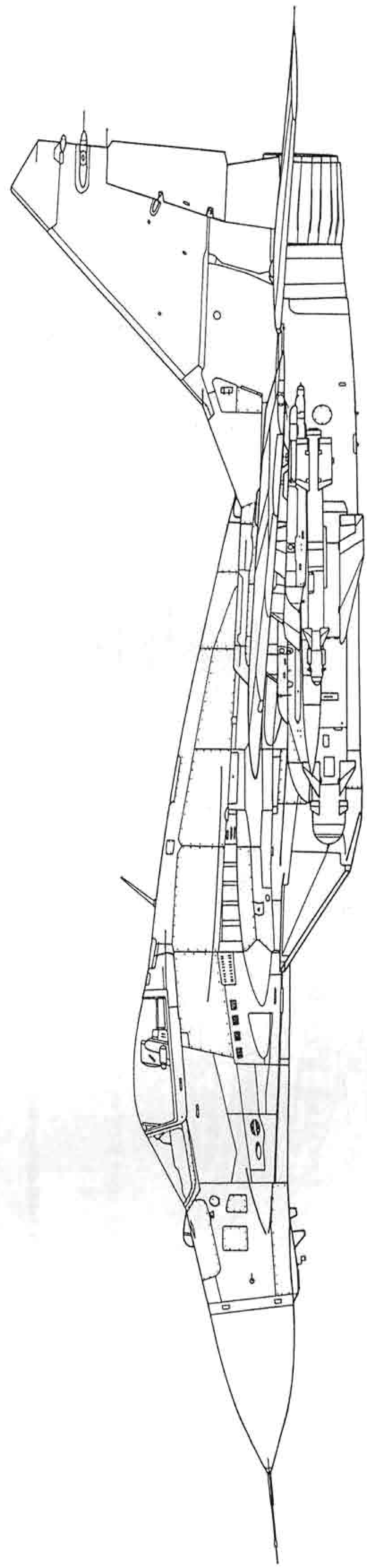
Scrap view of a MiG-29 *Fulcrum-C*, showing the inner face of the starboard engine nacelle.



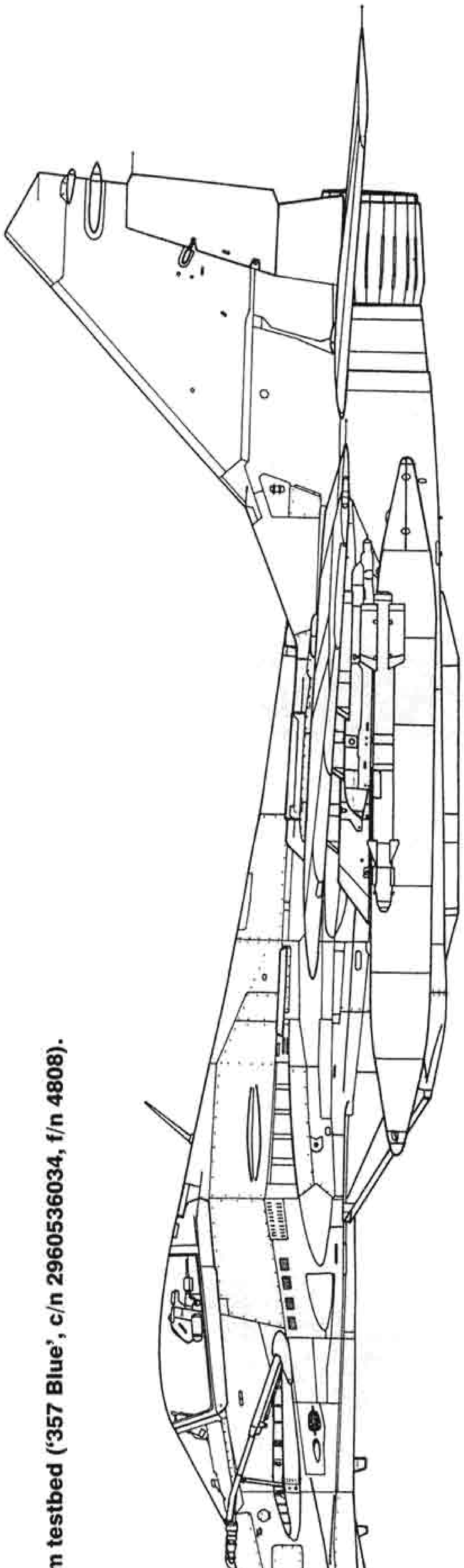
Upper view of a typical production MiG-29 *Fulcrum-C*.



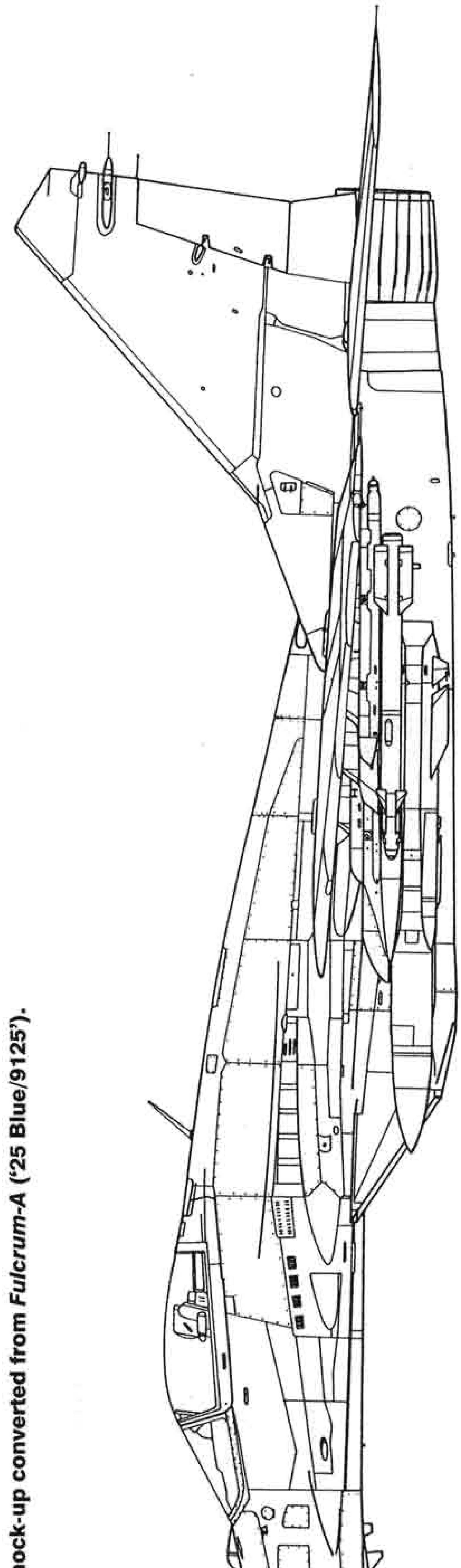
Rear view of a typical production MiG-29 *Fulcrum-C*.



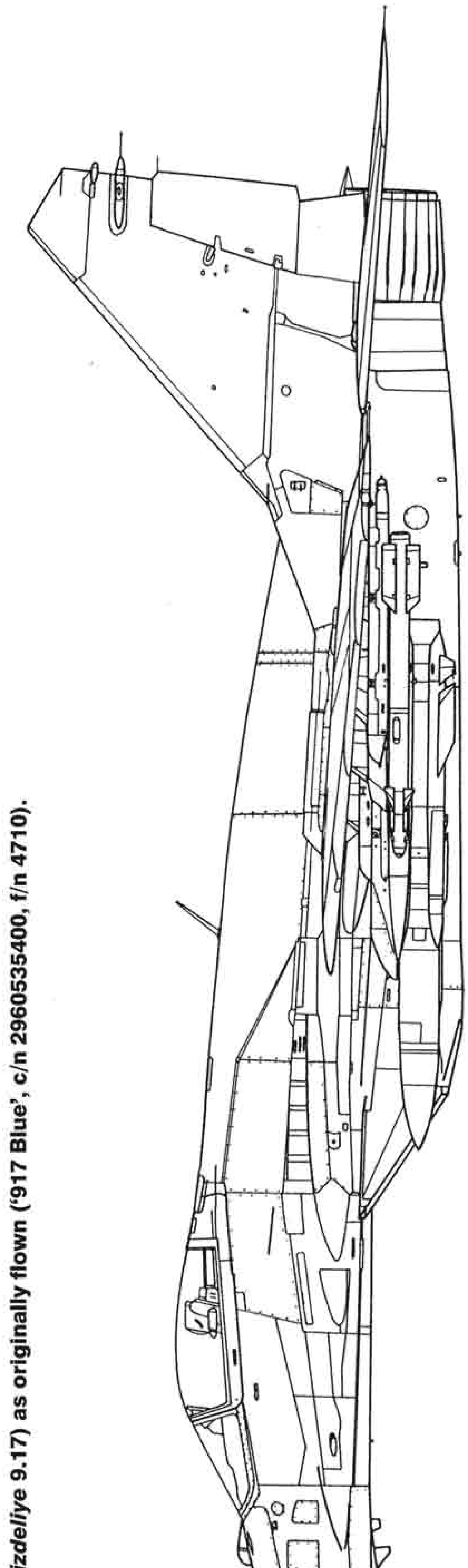
A MiG-29SM *Fulcrum-C* carrying a Kh-29T missile.



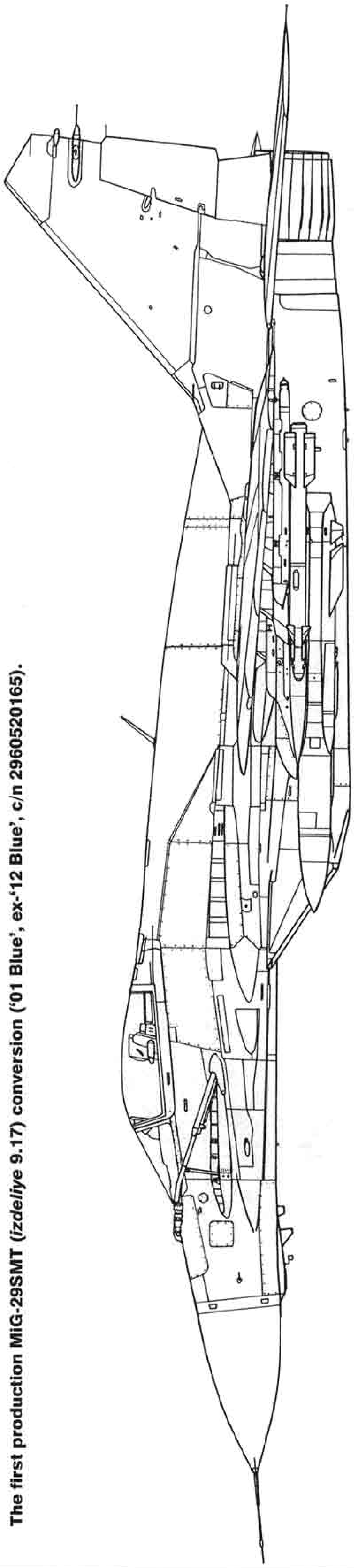
The MiG-29 *Fulcrum-A* IFR system testbed ('357 Blue', c/n 2960536034, f/n 4808).



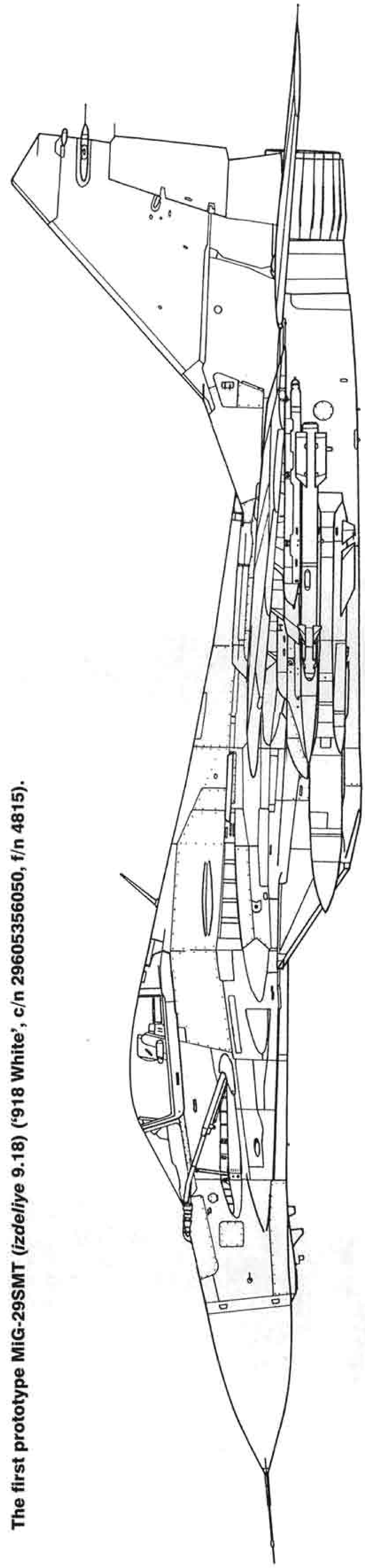
The MiG-29SMT (*izdeliye* 9.17) mock-up converted from *Fulcrum-A* ('25 Blue/9125').



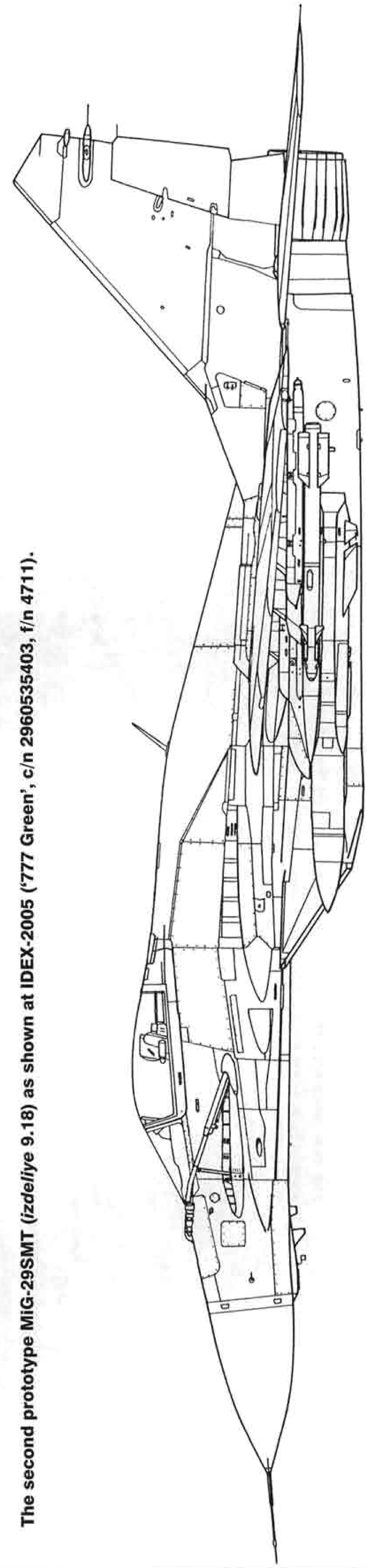
The first prototype MiG-29SMT (*izdeliye* 9.17) as originally flown ('917 Blue', c/n 2960535400, f/n 4710).



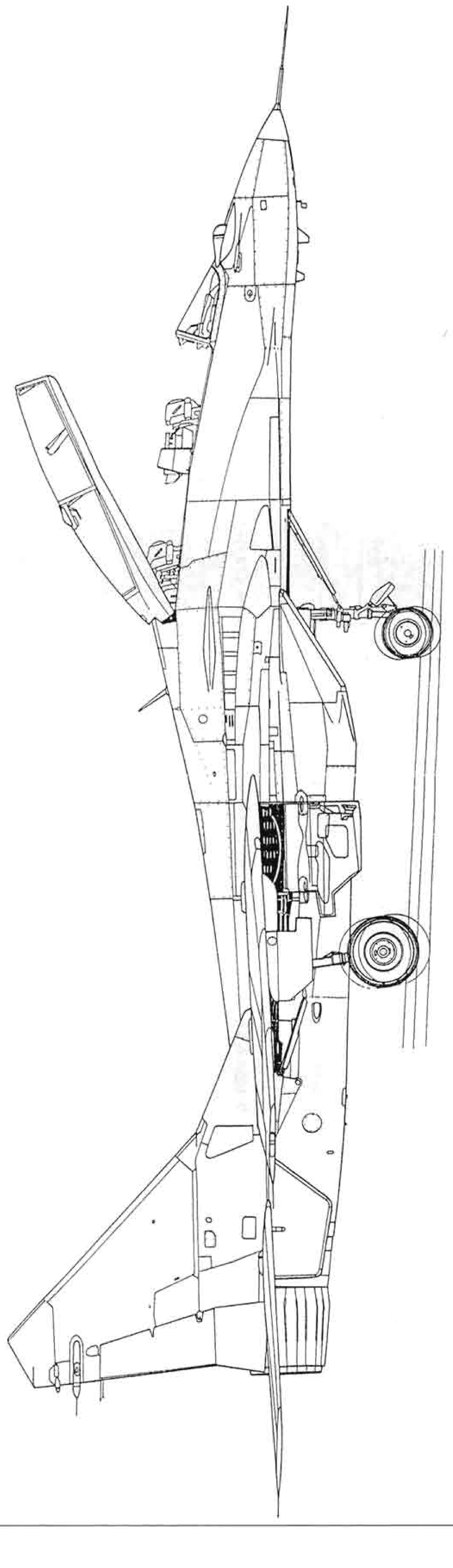
The first production MiG-29SMT (*izdeliye* 9.17) conversion ('01 Blue', ex-'12 Blue', c/n 2960520165).



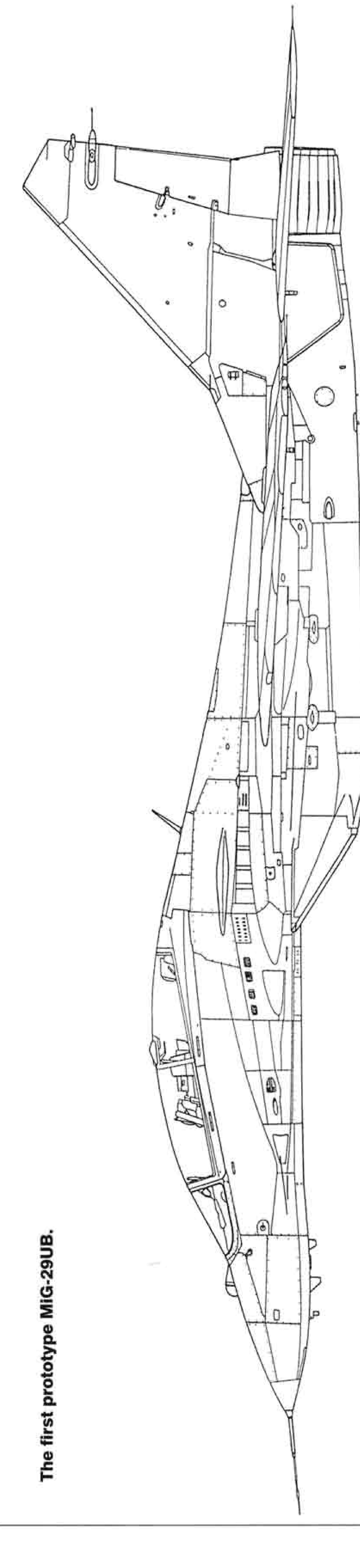
The first prototype MiG-29SMT (*izdeliye* 9.18) ('918 White', c/n 29605356050, f/n 4815).



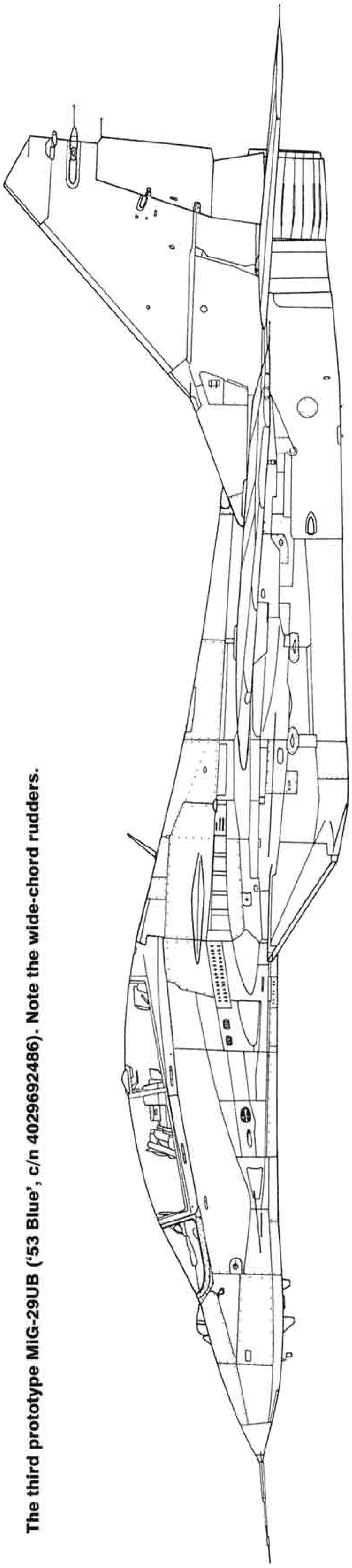
The second prototype MiG-29SMT (*izdeliye* 9.18) as shown at IDEX-2005 ('777 Green', c/n 2960535403, f/n 4711).



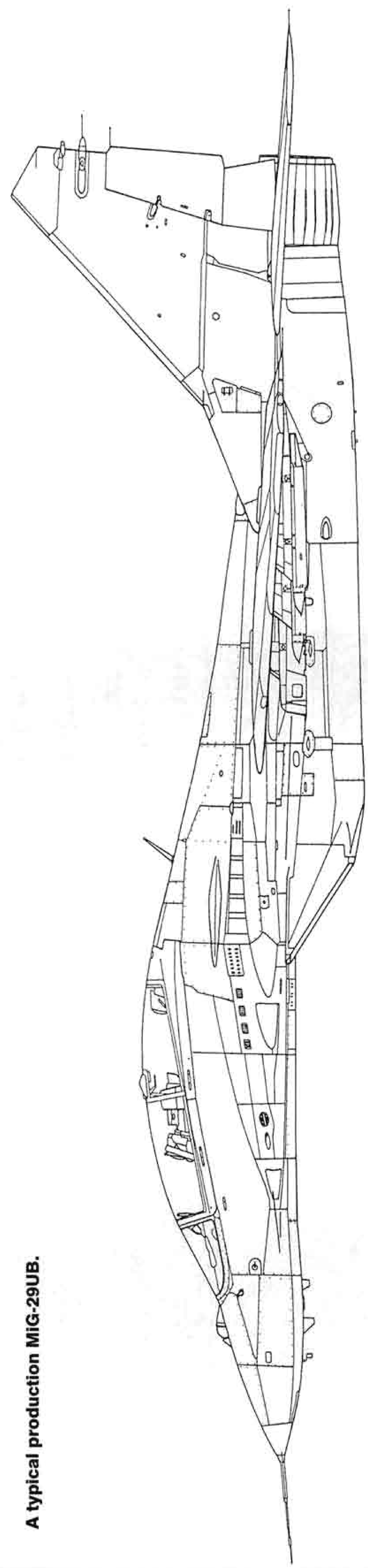
The first prototype MiG-29UB (*izdeliye* 9.51) ('51 Blue/951'). Note the ventral fins, narrow-chord rudders and 'butterfly' nose gear door.



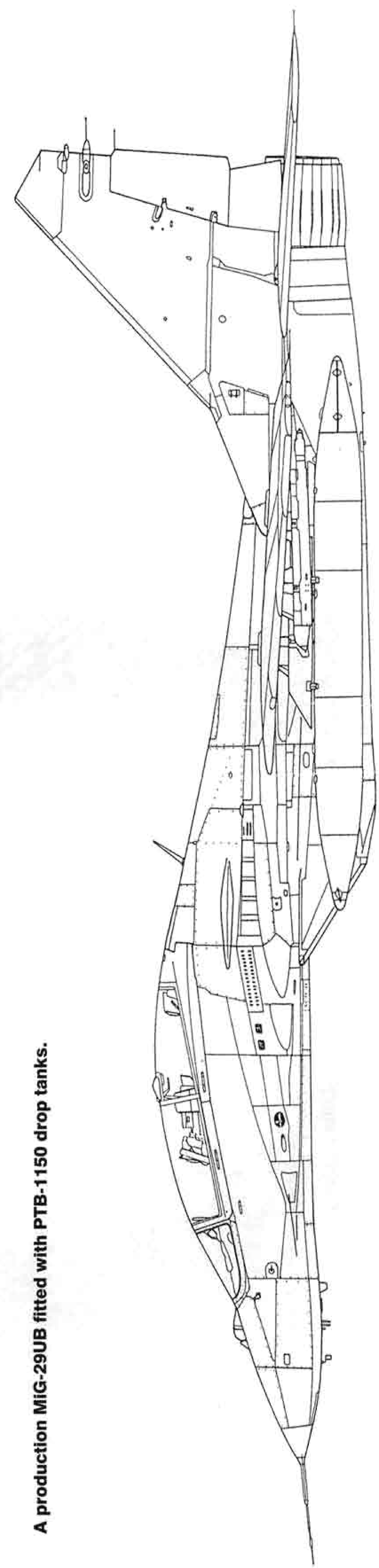
The first prototype MiG-29UB.



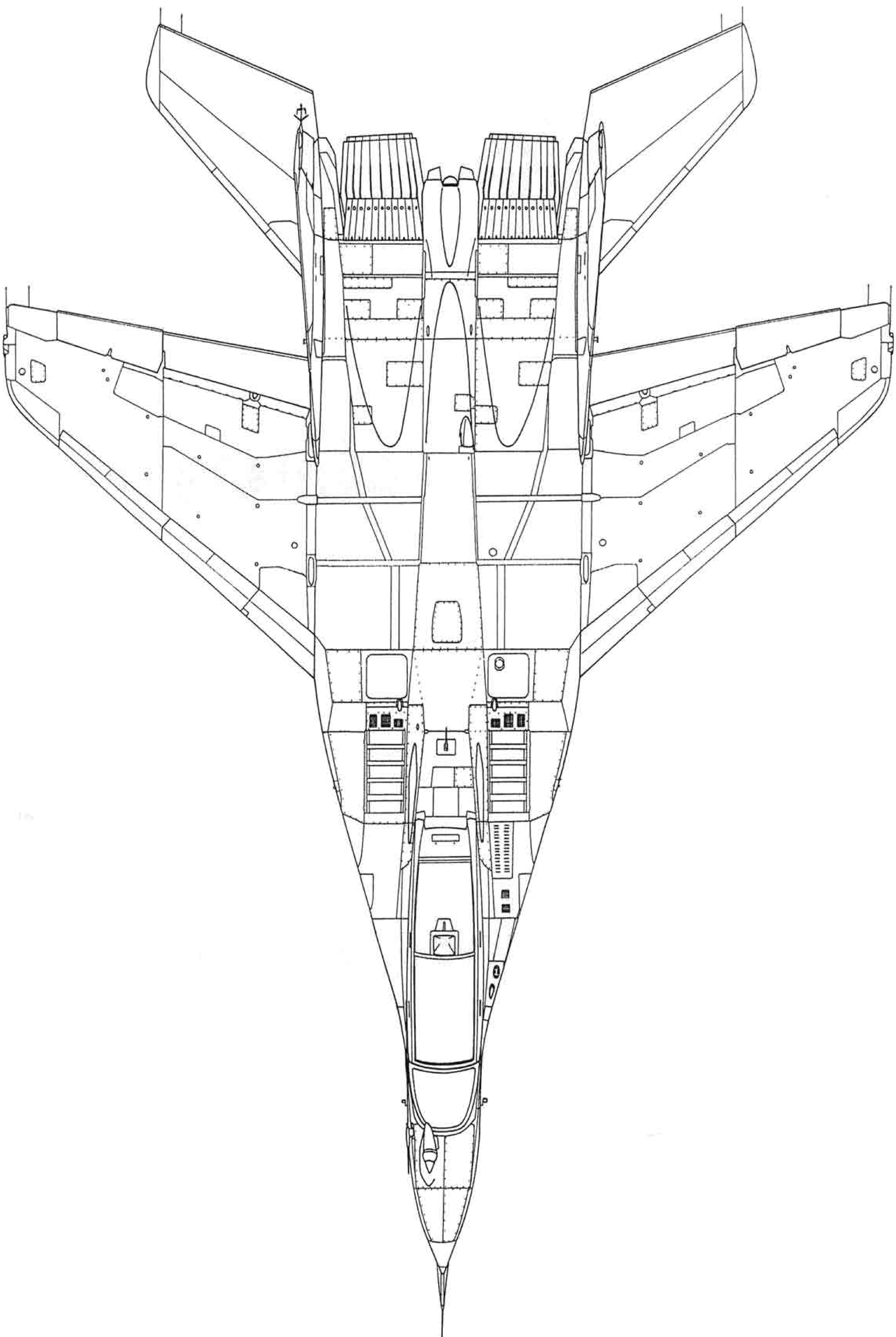
The third prototype MiG-29UB ('53 Blue', c/n 40296924[8]6). Note the wide-chord rudders.



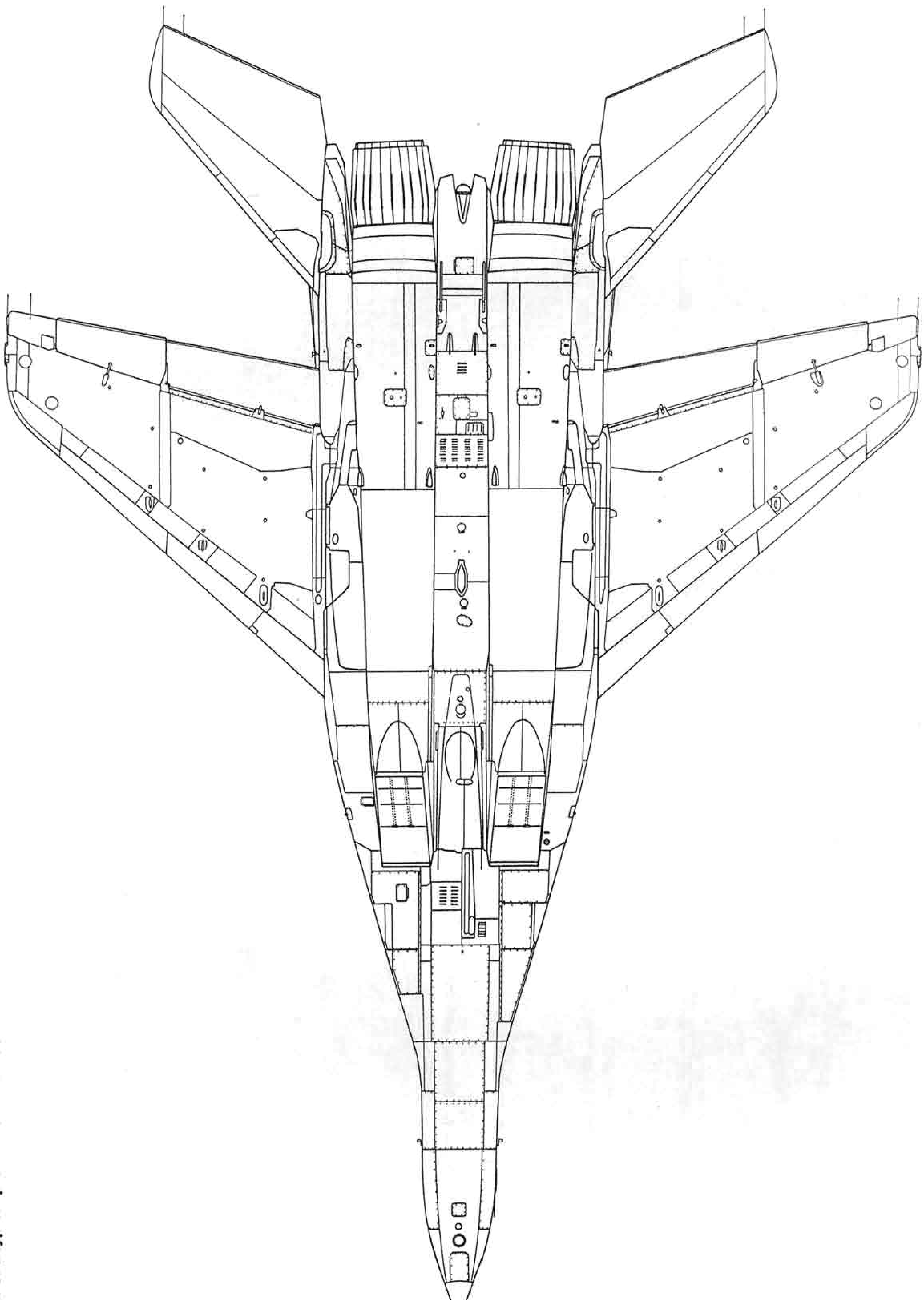
A typical production MiG-29UB.



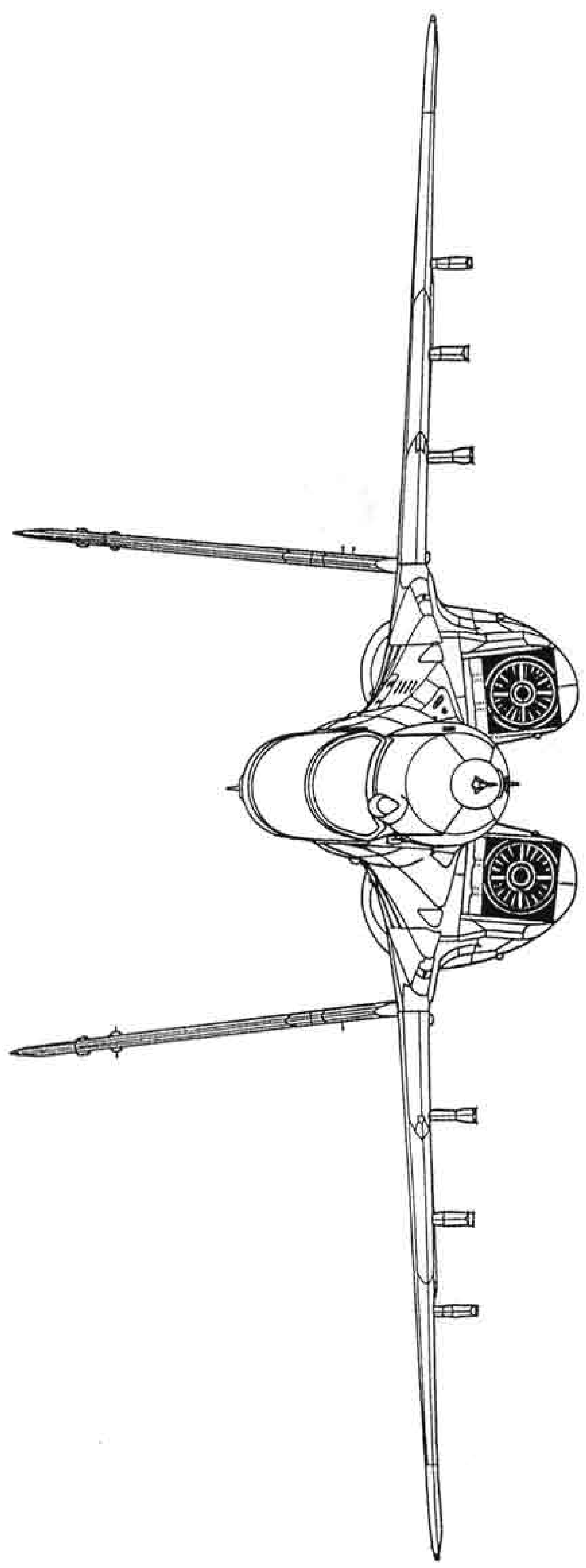
A production MiG-29UB fitted with PTB-1150 drop tanks.



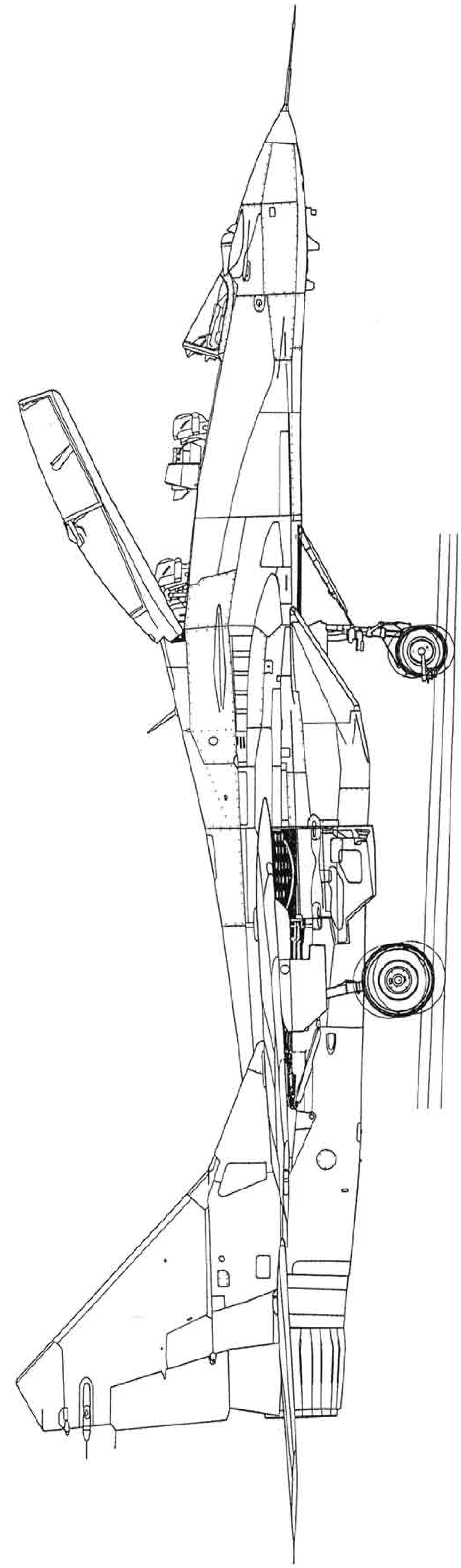
Upper view of a typical production MiG-29UB.



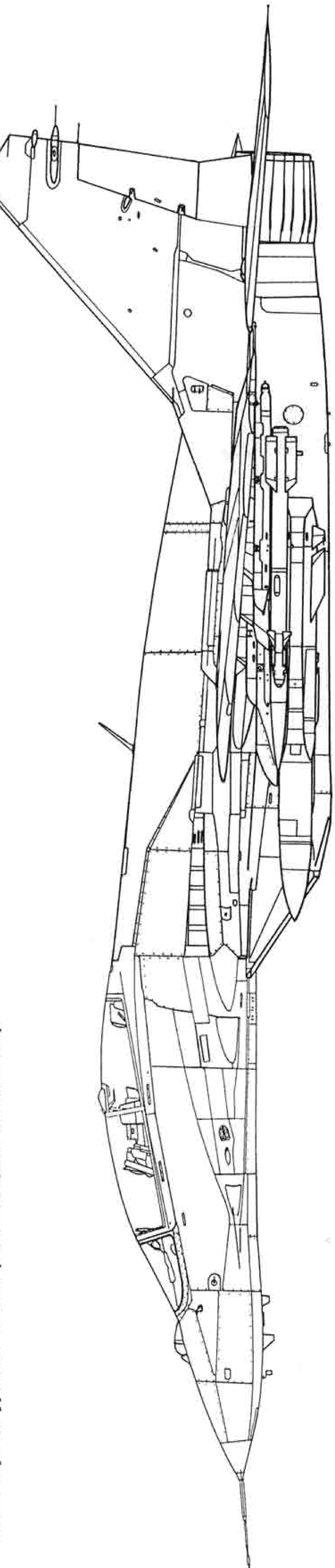
Lower view of a typical production MiG-29UB.



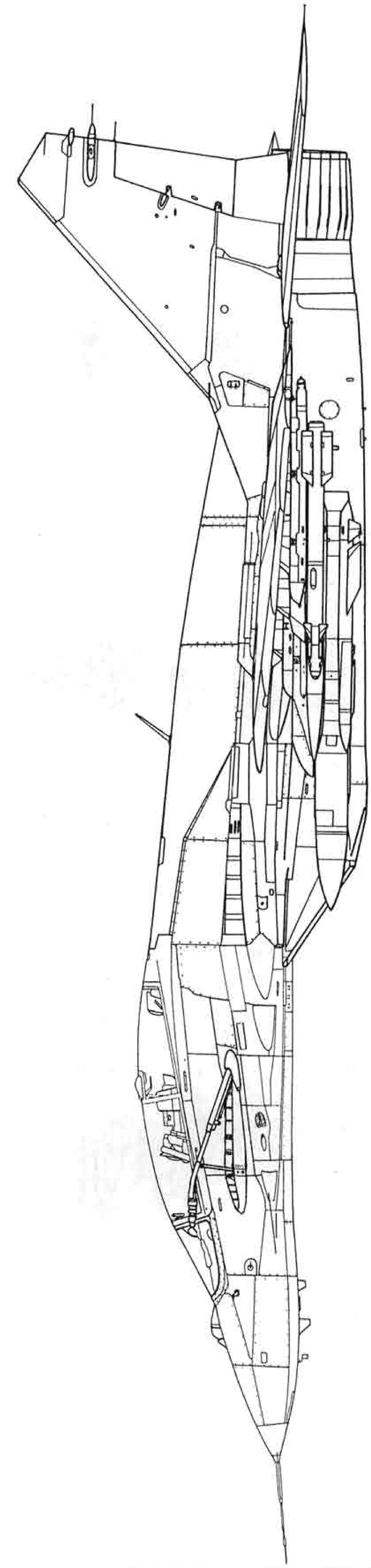
Front view of a typical production MiG-29UB.



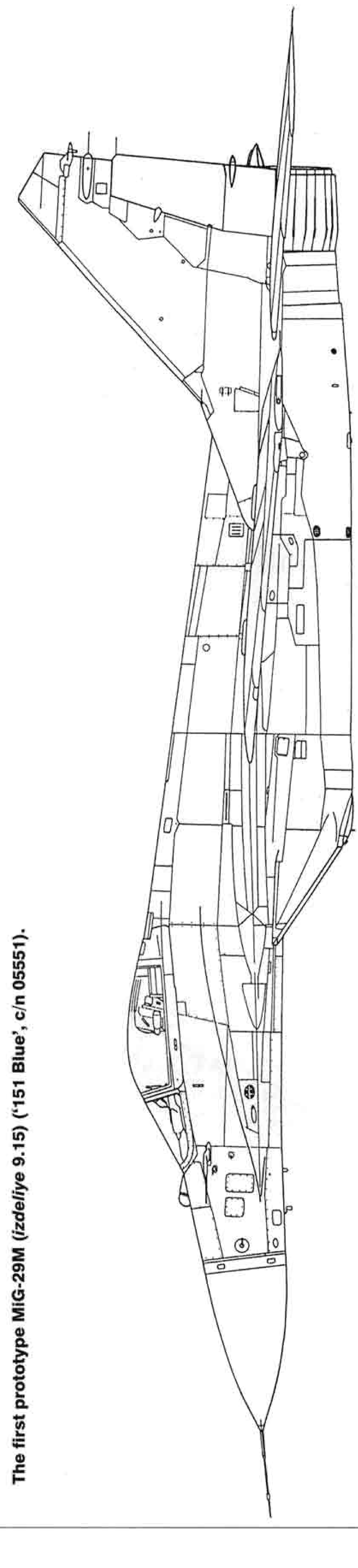
Starboard side view of a typical production MiG-29UB.



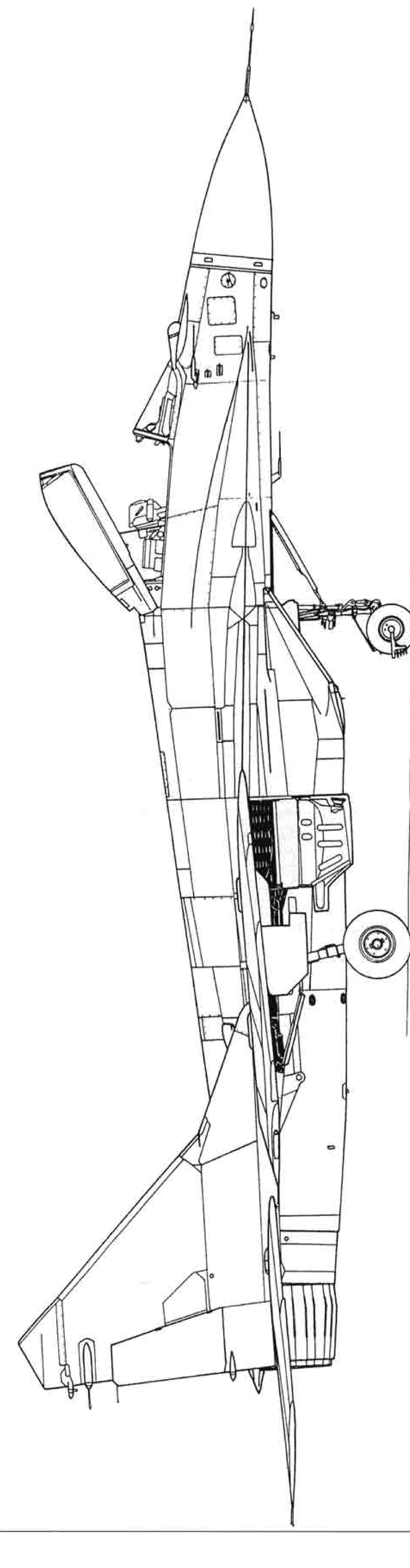
The first prototype MiG-29UBT ('304 Blue', c/n 40296692486).



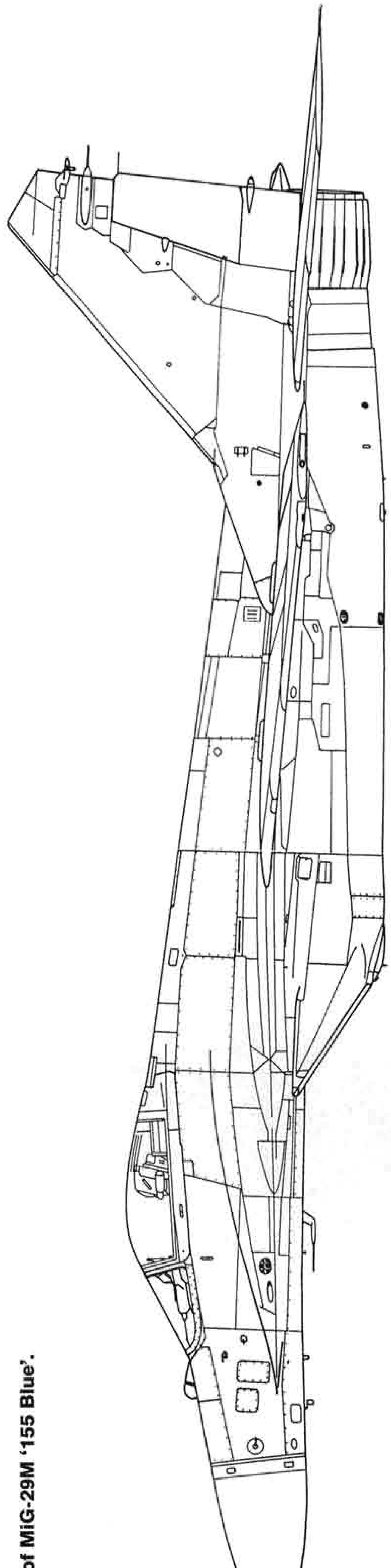
The second prototype MiG-29UBT ('52 Blue/952', c/n N50903025982).



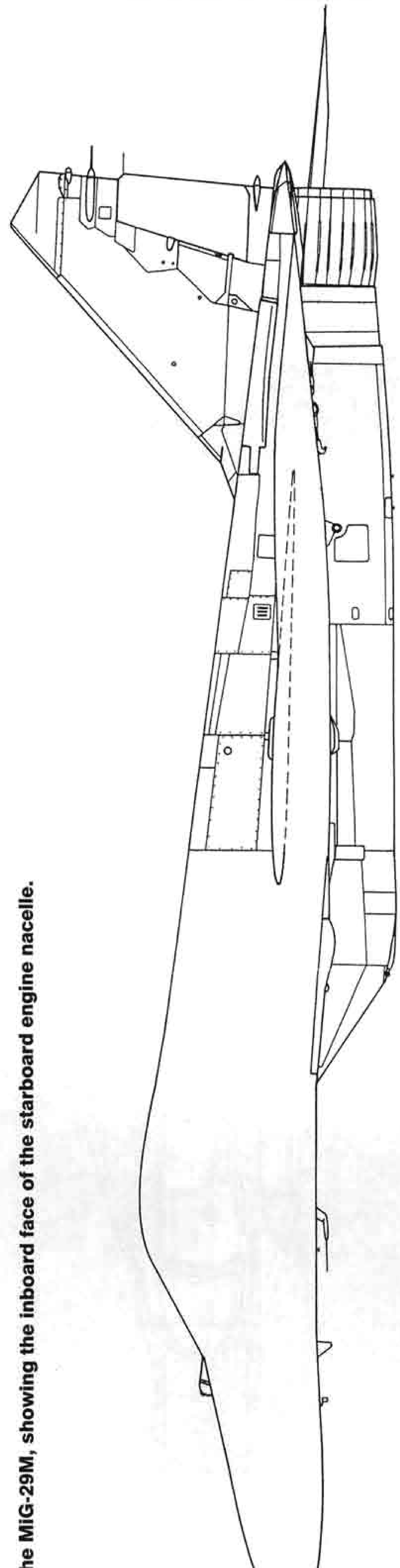
The first prototype MiG-29M (*izdeliye* 9.15) ('151 Blue', c/n 05551).



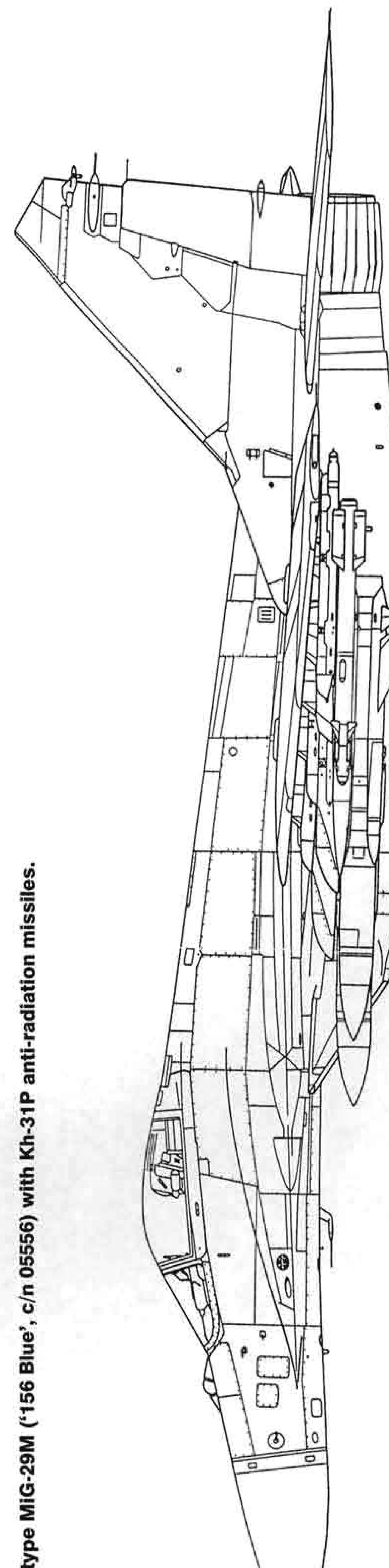
The fifth prototype MiG-29M ('155 Blue', c/n 05555).



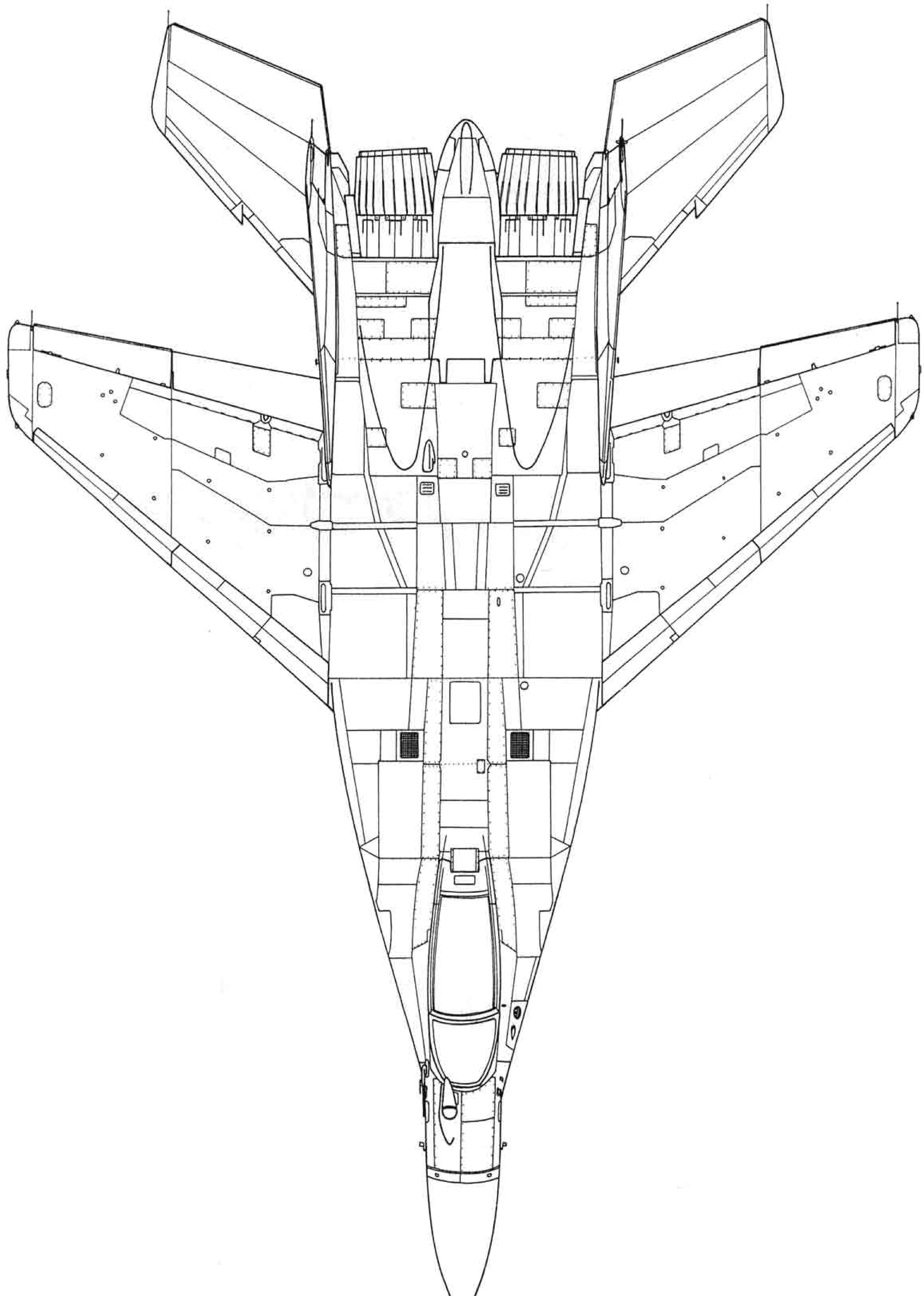
Port side view of MiG-29M '155 Blue'.



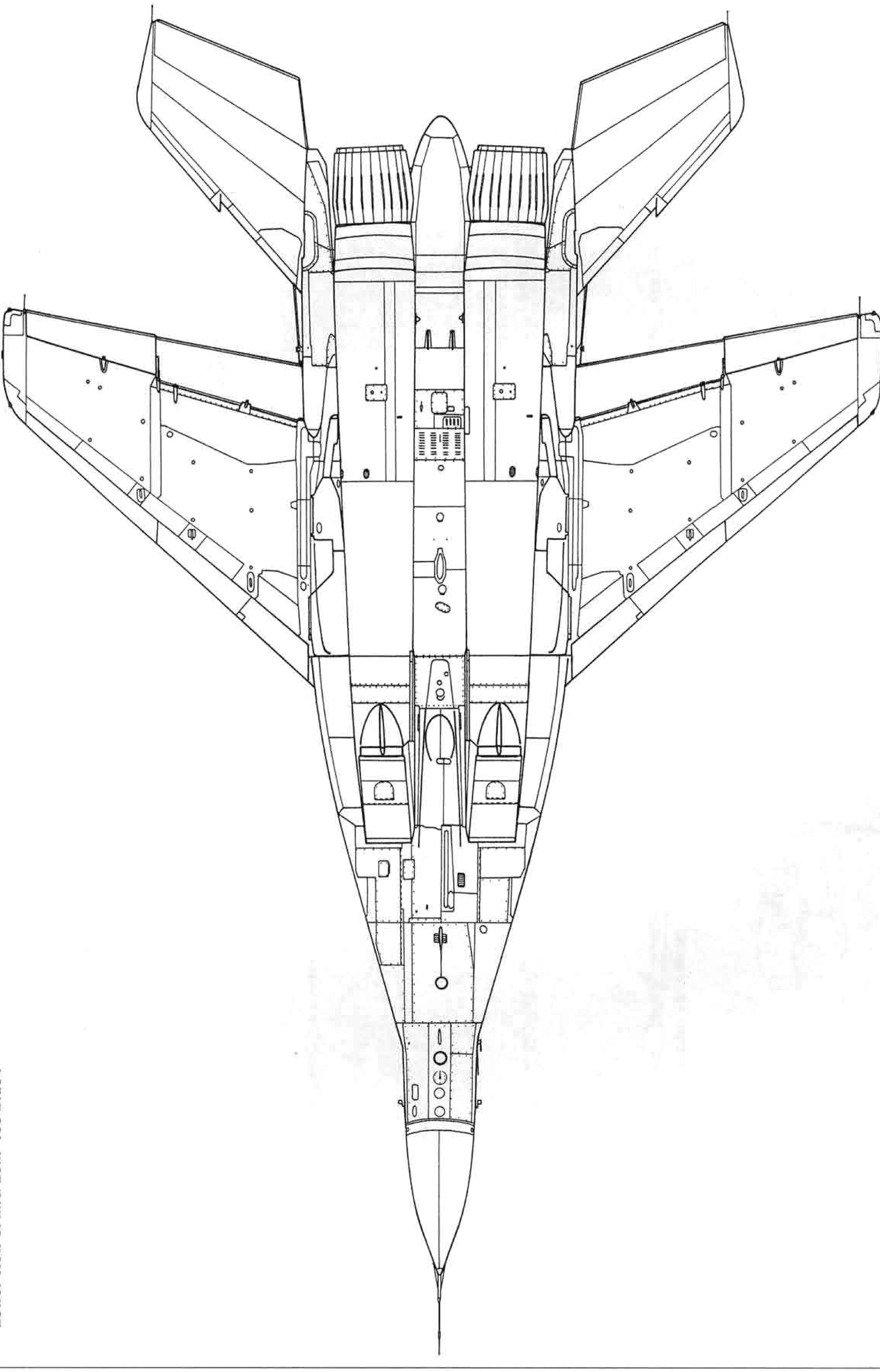
Scrap view of the MiG-29M, showing the inboard face of the starboard engine nacelle.



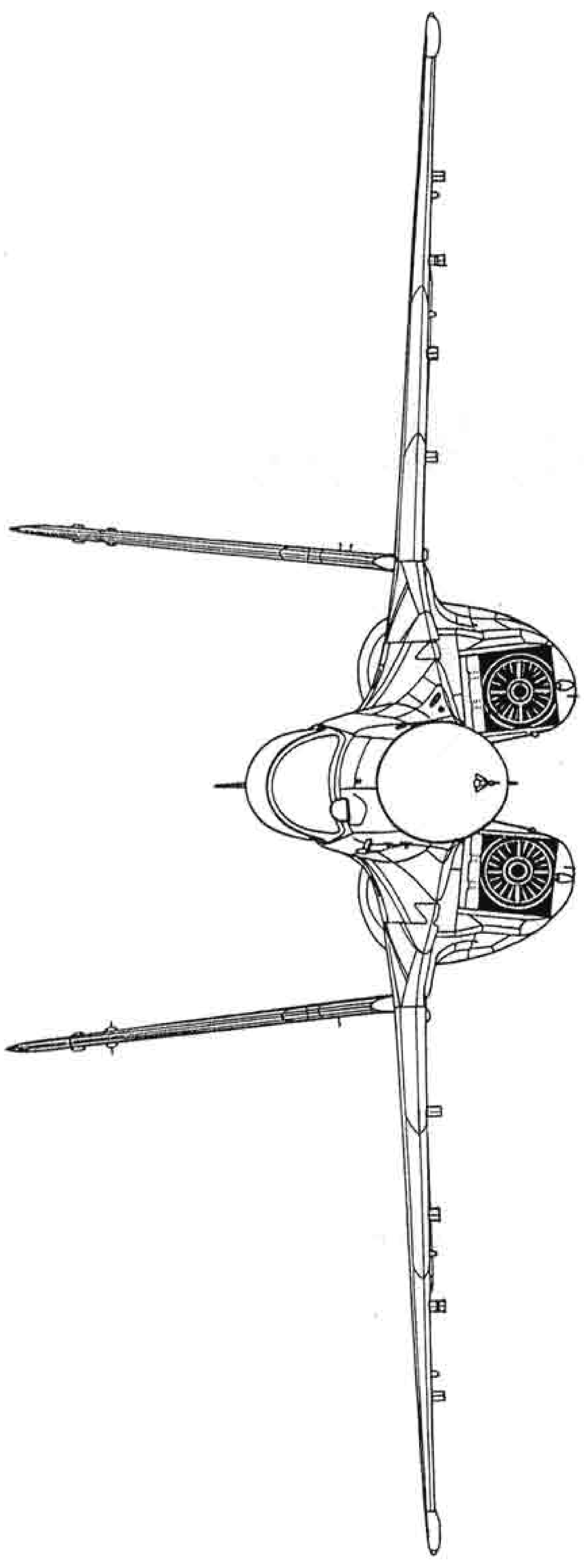
The sixth prototype MiG-29M ('156 Blue', c/n 05556) with Kh-31P anti-radiation missiles.



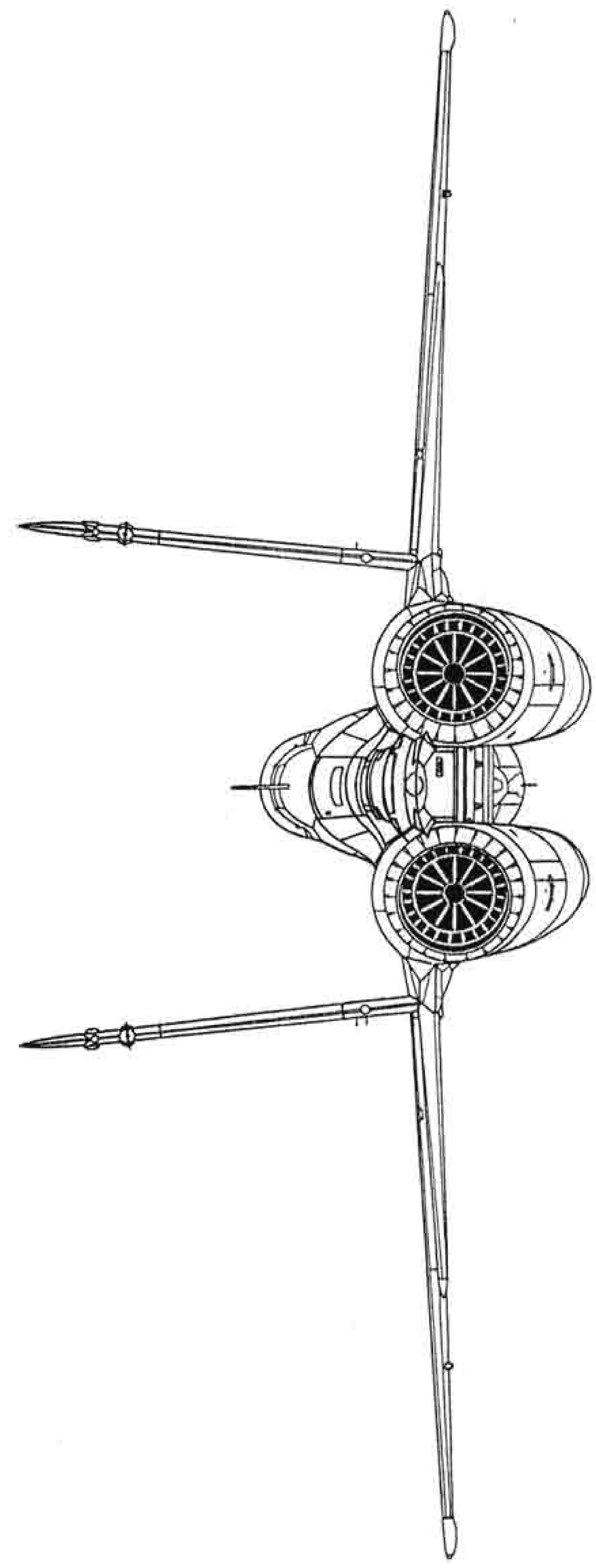
Upper view of MiG-29M '155 Blue'.



Lower view of MiG-29M '155 Blue'.

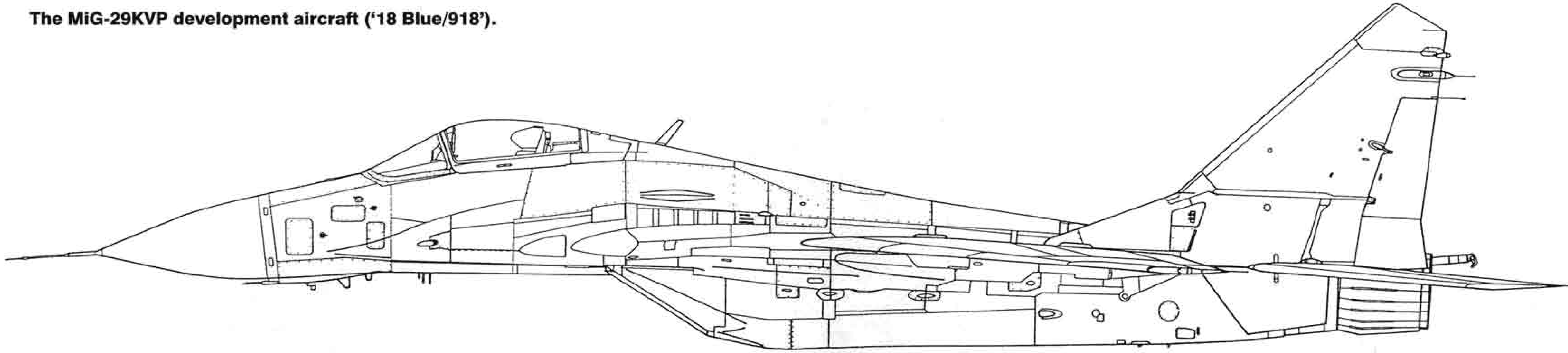


Front view of MiG-29M '155 Blue'.

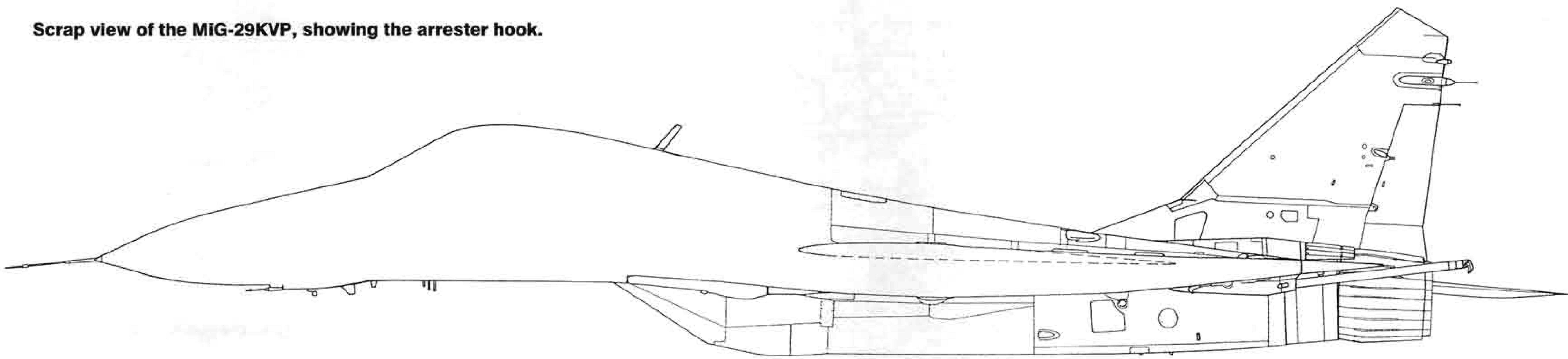


Rear view of the same aircraft.

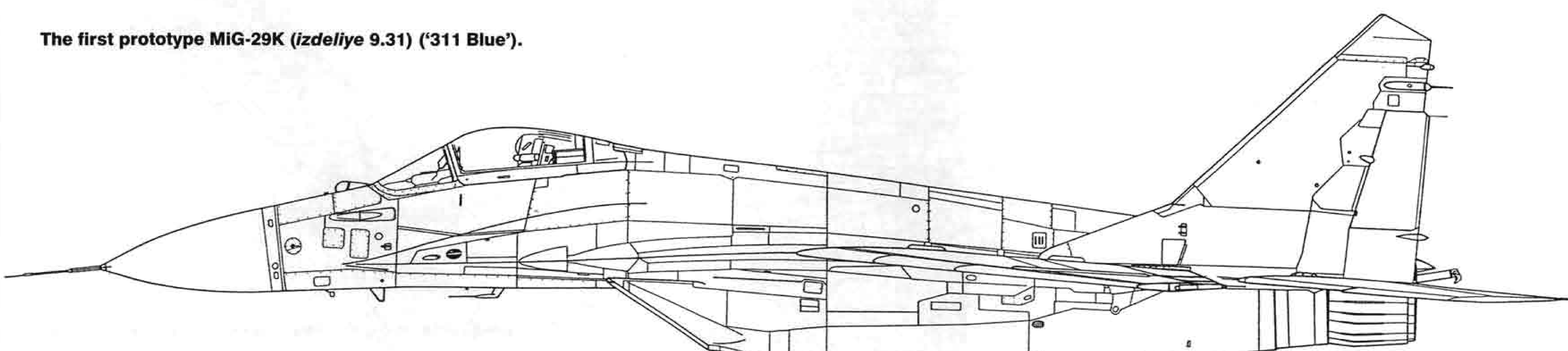
The MiG-29KVP development aircraft ('18 Blue/918').

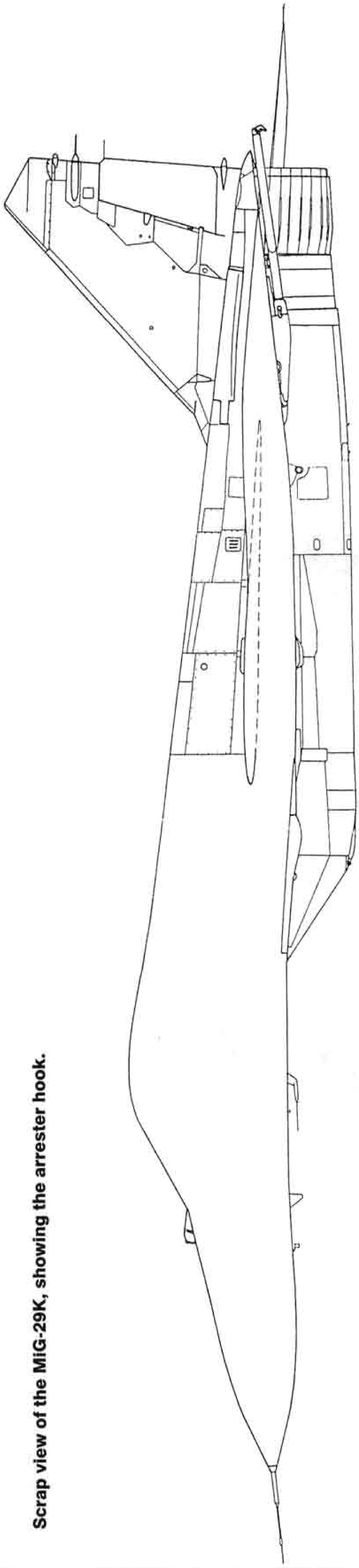


Scrap view of the MiG-29KVP, showing the arrester hook.

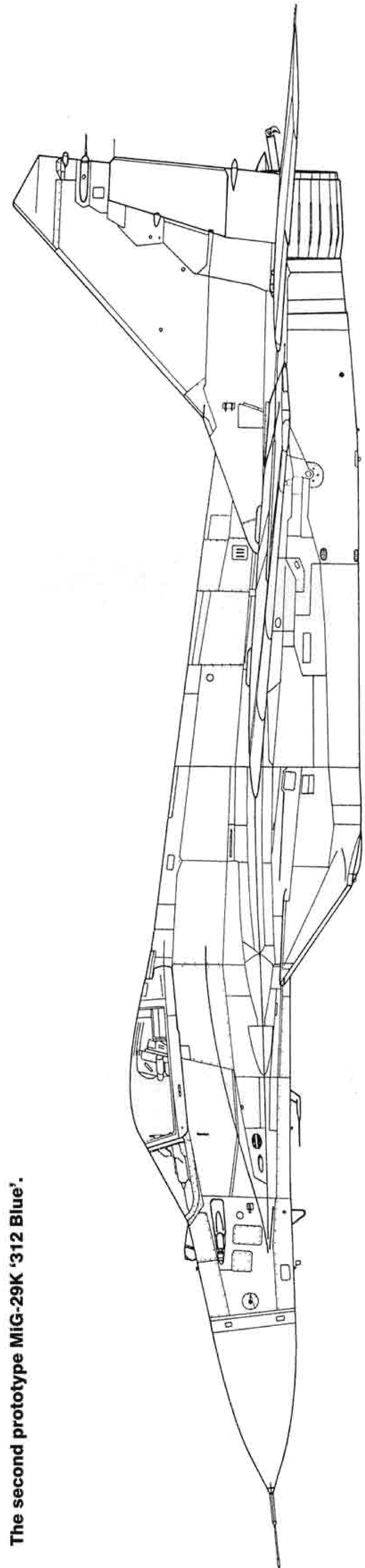


The first prototype MiG-29K (*izdeliye* 9.31) ('311 Blue').

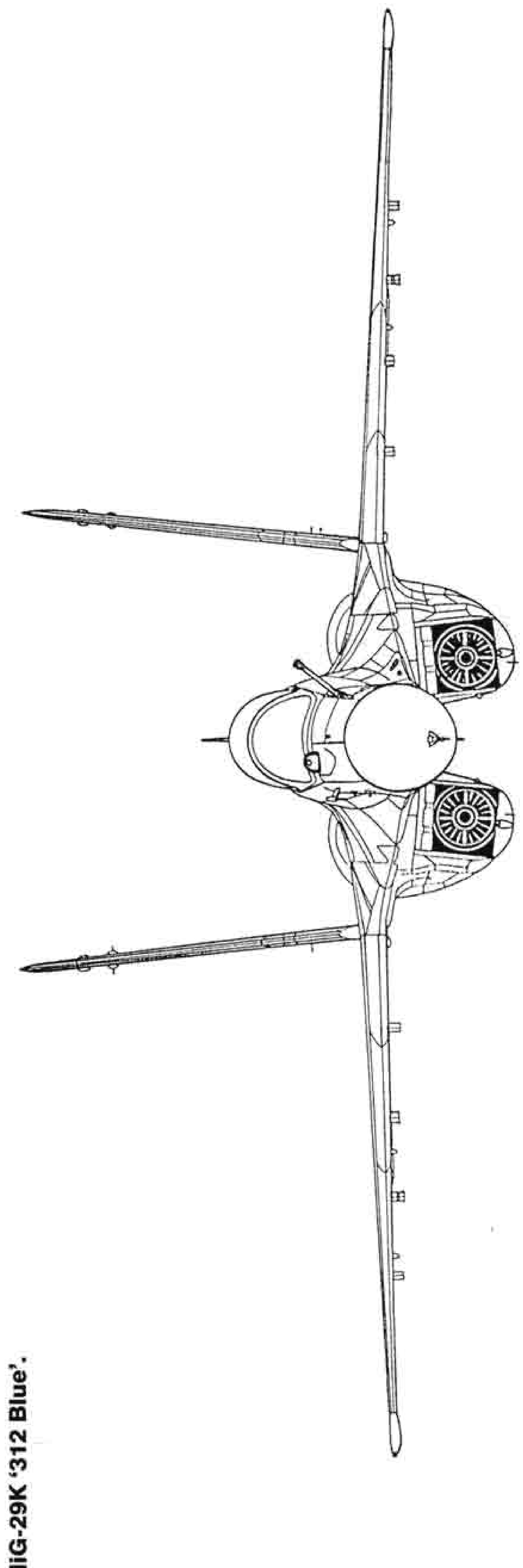




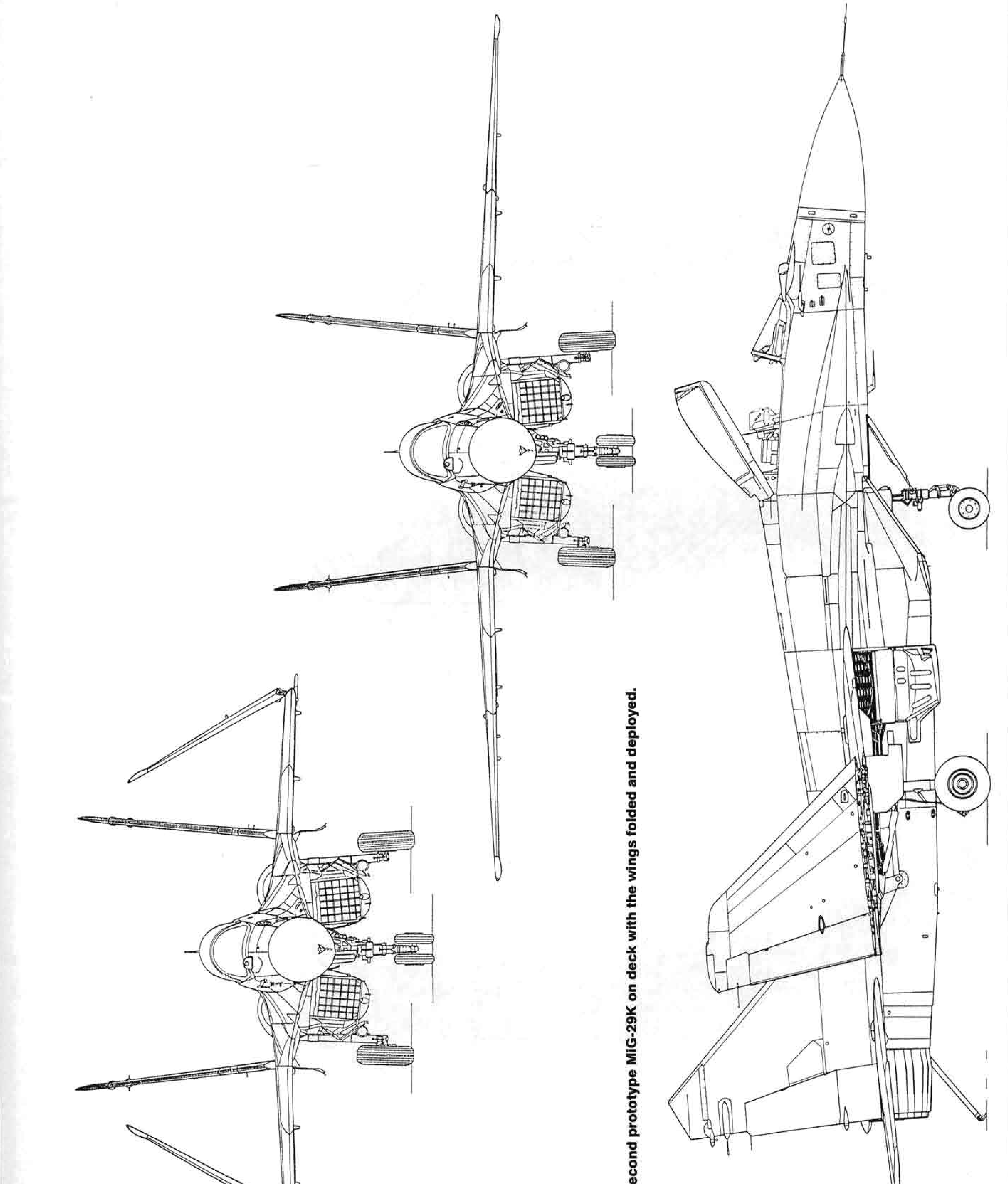
Scrap view of the MiG-29K, showing the arrester hook.



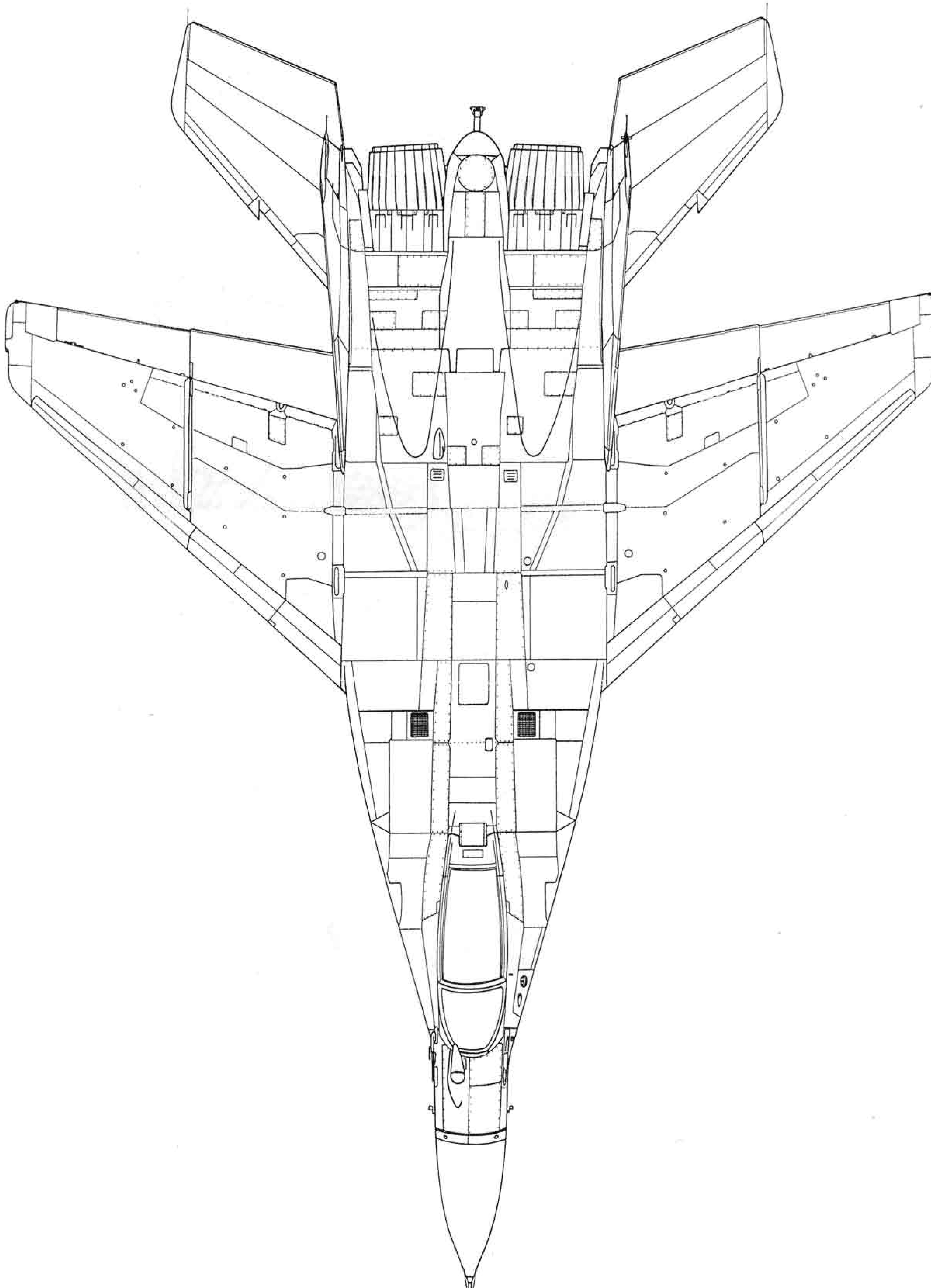
The second prototype MiG-29K '312 Blue'.



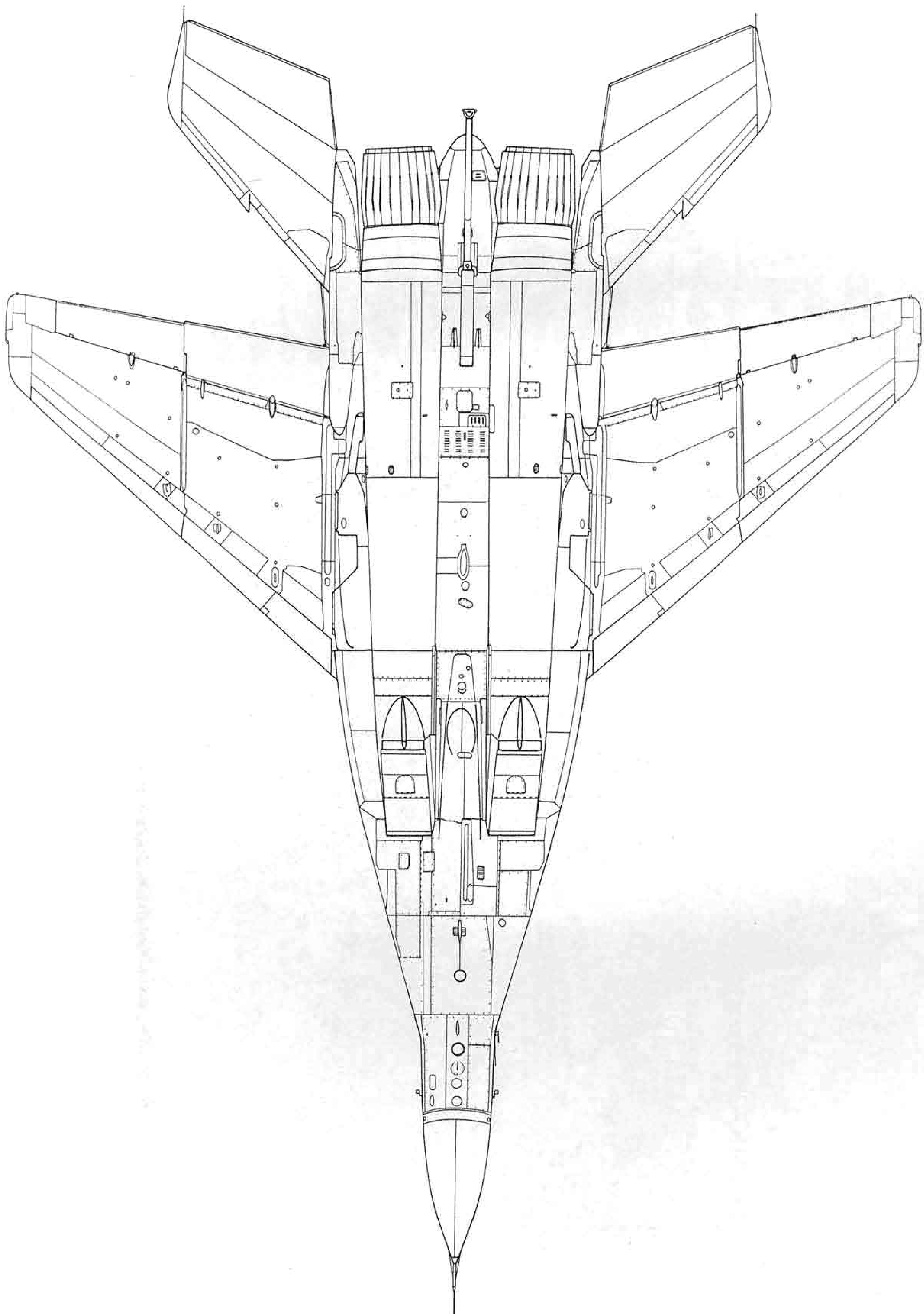
Front view of MiG-29K '312 Blue'.



The second prototype MiG-29K on deck with the wings folded and deployed.

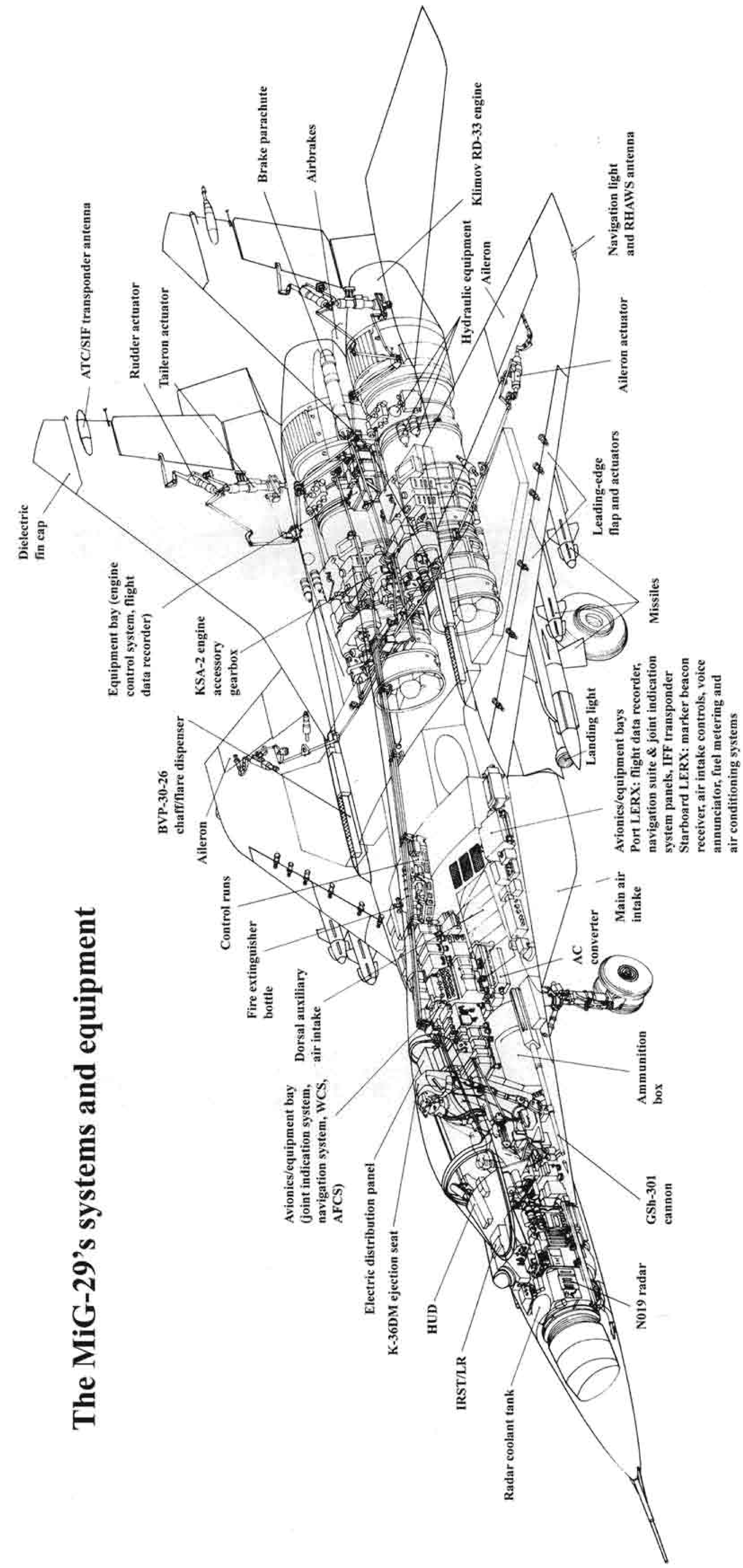


Upper view of MiG-29K '312 Blue'.



Lower view of the same aircraft.

The MiG-29's systems and equipment



PART ELEVEN

THE MiG-29 vs THE COMPETITION


Yefim Gordon

Three *Fulcrum-Cs* coded '26 Red', '41 Red' and '42 Red' make a formation take-off past a mobile searchlight mounted on a 1964-model ZiL-130 dropside lorry.

A fighter's development history inevitably includes a comparison of the aircraft's performance and operational characteristics, including maintainability and operating costs, with other aircraft in the same class. Initially this analysis is made by company engineers designing the aircraft proper and its systems; later, when the fighter enters production and service, the analysis is made by air force specialists. The MiG-29 was no exception. This chapter is a comparison of the *Fulcrum* with Western fighters based on press reports and analyses made by RSK MiG and Western experts.


These USAF F-16Cs loaded with AIM-9L Sidewinder, AIM-7 Sparrow and AGM-88 HARM missiles, 1,400-litre (308 Imp gal) drop tanks and AN/ALQ-131 ECM pods belong to the 35th FW/13th FS 'Panthers' at Misawa AB, Japan, hence the WW tailcode.


F-15E Strike Eagle 86-0190 was operated by the USAF Materiel Command's 412th Test Wing/415th FLTS at Edwards AFB when this picture was taken, as indicated by the ED tailcode.

A few Western fighters are readily comparable with the MiG-29 *sans suffixe* (*Fulcrum-A/C*), MiG-29S and MiG-29SE. These are the Lockheed Martin (General Dynamics) F-16C Fighting Falcon, Boeing (McDonnell Douglas) F/A-18C Hornet and F-15C Eagle, Dassault Mirage 2000-5 and Eurofighter EF2000 Typhoon. Some Russian experts compare these types with the MiG-29M and MiG-29SM which, although they did not enter production, became the basis for the development of the MiG-29SMT, MiG-29M2 and MiG-29K/KUB Generation 4+ fighters. These are now regarded as the baseline *Fulcrum* versions both for the home market and for export.

The F-16, a contemporary of the MiG-29, has become the world's most numerous fourth-generation fighter. The MiG-29 was the F-16's biggest competitor on the world fighter market – at any rate, until the turn of the century. As of mid-1994 more than 500 *Fulcrums* had been delivered to or ordered by 16 nations outside the CIS; as of this writing the MiG-29's export sales have grown further thanks to both new orders and second-hand examples.

The differences between the F-16 and the MiG-29 are due mainly to differing views on fighter tactics, which in turn are due to the different war experience the USA and the Soviet Union have had. In drawing up operational requirements for second-generation fighters the USAF relied mainly on Second World War and Korean War experience; in both cases the USAF usually enjoyed air superiority way beyond the frontlines, which meant American ground troops were well protected against enemy air strikes. Later, however, the USAF concentrated on nuclear strike capability, underestimating the importance of close-range aerial combat. As a result, the McDonnell (McDD) F-4 Phantom II, the main US air superiority fighter of the late 1960s, could be easily outmanoeuvred by the obsolescent MiG-17 *Fresco* – and often fell victim to the latter's guns in Vietnam.

Thus, when the USAF launched the Advanced Light Fighter (ALF) programme in 1972, it had to readopt the high thrust-to-weight ratio/low wing loading policy, as this gave the fighter good acceleration and a short turn time. American fighter designers began developing lightweight and compact aircraft optimised for air-to-air combat within visual range at transonic speeds and medium altitudes – that is, optimised for escorting strike groups. Maximum manoeuvrability would be attained at Mach 0.6-1.6; special attention was given to speeds around Mach 0.8-1.2.

The Soviet approach to the problem was somewhat different. As in Great Britain and France, the work of Soviet design bureaux after the Second World War was directed mainly at creating interceptors with the highest possible speed, service ceiling and rate of climb to ward off nuclear strikes against specific targets of importance. The aircraft was required to have the highest possible engine thrust and low wing loading. The latter was necessary to give the interceptor a good service ceiling but also gave a bonus in the form of agility and good field performance.

During the Korean War, MiG-15 *Fagot* fighters outperformed USAF fighters at high altitude. The new MiG-17 and MiG-19 *Farmer* that followed were high-performance jets in their day, but dogfighting at low altitude was not exactly their strong point. The next fighter from the Mikoyan stable, the MiG-21 *Fishbed*, was an outstanding aircraft in its class, but its combat capabilities were somewhat hampered by poor rearward visibility making it vulnerable to attack from behind. The variable-geometry (VG) MiG-23 *Flogger* had heavier armament, a bigger combat radius and better field performance but suffered from poor low-speed handling.

The MiG-29 was a light fighter, continuing the MiG-15/17/21 philosophy. Like its predecessors, it was required to have high speed, a high rate of climb and a high service ceiling because high-flying spyplanes were among its main targets. Obtaining good field performance (without

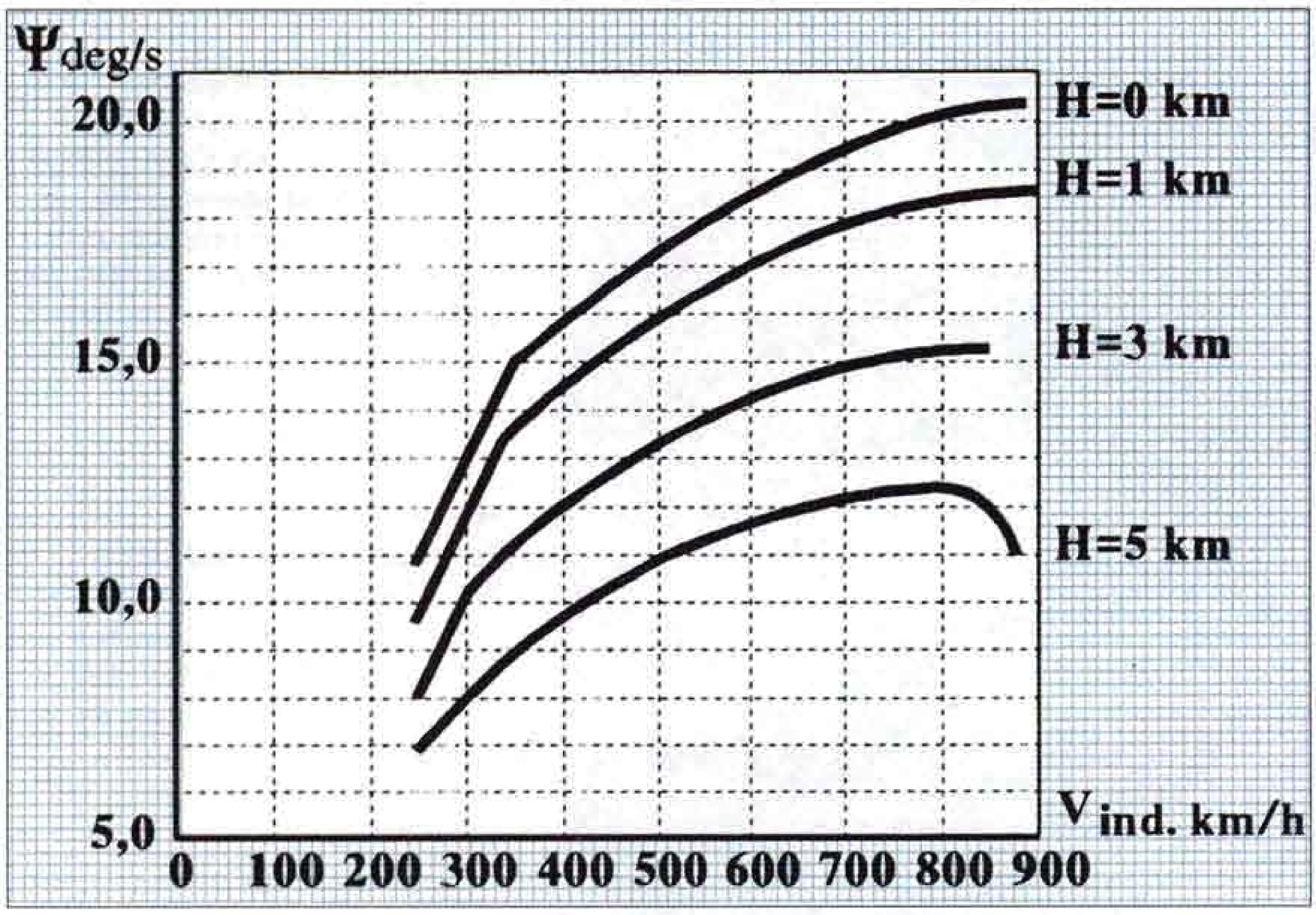
◄ **F/A-18C BuNo 164971/'NF-305' is operated by VFA-192 'Golden Dragons' of the 5th Carrier Wing (CVW-5) based aboard USS *Kittyhawk*. It is perhaps the closest equivalent of the MiG-29 as far as the layout is concerned.**

◄ **Dassault Mirage 2000C/RDI '5-OX/19' is operated by the French Air Force's EC 02.005 'Île de France' at Orange. The Mirage 2000 is famous for its agility.**

◄ **A French Air Force Dassault Rafale B two-seater. The Rafale is to be the nation's main fighter type along with the Mirage 2000.**

◄ **One of the F/A-18E Super Hornet prototypes. Despite the apparent similarity to the 'first-generation' Hornet (F/A-18A/B/C/D), this is a totally new aircraft with much higher capabilities.**

◄ **Displaying its 'quadroundel' test markings in addition to the RAF insignia, one of the Eurofighter Typhoon prototypes is seen during a test flight with the IFR probe deployed. The type is in service with the UK, Germany, Italy and Spain.**

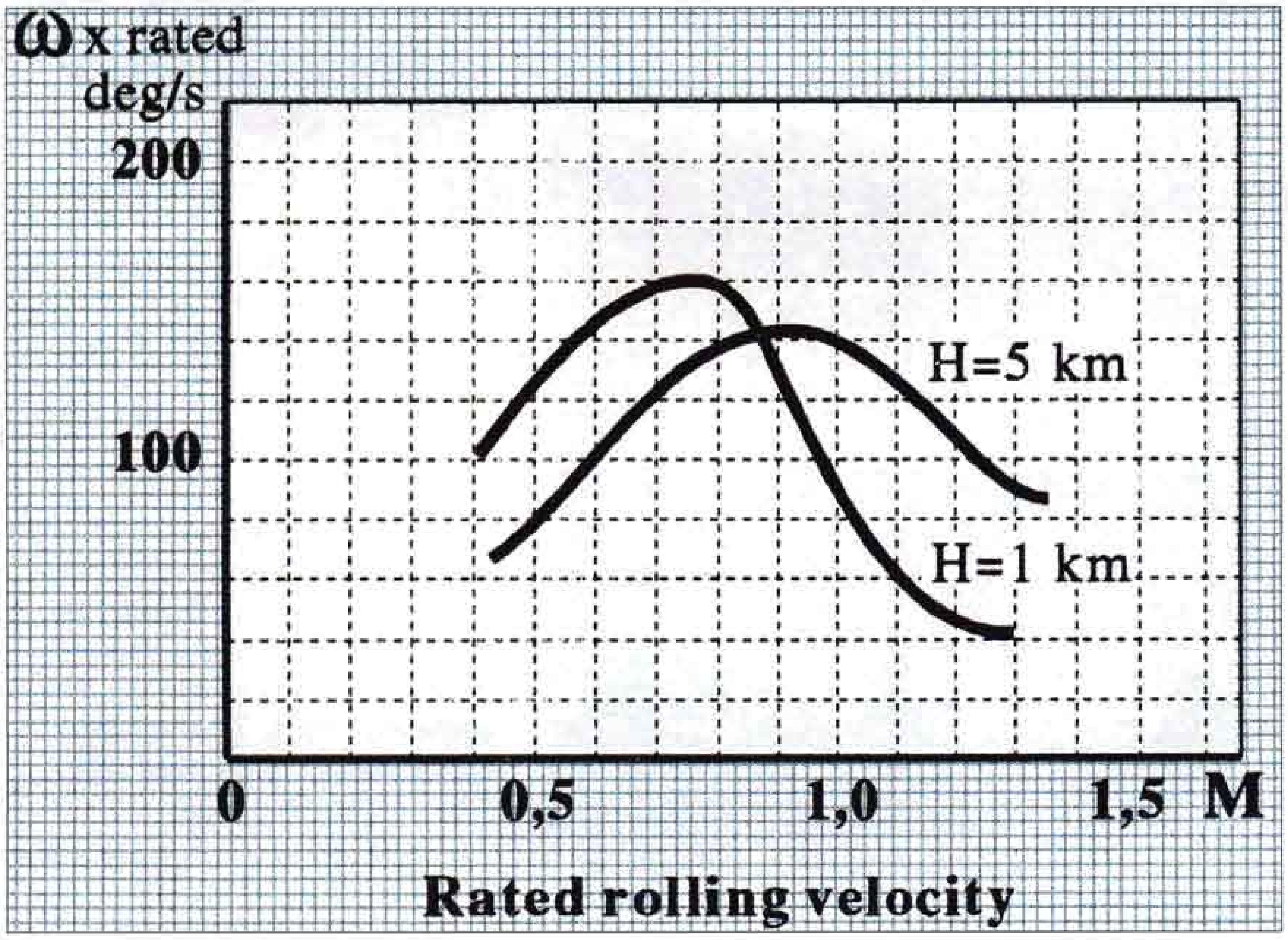


▲ **This diagram (which, like the ones that follow, comes from RSK MiG's export brochures) shows the MiG-29's sustained turn rate with missiles at various speeds and altitudes.**

resorting to VG), good low-speed handling and all-round cockpit visibility were priority design tasks.

Briefly, the F-16 and the MiG-29 compare as follows. The F-16 is an air superiority fighter designed to operate together with the heavier F-15. The exceptionally high performance, heavy armament and powerful fire control radar of the latter allowed the USAF to slacken the design requirements for the F-16 somewhat; still, the Fighting Falcon has a combat radius no less than the Eagle's. Conversely, the MiG-29 was to gain air superiority in the forward battle area without working in concert with the heavier Su-27 *Flanker*, the F-15's Soviet counterpart (the latter is tasked primarily with air defence of priority targets and long-range escort). The MiG-29 is designed for higher speeds and has highly effective armament, including short- and medium-range air-to-air missiles. Thus, the *Fulcrum* fits into a niche between the F-16 and the F-15 as regards armament and equipment but has shorter range than the American fighters.

This diagram shows the MiG-29's roll rate at different Mach numbers. ▼



Both the F-16 and the MiG-29 are stressed for 9 Gs. Both aircraft have prominent LERXes and air intakes suited to high-alpha operation.

The fundamental differences between the two types, however, were laid down at an early design stage. Research done in the US did not show twin-engined fighters to have any decisive advantages over single-engined aircraft. On the other hand, in the Soviet Union, unlike the US, twin-engined fighters had a much lower accident rate than their single-engined counterparts. The choice of a twin-engined layout for the MiG-29 was also influenced by wind tunnel research at TsAGI which showed that twin-engined fighters had an advantage because of their higher thrust-to-weight ratio.

The MiG-29 utilises the BWB layout in which the wings and fuselage are blended into a single lifting body. The F-16 is designed along more conventional lines with a classic separate fuselage.

Since the Fighting Falcon was optimised for maximum manoeuvrability at transonic speeds, a fixed-area monoshock air intake was chosen. This enables the engine to run steadily at up to Mach 2.0. American research showed that incorporating a variable air intake would add 180 kg (400 lb) of airframe weight without giving any appreciable improvement in performance at speeds below Mach 1.6.

The MiG-29 was designed for higher speeds, so Mikoyan engineers opted for variable four-shock intakes enabling steady engine operation at up to Mach 2.3. In both cases the intakes were located ventrally to minimise airflow distortion at high alpha or during tight turns. For the same reason General Dynamics made the inlet duct as short as possible but this was limited by the nose gear unit which stowed below the inlet duct. Mikoyan achieved the same result by placing the intakes under the LERXes which directed the airflow.

The different air intake design was also explained by the different approach to the FOD prevention problem. US specialists believed the F-16's air intake design made foreign object ingestion unlikely, since the intake was located forward of the nose gear unit and the distance from intake lower lip to ground was 1.2 times the intake's mean diameter – which, as experience showed, was quite enough for safe operation.

In the Soviet Union airfields were usually in much worse condition than in the US or Western Europe. When several 1st TFW F-15s from Langley AFB, Virginia, were to make a friendly visit to the Lipetsk Combat & Conversion Training Centre, a group of USAF experts arrived in advance to examine the airfield and stated that the F-15 could not operate from such poor-quality runways and taxiways. Fortunately, this was not the case and the visit went as planned; still, the F-15 pilots exercised extra care during take-off, landing and taxying.

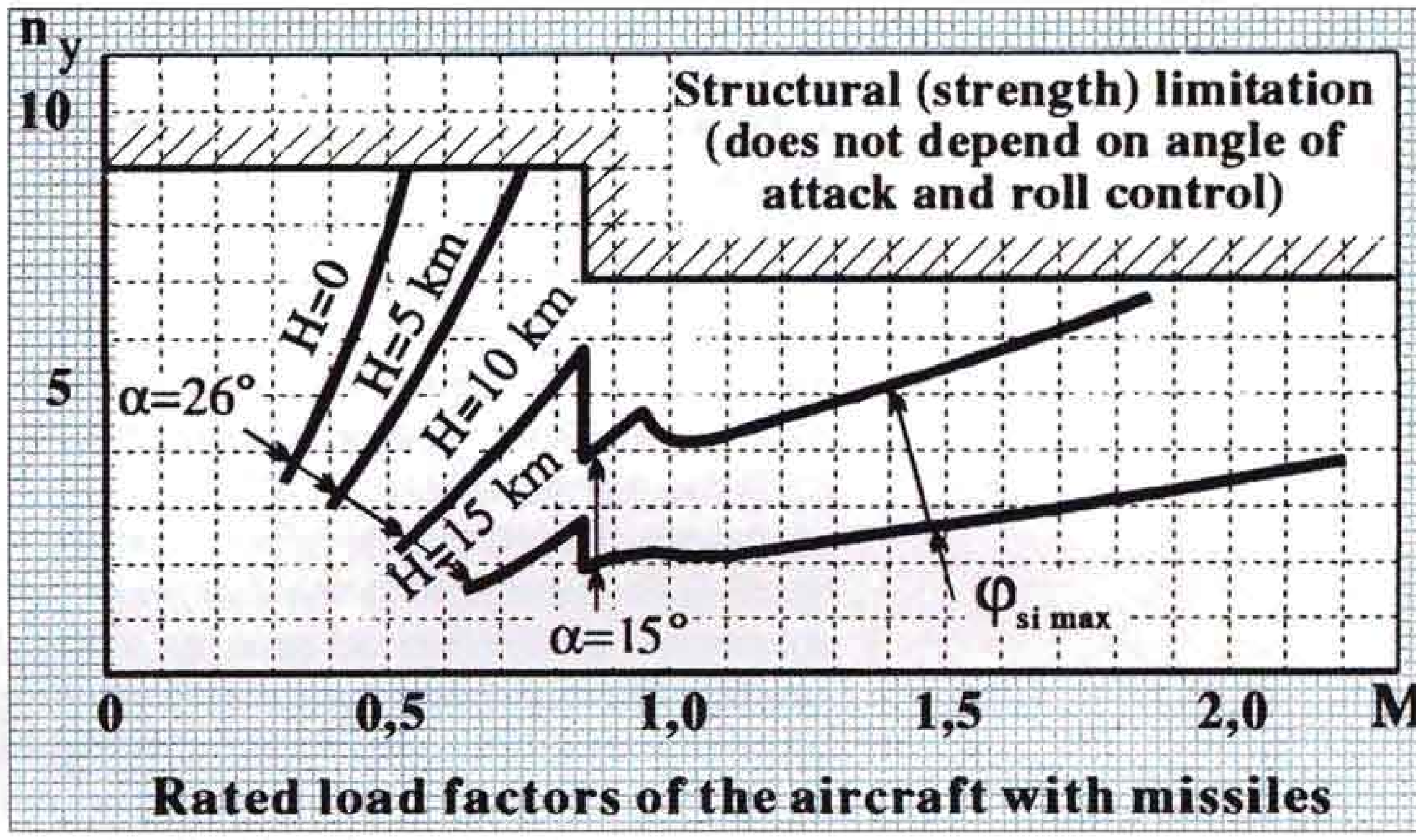
Besides, the VVS knew better than the USAF that fighters have to be capable of operating from semi-prepared tactical airstrips. From the MiG-23 onwards, Soviet (Russian) fighters are always fitted with mudguards on the nose-wheels; on the *Fulcrum* the engineers took the idea further, with the characteristic FOD protection doors and dorsal auxiliary intakes. Incidentally, Russian pilots are quite satisfied with the runways and taxiways in Lipetsk.

Another important difference is the tail unit design. General Dynamics had considered both single and twin vertical tails for the F-16 at the PD stage. Wind tunnel tests showed that the vortices generated by the LERXes maintained their direction at high AOAs and twin tails gave slightly better directional stability. Eventually, however, a single fin and rudder was chosen because of the lower technical risk.

The Mikoyan OKB, on the other hand, opted for twin tails because the MiG-29 was designed for higher speeds and more stringent requirements applied to directional stability. Also, the twin-tail layout had been verified on the MiG-25 *Foxbat*. The tail unit worked with four vortices generated by the LERXes and the vortex generators on the nose pitot.

The F-16 has trapezoidal wings (actually almost a cropped delta) with 40° leading-edge sweep, an aspect ratio of 3.2 and a 4% thickness-to-chord ratio at the roots. Wind tunnel tests revealed the necessity of automatic leading-edge flaps increasing lift and improving stability at high AOAs. At Mach 0.8 the LE flaps increase the turn rate by 18% as compared to wings with no leading-edge camber and by 10% as compared to the best wings with a modified airfoil incorporating leading-edge camber.

The MiG-29's wings have similar LE sweep (42°) and a marginally higher aspect ratio (3.5); theoretically this should result in slightly higher drag.

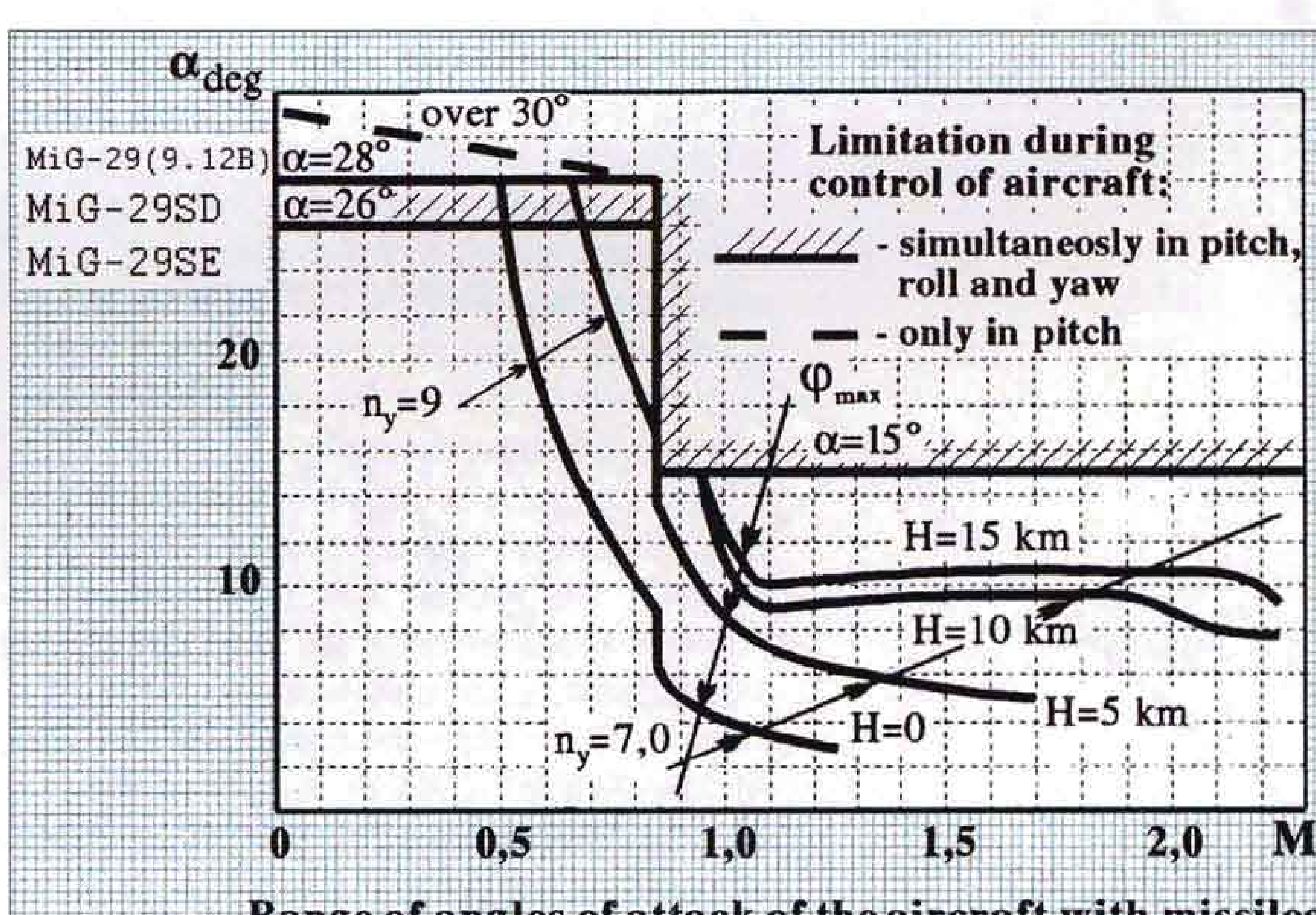


▲ **The MiG-29's operational G load limits with missiles at different Mach numbers.**

The F-16 is the world's first production fighter to feature a fly-by-wire control system. In contrast, Mikoyan decided to play safe and provided the MiG-29 with conventional mechanical controls. The American test pilot D. Farley, who had a chance to fly the *Fulcrum*, says the characteristics of its control system are similar to the F-15's. However, on the advanced MiG-29M and subsequent Generation 4+ versions (the MiG-29M2, MiG-29K/KUB and MiG-29OVT) Mikoyan did incorporate FBW controls which enhanced the fighter's combat capabilities a good deal.

The F-16A's AOA limit is 25°, though some sources quote 27°30'. Early production MiG-29s had a 26° AOA limit; on the MiG-29S (*izdeliye* 9.13S) and MiG-29SD/SE/SM, however, it was increased to 28°, while the fly-by-wire MiG-29M had a 30° AOA limit. If the limiter system is used the MiG-29 can safely exceed 30° alpha,

The MiG-29's AOA range with missiles at different Mach numbers. ▼



providing no roll control input is given. As for the latest super-agile thrust-vectoring versions of the *Fulcrum*, no AOA limits will be imposed at all.

The MiG-29's roll control circuit is similar to that of the MiG-23. At AOAs up to 8.7° the ailerons and differentially movable stabilators (tailerons) work in concert; beyond 8.7° the ailerons are locked neutral, leaving only the stabilators for roll control.

Despite the MiG-29's good high-alpha handling the pilots cannot use it to the full to shorten the landing run because the landing gear is fairly short, which creates the danger of a tailstrike. Touching down at 240 km/h (149 mph), the fighter has a 600-m (1,970-ft) landing run on a dry runway with the brake parachute deployed, increasing to 900 m (2,950 ft) on a wet runway. Similarly, with a normal landing weight the F-16A fighter has a 650-m (2,130-ft) landing run on a dry runway.

The F-16 features a miniature side-stick controller instead of a traditional control stick. This allows the pilot to fly the aircraft by moving his wrist only, increasing control precision. On the minus side, however, the pilot can use only his right hand to work the stick. Currently the F-16 is the world's only production fighter to have a side-stick. The MiG-29 – both the production *Fulcrum-A/B/C* and the fly-by-wire versions (the MiG-29M, MiG-29M2 and MiG-29K/KUB) – has a conventional stick; so do the F-15E Strike Eagle, F/A-18 and Eurofighter Typhoon.

The F-16's ejection seat is inclined at a greater angle than the MiG-29's (30°). This allows the pilot to withstand higher G forces during vigorous manoeuvres but makes it harder to look back over his shoulder. The F-16's one-piece frameless canopy offers better forward visibility; yet it is heavy and has to be jettisoned before ejection, as the glass is too thick to eject through it (for birdstrike protection reasons) and presumably even a micro-detonating cord wouldn't shatter it. Cockpit visibility in the MiG-29 is marginally worse (though the pilots are quite pleased with it) and the canopy likewise has to be jettisoned before ejection.

The Zvezda K-36D zero-zero ejection seat fitted to most of Russia's current combat jets, including the MiG-29, has demonstrated its impressive capabilities more than once. The most spectacular demonstration was at the 1989 Paris Air Show when the seat saved test pilot Anatoliy Kvochur's life in a minimum-altitude ejection. The seat can be used at indicated airspeeds up to 1,300 km/h (807 mph) and altitudes up to 25,000 m (82,020 ft); if a full-face pressure helmet is used, safe ejection is possible at 1,400 km/h (869 mph) IAS. On the minus side, the K-36 is much heavier than its Western counterparts, weighing 205 kg (452 lb). The F-16 is equipped with a McDonnell Douglas ACES II zero-zero ejection seat permitting ejection at up to 1,112 km/h (690 mph) IAS and 15,240 m (50,000 ft).

Dimensionally the two fighters are similar. The *Fulcrum* is slightly longer and has a bigger wing span and greater wing area but the F-16 is taller. The MiG-29's empty weight is higher but normal TOW with six short-range AAMs is only 24-27% higher than the F-16's because of the lower fuel volume relative to total internal volume; in fact, the F-16's MTOW is higher than the MiG-29's.

The F-16 has a much bigger combat radius than the basic production MiG-29 (*Fulcrum-A*) but, in fact, this is due mainly to the use of larger drop tanks. With two 1,400-litre (308 Imp gal) underwing tanks and a 1,136-litre (250 Imp gal) centreline tank, the Fighting Falcon's ferry range is 3,900 km (2,422 miles) versus the *Fulcrum-A*'s 2,900 km (1,801 miles) with two 800-litre (176 Imp gal) underwing tanks and a 1,520-litre (334.4 Imp gal) centreline tank or 2,100 km (1,304 miles) with the centreline tank only. On internal fuel only, however, the two fighters have almost identical range – 1,600 km (993 miles) for the F-16 and 1,500 km (931 miles) for the MiG-29. Moreover, the latest export versions of the *Fulcrum* – the MiG-29SMT (*izdeliye* 9.18) and the MiG-29M2 – have a maximum range of 2,100 and 1,800 km (1,304 and 1,118 miles) respectively on internal fuel, which increases to more than 3,000 and 2,700 km (1,863 and 1,677 miles) respectively with three drop tanks.

Moreover, in a scenario resembling a typical Vietnam War engagement when the adversaries began a dogfight with a full internal fuel load, no drop tanks and short-range AAMs only, the F-16 will undoubtedly have a higher specific wing loading and a lower thrust/weight ratio than the MiG-29. Combat specific wing loading is 3% higher for the F-16A and 16% higher for the F-16C; thrust/weight ratio is 14% and 5% worse respectively. This gives the MiG-29 an advantage, even though the Russian fighter has G load limits at speeds above Mach 0.85.

In 1993 US analysts compared the F-16C and MiG-29 in typical combat configuration (that is, with a 50% fuel load and two 'dogfight AAMs' on the outer wing pylons). Their verdict was that the F-16 would have a minor advantage over the MiG during transonic manoeuvring at low and medium altitude. According to US experts, in these conditions the MiG-29 would be handicapped by a G limit of 7 versus the F-16's 9 Gs, meaning the F-16 can make tighter turns. It should be noted, however, that these estimates were based on educated guesswork as to the MiG-29's performance characteristics, some of which were still unknown at the time.

The above is largely confirmed by a special combat efficiency evaluation programme held by Luftwaffe, the results of NATO exercises and mock combat between the MiG-29 and Western fighters. These showed the *Fulcrum* to be vastly superior to Western types in a dogfight – not so much because of its excellent manoeuvrability but first and foremost thanks to the weapons control system and the weapons proper.

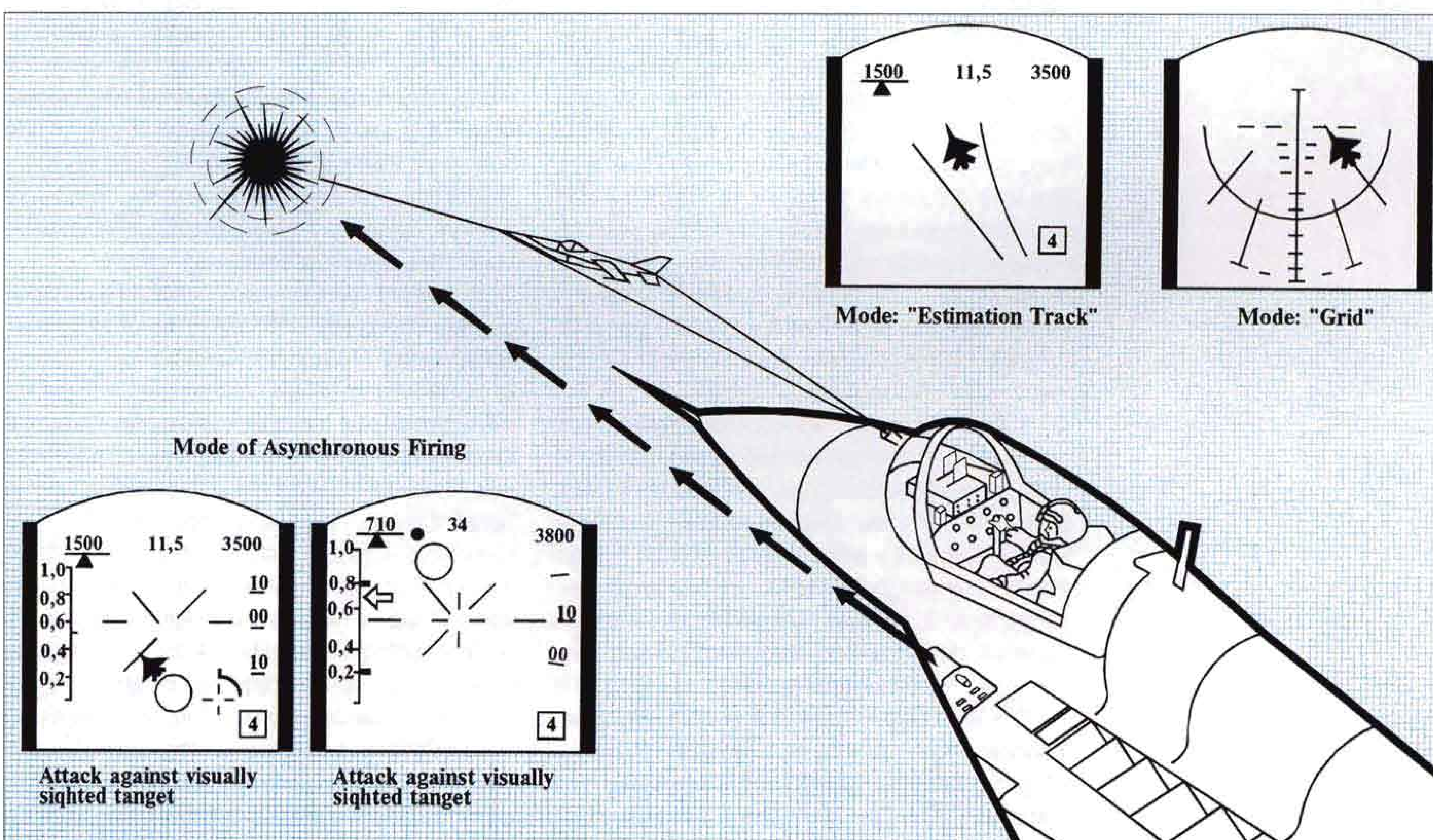
When Luftwaffe MiG-29s participated in mock combat sessions with USAF F-16Cs in 1994, the German pilots usually got the 'adversary' in their sights first, which meant victory ('first shoot, first kill'). The MiGs were armed with R-73 'dogfight AAMs' and the pilots used Schchel'-3UM helmet-mounted sights. Col. Jochen Both, detached to the Luftwaffe for the duration of the exercise, stated that the Fighting Falcons showed better manoeuvrability 60% of the time; on the other hand, consider that the F-16s flew in 'clean' condition while the MiGs had six pylons and carried a centreline drop tank and two fixed R-73 acquisition rounds. Still, the helmet-mounted sight enabled the MiG drivers to 'fire' first. Incidentally, this gave rise to a new aviation term. The Russian for 'helmet' is *shlem*, and when talking of target acquisition with an HMS it soon became customary to say the target had been *schlemmed*!

Mock combat was performed one-on-one or in pairs. In Both's opinion, the MiG-29's radar had the serious drawback of being able to track only one target at a time; this made it harder for the *Fulcrum* pilots in a melee with F-16Cs whose radars could track several targets. In reality, however, the standard N019 radar can track ten targets while the F-16C's AN/APG-68 tracks only eight. On the other hand, the Fighting Falcon can attack up to four separate targets at a time with a salvo of AIM-120A AMRAAM missiles while the Russian fighter can only fire R-27 AAMs at one target at a time.

Before that, JG 73 *Fulcrums* had engaged in similar mock combat with US Marine Corps F/A-18Cs. Still, Col. Both said it was unlikely that MiG-29s would participate in Red Flag or Green Flag exercises in the US in 1998 or 1999.

Col. Both said Luftwaffe MiG-29 pilots had no problems using the R-73 missiles or the Russian helmet-mounted sight. The latter fits the

A drawing from RSK MiG's export brochures showing the MiG-29's sighting modes during a gunnery attack. ▼



standard NATO flying helmet perfectly and weighs only 300 g (10.59 oz), which means the pilot will not suffer injuries in an ejection because of the added weight. The pilot simply turned his head towards the target and pushed the missile launch button; the time required for the missile's heat seeker to get a lock-on and the missile to blast off was just one second – excellent performance, as the German pilots put it.

On the other hand, MiG-29 pilots had to pay more attention to the instruments than their colleagues flying the F-16C, which has a higher degree of automation. Also, they had to keep certain flight envelope limits in mind during a dogfight; this forced them to check on the instruments every now and then, distracting their attention at the worst possible moment, which could cause them to lose target lock-on. By comparison, the F-16C's control system automatically kept the aircraft within the prescribed limits.

German pilots said they began to practise using the R-73 AAMs and HMS in a dogfight only after Germany's reunification and their integration into the Luftwaffe. In Cold War days the East German Air Force (LSK/LV) concentrated on GCI-assisted intercept. Thus German *Fulcrum* pilots realised the full strength of their weapons only when Western combat tactics were adopted, said Col. Both.

The combat efficiency of the German MiG-29s in a dogfight was indeed increased by implementing a special 'dogfight mode': the radar or IRST automatically locked on to the target when it entered a predetermined area and was displayed on the HUD. The HMS and the wide-angle seeker heads of the Vympel R-73 missiles contributed most to the advantage, enabling the pilot to attack targets at large off-centre sighting angles without wasting time to turn the aircraft squarely towards them ('if you can see 'em, you can shoot 'em').

This, incidentally, was demonstrated once again when Armée de l'Air and Belgian Air Force delegations visited the Czech Republic in 1996. Czech AF MiG-29s invariably emerged as the winners in mock combat against French Mirage 2000s and Belgian F-16As. In the West, the production Lockheed Martin F-22A Raptor, Dassault Rafale and Eurofighter Typhoon now feature an HMS as standard, too.

The R-73 (AA-11 *Archer*) is a 'wish 'em dead' weapon which can destroy violently manoeuvring targets in the daytime and at night over land and water, even if the pilot's aim is not very good. It is immune to ground clutter, active and passive ECM, since it is equipped with an all-aspect passive IR seeker head. The R-73 has a combined jet/aerodynamic control system giving it superb agility in all flight modes, especially immediately after launch when the missile's speed is low and rudder efficiency is poor. The seeker head's field of view is 90° (±45°); the missile has a 30-km (18.6-mile) 'kill' range, a minimum target altitude of 5 m (16 ft) and can be fired when the aircraft is pulling up to 12 Gs. The cylindrical warhead weighs 8 kg (17.63 lb).

The current R-73M version features a seeker head with a 180° (±90°) field of view (and twice the sensitivity (and hence twice the detection range). The seeker head has a multi-facet two-band IR sensor for better IRCM resistance. It is programmed to shift its aim from the engine efflux (the hottest part of the target) to the centre of the airframe when the missile closes in, so that the R-73M does not lose its lock-on so easily.

In two consecutive issues (16th October and 25th October 1995) *Aviation Week & Space Technology* published a report by a group of American aviation writers on the problems of creating a modern short-range air-to-air weapons system. The report contained specialist opinions on progress in this direction in the US, the UK, Germany and Russia. Research made by McDonnell Douglas showed that in combat the production-standard MiG-29 would enjoy 'first shot, first kill' capability much more often than the F-15. Israeli reports state that the combat potential of a fighter equipped with an HMS is three times that of an identical fighter lacking this system if both are armed with AIM-9 Sidewinder missiles; if the MiG-29 carries AAMs with wide-angle seeker heads the advantage becomes ninefold.

A former senior USAF official has been quoted as saying that 'the billions of dollars spent on the F-4 and F-15 are no use in a close-in engagement if the enemy is armed with missiles with wide-angle seeker heads and a helmet-mounted sight'. Evaluation of the R-73 and the MiG-29 caused the US and Germany to begin top-priority research for similar weapons systems, while the UK, Israel and the South African Republic stepped up research in the same direction.

The MiG-29's advantage in a dogfight is enhanced by its highly effective internal cannon. The IRST measures the target's coordinates and the laser rangefinder determines target range. The asynchronous aiming method based on these data gives the *Fulcrum* excellent gunfire accuracy during manoeuvring. This method is also used when there is no direct visibility of the target (that is, in IMC). When the target is plainly visible a gunsight reticle appears on the HUD and must be placed over the target in order to fire. In IMC conditions the HUD displays targeting error values calculated by the computer; these increase or decrease as the aircraft manoeuvres. When the error values drop to zero the pilot knows that the reticle is over the unseen target and it's time to fire. The heavy calibre (30 mm) and the fairly high rate of fire (1,500-1,800 rpm) enable the MiG-29 to score a 'kill' with the first burst of gunfire – some five or seven rounds.

In a beyond visual range (BVR) engagement the production *Fulcrum-A* (*izdeliye* 9.12, 9.12A and 9.12B) are admittedly inferior to the F-15C and F/A-18C, to say nothing of the more modern Boeing F/A-18E/F Super Hornet. On the other hand, they have almost 20% higher efficiency than the Mirage 2000-5 armed with Matra Super 530D missiles. An advantage in BVR combat is conferred by the high performance of the R-27R/R-27T medium-range AAMs and the MiG-29's high efficiency enabling it to dodge incoming missiles. In a BVR engagement with the F-16A, whose weapons range does not include medium-range AAMs, the MiG-29 enjoys overwhelming superiority. As for the MiG-29S/MiG-29SE and the later versions compatible with the R-77 (RVV-AE) and R-27ER/ET/R1/T1 AAMs (including the Malaysian MiG-29N), they are quite a match for the Eagle, Hornet and Super Hornet in a BVR engagement.

The Performance of Some Modern Production Fighters in Dogfight Configuration

	MiG-29	Su-27	F-15C	F-16C Block 50	F/A-18C	F/A-18E	Mirage 2000-5	Rafale M	EF2000 Typhoon
Powerplant	Klimov RD-33 Srs 3 [7]	Lyul'ka AL-31F	Pratt&Whitney F100-PW-220	General Electric F110-GE-129	General Electric F404-GE-402	General Electric F414-GE-400	SNECMA M.53-P-20	SNECMA M.88	Eurojet EJ200
Afterburning thrust, kgp (lbst):									
bench tests	2 x 8,800 (2 x 19,400)	2 x 12,500 (2 x 27,560)	2 x 12,300 (2 x 27,120)	13,420 (29,588)	2 x 7,300 (2 x 16,090)	2 x 10,000 (2 x 22,045)	9,870 (21,760)	2 x 8,870 (2 x 19,550)	2 x 9,175 (2 x 20,230)
dogfight mode	2 x 6,910 (2 x 15,230)	2 x 9,813 (2 x 21,633)	2 x 9,734 (2 x 21,460)	10,535 (23,225)	2 x 6,304 (2 x 13,897)	2 x 7,850 (2 x 17,305	7,750 (17,085)	2 x 6,963 (2 x 15,350)	2 x 7,222 (2 x 15,921)
Wing area, m² (sq ft)	38.1 (409.67)	62.0 (666.66)	56.6 (608.60)	27.87 (299.67)	37.16 (399.56)	46.45 (499.46)	41.0 (440.86)	46.0 (494.62)	50.0 (537.63)
Empty weight, kg (lb)	10,850 (23,920)	16,300 (35,930)	12,970 (28,590)	7,975 (17,580)	10,720 (23,630)	13,864 (30,564)	7,500 (16,530)	9,800 (21,600)	9,750 (21,490)
Ordnance load, kg (lb) [1]	547 (1,205) [2]	547 (1,205) [2]	537 (1,183) [3]	447 (985) [3]	450 (992) [3]	537 (1,183) [3]	470 (1,036) [4]	470 (1,036) [4]	542 (1,194) [5]
Fuel load, kg (lb) 6	1,782 (3,928)	4,700 (10,360)	3,075 (6,780)	1,565 (3,450)	2,463 (5,430)	3,265 (7,200)	1,561 (3,441)	2,090 (4,610)	2,000 (4,410)
All-up weight, kg (lb)	13,179 (29,054)	21,547 (47,502)	16,582 (36,556)	9,987 (22,017)	13,633 (30,055)	17,666 (38,946)	9,531 (21,011)	12,360 (27,250)	12,292 (27,098)
Effective range, km (miles)	750 (465)	1,950 (1,211)	950 (590)	1,000 (621)	1,100 (683)	950 (590)	825 (512)	1,000 (621)	1,100 (683)
Wing loading, kg/m² (lb/sq ft)	346 (70.93)	347 (71.14)	293 (60.07)	358 (73.4)	367 (75.24)	380 (77.91)	232 (47.56)	269 (55.15)	246 (50.43)
Thrust/weight ratio	1.05	0.91	1.17	1.03	0.91	0.89	0.80	1.13	1.18

Notes:

1. The weight of four IR-homing AAMs and the cannon's (or cannons') ammunition supply
2. Four R-73s and 30-mm ammunition for the GSh-301 cannon
3. Four AIM-9Ms and 20-mm ammunition for the General Electric M61A1 Vulcan cannon
4. Four Matra Magic 2s and 30-mm ammunition for the two DEFA 554 cannons
5. Four AIM-9Ms and 27-mm ammunition for the Mauser cannon
6. Half the maximum internal fuel load
7. Several versions, including export MiG-29s, are currently powered by uprated RD-33 Srs 3 engines

Yefim Gordon

▲ **In a remarkable union of former Cold War adversaries, US Navy/Blue Angels F/A-18Cs and Russian Air Force MiG-29s and Su-27s (representing the Roosskiye Vityazi and Strizhi teams respectively) made an extraordinary joint flypast at Kubinka AB when the Blue Angels staged a Russian tour.**

A 'fly-off' between the F-16C and MiG-29 showed that the Fighting Falcon has a much higher roll rate thanks to its FBW control system and wing planform. Theoretically this should give it a higher turn rate, reducing turn time. However, during the MiG-29's airshow debut at Farnborough International '88 Western specialists noted that the *Fulcrum* could perform 360° turns without losing altitude – a crucial asset for a fighter. At 800 km/h (496 mph), turning radius is 350 m (1,150 ft); in the same situation the F-16 had a turning radius around 400 m (1,310 ft). At speeds above 400 km/h (248 mph) the MiG-29 can turn with a 225-m (740-ft) radius, pulling 3.8 Gs. At 10,000 m (32,810 ft) and Mach 0.9 the MiG-29 can pull 4.6-5.0 Gs in a turn.

As a rule, initial comparative analysis of agile fighters is done by comparing such all-important parameters as thrust/weight ratio and wing loading; together with the lift/drag ratio they determine the fighter's manoeuvrability. Two other crucial factors affecting agility are turn rate (roll rate) and linear acceleration. At Mach 0.85 the MiG-29's linear acceleration is 11 m/sec^2 (36 ft/sec^2) at sea level, which means the fighter can go from 500 km/h (434 mph) to 1,000 km/h (621 mph) in just 13 seconds. At 6,000 m (19,685 ft) and Mach 0.85, linear acceleration is 6.5 m/sec^2 (21.32 ft/sec^2).

The comparative table on page 427 illustrates the performance of modern production fighters in dogfight configuration. Please note that the static thrust of a jet engine installed on an actual aircraft is somewhat lower than on a test bench because of the inevitable aerodynamic losses caused by the intake/inlet duct and the nozzle (and extension jetpipe, if any) and the power absorbed by the engine accessories. In flight the thrust is further reduced at higher altitude as the air grows thinner; at higher speeds the thrust grows, but so does the drag. Thus, in case you should feel like comparing the available thrust (and hence the thrust/weight ratio) in a dogfight at 3,000 m (9,840 ft) and Mach 0.8-0.85, the known static thrust of the engines obtained during bench tests should be multiplied by 0.785; this quotient is designed to make allowances for the losses mentioned earlier. This is why, in addition to the maximum static thrust, the calculated afterburner thrust in dogfight mode is stated in the table; it is the latter figure that was used to calculate the thrust/weight ratio.

At a glance, the figures stated above seem to assert the F-15C's ascendancy over the Russian fighters and make the F-16C and F/A-18C appear as very dangerous adversaries, too. The F/A-18C is currently being replaced by the F/A-18E whose agility is much worse (but the avionics suite is far more capable!). The Rafale, which recently entered full-scale production, is already challenging the lead of the American fighters. According to the figures published in the popular press, even in take-off ('dirty') configuration the Rafale can sometimes get the better of the MiG-29 and Su-27 in dogfight configuration. For instance, it has been quoted that when armed with eight Matra Mica AAMs and with the fuel tanks 60% full, the naval Rafale M standing on quick-reaction alert on the ship's catapult has a take-off weight of only some 13,000 kg (28,660 lb). This gives the French fighter a wing loading of only 283 kg/m^2 (58.0 lb/sq ft) and a thrust/weight ratio in excess of 1. Still, don't let's make hasty conclusions; the French MoD has acknowledged officially that the first production Rafales cannot use their potential to the full due to certain limits being imposed. This means the Rafale's performance figures published to date are somewhat hyped up.

Yet, the well-informed reader might demand how come the Russian fighters have emerged with ease as the winners from numerous dissimilar air combat training (DACT) sessions with their Western counterparts, given the Russian types' purportedly modest performance.

It should be noted that, thanks to its lower wing loading and high thrust/weight ratio, at altitudes up to 3,000 m (9,840 ft) the MiG-29 actually has a 5% better turn rate and acceleration than the F-16C. Obviously the heavier F/A-18C Hornet and its successor, the F/A-18E Super Hornet, rate even worse here. Also, remember that the Super Hornet, in effect, fits in between the light and heavy fighter classes; it is clearly optimised for strike missions, not the air superiority role which, in all probability, will be filled by the future F-35.

Judging by its wing loading, the Mirage 2000-5 has a good turn rate and is on a par with the MiG-29 in this respect. Yet, the French fighter's wings also generate less lift. Also, despite having FBW controls, the Mirage 2000-5 is rather unstable at high AOAs, which incurs sizeable aerodynamic losses associated with longitudinal trim (an inherent weakness of the tailless-delta layout) and reduces the lift/drag ratio. The single-engined Mirage also has a fairly low thrust/weight ratio, which means it cannot keep up with the Russian fighter in a tight turn. One may say that, given equal conditions at the time of the engagement, the Mirage pilot has virtually no hope of winning the fight if he does not get on the MiG's tail after the first turn and destroy the adversary with his first shot.

Thus, the MiG-29 is more than a match for the best light fighters of the West. However, this situation can only be maintained if the various upgrades which the *Fulcrum* is now undergoing do not cause an increase of the wing loading.

While we are on the subject of fighter agility, it should be noted that lately the Russian 'fighter makers' have been paying much attention to enhancing manoeuvrability through thrust vector control (TVC). Apart from its development and demonstrator aircraft, the Sukhoi company has introduced TVC on the production Su-30MKI multi-role fighter currently in service with the Indian Air Force. More than once the Indian *Flanker* pilots have shown the Su-30MKI's superiority in DACT sessions with American and French Generation 4+ fighters. Now, as already mentioned, RSK MiG intends to fit thrust-vectoring engines to new versions of the MiG-29 upgraded to Generation 4+ standards. Here the

Yefim Gordon

◄ **US military pilots were able to see the MiG-29's strengths for themselves when they were allowed to fly the MiG-29UB from the front seat in the early 1990s. This one is a US Navy/Blue Angels pilot.**

author would like to quote Gheorgiy Timofeyev, a Russian defence expert whose somewhat unusual views were stated in the feature *Super-agility: Unanswered Questions Remain* published by the Russian magazine *Istoriya Aviatsii* (Aviation History).

'Oddly enough, TVC cannot give the MiG-29 and the Su-27 a significant improvement of their dogfighting capability at speeds between Mach 0.5 and 0.9. Since the purpose of a fighter's manoeuvres in a dogfight is to get into a position where short-range AAMs or cannons can be brought to bear on the enemy, the slightest increase of the forces altering the fighter's flight path immediately affects the outcome of the engagement. In particular, experiments with models and actual aircraft have shown that, all other conditions being equal, increasing the turn rate at the start of the engagement by as little as 2-3 deg/sec allows you to assume the necessary position for attack quicker. However, TVC is necessary to improve agility at speeds approaching the minimum control speed and angles of attack close to the fighter's alpha limit.

If the vectoring nozzles are aft-mounted, deflecting them will only cause the fighter to lift or drop its nose while basically travelling in the same direction as it did. In order to give a significant increase of lift the vectoring nozzles should be located close to the aircraft's CG, the way it is on the [British Aerospace] Harrier. Yet, even so the value of TVC is more than questionable because, as the dogfight commences at speeds of Mach 0.8-0.9, the dynamic pressure is high and the fighters pull 9 Gs even at an AOA of 3-5°. In these circumstances there is no need for thrust vectoring, as the aircraft cannot pull more than 9 Gs for structural integrity reasons. Then, as the dogfight progresses and the fighters perform manoeuvres causing deceleration, thrust becomes too precious to use it for anything else than maintaining or regaining speed. The only situation where we can use TVC in the currently advertised form is on a fighter having a wing loading in excess of 400 kg/m² [82 lb/sq ft] *and a high thrust/weight ratio. (In case you haven't guessed, this is the Russian [Sukhoi] S-37/Su-47 Berkoot.)*

This is more or less how the advanced and heavier versions of the MiG-29 will look. [...] That's where TVC will allow the pilot to fly the machine confidently without running the risk of flicking into a spin.'

It makes sense to touch on several other criteria which experts use to assess a fighter's combat efficiency.

The MiG-29's two engines located in spaced nacelles increase combat survivability significantly, as there is little probability of both engines being disabled by a single missile or burst of cannon fire. This feature also reduces accident attrition in peacetime as compared to single-engined types, such as the F-16, Mirage 2000-5, SAAB JAS39 and others. In its 16th-24th August 1995 issue *Flight International* analysed military aircraft accident statistics for 1994; of the 22 accidents that year involving F-16s, eight were caused by engine failure. By comparison, since its service entry in 1983 the MiG-29 had only four accidents caused by engine failure. The RD-33 turbofan can be easily restarted at low speed (right down to 300 km/h or 186 mph), whereas the Pratt & Whitney F100-PW-200 of the F-16C/D requires a speed of 390-460 km/h (242-285 mph) for a successful relight.

General Electric have offered one of their engines for installation in the export MiG-29 subject to certain conditions (the engine model and other details were still undisclosed as of this writing). MAPO-MiG engineers said yes, providing GE modified the engine to make it at least as good as the RD-33 in certain respects. One particular parameter MAPO-MiG was dissatisfied with was surge resistance; in the American engine it was 6 conventional units (as per US standards), while in the case of the RD-33 it was 12. Incidentally, in one case the 'Westernisation' trend has been reversed. The RD-33 has been selected to re-engine the Atlas Cheetah, a South African spin-off of the Dassault Mirage III.

Although it was developed many years ago for the first Soviet fourth-generation fighter, even by today's standards the RD-33 has a fairly low SFC – 2.05 kg/kgp·hr (lb/lbst·hr) in full afterburner and 0.77 kg/kgp·hr at full military power. By comparison, the SNECMA M53-P20 powering the Mirage 2000-5 has an SFC of 2.08 and 0.89 kg/kgp·hr in these respective modes.

A critical factor reflecting an aircraft's operations is its attrition rate. Over the first ten years in service the mean accident rate per 100,000 flight hours is 7.8 for the MiG-29 and 14 for the F-16. Thirty-four MiG-29s were lost in accidents between 1983 and 1995, only six of these crashed because of design and manufacturing defects. Within the same time frame (excluding 1991-93, for which period no information is available) there were 110 major accidents involving F-16s, 41 of which were caused by design and manufacturing defects.

The above comparative analysis applies mainly to early MiG-29s (*izdeliye* 9.12, 9.12A and

9.12B). Yet below the reader will find some figures for the late versions of the *Fulcrum* – the production MiG-29SE and the experimental MiG-29SM and MiG-29M, which offer much-improved performance over the initial *Fulcrum-A* and a wider weapons range including R-77 (RVV-AE) 'AMRAAMski' missiles, various AGMs and (on the MiG-29M) heavy-calibre guided bombs. In the opinion of Russian defence and aviation experts, the latest versions of the MiG-29 have higher performance, combat efficiency, and better reliability and serviceability than most Western fighters. Comparative data are given in the tables on this page.

Coupled with the excellent aerodynamics, the higher thrust-to-weight ratio gives the MiG-29 an advantage in manoeuvrability over its opponents.

The upgraded fire control radars of the latest MiG-29 versions have a large field of view. In the MiG-29M's Phazotron N010 Zhuk radar and the Phazotron N019M Topaz of the MiG-29S the beam is scanned in azimuth through 180° and 140° respectively. By comparison, the Hughes Electronics AN/APG-65 radar fitted to the F/A-18C and the F-16C's Westinghouse AN/APG-68 have 140° and 120° scanning in azimuth respectively.

Western and Russian assessments of the fighters' armament, weapons control systems and combat potential differ somewhat, to say the least. US specialists claim that the F-16A's Westinghouse AN/APG-66 radar is superior to the N019, having, for example, 20% longer detection range. MAPO MiG, however, maintain that the N019 has longer range not only than the AN/APG-66 but the much more powerful AN/APG-65!

Table 11 (see page 433) illustrates the so-called combined combat efficiency quotient calculated by MAPO MiG experts. This is a relative unit which includes the performance of the WCS and other mission avionics, the fighter's top speed in intercept mode and the characteristics of its weapons.

In dogfight mode the MiG-29's combined combat efficiency quotient, which here includes the characteristics of the ESM suite and the aircraft's acceleration as well, will be even higher (see below).

In strike mode the F-16 is superior to the early versions of the MiG-29 due to its higher MTOW. For example, with 2,000 kg (4,410 lb) of bombs and two R-60M AAMs the MiG-29 can only carry a single drop tank; with a similar ordnance load the F-16 can carry three drop tanks giving it longer range. Besides, the

Table 1. Thrust-to-Weight Ratio

	Thrust-to-weight ratio: Combat*	Take-off
MiG-29SE/SM	1.52	1.08
MiG-29M	1.43	1.05
F-16C	1.05	1.09
F/A-18C	1.00	0.93
EF2000	1.30	1.22
Mirage 2000-5	0.95	n/a

* at 1,000 m (3,280 ft) and Mach 1.0 with a full internal fuel load

Table 2. Rate of Climb at 1,000 m (3,280 ft) and Mach 0.9 with a Full Internal Fuel Load

	Rate of climb, m/sec (ft/min)
MiG-29SE	330 (64,944)
MiG-29M	320 (62,976)
F-16C	265-275 (52,152-54-120)
F/A-18C	256 (50,380)
EF2000	300 (59,040)
Mirage 2000-5	285 (56,088)

Table 3. Maximum Turn Rate at 3,000 m (9,840 ft) with 50% Fuel

	Turn rate, deg/sec
MiG-29SE	23.5
MiG-29M	22.8
F-16C	21.5
F/A-18C	20.0
EF2000	22.0
Mirage 2000-5	20.0

Table 4. Specific Wing Loading at Take-Off

	Wing loading, kg/m² (lb/sq ft)
MiG-29SE	403 (82.62)
MiG-29M	439 (90.0)
F-16C	435 (89.18)
F/A-18C	420 (86.11)
EF2000	300 (61.5)

Table 5. G Limits of 4th-Generation Fighters

	Airframe G Limit	Max G Force in a Turn
MiG-29SE	9.0	7.0
MiG-29M	9.0	7.0
F-16C	9.0	6.4
F/A-18C	7.5	6.2
EF2000	9.0	7.0

Table 6. Acceleration from 600 to 1,000 km/h at 1,000 m (372-621 mph at 3,280 ft)	
	Acceleration time, in seconds
MiG-29SE	13.5
MiG-29M	13.5
F-16C	14.0
F/A-18C	18.0
EF2000	14.0

Table 7. Fire Control Radar Performance Data			
	N019	AN/APG-66	AN/APG-65
Weight, kg (lb)	250 (551)	160 (352)	224 (493)
Volume, m^3 (cu ft)	n/a	0.11 (3.88)	0.12 (4.23)
Scanner diameter	n/a	0.6 m (1 ft 11⅝ in)	0.7 m (2 ft 3 35/64 in)
Mean radiation power, W	n/a	150-250	400-450
Aerial target detection range, km (miles): *			
in open airspace	75 (46.5)	40 (24.8)	65 (40.3)
in 'look-down/shoot-down' mode, head-on mode	65 (40.3)	n/a	60 (37.2)
in 'look-down/shoot-down' mode, pursuit mode	35 (21.7)	n/a	40 (24.8)

Table 8. Weapons Control System Data of Fourth-Generation Fighters					
	MiG-29SE	MiG-29M	F-16C	F/A-18C	EF2000
Fire control radar model	Phazotron N019ME	Phazotron N010	Westinghouse AN/APG-68	Hughes AN/APG-65	GEC-Marconi ECR90
Aerial target detection range, km (miles): *					
in open airspace	60-70 (37.2-43.4)	80 (49.6)	50-60 (31-37.2)	60-65 (37.2-40.3)	70-80 (43.4-49.6)
in 'look-down/shoot-down' mode, head-on mode	60 (37.2)	80 (49.6)	50-60 (31-37.2)	60 (37.2)	70 (43.4)
in 'look-down/shoot-down' mode, pursuit mode	30-35 (18.6-21.7)	40-50 (24.8-31)	30-35 (18.6-21.7)	35-40 (21.7-24.8)	40 (24.8)
Targets tracked	10	10	10	10	10
Targets attacked simultaneously	2	4	4	4	4
Scanning in azimuth	140°	180°	120°	120°	140°
Surface ship detection range, km (miles) †	n/a	120-150 (74.5-93.1)	120-150 (74.5-93.1)	120-150 (74.5-93.1)	120-150 (74.5-93.1) ‡
Optoelectronic targeting system					
Aerial target detection range, km (miles): *					
head-on mode	n/a	10 (0.62)	none	none	n/a
pursuit mode	15 (0.93)	30 (18.6)	none	none	n/a
Laser rangefinder	yes	yes	yes §	yes §	no
Use in strike mode	no	yes	yes §	yes §	yes†
Active ECM	yes	yes	yes	yes	yes

Notes:
* Fighter-type targets with an RCS of 3 m^2 (32.25 sq ft); † Surface ship with an RCS of 3,000 m^2 (32,258 sq ft);
‡ To be introduced around 2005; § Podded laser ranger/designator only.

Table 9. Armament of Fourth-Generation Fighters

	MiG-29SM	MiG-29M	F-16C	F/A-18C	EF2000
Internal gun	1 x GSh-301 30 mm	1 x GSh-301 30 mm	1 x M-60A1 20 mm	1 x M-60A1 20 mm	1 x Mauser 27 mm
Air-to-air missiles ('kill' range, km/miles): *					
semi-active radar homing	2 x R-27ER (60/37.2) 2 x R-27R1 (50/31)	2 x R-27ER (60/37.2) 2 x R-27R1 (50/31)	2 x AIM-7 Sparrow (40/24.8)	2 x AIM-7 Sparrow (40/24.8)	n/a
active radar homing	6 x R-77 (50/31)	6 x R-77 (50/31)	6 x AIM-120 AMRAAM (50/31)	6 x AIM-120A AMRAAM (50/31)	6 x AIM-120A AMRAAM (50/31)
passive IR homing	2xR-27T/ET (50/31) 6xR-73 (20/12.4)	2xR-27T/ET (50/31) 8xR-73 (20/12.4)	6 x AIM-9 Sidewinder (20/12.4)	4 x AIM-9 Sidewinder (20/12.4)	6 x AIM-9 Sidewinder (20/12.4)
Air-to-surface missiles:					
passive radar homing	2 x Kh-31P	4 x Kh-31P	2 x AGM-88A HARM	2 x AGM-88A HARM	n/a
active radar homing	2 x Kh-31A	4 x Kh-31A	4 x AGM-84 Harpoon	4xAGM-84 Harpoon	n/a
TV-guided	2 x Kh-29T	4 x Kh-29T	6 x AGM-65A Maverick	4 x AGM-65A Maverick	n/a
laser-guided	none	4 x Kh-25ML	6 x AGM-65E Maverick	4 x AGM-65E Maverick	n/a
passive IR homing	none	none	6 x AGM-65F Maverick	4 x AGM-65F Maverick	n/a
Guided bombs	2 x KAB-500KR	2 x KAB-500KR	2-4 x GBU-15	2-4 x GBU-15	n/a
Unguided rockets and free-fall bombs	yes	yes	yes	yes	yes

* against fighter-type targets with an RCS of 3 m^2 (32.25 sq ft)

Table 10. Maximum Air-to-Air Missile Launch Range of Fourth-Generation Fighters

	Medium-range AAMs in head-on mode	Medium-range AAMs in pursuit mode	Short-range AAMs in pursuit mode
MiG-29M	60 km (37.2 miles)	27 km (16.7 miles)	20 km (12.4 miles)
MiG-29	50 km (31 miles)	20 km (12.4 miles)	20 km (12.4 miles)
F-16C	40-45 km (24.8-27.9 miles)	18-20 km (11.1-12.4 miles)	18-20 km (11.1-12.4 miles)
F/A-18C	40-45 km (24.8-27.9 miles)	18-20 km (11.1-12.4 miles)	18-20 km (11.1-12.4 miles)

Table 11. Combined Combat Efficiency Quotient of Fourth-Generation Fighters in Intercept Mode

MiG-29SE	0.82
MiG-29SM	0.82
MiG-29M	1.00
F-16C	0.76
F/A-18C	0.85
Mirage 2000-5	0.68
EF2000	0.9-1.0

Table 12. Combined Combat Efficiency Quotient of Fourth-Generation Fighters in Dogfight Mode

MiG-29SE	0.90
MiG-29SM	0.90
MiG-29M	1.00
F-16C	0.79
F/A-18C	0.65
Mirage 2000-5	0.82
EF2000	0.9-1.0

Table 13. Combined Combat Efficiency Quotient of Fourth-Generation Fighters in Strike Mode

MiG-29SE	0.34
MiG-29SM	0.75
MiG-29M	1.00
F-16C	1.00
F/A-18C	1.00
Mirage 2000-5	0.70
EF2000	0.8-1.0

Table 14. Summarised Combat Efficiency Evaluation of Fourth-Generation Fighters

	Air-to-air mode	Strike mode
MiG-29SE	0.86	0.34
MiG-29SM	0.86	0.75
MiG-29M	1.00	1.00
F-16C	0.78	1.00
F/A-18C	0.79	1.00
Mirage 2000-5	0.75	0.70
EF2000	0.9-1.0	0.8-1.0

Table 15. Cost-Effectiveness of Fourth-Generation Fighters

	Air-to-air mode	Strike mode
MiG-29SM	1.0	1.0
MiG-29SE	1.23	0.74
F-16C	0.87	1.02
F/A-18C	0.75	0.88
Mirage 2000-5	0.76	0.67

Fighting Falcon has aerial refuelling capability which production versions of the *Fulcrum* lack (it is to be introduced under a mid-life update programme). According to US experts, with two 900-kg (1,984-lb) bombs and two AIM-9 Sidewinder short-range AAMs the F-16C has a 1,200-km (745-mile) combat radius on a 'hi-lo-hi' mission profile; in similar conditions (two 900-kg bombs, two R-60M 'dogfight AAMs', 'hi-lo-hi') the MiG-29's combat radius is 500 km (310 miles). With the same armament on a 'lo-lo-lo' mission profile the two fighters' combat radius should be 740 km (459 miles) and 315 km (195 miles) respectively.

According to Russian analysts, combat radius in supersonic (Mach 1.5) intercept mode with four medium-range AAMs, two short-range AAMs and three drop tanks is 410 km (254 miles) for the MiG-29M, 389 km (241 miles) for the F-16C, 370 km (229 miles) for the F/A-18C and 345 km (214 miles) for the MiG-29S. In low-level penetration mode (200 m/660 ft) with drop tanks the fighters have a combat radius of 385 km (239 miles), 400 km (248 miles), 372 km (231 miles) and 340 km (211 miles) respectively. Thus, Russian and US fourth-generation light fighters are similar as regards range.

The above data indicate that the F-16 is an air superiority fighter optimised for air-to-air combat at subsonic and transonic speeds at low and medium altitude. The F-16's high MTOW also gives it strike capability. While the MiG-29, too, was conceived as an air superiority fighter, its early versions had limited strike capability; however, it is effective in the air defence role against high-flying high-speed targets.

MAPO MiG calculations show that the MiG-29SE and MiG-29SM are a much more cost-effective solution as compared to their Western counterparts, as illustrated by Table 15.

Russian defence industry analysts claimed the most advanced fourth-generation version of the *Fulcrum*, the MiG-29M, to be three times more cost-effective than the Eurofighter EF2000. MAPO-MiG also believed the latest fourth-generation versions of the MiG-29 to have better reliability and serviceability than their US competitors. The MTBF is 7.3 hours for the MiG-29M and 13.6 hours for the MiG-29S versus 3.7 hours for the F/A-18C and 2.9 hours for the F-16C. Specific maintenance labour intensity is 11 man-hours per flight hour for the MiG-29S and MiG-29M, compared to 16 man-hours for the F/A-18C and 18 man-hours the F-16C during the initial service (IOC) period.

Experts from Germany's Federal Accounting Office (BRH – *Bundesrechnungshof*) stated that in the configuration selected for the Luftwaffe – that is, without the IRST and built-in DASS ECM suite – the EF2000 would be inferior to the MiG-29. At the same time, the then First Deputy General Designer Anatoliy A. Belosvet claimed that the production MiG-29S (*izdeliye* 9.13S) armed with R-77 AAMs is a more capable 'dogfighter' than the F-15C, F-16C and F/A-18C with AIM-120A AMRAAM missiles or the Mirage 2000-5 with Matra Mica AAMs, and that the MiG-29M has similar combat potential to the USAF's high-tech Boeing/Lockheed Martin F-22A Raptor.

Western aviation experts have often criticised the MiG-29's cockpit as being '1960s style'. In the early 1990s Mikhail R. Val'denberg's countered this criticism with something like 'If a state-of-the-art cockpit is all you need, then the

Table 16. Reliability and Serviceability Parameters of Fourth-Generation Fighters

	MiG-29SE	MiG-29M	F-16C	F/A-18C
Operational readiness quotient	0.9	0.9	0.8	0.85
Specific maintenance labour intensity, man-hours per flight hour	11.3	11.0	18	16-18
MTBF, hrs	13.6	7.3	2.9	3.7
Airframe life, hrs	7,000	7,000	8,000	8,000
Relative cost	0.7	0.8	0.7	1.0

MiG-29 is not your best buy. But if you need a good aircraft for the counter-air role, well, that's something else again'. Moreover, now that a 'glass cockpit' has been incorporated in the MiG-29M2 and the modified second prototype MiG-29K ('312 Blue'), the critics should be singing a different tune. The EFIS will be fitted as standard to the 'new' MiG-29K (*izdeliye* 9.41) and MiG-29KUB developed for the Indian Navy.

Of course, any analysis should be taken with a grain of salt. Analysts are never completely objective on either side, and of course all companies try to advertise their aircraft. Still, the MiG-29's impressive displays at various air-shows, especially MAKS-2005 where the MiG-29M2 and the MiG-29OVT thrilled the spectators, speak for themselves. Also, appraisals by Western experts – and not least fighter pilots – show beyond doubt that the *Fulcrum* is treated with respect, as it should be.

Table 17. Comparative Performance Data of MiG-29 and the Best Western Fourth-Generation Fighters

	MiG-29SE	MiG-29M	F-16C Block 42	F/A-18C	EF2000
Powerplant	2 x Izotov RD-33	2 x Izotov RD-33K	Pratt & Whitney F100-PW-220	2 x General Electric F404-GE-400	2 x Eurojet EJ200
Rating in full afterburner, kgp (lbst)	2 x 8,300 (2 x 18,390)	2 x 8,800 (2 x 19,400)	12,300 (27,120)	2 x 7,300 (2 x 16,090)	2 x 9,175 (2 x 20,230)
Normal TOW, kg (lb)	15,300 (33,730)	16,680 (36,770)	12,000 (26,455)	15,700 (34,611)	15,000 (33,070)
MTOW, kg (lb)	19,700 (43,430)	22,000 (48,500)	19,187 (42,300)	23,500 (51,807)	21,000 (46,300)
Internal fuel, kg (lb)	3,832 (8,448)	4,460 (9,830)	3,104 (6,846)	4,900 (10,800)	4,000 (8,820)
External fuel, kg (lb)	3,040 (6,700)	3,290 (7,250)	3,066 (6,760)	3,100 (6,830)	3,600 (7,940)
Ordnance load, kg (lb)	4,000 (8,820)	4,500 (9,920)	5,443 (12,000)	4,500 (9,920)	6,500 (14,330)
Top speed, km/h (mph):					
at sea level	1,480 (919)	1,500 (931)	1,450 (900)	1,300 (807)	n/a
at altitude	2,450 (1,521)	2,500 1,552)	2,000 (1,242)	1,900 (1,180)	2,200-2,300 (1,366-1,428)
Range, km (miles):					
on internal fuel only (at altitude)	n/a	2,000 (1,242)	1,600 (993)	2,200 (1,366)	1,800-2,200 (1,118-1,366)
with 3 drop tanks	n/a	3,200 (1,987)	3,900 (2,422)	3,200 (1,987)	3,000-4,000 (1,863-2,484)

Table 18. MiG-29 and F-16 Compared

	MiG-29	MiG-29SE	MiG-29M	F-16A Block 1-15	F-16C Block 25	F-16C Block 32	F-16C Block 42	F-16C Block 50
First flight	1983	1986	1986	1979-82	1984	1986	1989	1992
Powerplant	2 x Izotov RD-33	2 x Izotov RD-33	2 x Izotov RD-33K [1]	P&W F100-PW-200	P&W F100-PW-200	P&W F100-PW-220	P&W F100-PW-220	GE F110-GE-129
Rating in full afterburner, kgp (lbst)	2 x 8,340 (2 x 18,390)	2 x 8,340 (2 x 18,390)	2 x 8,800 (2 x 19,400)	11,340 (25,000)	11,340 (25,000)	12,300 (27,116)	12,300 (27,116)	13,420 (29,588)
Length	17.32 m (56 ft 9 7/8 in)	17.32 m (56 ft 9 7/8 in)	17.32 m (56 ft 9 7/8 in)	15.03 m (49 ft 3 47/64 in)	15.03 m (49 ft 3 47/64 in)	15.03 m (49 ft 3 47/64 in)	15.03 m (49 ft 3 47/64 in)	15.03 m (49 ft 3 47/64 in)
Wing span	11.36 m (37 ft 3 15/64 in)	11.36 m (37 ft 3 15/64 in)	11.36 m (37 ft 3 15/64 in)	9.54 m (31 ft 3 19/32 in)	9.54 m (31 ft 3 19/32 in)	9.54 m (31 ft 3 19/32 in)	9.54 m (31 ft 3 19/32 in)	9.54 m (31 ft 3 19/32 in)
Height on ground	4.73 m (15 ft 6 7/32 in)	4.73 m (15 ft 6 7/32 in)	4.73 m (15 ft 6 7/32 in)	5.09 m (16 ft 8 25/64 in)	5.09 m (16 ft 8 25/64 in)	5.09 m (16 ft 8 25/64 in)	5.09 m (16 ft 8 25/64 in)	5.09 m (16 ft 8 25/64 in)
Wing area, m^2 (sq ft)	38.00 (408.6)	38.00 (408.6)	38.00 (408.6)	27.87 (299.67)	27.87 (299.67)	27.87 (299.67)	27.87 (299.67)	27.87 (299.67)
Normal TOW, kg (lb)	15,000 (33,070)	15,300 (33,730)	16,680 (36,770)	11,200 (24,690)	11,470 (25,290)	n/a	12,000 (26,455)	12,933 (28,511)
MTOW, kg (lb)	18,000 (39,682)	19,700 (43,430)	22,000 (48,500)	16,060 (35,405)	17,010 (37,500)	17,010 (37,500)	19,187 (42,300)	19,187 (42,300)
Internal fuel, kg (lb)	3,630 (8,002)	3,832 (8,448)	4,460 (9,832)	3,104 (6,846)	3,104 (6,846)	3,104 (6,846)	3,104 (6,846)	3,104 (6,846)
Thrust-to-weight ratio [2]	1.11	1.09	1.11	0.95	n/a	n/a	1.03	1.03
Top speed, km/h (mph):								
at sea level	1,480 (919)	1,480 (919)	1,500 (931)	1,450 (900)	1,450 (900)	1,450 (900)	1,450 (900)	1,450 (900)
at altitude	2,450 (1,521)	2,450 (1,521)	2,500 (1,552)	2,100 (1,304)	n/a	n/a	2,000 (1,242)	2,000 (1,242)
Landing speed, km/h (mph)	260 (161)	260 (161)	260 (161)	245 (152)	245 (152)	245 (152)	245 (152)	245 (152)
Service ceiling, m (ft)	17,500 (57,410)	17,000 (55,770)	17,000 (55,770)	15,200 (49,870)	15,240 (50,000)	15,240 (50,000)	15,240 (50,000)	18,000 (59,055)
Rate of climb, m/sec (ft/min) [3]	330 (64,944)	330 (64,944)	300 (59,040)	245 (48,216)	n/a	265 (52,152)	265 (52,152)	265 (52,152)
Range, km (miles):								
on internal fuel at S/L	710 (440)	n/a	900 (559)	700 (434)	700 (434)	700 (434)	700 (434)	700 (434)
on internal fuel at altitude	1,500 (931)	n/a	2,000 (1,242)	1,600 (993)	1,600 (993)	1,600 (993)	1,600 (993)	1,600 (993)
with 1 drop tank	2,100 (1,304)	n/a	n/a	n/a	n/a	n/a	n/a	n/a
with 3 drop tanks	2,900 (1,801)	n/a	3,200 (1,987)	3,900 (2,422)	3,900 (2,422)	3,900 (2,422)	3,900 (2,422)	3,900 (2,422)
Long-range AAMs	–	R-27ER R-27ET	R-27ER R-27ET	–	–	–	–	–
Medium-range AAMs	R-27R1 R-27T1	R-27R1 R-27T1	R-27R1 R-27T1	–	–	–	AIM-120	AIM-120
Short-range AAMs	R-60M R-73	R-60M R-73E	R-60M R-73	AIM-9	AIM-9	AIM-9	AIM-9	AIM-9
Air-to-surface missiles	–	–	Kh-25ML Kh-25MP Kh-29T Kh-31A/P	AGM-84 [4] Popeye-2 [5]	Gabriel [5]	AGM-65 AGM-45	AGM-65 AGM-88	AGM-65 AGM-88

Notes:

1. 'Land-based' version lacking the 9,400-kgp (20,720 lbst) take-off contingency rating of the naval engine;
2. With normal TOW; 3. At 1,000 m (3,280 ft); 4. Royal Norwegian Air Force only; 5. Israeli Defence Force/Air Force (IDF/AF) only.

PART TWELVE

THE OPERATORS

Yefim Gordon

▲
968th IISAP MiG-23UB '20 Blue' (c/n N50903014938?) heads a line of *Fulcrums* on the apron at the Russian Air Force's 4th Combat & Conversion Training Centre in Lipetsk.

Yefim Gordon

►
A line-up of Russian Air Force (28th GvIAP) *Fulcrum-Cs* at Andreapol'.

According to available information, the MiG-29's total production run between late 1982 and early 1996 amounted to 1,478 production examples, built by MAPO's Moscow and Lookhovitsy plants and the Gor'kiy (Nizhniy Novgorod) aircraft factory. This amount included 779 *Fulcrum-As*, 478 *Fulcrum-Cs* and 221 MiG-29UBs. About 100 single-seaters remained unsold and were in storage at Lookhovitsy-Tret'yakovo until 1998-2002 when customers were finally found for them. Concurrently another 22 MiG-29UBs were manufactured, increasing the production total to 1,500. However, this figure does not include the 24 prototypes built by the OKB's experimental plant (MMZ No.155) – 14 *Fulcrum-As*, two MiG-29UBs, two MiG-29Ks and six MiG-29Ms. Also, production is due to resume in connection with the Indian Navy's MiG-29K/KUB order.

Of the 1,500 production machines built to date, 999 were delivered to the home market (the Soviet/CIS air forces) and 501 were exported as new aircraft. As of 2006, the MiG-29 had been delivered to or ordered by the air forces of 25 nations. The *Fulcrum* is in service with 29 nations, including seven of the former Soviet republics. Known operators of the type are listed in this chapter, and the USSR and the CIS republics are dealt with first.

Soviet Union/Russia

The **Soviet Air Force (VVS)** was, of course, the first and largest operator of the MiG-29. As described in previous chapters, the type attained initial operational capability with the 455th IISAP of the Lipetsk-based 4th TsBP i PLS in 1983. The 234th GvIAP at Kubinka AB and the 968th *Sevastopol'skiy* IAP at Ross' followed later that year. Gradually other units stationed both in Soviet territory and in Eastern Europe re-equipped with the new type. For instance, the Western Group of Forces (formerly Group of Soviet Forces in Germany) operated 249 MiG-29s; the Southern Group of Forces in Hungary had 101, while the Central Group of Forces in Czechoslovakia managed to receive only ten. In the USSR, 348 MiG-29s were

Units that Operated the MiG-29 in Soviet Times

Formation	Unit	Base	Notes
Moscow Defence District			
9th IAD, HQ Kubinka AB	234th GvIAP	Kubinka AB	Transformed to 237th TsPAT
4th TsBP i PLS, Lipetsk	91st UIAP	Lipetsk	
	455th IISAP	Lipetsk	Disbanded
	760th UAP		
1080th UATs PLS, Borisoglebsk	160th UAP	Borisoglebsk	
	343rd UAP	Sennoye AB	
Baltic Defence District, 15th Air Army	53rd IAP	Siauliai, Lithuanian SSR	To 53rd APIB, re-equipped with MiG-27s in 1988
Belorussian Defence District, 26th Air Army	116th IAP	Ross'	Base formerly occupied by 968th IAP. To 116th APIB, re-equipped with Su-24s in 1989
	927th IAP	Beryoza AB	Ex-927th APIB, re-equipped 1990
	968th IAP	Ross'	Transferred to Western Group of Forces, see below
Carpathian Defence District, 14th Air Army, HQ L'vov, Ukrainian SSR			
4th IAD, HQ Ivano-Frankovsk	92nd IAP	Mukachovo, Ukrainian SSR	To Ukrainian Air Force
	145th IAP	Ivano-Frankovsk, Ukrainian SSR	To Ukrainian Air Force
Red Banner Odessa Defence District, 5th Air Army, HQ Odessa, Ukrainian SSR			
303rd ADIB	642nd IAP	Martynovka	To Ukrainian Air Force
Transcaucasian Defence District, 34th Air Army, HQ Tbilisi, Georgian SSR			
283rd IAD, HQ Mikha Tskahkaya AB	176th IAP	Mikha Tskahkaya AB, Georgian SSR	Disbanded
Central Asian Defence District, 73rd Air Army, HQ Tashkent, Uzbek SSR	115th GvIAP	Kokaïdy AB, Uzbek SSR	To Uzbekistan Air Force
	715th UIAP	Loogovaya AB, Kirghiz SSR	To Kyrghyzstan Air Force
	1251st Air Base	Maryy-1 AB, Turkmen SSR	To Turkmenistan Air Force
Far Eastern Defence District, 1st Air Army, HQ Khabarovsk			
20th IAD	404th IAP	Orlovka AB	Disbanded 2000
Naval Aviation, Black Sea Fleet Air Arm, HQ Sevastopol'			
119th IAD, HQ Tiraspol'	86th IAP	Markuleshty, Moldavian SSR	To Moldovan Air Force
	161st IAP	Limanskoye AB, Ukrainian SSR	To Ukrainian Air Force
UNITS BASED OUTSIDE THE USSR			
Southern Group of Forces, 36th Air Army, HQ Budapest			
11th IAD, HQ Tököl	5th GvIAP	Sarmellek	To Beryoza AB, Belorussia, 10-90 and disbanded
	14th IAP	Tököl	To Martynovka AB, the Ukraine, 22-4-91
	515th IAP	Kiskunlachaza	To Russia 5-90
Central Group of Forces, HQ Prague			
131st Composite Air Division, HQ Milovice	114th IAP	Mladá-Milovice AB	To Ivano-Frankovsk, the Ukraine, 1991
Western Group of Forces, 16th Air Army, HQ Wünsdorf			
6th IAD, HQ Merseburg	31st GvIAP	Falkenberg	To Zernograd, Russia, 15-6-93
	85th GvIAP	Merseburg	To Starokonstantinov, the Ukraine, 5-91
	968th IAP	Altenburg	Ex-Belorussian DD. To Lipetsk, Russia, 22-4-92 and disbanded
16th IAD, HQ Falkenberg	33rd IAP	Wittstock	To Zernograd, Russia, 11-4-94; disbanded 1-6-94
	773rd IAP	Damgarten	To Zernograd, Russia, 11-4-94; disbanded 1-6-94
	787th IAP	Finow	To Ross', Belorussia, 11-5-93 and disbanded
126th IAD, HQ Zerbst	35th IAP	Zerbst	To Zherdyovka AB, Russia, 10-6-92; disbanded 1996
	73rd GvIAP	Köthen	To Shaykovka AB, Russia, 4-91; disbanded 1998

Active Russian Air Force MiG-29 Units as of January 2006

Formation	Unit	Base
Direct reporting units		
4th TsBP i PLS, Lipetsk	968th IISAP	Lipetsk
116th TsBP i PLS, Astrakhan'	160th ISAP	Astrakhan'
Krasnodar VVAUL (Military Pilot College)	797th UAP	Krasnodar
Armavir VVAUL	713th UAP	Armavir
929th GLITs, Akhtoobinsk	267th	Vladimirovka AB
Moscow VVS and PVO District		
5th PVO Division	14th GvIAP	Khalino AB, Kursk
	28th GvIAP	Andreapol'
	237th TsPAT	Kubinka AB
4th VVS and PVO Army		
51st Air Corps	31st GvIAP	Zernograd
	19th GvIAP	Millerovo
50th Independent VVS and PVO Corps		
21st Independent Composite Air Division	120th GvIAP	Domna AB, Chita

deployed in the European part of the nation (221 of these were operated by first-line units and another 127 by training units); a further 117 examples (79 in first-line units and 38 in training units) were based in the Asian and Far Eastern regions. Overall, in 1989-90 the Soviet Air Force had 465 *Fulcrums* stationed on home ground and a further 360 abroad, giving a total of 825. In 1991 the total number increased to 885.

In 1992-93 the Russian Air Force operated about 580 MiG-29s, including the test and development aircraft owned by the Mikoyan OKB. By 2002 this had dwindled to about 490 machines, including 239 *Fulcrums* in service with first-line units, 145 aircraft operated by training units and 89 aircraft at the Air Force's storage depots. Also, the 100 unclaimed aircraft stored at Lookhovitsy-Tret'yakovo have now been sold off. As of this writing, after several reorganisations,

Soviet and Russian Air Force MiG-29s

C/n	F/n	Version	Tactical code	Notes
?		MiG-29 (*izd.* 9.12)*	'01 Blue' (901)	Mikoyan OKB, first prototype. Preserved Central Russian Air Force Museum, Monino
?		MiG-29 (*izd.* 9.12)*	'02 Blue' (902)	Mikoyan OKB, second prototype. WFU and destroyed as ground test article at NIPAV
?		MiG-29 (*izd.* 9.12)*	'03 Blue' (903)	Mikoyan OKB, third prototype. Crashed near Zhukovskiy 15-6-78
?		MiG-29 (*izd.* 9.12)*	'04 Blue' (904)	Mikoyan OKB, fourth prototype. To LII; preserved Moscow-Khodynka museum
?		MiG-29 (*izd.* 9.12)*	'08 Blue' (908)	Mikoyan OKB, fifth prototype. Crashed near Zhukovskiy 31-10-80
?		MiG-29 (*izd.* 9.12)*	'17 Blue' (917)	Mikoyan OKB, sixth prototype. Ground instructional airframe, Air Force Engineering Academy, Moscow
?		MiG-29 (*izd.* 9.12)*	'18 Blue' (918)	Mikoyan OKB, seventh prototype. Converted to MiG-29KVP, see next line
		MiG-29KVP		Preserved Central Russian Air Force Museum, Monino
?		MiG-29 (*izd.* 9.12)*	'19 Blue' (919)	Mikoyan OKB, eighth prototype. WFU 198, instructional airframe at Elektrougli
?		MiG-29 (*izd.* 9.12)*	'20 Blue' (920)	Mikoyan OKB, ninth prototype. To ground test article at Novaya Zemlya nuclear test range
?		MiG-29 (*izd.* 9.12)*	'21 Blue' (921)	Mikoyan OKB, tenth prototype. WFU Zhukovskiy
?		MiG-29 (*izd.* 9.12)*	'22 Blue' (922)?	Mikoyan OKB, 11th prototype. To TsAGI for wind tunnel tests; dumped Zhukovskiy
?		MiG-29 (*izd.* 9.12)*	'23 Blue' (923)	Mikoyan OKB, 12th prototype. To GosNIPAS as fire suppression systems test rig
0390501625	0101	MiG-29 (*izd.* 9.12)*	'24 Blue' (924)	Mikoyan OKB
?		MiG-29 (*izd.* 9.12)*	'25 Blue' (925)	Mikoyan OKB. Ground instructional airframe, Moscow Aviation Institute
03905.02017	0102	MiG-29 (*izd.* 9.12)*	'12 Blue'	Ground instructional airframe, Air Force Engineering Academy named after Nikolay Ye. Zhukovskiy, Moscow
0390502020	0103	MiG-29 (*izd.* 9.12)*	'03 Blue'	Preserved Central Russian Air Force Museum, Monino
?	0203	MiG-29 (*izd.* 9.12)*	not known	Crashed 14-12-87
2960505533	0405	MiG-29 (*izd.* 9.12)*	not known	Converted to *izdeliye* 9.13, see next line
		MiG-29 (*izd.* 9.13)	'05 Blue'	Prototype, Mikoyan OKB. F/n reported as 3916 but unlikely in view of c/n! Converted to *izdeliye* 9.17, see next line
			'331 Blue'	MiG-29SMT (*izdeliye* 9.17) 'glass cockpit' testbed. Converted and recoded, see next line
		MiG-29SMT (*izd.* 9.17)	'405 Blue'	RSK MiG, MiG-29SMT (*izdeliye* 9.17) aerodynamics test vehicle
2960505561	?	MiG-29 (*izd.* 9.12)*	'23 Blue'	Stored 121st ARZ, Kubinka AB
2960506161	?	MiG-29 (*izd.* 9.12)*	'37 Blue'	Stored
2960507622	?	MiG-29 (*izd.* 9.12)*	'32 Blue'	Sold to the USA as N6394K; c/n also reported as 2960507662
2960507641	?	MiG-29 (*izd.* 9.12)*	'07 Orange'	968th IAP, unit badge. Recoded, see next line
			'20 Red'	Stored 4020th BRS
2960507649	?	MiG-29 (*izd.* 9.12)*	'09 Red'	1521st AB. Hornet tail art. Stored 121st ARZ
2960507657	?	MiG-29 (*izd.* 9.12)*	'15 Orange'	968th IAP, unit badge. Recoded, see next line
			'22 Red'	Unit unknown. Stored 4020th BRS
2960507668	0705?	MiG-29 (*izd.* 9.12)*	'19 White'	Stored 4020th BRS
2960507670	0706	MiG-29 (*izd.* 9.12)*	'33 White'	120th IAP, 'double eagle' badge

2960507682	0707	MiG-29 (*izd.* 9.12)*	not known	Converted to *izdeliye* 9.13, see next line
		MiG-29 (*izd.* 9.13)	'07 Blue'	Prototype, Mikoyan OKB. Converted to *izdeliye* 9.14, see next line
		MiG-29 (*izd.* 9.14)	'407 Blue'	RSK MiG
2960507683	0708	MiG-29 (*izd.* 9.12)*	'52 White'	120th IAP. 'Double eagle' badge, sharkmouth and nose art
2960507687	070...	MiG-29 (*izd.* 9.12)*	not known	
2960507693	?	MiG-29 (*izd.* 9.12)*	'02'	Unit unknown. Recoded, see next line
			'23 Red'	Stored 4020th BRS
2960507747	?	MiG-29 (*izd.* 9.12)*	not known	234th GvIAP
2960509151	?	MiG-29 (*izd.* 9.12)*	'27 Red'	Stored 4020th BRS
2960509162	?	MiG-29 (*izd.* 9.12)*	'21 Red'	Stored 4020th BRS
2960509165?	?	MiG-29 (*izd.* 9.12)*	not known	LII?
2960509177	?	MiG-29 (*izd.* 9.12)*	'21'	Unit unknown. Recoded, see next line
			'53 Blue'	Stored 4020th BRS
2960509184	?	MiG-29 (*izd.* 9.12)*	'25'	Unit unknown. Recoded, see next line
			'11 Blue outline'	960th IAP. Recoded, see next line
			'11 Red'	Stored 4020th BRS
2960509199	?	MiG-29 (*izd.* 9.12)*	'37 Blue'	Unit unknown. Stored 4020th BRS
2960510107	?	MiG-29 (*izd.* 9.12)*	'39 Red'	(Ex) 35th IAP, Russian flag rudder colours. Stored 4020th BRS
2960510176	?	MiG-29 (*izd.* 9.12)	'09 Red'	53rd GvIAP, later 35th IAP
2960510179	?	MiG-29 (*izd.* 9.12)*	'10 Red'	53rd GvIAP, later 35th IAP
2960510180	?	MiG-29 (*izd.* 9.12)*	'11 Red'	53rd GvIAP, later 35th IAP
2960510181	?	MiG-29 (*izd.* 9.12)	'20 Red'	53rd GvIAP, later 35th IAP
2960510183	?	MiG-29 (*izd.* 9.12)*	'21 Red'	53rd GvIAP, later 35th IAP. Then to
				960th IAP; 'Excellent aircraft' badge. Stored 4020th BRS
2960510184	?	MiG-29 (*izd.* 9.12)	'22 Red'	53rd GvIAP, later 35th IAP
2960510186	?	MiG-29 (*izd.* 9.12)	'24 Red'	53rd GvIAP, later 35th IAP
2960510188	?	MiG-29 (*izd.* 9.12)*	'04 Red'	Unit unknown, later 960th IAP. Stored 4020th BRS
2960510194	?	MiG-29 (*izd.* 9.12)	'25 Red'	53rd GvIAP, later 35th IAP
2960510195	?	MiG-29 (*izd.* 9.12)	'26 Red'	53rd GvIAP, later 35th IAP
2960510197	?	MiG-29 (*izd.* 9.12)	'12 Red'	53rd GvIAP, later 35th IAP
2960512102	?	MiG-29 (*izd.* 9.12)	'23 Red'	53rd GvIAP, later 35th IAP
2960512107	?	MiG-29 (*izd.* 9.12)*	'27 Red'	53rd GvIAP, later 35th IAP
2960512120	?	MiG-29 (*izd.* 9.12)*	'21 Red'	31st GvIAP. Recoded, see next line
			'29 Red'	960th IAP, Russian flag rudder colours. Stored 121st ARZ
2960512125	?	MiG-29 (*izd.* 9.12)	not known	234th GvIAP. Recoded, see next line
			'24 White'	773rd IAP
2960512126	?	MiG-29 (*izd.* 9.12)*	'25 White'	773rd IAP
2960512149	?	MiG-29 (*izd.* 9.12)*	'23 White'	773rd IAP; leaping tiger nose art
2960512155	?	MiG-29 (*izd.* 9.12)*	'34 Red'	Unit unknown, later 960th IAP, unit badge and Russian flag rudder colours. Stored 121st ARZ
2960515035	?	MiG-29 (*izd.* 9.12)	'73 Blue'	Unit unknown. Stored 4020th BRS
2960515071	?	MiG-29 (*izd.* 9.12)	'11 Blue'	Unit unknown. Stored 4020th BRS
2960515125	?	MiG-29 (*izd.* 9.12)	'21 White'	Unit unknown. Recoded, see next line
			'11 Blue'	773rd IAP, 'frog' ('wraparound ZGV scheme' camouflage)
2960515380	?	MiG-29 (*izd.* 9.12)	'03 Red'	Unit unknown, later 960th IAP. Stored 4020th BRS
2960515389	?	MiG-29 (*izd.* 9.12)	'101 White'	Unit unknown. Stored 4020th BRS
2960515803	?	MiG-29 (*izd.* 9.12)	'01 White'	120th IAP. Russian flag & Russian AF flag on tails
2960515824	?	MiG-29 (*izd.* 9.12)	'27'	Unit unknown. Recoded, see next line
			'55 Blue'	Unit unknown; Russian flag & MiG logo. Stored 4020th BRS
2960515835	?	MiG-29 (*izd.* 9.12)	'73 Blue'	Unit unknown. Stored 4020th BRS
2960515840	?	MiG-29 (*izd.* 9.12)	'22 White'	773rd IAP
2960516505	?	MiG-29 (*izd.* 9.12)	'45 White'	120th IAP. 'Double eagle' badge, sharkmouth and nose art
2960516515	?	MiG-29 (*izd.* 9.12)	'49 White'	120th IAP. 'Double eagle' badge and sharkmouth
2960516532	?	MiG-29 (*izd.* 9.12)	'29 Red'	Unit unknown. Stored 4020th BRS
2960516552	?	MiG-29 (*izd.* 9.12)	'10 Red'	Unit unknown. Stored 4020th BRS
2960516557	?	MiG-29 (*izd.* 9.12)	'12 Blue'	Unit unknown. Sharkmouth. Stored 4020th BRS
2960516740?	?	MiG-29 (*izd.* 9.12)	'54 Blue'	234th GvIAP; c/n not 100% sure

2960516767	?	MiG-29 (*izd.* 9.12)	'10 Blue'	Mikoyan OKB demonstrator. Recoded, see next line
			'303 Blue'	Crashed Paris-Le Bourget 8-6-89
2960516768	?	MiG-29 (*izd.* 9.12)	not known	234th GvIAP. Recoded, see next line
			'26 White'	773rd IAP. Recoded, see next line
			'21 Blue'	28th GvIAP, Guards emblem and unit badge
2960516773	?	MiG-29 (*izd.* 9.12)	'55 White'	120th IAP. 'Double eagle' badge and sharkmouth
2960516785	?	MiG-29 (*izd.* 9.12)	'40 Red'	Unit unknown. Recoded, see next line
			'40 White'	120th IAP. 'Double eagle' badge and sharkmouth
2960516793	?	MiG-29 (*izd.* 9.12)	'44 Blue'	404th IAP. Unit badge and Russian flag rudder colours
2960518051	?	MiG-29 (*izd.* 9.12)	'50'	Unit unknown. Recoded, see next line
			'31 White'	33rd IAP. Converted to, see next line
		MiG-29SMT (*izd.* 9.17A)	'51 White'	Second 'production' conversion, 121st ARZ
2960518063	?	MiG-29 (*izd.* 9.12)	'03 White'	33rd IAP
2960518064	?	MiG-29 (*izd.* 9.12)	'02 White'	33rd IAP. Recoded, see next line
			'36 Red'	960th IAP, Russian flag rudder colours. Stored 4020th BRS
2960518070	?	MiG-29 (*izd.* 9.12)	'05 White'	33rd IAP
2960518073	?	MiG-29 (*izd.* 9.12)	'07 White'	33rd IAP
2960518074	?	MiG-29 (*izd.* 9.12)	'08 White'	33rd IAP, unit badge
2960518079	?	MiG-29 (*izd.* 9.12)	'11 White'	33rd IAP. Recoded, see next line
			'40 Red'	960th IAP, Russian flag rudder colours. Stored 4020th BRS
2960518081	?	MiG-29 (*izd.* 9.12)	'15 Blue'	33rd IAP. Recoded, see next line
			'35 White'	33rd IAP
2960518082	?	MiG-29 (*izd.* 9.12)	'04 White'	33rd IAP
2960518084	?	MiG-29 (*izd.* 9.12)	'01 White'	33rd IAP, unit badge. Recoded, see next line
			'01 Blue'	28th GvIAP, Guards emblem and unit badge
2960518091	?	MiG-29 (*izd.* 9.12)	'09 White'	33rd IAP
2960518094	?	MiG-29 (*izd.* 9.12)	'12 White'	33rd IAP
2960518450	?	MiG-29 (*izd.* 9.12)	'22 White'	33rd IAP. Recoded, see next line
			'62 White'	28th GvIAP. Stored 121st ARZ
2960518454	?	MiG-29 (*izd.* 9.12)	'23 White'	33rd IAP
2960518457	?	MiG-29 (*izd.* 9.12)	'25 Blue'	33rd IAP, MiG logos
2960518458	?	MiG-29 (*izd.* 9.12)	'26 Blue'	33rd IAP
2960518462	?	MiG-29 (*izd.* 9.12)	'27 Blue'	33rd IAP
2960518463	?	MiG-29 (*izd.* 9.12)	'28 Blue'	33rd IAP
2960518464	?	MiG-29 (*izd.* 9.12)	'29 White'	33rd IAP
2960518465	?	MiG-29 (*izd.* 9.12)	'12 Red'	31st GvIAP
2960518471	?	MiG-29 (*izd.* 9.12)	'32 Blue'	33rd IAP
2960518473	?	MiG-29 (*izd.* 9.12)	'33 Blue'	33rd IAP. Later with same unit as '33 White'. Recoded, see next line
			'43 White'	28th GvIAP. Stored 121st ARZ
2960518479	?	MiG-29 (*izd.* 9.12)	'41'	Unit unknown. Recoded, see next line
			'37 White'	33rd IAP, unit badge and lightning bolt
2960518751	?	MiG-29 (*izd.* 9.12)	'40'	Unit unknown. Recoded, see next line
			'36 White'	33rd IAP, unit badge
2960518755	?	MiG-29 (*izd.* 9.12)	'22 Red'	31st GvIAP
2960520115	?	MiG-29 (*izd.* 9.12)	'35 Red'	31st GvIAP
2960520145	?	MiG-29 (izd. 9.12)	'06 White'	33rd IAP. Recoded, see next line
			'47 White'	28th GvIAP. Stored 121st ARZ
2960520149	?	MiG-29 (izd. 9.12)	'10 White'	33rd IAP. Recoded, see next line
			'48 White'	28th GvIAP. Stored 121st ARZ
2960520155	?	MiG-29 (izd. 9.12)	'09 Red'	Sold to the USA as N6394G
2960520165	?	MiG-29 (izd. 9.12)	'01 Red'	31st GvIAP. Recoded, see next line
			'12 Blue'	Unit unknown. Converted/recoded as, see next line
		MiG-29SMT	'01 Blue'	968th IISAP, first 'production' conversion
2960520561	181...?	MiG-29 (*izd.* 9.12)	'14 Blue'	Recoded, see next line
			'34 White'	33rd IAP. Recoded, see next line
			'44 White'	Stored 121st ARZ

2960520565	1817?	MiG-29 (*izd.* 9.12)	'20 White'	33rd IAP. Crashed near Wulfersdorf, Germany, 15-8-93 ('friendly fire' accident)
2960520568	181…?	MiG-29 (*izd.* 9.12)	'21 Blue'	33rd IAP. Recoded, see next line
			'71 White'	28th GvIAP. Stored 121st ARZ
2960520571	18…?	MiG-29 (*izd.* 9.12)	'24 Blue'	33rd IAP. Recoded, see next line
			'64 White'	28th GvIAP. Stored 121st ARZ
2960520572	18…?	MiG-29 (*izd.* 9.12)	'30 White'	33rd IAP
2960522971	?	MiG-29 (*izd.* 9.12)	'10 Blue'	LII
2960525078	3315?	MiG-29 (*izd.* 9.12)	'315 Blue'	Mikoyan OKB demonstrator; c/n also reported as 2960513315 but possible confusion with f/n!
2960525772	3611	MiG-29 (*izd.* 9.12)	'48 White'	234th GvIAP, later 237th TsPAT (Strizhi team),
2960526305	3707?	MiG-29 (*izd.* 9.12)	'51 Blue'	Preserved in front of General Staff Academy building, Moscow. F/n may be 3708 or 3709
2960530002	3912	MiG-29 (*izd.* 9.12)	'40 White'	234th GvIAP, later 237th TsPAT (Strizhi team)
2960530005	3913?	MiG-29 (*izd.* 9.12)	'42 White'	234th GvIAP, later 237th TsPAT (Strizhi team)
2960530010	3915	MiG-29 (*izd.* 9.12)	'43 White'	234th GvIAP, later 237th TsPAT (Strizhi team)
2960530011	4001	MiG-29 (*izd.* 9.12)	'44 Blue'	234th GvIAP. Recoded, see next line
			'44 White'	234th GvIAP, later 237th TsPAT (Strizhi team)
2960530015	4003	MiG-29 (*izd.* 9.12)	'46 Blue'	234th GvIAP. Recoded, see next line
			'46 White'	234th GvIAP, later 237th TsPAT (Strizhi team)
2960535121	4506	MiG-29 (*izd.* 9.12)	'31 White'?	Recoded, see next line
			'506 Blue'	ANPK MiG demonstrator. Recoded, see next line
			'332 Blue'	RSK MiG demonstrator
2960535400	4710	MiG-29S (*izd.* 9.12S)	'555 Silver'	MAPO MiG demonstrator, three-tone blue camouflage, Russian flag. Converted/recoded as, see next line
		MiG-29SMT (*izd.* 9.17)	'917 Blue'	RSK MiG, first prototype
2960535403	4711	MiG-29S (*izd* .12S)	'777 Silver'	MAPO MiG demonstrator, three-tone blue camouflage, Russian flag. Converted/recoded as, see next line
		MiG-29SM (*izd.* 9.12SM)	'777 Blue'	RSK MiG. Converted/recoded as, see next line
		MiG-29SMT2 (*izd.* 9.18)	'777 Green'	RSK MiG, three-tone grey/green camouflage, strap-on dorsal tank
2960536034	4808	MiG-29SD (*izd.* 9.12SD)	no code	MAPO MiG, grey overall/no insignia, IFR system testbed. Became, see next line
			'357 Blue'	RSK MiG
2960536050	4815	MiG-29SMT2 (*izd.* 9.18)	'918 White'	RSK MiG, desert camouflage, no strap-on tank
2960536093	?	MiG-29S (*izd.* 9.12S)	'333 Silver'	MAPO MiG demonstrator, Russian flag, non-standard MiG logo
2960536501	?	MiG-29S (*izd.* 9.12S)	'999 Silver'	MAPO MiG demonstrator, three-tone blue camouflage, Russian flag. Sold to Bangladesh Air Force as 36501
2960536581	5211	MiG-29 (*izd.* 9.12)	'299 Blue'	RSK MiG
?	1601	MiG-29E (*izd.* 9.21)	'11 Blue' (211)	MiG OKB, avionics testbed
2960705560	1616	MiG-29 (*izd.* 9.13)	'26 Blue'	First production *Fulcrum-C*. Preserved Great Patriotic War Museum, Moscow
2960705561	1617	MiG-29 (*izd.* 9.13)	'09 White'	773rd IAP. Recoded, see next line
			'33'	Unit unknown. Recoded, see next line
			'11 White'	Unit unknown. Stored 275th ARZ
2960705565	1618?	MiG-29 (*izd.* 9.13)	'11 White'	773rd IAP. Recoded, see next line
			'34'	Unit unknown. Recoded, see next line
			'67 White'	28th GvIAP, MiG logo
2960705566	1619?	MiG-29 (*izd.* 9.13)	'06 Red'	31st GvIAP
2960705568	1620?	MiG-29 (*izd.* 9.13)	'04 White'	773rd IAP
2960705570	1621?	MiG-29 (*izd.* 9.13)	'36 Red'	773rd IAP
2960705571	1622?	MiG-29 (*izd.* 9.13)	'05 White'	773rd IAP. Recoded, see next line
			'43'	Unit unknown. Recoded, see next line
			'65 White'	28th GvIAP
2960705577	?	MiG-29 (*izd.* 9.13)	'07 White'	773rd IAP
2960705578	?	MiG-29 (*izd.* 9.13)	'42'	33rd IAP. Recoded, see next line
			'36 Red'	31st GvIAP
2960705580	?	MiG-29 (*izd.* 9.13)	'39 White'	33rd IAP, unit badge. Recoded, see next line
			'43'	Unit unknown. Recoded, see next line
			'69 White'	28th GvIAP
2960705585	?	MiG-29 (*izd.* 9.13)	'44 White'	773rd IAP, 'frog' ('wraparound ZGV scheme' camouflage)
2960705587	?	MiG-29 (*izd.* 9.13)	'45 White'	33rd IAP, later 773rd IAP. Recoded, see next line
			'49 White'	28th GvIAP
2960705588	?	MiG-29 (*izd.* 9.13)	'46 White'	773rd IAP
2960705589	?	MiG-29 (*izd.* 9.13)	'47 White'	773rd IAP

2960707701	?	MiG-29 (*izd.* 9.13)	'48'	33rd IAP. Recoded, see next line
			'38 White'	33rd IAP. Crashed near Augzin, Germany, 17-9-92
2960707702	?	MiG-29 (*izd.* 9.13)	'49'	33rd IAP. Recoded, see next line
			'25 Red'	31st GvIAP
2960707703	?	MiG-29 (*izd.* 9.13)	'51 White'	33rd IAP, later 773rd IAP
2960707706	?	MiG-29 (*izd.* 9.13)	'52 White'	33rd IAP, later 773rd IAP
2960707707	?	MiG-29 (*izd.* 9.13)	'53 White'	33rd IAP, later 773rd IAP, ' frog' ('wraparound ZGV scheme' camouflage). Believed transferred, see next line
			'01'	LII
2960707710	?	MiG-29 (*izd.* 9.13)	'54 White'	33rd IAP, later 773rd IAP
2960707714	?	MiG-29 (*izd.* 9.13)	'01 White'	787th IAP
2960707717	?	MiG-29 (*izd.* 9.13)	'02 White'	787th IAP
2960707721	?	MiG-29 (*izd.* 9.13)	'03 Blue'	Unit unknown. Stored 121st ARZ. Recoded, see next line
			'11 Red'	14th GvIAP, Guards emblem and unit badge
2960707727	?	MiG-29 (*izd.* 9.13)	'04 White'	787th IAP
2960707731	?	MiG-29 (*izd.* 9.13)	'05 White'	787th IAP
2960707740	?	MiG-29 (*izd.* 9.13)	'06 White'	787th IAP
2960707766	?	MiG-29 (*izd.* 9.13)	'07 White'	787th IAP
2960707769	?	MiG-29 (*izd.* 9.13)	'08 White'	787th IAP
2960710039	?	MiG-29 (*izd.* 9.13)	'70 Blue'	Ground instructional airframe, Air Force Academy named after Yuriy A. Gagarin, Monino
2960710801	?	MiG-29 (*izd.* 9.13)	'09 White'	787th IAP
2960710810	?	MiG-29 (*izd.* 9.13)	'10 White'	787th IAP
2960710813	?	MiG-29 (*izd.* 9.13)	'06 Red'	Unit unknown. Stored 4020th BRS
2960710829	?	MiG-29 (*izd.* 9.13)	'02 White'	773rd IAP ('wraparound ZGV scheme' ?)
2960710833	?	MiG-29 (*izd.* 9.13)	'03 Red'	31st GvIAP
2960710835	?	MiG-29 (*izd.* 9.13)	'10 White'	773rd IAP
2960710836	?	MiG-29 (*izd.* 9.13)	'01 White'	773rd IAP. Recoded, see next line
			'25 Blue'	28th GvIAP
2960710941	?	MiG-29 (*izd.* 9.13)	'03 White'	787th IAP
2960710944	?	MiG-29 (*izd.* 9.13)	'43'	Unit unknown. Recoded, see next line
			'08 Red'	Unit unknown. Stored 4020th BRS
2960710963	?	MiG-29 (*izd.* 9.13)	'40 Red'	35th IAP
2960710964	?	MiG-29 (*izd.* 9.13)	'54'	Unit unknown. Recoded, see next line
			'09 Red'	Unit unknown. Stored 4020th BRS
2960714320	?	MiG-29 (*izd.* 9.13)	'08 Red'	35th IAP
2960714325	?	MiG-29 (*izd.* 9.13)	'41 Red'	35th IAP. Recoded, see next line
			'03 Red'	Unit unknown. Stored 4020th BRS
2960714329	?	MiG-29 (*izd.* 9.13)	'42 Red'	35th IAP
2960714622	?	MiG-29 (*izd.* 9.13)	not known	Unit unknown. Recoded, see next line
			'31 Blue'	28th GvIAP, Guards emblem and unit badge
2960714626	?	MiG-29 (*izd.* 9.13)	'49 White'	773rd IAP. Recoded, see next line
			'61'	773rd IAP. Recoded, see next line
			'14 White'	787th IAP
2960714627	?	MiG-29 (*izd.* 9.13)	'27 White'	773rd IAP. Recoded, see next line
			'62'	773rd IAP. Recoded, see next line
			'24 White'	787th IAP, MiG logo
2960714907	?	MiG-29 (*izd.* 9.13)	'67 Red'	5th GvIAP. Recoded, see next line
			'72 White'	787th IAP. To Belorussian Air Force as '23 Red'
2960714909	?	MiG-29 (*izd.* 9.13)	'69 Red'	5th GvIAP. Recoded, see next line
			'70 White'	787th IAP
2960714928	?	MiG-29 (*izd.* 9.13)	'74 Red'	5th GvIAP. Recoded, see next line
			'74 White'	787th IAP
2960714930	?	MiG-29 (*izd.* 9.13)	'64 Red'	5th GvIAP. Recoded, see next line
			'73 White'	787th IAP
2960714933	?	MiG-29 (*izd.* 9.13)	'75 Red'	5th GvIAP. Recoded, see next line
			'75 White'	787th IAP, 'Excellent aircraft' badge
2960714935	?	MiG-29 (*izd.* 9.13)	not known	5th GvIAP. Recoded, see next line

			'76 White'	787th IAP, 'Excellent aircraft' badge
2960715130	?	MiG-29 (*izd.* 9.13)	'77 Red'	5th GvIAP. Recoded, see next line
			'77 White'	787th IAP, MiG logo & 'Excellent aircraft' badge
2960715133	?	MiG-29 (*izd.* 9.13)	'76 Red'	5th GvIAP. Recoded, see next line
			'78 White'	787th IAP, MiG logo & 'Excellent aircraft' badge
2960715136	?	MiG-29 (*izd.* 9.13)	'79 Red'	5th GvIAP. Recoded, see next line
			'79 White'	787th IAP, MiG logo & 'Excellent aircraft' badge
2960715150	?	MiG-29 (*izd.* 9.13)	'62 Red'	5th GvIAP. Recoded, see next line
			'41 White'	787th IAP, 'Excellent aircraft' badge. Recoded, see next line
			'34 White'	28th GvIAP
2960715151	?	MiG-29 (*izd.* 9.13)	'83 White'	5th GvIAP, later 787th IAP
2960715154	?	MiG-29 (*izd.* 9.13)	'84 White'	5th GvIAP, later 787th IAP
2960715156	?	MiG-29 (*izd.* 9.13)	'85 White'	5th GvIAP, later 787th IAP
2960715157	?	MiG-29 (*izd.* 9.13)	'66 Red'	5th GvIAP. Recoded, see next line
			'69 White'	787th IAP
2960715158	?	MiG-29 (*izd.* 9.13)	'87 White'	5th GvIAP, later 787th IAP
2960715159	?	MiG-29 (*izd.* 9.13)	'68 White'	5th GvIAP, later 787th IAP
2960715161	?	MiG-29 (*izd.* 9.13)	'89 White'	5th GvIAP, later 787th IAP. To Belorussian Air Force/927th Fighter Base as '15 White'
2960715164	?	MiG-29 (*izd.* 9.13)	'70 Red'	5th GvIAP. Recoded, see next line
			'80 White'	787th IAP
2960715165	?	MiG-29 (*izd.* 9.13)	'71 White'	5th GvIAP, later 787th IAP
2960715168	?	MiG-29 (*izd.* 9.13)	'72 Red'	5th GvIAP. Recoded, see next line
			'42 White'	787th IAP, 'Excellent aircraft' badge. Recoded, see next line
			'06 White'	28th GvIAP
2960715564	2925?	MiG-29 (*izd.* 9.13)	'08 Red'	115th GvIAP. Recoded, see next line
			'925 Black'	LII/Aviatika display team. Crashed RAF Fairford 24-7-93, mid-air collision with MiG-29 c/n 2960725887
2960717475	?	MiG-29 (*izd.* 9.13)	'16 Red'	14th GvIAP
2960717491	?	MiG-29 (*izd.* 9.13)	'48 Red'?	515th IAP. Recoded, see next line
			'08 Red'	515th IAP. Recoded, see next line
			'33 Red'	14th GvIAP. Guards emblem and unit badges
2960717501	?	MiG-29 (*izd.* 9.13)	'12 White'	773rd IAP
2960717502	?	MiG-29 (*izd.* 9.13)	'38 Red'	31st GvIAP
2960717941	3425	MiG-29SM (*izd.* 9.12SM)	no code	Prototype, Mikoyan OKB
2960718034	?	MiG-29 (*izd.* 9.13)	'47'	Unit unknown. Recoded, see next line
			'03 White'	773rd IAP, ' frog' ('wraparound ZGV scheme' camouflage). Recoded, see next line
			'04 White'	28th GvIAP
2960718121	?	MiG-29 (*izd.* 9.13)	'51 Blue'	Ground instructional airframe, Air Force Academy named after Yuriy A. Gagarin, Monino
2960718706	?	MiG-29 (*izd.* 9.13)	'40 Blue'	85th IAP
2960725887	3526?	MiG-29 (*izd.* 9.13)	'26 Red'	115th GvIAP. Recoded, see next line
			'526 Black'	LII/Aviatika display team. Crashed RAF Fairford 24-7-93, mid-air collision with MiG-29 c/n 2960715564
2960725953	?	MiG-29 (*izd.* 9.13)	'21'	Unit unknown. Recoded, see next line
			'11 Red'	Unit unknown. Stored 4020th BRS
2960725975?	?	MiG-29 (*izd.* 9.13)?	not known	C/n painted on MiG-29 (*izd.* 9.13) '04 Blue' (404), Mikoyan OKB, but does not fit this aircraft!
2960727413	?	MiG-29 (*izd.* 9.13)	'20 Red'	31st GvIAP
2960727415	?	MiG-29 (*izd.* 9.13)	'21 Red'	968th IAP
2960727420	?	MiG-29 (*izd.* 9.13)	'22 Red'	968th IAP. Recoded, see next line
			'04 Red'	19th GvIAP
2960727421	?	MiG-29 (*izd.* 9.13)	'01 Red'	968th IAP
2960727422	?	MiG-29 (izd. 9.13)	'02 Red'	31st GvIAP, Guards emblem
2960727423	?	MiG-29 (izd. 9.13)	'03 Red'	968th IAP
2960727424	?	MiG-29 (*izd.* 9.13)	'04 Red'	31st GvIAP, Guards emblem, sharkmouth and other artwork
2960727429	?	MiG-29 (*izd.* 9.13)	'05 Red'	968th IAP
2960727430	?	MiG-29 (*izd.* 9.13)	'06 Red'	968th IAP
2960727436	?	MiG-29 (*izd.* 9.13)	'07 Red'	31st GvIAP, Guards emblem, Russian flag rudder colours, sharkmouth and other artwork
2960727437	?	MiG-29 (*izd.* 9.13)	'08 Red'	31st GvIAP
2960727438	?	MiG-29 (*izd.* 9.13)	'09 Red'	31st GvIAP

2960727439	?	MiG-29 (*izd.* 9.13)	'10 Red'	31st GvIAP, Guards emblem, Russian flag rudder colours, sharkmouth and other artwork. Recoded, see next line
			'27 Blue'	3624th Air Base. Light grey finish, Russian flag tail colours/no sharkmouth
2960727440	?	MiG-29 (*izd.* 9.13)	'11 Red'	31st GvIAP, Guards emblem
2960727443	?	MiG-29 (*izd.* 9.13)	'23 Red'	31st GvIAP
2960727444	?	MiG-29 (*izd.* 9.13)	'24 Red'	31st GvIAP, Guards emblem, Russian flag rudder colours, sharkmouth and other artwork
2960727448	?	MiG-29 (*izd.* 9.13)	'02 Blue'	19th GvIAP
2960727450	?	MiG-29 (*izd.* 9.13)	'25 Red'	968th IAP, later 19th GvIAP, MiG logo and unit badge. Recoded, see next line
			'02 Blue'	3624th Air Base
2960728100	?	MiG-29 (*izd.* 9.13)	'26 Red'	968th IAP
2960728101	?	MiG-29 (*izd.* 9.13)	'27 Red'	31st GvIAP, Guards emblem, Russian flag rudder colours, 'American eagle' and other artwork
2960728102	?	MiG-29 (*izd.* 9.13)	'28 Red'	31st GvIAP, Guards emblem, Russian flag rudder colours, 'American eagle', sharkmouth and other artwork
2960728105	?	MiG-29 (*izd.* 9.13)	'29 Red'	31st GvIAP, Guards emblem, Russian flag rudder colours, sharkmouth and other artwork
2960728106	?	MiG-29 (*izd.* 9.13)	'30 Red'	31st GvIAP
2960728107	?	MiG-29 (*izd.* 9.13)	'31 Red'	31st GvIAP, Guards emblem
2960728108	?	MiG-29 (*izd.* 9.13)	'32 Red'	31st GvIAP
2960728109	?	MiG-29 (*izd.* 9.13)	'33 Red'	31st GvIAP
2960728110	?	MiG-29 (*izd.* 9.13)	'34 Red'	31st GvIAP
2960728111	?	MiG-29 (*izd.* 9.13)	'35 Red'	968th IAP
			'26 Red'	968th IISAP, Rusavia advertising titles
2960728114	?	MiG-29 (*izd.* 9.13)	'36 Red'	968th IAP
2960728115	?	MiG-29 (*izd.* 9.13)	'37 Red'	31st GvIAP, Guards emblem, Russian flag rudder colours, sharkmouth and other artwork
2960728116	?	MiG-29 (*izd.* 9.13)	'38 Red'	968th IAP. Recoded, see next line
			'22 Red'	968th IISAP
2960728117	?	MiG-29 (*izd.* 9.13)	'39 Red'	31st GvIAP
2960728139	?	MiG-29 (*izd.* 9.13)	'33 Blue'	28th GvIAP, Guards emblem, unit badge and other artwork
2960728140	?	MiG-29 (*izd.* 9.13)	'05 Red'	Unit unknown. Stored 4020th BRS
2960728142	?	MiG-29 (*izd.* 9.13)	'12'	Unit unknown. Recoded, see next line
			'15 Blue'	28th GvIAP, Guards emblem, unit badge and other artwork
2960728143	?	MiG-29 (*izd.* 9.13)	'01 Red'	35th IAP. Recoded, see next line
			'21'	Unit unknown. Recoded, see next line
			'04 Red'	Unit unknown. Stored 4020th BRS
2960728152	?	MiG-29 (*izd.* 9.13)	'02 Red'	35th IAP
			'26'	Unit unknown. Recoded, see next line
			'14 Red'	14th GvIAP, Guards emblem and unit badge
2960728156	?	MiG-29 (*izd.* 9.13)	'10'	Unit unknown. Recoded, see next line
			'20 Red'	73rd GvIAP. Recoded, see next line
			'62 Blue'	234th GvIAP, Guards emblem
2960728159	?	MiG-29 (*izd.* 9.13)	'03 Red'	35th IAP. Recoded, see next line
			'15 Red'	14th GvIAP, Guards emblem and unit badge
2960728160	?	MiG-29 (*izd.* 9.13)	'11'	Unit unknown. Recoded, see next line
			'21 Red'	73rd GvIAP? Recoded, see next line
			'57 White'	237th TsPAT (Strizhi team)
2960728170	?	MiG-29 (*izd.* 9.13)	'04 Red'	35th IAP
2960728185	?	MiG-29 (*izd.* 9.13)	'02 Blue'	28th GvIAP, Guards emblem, unit badge and other artwork
2960728186	?	MiG-29 (*izd.* 9.13)	'05 Red'	73rd GvIAP, later 35th IAP
2960728187	?	MiG-29 (*izd.* 9.13)	'3... Red'	Unit unknown. Recoded, see next line
			'23 Blue'	14th GvIAP, Guards emblem, unit badge and other artwork
2960728188	?	MiG-29 (izd. 9.13)	'45'	Unit unknown. Recoded, see next line
			'03 Blue'	28th GvIAP, Guards emblem and unit badge
2960729019	?	MiG-29 (*izd.* 9.13)	'23 White'	343rd IIAP, later to 120th IAP. 'Double eagle' badge, sharkmouth and nose art. Recoded, see next line
			'23 Blue'	160th UAP, later to 713th UAP
2960729024	?	MiG-29 (*izd.* 9.13)	'45'	Unit unknown. Recoded, see next line
			'12 Red'	28th GvIAP
2960729025	?	MiG-29 (*izd.* 9.13)	'47 White'	343rd IIAP, later to 120th IAP. 'Double eagle' badge, sharkmouth and nose art. To 160th UAP, then to 713th UAP
2960729031	?	MiG-29 (*izd.* 9.13)	'51 White'	343rd IIAP, later to 120th IAP. 'Double eagle' badge, sharkmouth and nose art. To 160th UAP, then to 713th UAP
2960729359	?	MiG-29 (*izd.* 9.13)	'29 Blue'	343rd IIAP. Recoded, see next line

			'29 Red'	14th GvIAP, named *Nikolay Zelenov, HSU*; Guards emblem, unit badge and other artwork
2960729363	?	MiG-29 (*izd*. 9.13)	'57'	Unit unknown. Recoded, see next line
			'24 Red'	14th GvIAP; Guards emblem, unit badge and other artwork
2960729387	?	MiG-29 (*izd*. 9.13)	'05'	Unit unknown. Recoded, see next line
			'05 Blue'	28th GvIAP; Guards emblem, unit badge and other artwork
2960731207	5318	MiG-29 (*izd*. 9.13)	'56 White'	237th TsPAT (Strizhi team)
2960731631	?	MiG-29 (*izd*. 9.13)	'23 Red'	968th IISAP, Russian flag rudder colours and Rusavia titles
2960731640	?	MiG-29S (*izd*. 9.13S)	'52 Blue'	Unit unknown. Recoded, see next line
			'02 Blue'	Unit unknown
2960731646	?	MiG-29S (*izd*. 9.13S)	'50 Blue'	Unit unknown. Recoded, see next line
			'04 Blue'	Unit unknown
2960731659	?	MiG-29S (*izd*. 9.13S)	'55 Blue'	Unit unknown. Recoded, see next line
			'05 Blue'	Unit unknown
2960731660	?	MiG-29S (*izd*. 9.13S)	'64 Blue'	Unit unknown. Recoded, see next line
			'14 Blue'	Unit unknown
2960731667	?	MiG-29S (*izd*. 9.13S)	'57 Red'	Unit unknown. Recoded, see next line
			'31 Red'	
2960731668	?	MiG-29S (*izd*. 9.13S)	'58'	Unit unknown. Recoded, see next line
			'32 Red'	968th IISAP, Russian flag rudder colours and Rusavia titles
2960731670	?	MiG-29S (*izd*. 9.13S)	'60'	73rd GvIAP. Recoded, see next line
			'10 Red'	14th GvIAP; Guards emblem, unit badge, MiG logo and other artwork
2960731677	?	MiG-29S (*izd*. 9.13S)	'62'	73rd GvIAP. Recoded, see next line
			'08 Red'	14th GvIAP; two Guards emblems and unit badge
2960905551?	?	MiG-29M	'151 Blue'	Mikoyan OKB
2960905552?	?	MiG-29M	'152 Blue'	Mikoyan OKB
2960905553?	?	MiG-29M	'153 Blue'	Mikoyan OKB
2960905554?	?	MiG-29M	'154 Blue'	Mikoyan OKB. Converted and recoded, see next line
		MiG-29M2	'154 White'	RSK MiG demonstrator, MRCA tail titles, later MiG tail titles
2960905555?	?	MiG-29M	'155 Blue'	Mikoyan OKB
2960905556?	?	MiG-29M	'156 Blue'	Mikoyan OKB. C/n also reported as 27585. Recoded, see next line
			'301 Blue'	Converted and recoded, see next line
		MiG-29OVT	'156 White'	RSK MiG demonstrator, red/white/blue display scheme
?		MiG-29UB	'51 Blue' (951)	Mikoyan OKB, first prototype; converted MiG-29 (*izdeliye* 9.12). WFU Zhukovskiy
?		MiG-29UB	'52 Blue'	Mikoyan OKB, second prototype. Derelict Riga-Spilve aviation museum
4029692486	?	MiG-29UB	'53 Blue'	Mikoyan OKB. Recoded, see next line
			'304 Blue'	Mikoyan OKB. Converted as, see next line and c/n N50903008134!
		MiG-29UBT (*izd*. 9.52)	'304 Blue'	RSK MiG, first prototype
N50903001052	?	MiG-29UB	'80 White'	773rd IAP
N50903003593	?	MiG-29UB	'71 Black outline'	33rd IAP
N50903005494	?	MiG-29UB	'72 White'	33rd IAP
N50903005603	?	MiG-29UB	'73 White'	33rd IAP. Recoded, see next line
			'74 White'	773rd IAP. Recoded, see next line
			'82 White'	28th GvIAP, Guards emblem, leaping tiger nose art
N50903007603	?	MiG-29UB	'55 Blue'	773rd IAP. Recoded, see next line
			'55 Black outline'	33rd IAP, unit badge
N50903008094	?	MiG-29UB	'64 Orange'	968th IAP, unit badge. Recoded, see next line
			'64 Black outline'	33rd IAP, unit badge
N50903008134	?	MiG-29UB	'304 Blue' ?	Mikoyan OKB. This c/n also quoted for the first prototype MiG-29UBT (see c/n 4029692486)!
N50903008303	?	MiG-29UB	'66 Blue'	53rd GvIAP, later to 773rd IAP
N50903008467	?	MiG-29UB	'82 Red'	Unit unknown. Russian flag on tails. Stored 4020th BRS
N50903008893	?	MiG-29UB	'37 Red'	968th IISAP. Stored 4020th BRS
N50903010376	?	MiG-29UB	'71 White'	120th IAP, nose art
N50903013569	?	MiG-29UB	'04'	160th UAP, later to 713th UAP
N50903013814	?	MiG-29UB	'71 Red'	31st GvIAP; Guards emblem, sharkmouth, Russian flag rudder colours and other artwork
N50903013912	?	MiG-29UB	'11 White'	787th IAP. To Belorussian Air Force/927th Fighter Base as '19 Red'
N50903014007	?	MiG-29UB	'33 White'	787th IAP

N50903014019	?	MiG-29UB	'06 Blue'	Unit unknown. Stored 4020th BRS
N50903014144	?	MiG-29UB	'08 Blue'	Unit unknown. Stored 4020th BRS
N50903014165	?	MiG-29UB	'10 Blue'	Unit unknown. Stored 4020th BRS
N50903014414	?	MiG-29UB	'16 Blue'	Unit unknown. Stored 4020th BRS
N50903014905	?	MiG-29UB	'33 White'	234th IAP, later 237th TsPAT (Strizhi team)
N50903014938	?	MiG-29UB	'20 Blue'	Unit unknown. Stored 4020th BRS
N50903015148	?	MiG-29UB	'40 Blue'	Unit unknown. Stored 4020th BRS
N50903015406	?	MiG-29UB	'48 Blue'	Unit unknown. Stored 4020th BRS
N50903015479	?	MiG-29UB	'89 Blue'	28th GvIAP, previous unit unknown. MiG logo and Russian flag rudder colours
N50903016527	?	MiG-29UB	'32 White'	234th IAP, later 237th TsPAT (Strizhi team)
N50903016584	?	MiG-29UB	'71 Red'	234th IAP. Recoded, see next line
			'34 White'	234th IAP, later 237th TsPAT (Strizhi team)
N50903017048	?	MiG-29UB	'70 Red'	73rd GvIAP. Stored 4020th BRS
N50903017124	?	MiG-29UB	'91 Red'	73rd GvIAP, later to 33rd IAP
N50903019347	?	MiG-29UB	'26 Blue'	Unit unknown. Stored 4020th BRS. Recoded, see next line
			'74 Red'	14th GvIAP. Stored 4020th BRS
N50903021336	?	MiG-29UB	'33 Red'	968th IISAP, previous unit unknown. Stored 4020th BRS
N50903021583	?	MiG-29UB	'37 Red'	Unit unknown. Stored 4020th BRS; later to 968th IISAP
N50903021629	?	MiG-29UB	'75 Red'	14th GvIAP, previous unit unknown; Guards emblem and unit badge
N50903021704	?	MiG-29UB	'38 Red'	Unit unknown. Stored 4020th BRS; later to 968th IISAP
N50903023006	?	MiG-29UB	'86 White'	Unit unknown. Stored 4020th BRS
N50903023774	?	MiG-29UB	'102 White'	Unit unknown. Stored 4020th BRS
N50903023893	?	MiG-29UB	'81 Red'	14th GvIAP, previous unit unknown; Guards emblem and unit badge
N50903024019	?	MiG-29UB	'74 Red'	14th GvIAP, stored 4020th BRS; Guards emblem and unit badge
N50903024113	?	MiG-29UB	'56 Blue'	Unit unknown. Recoded, see next line
			'20 Blue'	Unit unknown. Stored 4020th BRS
N50903025235	?	MiG-29UB	'84 Red'	Unit unknown
N50903025982	?	MiG-29UB	not known	Unit unknown. Converted and recoded, see next line
		MiG-29UBT (*izd.* 9.52)	'52 Blue' (952)	RSK MiG, second prototype
N50903026004	?	MiG-29UB	'82 Blue'	14th GvIAP, stored 4020th BRS; Guards emblem and unit badge
N50903026146	?	MiG-29UB	'25 Red'	
N50903026414	?	MiG-29UB	'84 Blue'	LII
N50903026539	?	MiG-29UB	'86 Blue'	LII
N50903026767	?	MiG-29UB	'74 White'	120th IAP. 'Double eagle' badge, sharkmouth and nose art
N50903026848	?	MiG-29UB	'90 Blue'	RSK MiG
N50903026969	?	MiG-29UB	'75 White'	120th IAP. 'Double eagle' badge, sharkmouth and nose art
N509030...	1607	MiG-29UB		Mikoyan OKB, no further details known
N509030...	2410	MiG-29UB		Mikoyan OKB, no further details known
?	?	MiG-29K (*izd.* 9.31)	'311 Blue'	Mikoyan OKB/RSK MiG, first prototype. C/n quoted as 27578 and 2016188; f/n reported in error as 6802!
?	?	MiG-29K (*izd.* 9.31)	'312 Blue'	Mikoyan OKB/RSK MiG, second prototype. C/n quoted as 27579

the Russian Air Force order of battle includes active MiG-29 units listed on page 440.

Known Russian Air Force MiG-29s are listed on pages 440-448. Some Soviet examples (apart from those which ended up in other CIS states and are described under appropriate headings) have been included for the sake of completeness.

Belorussia

Established in June 1992, the **Belorussian Air Force** was the third-largest operator of the type in the CIS (Russia and the Ukraine take first and second place), taking over 84 MiG-29s. Of these, 47 *Fulcrum-A/Cs* and six MiG-29UBs were operated by the 927th IAP of the former Belorussian Defence District's 26th VA at Beryozy (Byarozy) AB; in the course of the military reform following Belorussia's independence the regiment and the airbase were reorganised into a single entity called the 927th Fighter Base (IAB – *istre**bit**el'naya **avia**ba**za*). 31 more MiG-29s (26 *Fulcrum-A/Cs* and five MiG-29UBs) were transferred to Ross' AB from the 16th VA's 787th IAP, which was disbanded after the Russian pullout from Germany. Later these aircraft went to Baranovichi, where the 61st IAB was set up on the basis of the local airbase and the former 61st IAP of the Soviet PVO's 2nd Independent Army.

Maksim Bryanskiy

◄ **MiG-29 '26 Black' displays the grey/green camouflage and black tactical codes that have become typical of Belorussian Air Force *Fulcrums* lately.**

However, the economic problems of the 1990s and the trimming of the air force fleet to a realistic size led Belorussia to put some of the MiG-29s up for sale as surplus to requirements. At the 927th IAB, 38 *Fulcrum-Cs* and four MiG-29UBs remained active, while ten and two respectively were mothballed pending export; at the 61st IAB it was 20+4 and 5+1 respectively.

In 1996 the Beltechexport arms export company signed a contract with the Peruvian government for the delivery of 16 single-seaters and two trainers to the Peruvian Air Force; all 18 aircraft were shipped to Peru before the end of the year. Some sources state that the MiG-29s were sold for US$ 11-14 million apiece – half the real market price; there have been rumours, however, that the price was as low as US$ 4.0-4.5 million apiece. (The price quoted by Aviaexport in 1989 was US$ 23 million for the single-seater and US$ 28 million for the MiG-29UB.) In 1999-2002 the Belorussian Air Force sold 31 *Fulcrums* to Algeria. Thus by the turn of the century the Belorussian Air Force had 43 MiG-29s remaining – 23 *Fulcrum-Cs* and four MiG-29UBs at Beryoza plus 12 and 4 respectively at Baranovichi.

In an attempt to solve the maintenance problem the Belorussian Air Force assigned its MiG-29s to the Air Force's 558th Aircraft Overhaul Plant in Baranovichi. There, five 'fatbacks' have been upgraded to MiG-29BMs; four of these are operational.

Known Belorussian Air Force examples are listed here. Because of the system of tactical codes inherited from the Soviet Union, the list is in c/n order. A few aircraft with unknown c/ns are included as well, since the Belorussian Air Force obviously does not have that many MiG-29s to make multiple code repetition possible.

Known Belorussian Air Force MiG-29s

C/n	F/n	Tactical code	Version	Notes
2960714345	?	'03 Red'	MiG-29BM	61st Fighter Base. (see three lines down!)
2960714444?	?	'24 Red'	MiG-29 (*izd.* 9.13)	To '24 Black'
2960714907	?	'23 Red'	MiG-29 (*izd.* 9.13)	Ex-Russian AF '72 White'
2960715135	?	'28 Red'	MiG-29 (*izd.* 9.13)	To '28 Black'
2960715161	?	'15 White'	MiG-29 (*izd.* 9.13)	Ex-Russian AF '89 White'. Sold to Peruvian AF as 031.
2960715173	?	'03 Red'?	MiG-29 (*izd.* 9.13)	61st IAP. Reported as such (see three lines up!)
2960715177	?	'06 Black'	MiG-29BM	61st Fighter Base. Ex-'06 Red'
2960715535	?	'04 White'	MiG-29 (*izd.* 9.13)	61st IAP. Ex-SovAF '28 Red'. Sold to Peruvian AF as '030'
2960715540	?	'11 Red'	MiG-29 (*izd.* 9.13)	61st IAP. Ex-Soviet Air Force '31 Red'
2960715178	?	'07 Red'	MiG-29 (*izd.* 9.13)	61st IAP. Ex-Soviet Air Force '27 Red'
2960717911	?	'25 Red'	MiG-29 (*izd.* 9.13)	927th IAP. Ex-Soviet Air Force '35 Red'
2960717946	3427?	'32 Red'	MiG-29 (*izd.* 9.13)	Sold to Peruvian Air Force as '045'
2960719164	?	'80 Red'	MiG-29 (*izd.* 9.13)	61st IAP. Ex-Soviet Air Force '70 Red'
2960725893	?	'11 Red'	MiG-29 (*izd.* 9.13)	Ex-Soviet Air Force '46'. 927th Fighter Base.
N509030073...	?	'17 Red'	MiG-29UB	
N50903012547	?	not known	MiG-29UB	927th Fighter Base. Ex-Soviet Air Force '63 Red'
N50903026013	?	'63 Red'	MiG-29UB	927th Fighter Base
?	?	'01 Red'	MiG-29 (*izd.* 9.13)	
?	?	'02 Black'	MiG-29 (*izd.* 9.13)	61st Fighter Base?
?	?	'04 Black'	MiG-29BM	61st Fighter Base
?	?	'05 Black'	MiG-29BM	558th ARZ. Ex-'05 Red'
?	?	'07 Black'	MiG-29BM	61st Fighter Base. Ex-'07 Red'
?	?	'22 Black'	MiG-29 (*izd.* 9.13)	
?	?	'26 Black'	MiG-29 (*izd.* 9.13)	61st Fighter Base?
?	?	'29 Black'	MiG-29 (*izd.* 9.13)	
?	?	'30 Red'	MiG-29 (*izd.* 9.13)	To '30 Black'
?	?	'31 Red'	MiG-29 (*izd.* 9.13)	
?	?	'43 Red	MiG-29 (*izd.* 9.13)	
?	?	'49 Red'	MiG-29 (*izd.* 9.13)	
?	?	'52 Red'	MiG-29 (*izd.* 9.13)	
?	?	'53 Red'	MiG-29UB	To '53 Black'
?	?	'61 Black'	MiG-29UB	
?	?	'62 Red'	MiG-29UB	
?	?	'64 Red'	MiG-29UB	To '64 Black'

Kazakhstan (Kazakstan)

After the break-up of the Soviet Union Kazakhstan – or Kazakstan, as this CIS republic has been called of late – took over the 715th IAP based at Loogovaya AB. This unit included a *Fulcrum* squadron operating 12 single-seaters (*izdeliye* 9.12 standard) and two MiG-29UBs. In 1995 the **Kazakhstan Air Force** took delivery of a further 22 MiG-29s (18 *Fulcrum-As* and four trainers) from Russia. At least one Kazakh MiG-29 is reported to have been lost in an accident.

Known examples are *Fulcrum-As* coded '01 Red' through '04 Red' (very early example with ventral fins) and MiG-29UB '23 Red'. No c/ns are known.

An interesting 'parking lot'. Kazakstan Air Force MiG-29s at Loogovaya AB; note that the fighters still have ventral fins. ▼

via Internet

via Internet

Moldova

After the collapse of the Soviet Union a good deal of military equipment was left behind in the now-independent CIS states. Moldova (the former Moldavian SSR) inherited a MiG-29 unit based at Markuleshty – the 86th GvIAP of the Black Sea Fleet Air Arm. The inventory of the **Moldovan Air Force** (FARM – *Forțele Aeriene de Republica Moldova*) thus came to include 33 MiG-29s; these included seven very early *Fulcrum-As* with ventral fins, 24 *Fulcrum-Cs* and two MiG-29UBs.

The fighters wore a non-standard crudely applied two-tone green camouflage (which was partly weathered away on some aircraft, revealing the original grey finish) and the FARM's gaudy insignia – a red/yellow/blue eight-rayed star on a white roundel. In contrast, MiG-29UB '61 White' wore a conspicuous dark blue/pale blue colour scheme, suggesting it was used for display purposes.

However, the republic was just too small for the MiG-29s and, more importantly perhaps, its defence budget was too small to maintain a lot of costly fighters. The point was that the civil war, which led to the emergence of the self-proclaimed Trans-Dniester Moldavian Republic, was taxing the budget heavily. (Incidentally, one of the *Fulcrum-As* used operationally against the separatists was shot down in 1992.) Therefore the Moldovan government tried to sell the fighters via third parties. Five aircraft were sold to South Yemen in this fashion and one more to Romania. However, Yemen soon dropped Moldova as an arms supplier because the aircraft came incomplete, and without adequate technical support they were just costly but useless pieces of metal.

Yet, on 6th September 1997 Russian media announced that the USA had bought 21 ex-Moldovan MiG-29s – six *Fulcrum-As*, 14 *Fulcrum-Cs* and a single MiG-29UB. The reason for this deal is noteworthy. Moldova kept looking for customers and, among other countries, offered the fighters to Iran, which already operated the type. This was the least desirable customer as far as the USA was concerned because the Iranian government, putting it mildly, wasn't (and isn't) pro-American. The *Fulcrum-C* has tactical nuclear strike capability; therefore the USA offered to buy the fighters wholesale in order to prevent them from ending up in 'rogue states' such as Iran.

There have been unconfirmed reports that the deal, which included 21 aircraft and about 500 AAMs, was worth US$ 80 million. If this is true, Moldova sold the fighters dirt-cheap – at about US$ 4 million apiece. That left the FARM with another six *Fulcrum-Cs* which were still in storage, awaiting sale.


via Internet


via Internet

▲
Pre-sale maintenance on Moldovan Air Force MiG-29s at Markuleshty AB, with '51 White' heading the row. The crude green camouflage has partly disappeared.

Known Moldovan Air Force MiG-29s

C/n	F/n	Version	Tactical code	Notes
2960512124	?	MiG-29 (*izdeliye* 9.12)	'27 White'	Sold to the USA
2960512140	?	MiG-29 (*izdeliye* 9.12)	'28 White'	Sold to the USA
2960516753	?	MiG-29 (*izdeliye* 9.12)	'20 White'	Sold to the USA
2960516755	?	MiG-29 (*izdeliye* 9.12)	'21 White'	Sold to the USA
2960516761	?	MiG-29 (*izdeliye* 9.12)	'25 White'	Sold to the USA
2960516766	?	MiG-29 (*izdeliye* 9.12)	'22 White'	Sold to the USA
2960707750	?	MiG-29 (*izdeliye* 9.13)	'24 White'	Sold to the USA
2960707753	?	MiG-29 (*izdeliye* 9.13)	'29 White'	Sold to the USA
2960710828	?	MiG-29 (*izdeliye* 9.13)	'09 White'	Sold to the USA
2960717453	3126	MiG-29 (*izdeliye* 9.13)	'01 Red'	Sold to Romania in 1994 as '53 Red'; see comment on this code in Romanian section
2960717456	312...?	MiG-29 (*izdeliye* 9.13)	'03 White'	Sold to the USA
2960717458	3129?	MiG-29 (*izdeliye* 9.13)	'10 White'	Sold to the USA
2960717459	3130?	MiG-29 (*izdeliye* 9.13)	'11 White'	Sold to the USA
2960717464	320...?	MiG-29 (*izdeliye* 9.13)	'12 White'	Sold to the USA
2960717469	32...?	MiG-29 (*izdeliye* 9.13)	'04 White'	Sold to the USA
2960717473	32...?	MiG-29 (*izdeliye* 9.13)	'06 White'	Sold to the USA
2960717940	3424?	MiG-29 (*izdeliye* 9.13)	'02 White'	Sold to the USA
2960721907	?	MiG-29 (*izdeliye* 9.13)	'08 White'	Sold to the USA
2960721930	?	MiG-29 (*izdeliye* 9.13)	'41 White'	Sold to the USA
2960721940	?	MiG-29 (*izdeliye* 9.13)	'46 White'	Sold to the USA
2960721945	?	MiG-29 (*izdeliye* 9.13)	'48 White'	Sold to the USA
N50903012038	?	MiG-29UB	'61 White'	Sold to the USA
?	?	MiG-29 (*izdeliye* 9.13)	'16 White'	Sold to the USA
?	?	MiG-29 (*izdeliye* 9.13)	'51 White'	Fate unknown
?	?	MiG-29 (*izdeliye* 9.13)	'54 White'	Fate unknown

Gaudily painted MiG-29UB '61 White' (c/n N50903012038) was a display aircraft. Not all Moldovan MiG-29s wore the FARM roundels.

via Internet

The same aircraft is loaded into a USAF C-17A for delivery to its new owner.

via Internet

Turkmenistan

The **Turkmenistan Air Force** operates 24 ex-VVS MiG-29s – ten *Fulcrum-As*, 12 *Fulcrum-Cs* and two trainers. These include *Fulcrum-Cs* '19 Red' and '31 Red' painted in a rather shocking three-tone blue camouflage. The aircraft were originally operated by the 1521st Air Base at Maryy-1 AB inherited from the Soviet Union; 1993 saw the disbandment of this unit and the aircraft were transferred to the newly formed 67th Composite Air Regiment at Maryy-2 AB.

The Ukraine

After the break-up of the Soviet Union the newly formed **Ukrainian Air Force** (UAF, or VPS – *Viys'**kovo**-po**vit**ryany **see**ly*) took possession of all ex-VVS aircraft based in the republic, as well as some of the CISAF aircraft being withdrawn from the reunified Germany. These included 216 MiG-29s, including 155 *Fulcrum-Cs* (*izdeliye* 9.13 and 9.13S). Thus, the Ukraine is the world's second-largest MiG-29 operator.

When the Ukraine introduced its own national insignia, several variations on the theme were tried before the UAF arrived at a common standard. First, the Soviet red stars gave place to blue roundels with a yellow centre on the wings and blue circle with the stylised St. Volodymir's trident in yellow on the tail. Later the colour of the roundels was reversed and the shape of the tail insignia changed from a circle to a stylised shield. Even so, variations occurred; some MiG-29s carried additional roundels on the air intake trunks in lieu of the tactical code, which was relocated to the nose.

via Internet

'31 Red', a Turkmenistan Air Force *Fulcrum-C*.

Sergey Popsuyevich

◄ *Fulcrum-C* '44 White' (c/n 2960731230; f/n 5329?) wears the early round version of the UAF's tail insignia.

A Ukrainian Air Force MiG-29UB sporting the current shield-and-trident insignia. Red tactical codes are rare on Ukrainian military aircraft. ▼

'90 White', another UAF MiG-29UB, sporting the distinctive 'leaping cheetah' nose art of the 94th IAP based at Vasil'kov. Note the overpainted red stars. ▼▼

The Ukrainian MiG-29s were initially based at eight strategically important bases. The units operating the type included the 40th IAP at Vasil'kov, the 62nd IAP at Bel'bek, the 85th IAP at Starokonstantinov, the 114th IAP at Ivano-Frankovsk and the 642nd IAP at Martynovka. Additionally, the **Ukrainian Naval Aviation** included the 161st IAP at Limanskoye. However, several bases have now been closed and the aircraft redistributed or mothballed. Current units

Alfred Matusevich

Sergey Popsuyevich

▲ **The early version of the Ukrainian Air Force's tail insignia.**

are the 6th Air Base (Training) at Mykolaïv (Nikolayev), the 92nd IAP at Vasil'kiv (Vasil'kov), the 62nd IAP at Bel'bek – all of them in the 5th Air Corps – and the 114th IAP of the 14th Air Corps at Ivano-Frankivs'k (Ivano-Frankovsk). On 1st December 1999 the 40th IAP was transferred to the Air Defence Command.

Ukrainian MiG-29s had their share of accidents, including fatal ones. On 30th July 1996 a single-seat *Fulcrum* crashed during a training sortie, killing deputy squadron leader Vadim Kiril'chuk. The aircraft was on a ferry flight from the Crimea Peninsula and the pilot lost his way, eventually ejecting over the sea.

In the early 1990s the UAF established its own display team, the *Ookraïns'ki **Sokoly*** (Ukrainian Falcons). The team operated at least seven *Fulcrum-Cs* and two MiG-29UB trainers in an attractive livery with the wings and tail surfaces painted blue and yellow (the Ukraine's national colours) and a predominantly white fuselage. The Ukrainian Falcons had their debut on 9th May 1997 during the VE-Day celebrations in the country's capital, Kiev. On 19th-20th July that year the team performed at the RIAT '97 airshow at RAF Fairford.

On 26th March 1998 the team suffered a loss during a training session for a display in France when one of the single-seaters crashed on approach to Kirovskoye AB (the UAF's training centre on the Crimea Peninsula) in poor weather. The pilot suffered critical injuries and died in hospital. However, this was as nothing compared to the accident at Sknyliv (Sknilov) AB near L'vov on 27th July 2002 which, although the Ukrainian Falcons were not directly involved, sealed the team's fate. A Su-27UB two-seater performing aerobatics clipped some trees when pulling out of a dive and crashed into the crowd, killing 83 spectators. After this tragedy the Ukrainian Ministry of Defence banned military display flying altogether, with the result that the Ukrainian Falcons team was wound up.

Once again, because of economic difficulties and the inability to keep large armed forces, the Ukrainian Government has been trying to sell off

Sergey Popsuyevich

▲ **A trio of Ukrainian Air Force *Fulcrum-As* and *-Cs*, their tails looking very weathered.**

Vyacheslav Moiseyev

► **Two blue-coded UAF MiG-29s. The nearest aircraft wears a non-standard grey/blue camouflage, the bright blue blotches looking almost like an afterthought.**

part of its military aircraft, including some of the MiG-29s. Sales prospects, however, have been hampered by the inability to provide spares (as these have to be sourced in Russia) and adequate maintenance.

Unfortunately few UAF MiG-29s have been positively identified because of the tactical code system inherited from the Soviet Union. In addition to those in the table, a few others may be mentioned, though. The 92nd IAP at Vasil'kiv operated *Fulcrum-Cs* '25 White', '26 Blue', '27 White', '40 White' and MiG-29UBs '80 White' and '90 White' with distinctive running cheetah nose art. The 642nd IAP operated *Fulcrum-Cs* '26 Yellow' (ex-'46'), '43 Blue', '45 Blue' and '77 Blue' in a tactical camouflage scheme. Even before the Ukrainian Falcons came into existence, the UAF had a pair of MiG-29s (*Fulcrum-C* '01 White' and MiG-29UB '02 White') painted in an overall blue/yellows display scheme with the early-style round tail insignia to promote the Ukraine on the international airshow circuit.

Fulcrum-A '09 Yellow', *Fulcrum-C* '97 Yellow' and MiG-29UB '80 Yellow' belonged to the 161st IAP and accordingly sported the white/blue Soviet Navy flag on the nose. These and other aircraft were placed in storage following the unit's deactivation.

Mention should also be made of the fact that, like some other European air arms, the Ukrainian Air Force has adopted the practice of using straight sections of motorway as auxiliary airstrips in the event that regular runways should be destroyed. The first landings and take-offs of this kind in the history of the UAF were made on the Kiev-Chop highway on the morning of 10th September 1999 by five MiG-29s piloted by Col. Gen. Viktor Strel'nikov (the then Ci-in-C of the UAF and Deputy Minister of Defence), Col. Sergey Gherasimchuk, Lt. Col. Sergey Bykhovets, Maj. Viktor Olifer and Maj. Vladimir Brighinets.

Uzbekistan

After the collapse of the Soviet Union Uzbekistan took over 30 'fatback' MiG-29s (though some reports say these are *Fulcrum-As*) and six MiG-29UBs; the fighters were operated by the

▲ **The current standard of the UAF insignia (the tail 'shield' and wing roundels). As a point of interest, the Ukrainian Army Aviation used roundels with a reversed colour order.**

Known Ukrainian Air Force MiG-29s

C/n	F/n	Version	Tactical code	Notes
2960505534	0406	MiG-29 (*izdeliye* 9.12)	'06 White'	92nd IAP, early version with ventral fins. Preserved Ukrainian National Aviation Museum, Kiev-Zhulyany
2960512111	?	MiG-29 (*izdeliye* 9.12)	'26 White'	40th Fighter Wing
2960515104	?	MiG-29 (*izdeliye* 9.12)	'22 Blue'	
2960515118	?	MiG-29 (*izdeliye* 9.12)	not known	
2960515147	?	MiG-29 (*izdeliye* 9.12)	'28 Blue'	
2960519270?	?	MiG-29 (*izdeliye* 9.12)	not known	
2960728120	4717	MiG-29 (*izdeliye* 9.13)	'106 White'	Ukrainian Falcons
2960728196	?	MiG-29 (*izdeliye* 9.13)	'108 White'	Ukrainian Falcons
2960731222	5324	MiG-29 (*izdeliye* 9.13)	'101 Blue'	Ukrainian Falcons. Recoded, see next line
			'105 White'	Ukrainian Falcons
2960731225	5326	MiG-29 (*izdeliye* 9.13)	'102 White'	Ukrainian Falcons
2960731227	5327	MiG-29 (*izdeliye* 9.13)	'103 White'	Ukrainian Falcons
2960731230	5329?	MiG-29 (*izdeliye* 9.13)	'44 White'	Early version of insignia
2960731232	5330	MiG-29 (*izdeliye* 9.13)	'101 White'	Ukrainian Falcons
2960731239	5420	MiG-29 (*izdeliye* 9.13)	'108 Blue'	Ukrainian Falcons. Recoded, see next line
			'104 White' No.2	Ukrainian Falcons
2960731641	?	MiG-29 (*izdeliye* 9.13)	not known	
N50903001024	?	MiG-29UB	not known	
N50903003127	?	MiG-29UB	not known	
N50903021006	?	MiG-29UB	'02'	Colour of code not known
N50903024155	?	MiG-29UB	'104 White' No.1	Ukrainian Falcons
N50903024156	?	MiG-29UB	'111 Blue'	Ukrainian Falcons
?	?	MiG-29 (*izdeliye* 9.13)	'102 Blue'	Ukrainian Falcons
?	?	MiG-29 (*izdeliye* 9.13)	'107 White'	Ukrainian Falcons

MiG-29 *Fulcrum-A* '06 White'
Ukrainian Air Force, 92nd IAP, Vasil'kiv

MiG-29UB '80 White'
Ukrainian Air Force, 92nd IAP, Vasil'kiv

MiG-29 *Fulcrum-C* '25 White' (note red outline
Ukrainian Air Force, 92nd IAP, Vasil'kiv

MiG-29 *Fulcrum-C* '77 Blue'
Ukrainian Air Force, 642nd IAP, Martynovka

MiG-29BM '02 Black'
Belorussian Air Force (61st IAB, Baranovichi?)

MiG-29 *Fulcrum-A* '01 Red'
Kazakstan Air Force, 715th IAP, Loogovaya AB

MiG-29 *Fulcrum-C* '03 White' (c/n 2960717456)
Moldovan Air Force, 86th IAP, Markuleshty

MiG-29UB '61 White' (c/n N50903012038)
Moldovan Air Force, 86th IAP, Markuleshty

MiG-29 *Fulcrum-C* '31 Red'
Turkmenistan Air Force, 67th SAP, Maryy-2 AB

MiG-29 *Fulcrum-C* '45 White'
Uzbekistan Air Force, 115th IAP, Kokaïdy AB

115th IAP at Kokaïdy close to the Afghan border. The single-seaters include '45 White' wearing a three-tone camouflage with roundels on the nose, Uzbek flag fuselage/fin stripes and 'Uz AIR FORCE' titles (which, in the light of Uzbekistan's recent affiliations with the USA, are sometimes mockingly deciphered as '*United Ztatez* Air Force'!). In 1993 the unit was reorganised to become the 61st Fighter Air Brigade.

Non-CIS Operators

Algeria

Reports on MiG-29 operations in Algeria are highly contradictory. The **Algerian Air Force** (*Al Quwwat al Jawwiya al Jaza'eriya/Force Aérienne Algérienne*) reportedly purchased 31 MiG-29s from Belorussia. The first 16 fighters were delivered in 1999, followed by eleven in 2000, two in 2001 and the final two in 2002. The *Fulcrums* were reportedly delivered under a trade-in arrangement in exchange for 120 MiG-21s which Beltechexport hopes to resell to other African countries. Other sources, however, say 36 MiG-29s were received from the Ukraine in 1999-2000 – or 28 *Fulcrum-Cs* from Belorussia and eight MiG-29UBs from Russia. Moreover, it has been reported that a batch of 'older' MiG-29s has been resold to Myanmar!

Known examples are single-seaters serialled FC-16, FC-35, FC-45, FC-53, FC-60, FC-61, FC-64 and FC-93 and MiG-29UBs FB-20, FB-30, FB-60 and FB-90. The latter aircraft and FC-35 wear a dark camouflage scheme, while others retain their factory finish.

The MiG-29s are operated by 3^e *Escadre de Chasse* (3rd Fighter Wing) comprising the 152^e, 153^e and 193^e *Escadron de Chasse* (Fighter Sqn) at Bou Sfer AB and by 140^e *Escadron de Chasse* of an unidentified Fighter Wing at Ouargla AB. On 19th January 2000 the 193 Sqn lost one of its *Fulcrums* in a fatal crash in Oran Province.

Bangladesh

On 28th June 1999 the **Bangladesh Air Force** (BAF, or *Biman Bahini*) ordered eight MiG-29SE *Fulcrum-As* and MiG-29UBs. The price of the deal signed by Chief of Bangladesh Air Staff Air Vice-Marshal Jamal Uddin Ahmed and leader of the visiting Russian delegation was stated as US$ 115 million for the fighters (which cost US$ 11 million apiece with fly-away kit) and associated ground support equipment, plus about US$ 9 million for the training, transportation and technical services package. The latter included the cost of 12 Russian experts' stay in Dhaka for six months for providing initial assistance to BAF personnel, as well as the cost of three month's training for 10 Bangladeshi pilots and 70 technicians in Russia. In a press interview on 5th July 1999 Air Vice-Marshal Jamal Uddin Ahmed said that, although Bangladesh was not facing a military threat from outside, it was necessary to be able to cope with such a threat, should it arise.

MiG-29 *Fulcrum-C* FC-93
Algerian Air Force, 3rd Air Defence Wing

MiG-29 *Fulcrum-A* 36100 (c/n 2960536100)
Bangladesh Air Force, 5th Sqn 'Supersonics'

Air Fleet

▲
Algerian Air Force MiG-29.

Bangladesh Air Force

▲
Bangladesh Air Force MiG-29SE '36100'.

Bangladesh Air Force MiG-29s

Serial	Version	C/n	Notes
28264	MiG-29UB	N50903028264	
...375	MiG-29UB	N509030...375	
36100	MiG-29SE (*izdeliye* 9.12SE)	2960536100	
36501	MiG-29SE (*izdeliye* 9.12SE)	2960536501	Ex-'999 Silver' (MAPO-MiG demonstrator)
36502	MiG-29SE (*izdeliye* 9.12SE)	2960536502	
36503	MiG-29SE (*izdeliye* 9.12SE)	2960536503	
36506	MiG-29SE (*izdeliye* 9.12SE)	2960536506	
36507	MiG-29SE (*izdeliye* 9.12SE)	2960536507	

The first four aircraft were delivered in December 1999 (two on 25th December and two on 28th December), the other four following in February 2000. Known aircraft are listed above.

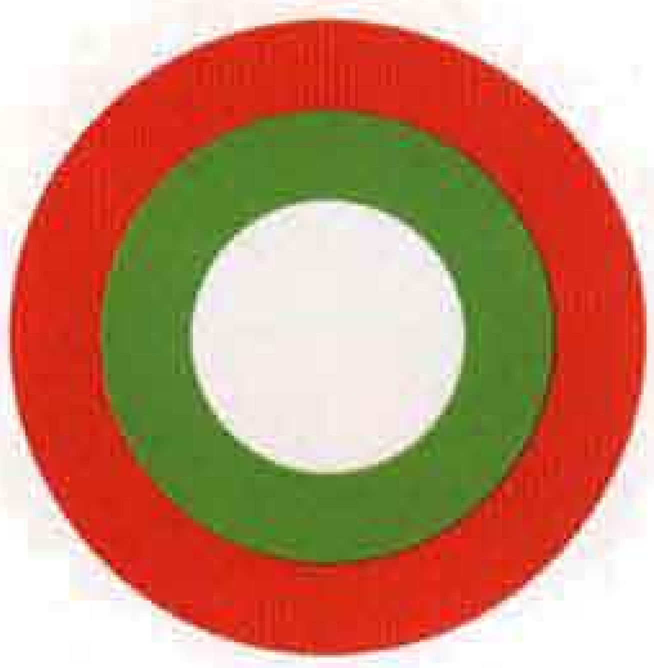
The aircraft officially entered service with No.5 Sqn 'Supersonics' at Bashar AB near Dhaka in March 2000. However, even before they did so the MiG-29s became the subject of a major controversy. Begum Khaleda Jia, chairperson of the main opposition Bangladesh Nationalist Party (BNP), questioned as to in whose interest the government was buying the MiGs. The aircraft, she said, are manufactured in Russia 'and also in India' (*sic*). For spares the BAF will have to depend on India, she alleged. In an obvious reference to India, the former premier said 'the government is buying the Mikoyan fighters to appease a particular country'. This was unfair criticism; nobody had objected when Bangladesh accepted more than 40 Shenyang F-6Cs and FT-6s (Chinese derivatives of the MiG-29 *Farmer*) from India's arch-rival, Pakistan.

Prime Minister Sheikh Hasina countered that it was the responsibility of the government to modernise the armed forces. She said that in the past, those who used the armed forces for capturing power had failed to modernise them. In 1972, she said, 'the Awami League government procured MiG fighter planes for the armed forces and again this time we have purchased these'. She refuted allegations of any 'irregularities' (read: corruption) in the purchase deal. The prime minister added that the fighters were purchased at a discount as it was a state-to-state deal; she claimed that nobody could buy them at a price lower than that paid by the government. The prime minister said Bangladesh had wanted to buy F-16s but the United States refused to sell the fighters, saying they 'have no utility in this subcontinent'; the price of the F-16s was also very high. When her attention was drawn to the reaction of the United States on this issue, Sheikh Hasina said 'they have made their own comments. We have performed our responsibility as a sovereign and independent state. If they repent for their blunder, let them give us 16 F-16 fighter planes. We will happily accept these planes...' The *Fulcrums* are now reportedly up for sale in order to reduce overall maintenance costs.

Bulgarian Air Force MiG-29 '22 White' on the ramp at Graf Ignatievo AB.

Carlo Kuit

'04 White', the newest of the Bulgarian Air Force's four MiG-29UB trainers.



Carlo Kuit

Bulgarian Air Force MiG-29s

Serial	Version	C/n	F/n	Notes
'01 White'	MiG-29UB	N50903013375	?	Reserialled '11 White' by 2006
'02 White'	MiG-29UB	N50903013394	?	Reserialled '12 White' by 2006
'03 White'	MiG-29UB	N50903018908	?	Reserialled '13 White' and then '33 White' by 2006
'04 White'	MiG-29UB	N50903018945	?	Reserialled '14 White' by 2006
'15 White'	MiG-29 (*izdeliye* 9.12A)	2960526321	3714	
'16 White'	MiG-29 (*izdeliye* 9.12A)	2960526322	3715	
'17 White'	MiG-29 (*izdeliye* 9.12A)	2960526324	3801	
'18 White'	MiG-29 (*izdeliye* 9.12A)	2960526325	3802	
'19 White'	MiG-29 (*izdeliye* 9.12A)	2960526333	3803	
'20 White'	MiG-29 (*izdeliye* 9.12A)	2960526334	3804	
'21 White'	MiG-29 (*izdeliye* 9.12A)	2960532035	4115	
'22 White'	MiG-29 (*izdeliye* 9.12A)	2960532036	4201	
'23 White'	MiG-29 (*izdeliye* 9.12A)	2960532377	4311	
'24 White'	MiG-29 (*izdeliye* 9.12A)	2960532379	4312	
'25 White'	MiG-29 (*izdeliye* 9.12A)	296053238...	4313	Crashed 28-9-94
'26 White'	MiG-29 (*izdeliye* 9.12A)	2960532382	4314	
'27 White'	MiG-29 (*izdeliye* 9.12A)	2960532383	4315?	
'28 White'	MiG-29 (*izdeliye* 9.12A)	2960535100	4409	
'29 White'	MiG-29 (*izdeliye* 9.12A)	2960535101	4410	
'30 White'	MiG-29 (*izdeliye* 9.12A)	2960535102	4411	
'31 White'	MiG-29 (*izdeliye* 9.12A)	2960535103	4412	
'32 White'	MiG-29 (*izdeliye* 9.12A)	2960535104	4413	

Bulgaria

In 1990 the **Bulgarian Air Force** (*Voyenno Vozdooshni Seeli*) took delivery of 12 MiG-29s – ten single-seaters (*izdeliye* 9.12A) and two MiG-29UBs. The fleet was later expanded to 18 single-seaters and four trainers. They were operated by 2/3 *Iztrebitelna Aviatsionna Eskadrila* (Fighter Squadron) at Graf Ignatievo AB (3 *Iztrebitelna Aviatsionna Baza*), Plovdiv.

On 29th-30th June 1996 Bulgarian Air Force MiG-29 '15 White' and MiG-29UB '02 White' participated in the Czech International Air Fest (CIAF'96) at Hradec Kralové AB.

In 1996 Russia and Bulgaria began negotiations on new military aircraft purchases. The Bulgarian Telegraph Agency (BTA) reported that Russia offered Bulgaria a US$ 450 million credit with a three-year zero-interest period. Part of the money would pay for 14 MiG-29SM fighters and two MiG-AT advanced trainers, while the rest would be used to reconstruct the TEREM aircraft overhaul facility at Graf Ignatievo AB, Plovdiv, creating 1,000 jobs. Bulgaria would also receive the right to overhaul Mikoyan aircraft operated by European, Asian, Middle Eastern and North African states. This is a huge market, with some 1,200 MiG-21s, 750 MiG-23s and 350 MiG-29s in service in the above regions, and the overhaul business can generate sizeable profits.

The VPK MAPO industry association manufacturing the MiG-29 led the negotiations as the Russian party. These culminated in the

Moscow meeting of the then Russian Prime Minister Viktor S. Chernomyrdin and Bulgarian Prime Minister S. Sofiyanskiy where the two government leaders voiced agreement to sign a deal. The issue was all the more important because the MiG-29 formed the backbone of Bulgaria's air arm. The Bulgarian Air Force had accumulated a wealth of experience with the type and had well-equipped maintenance facilities and highly qualified personnel. However, the country's recent economic problems had taken their toll on the air force as well; the fighter force needed new and more modern hardware.

For the first time since the fall of communism in Bulgaria, economic ties with Russia made the headlines in the country's newspapers. The main debates raged around the possible deliveries of new MiG-29s; opinions varied from utter denouncement to claims that the deal was the air force's only chance of survival. Bulgarian Air Force C-in-C Mikho Mikhov was among the supporters of the deal, stating that the MiG-29 was the most cost-effective solution.

Opponents in the government claimed that buying Russian weapons would increase the country's dependence on Russia and prevent NATO membership (which Bulgaria has since attained). Mikhov's counter-argument was that a decision to follow the Polish or Czech example and re-equip with Western fighters would mean paying exorbitant sums for second-hand F-16s or F/A-18s; besides, this would require complete replacement of ground support equipment, which meant further expenditure.

Russia, on the other hand, offered the latest version of the *Fulcrum* on extremely favourable terms. Also, the MiG-29 can be fitted with Western avionics compatible with NATO standards at customer request. At the time, 'Westernised' MiG-29s were already being successfully used operationally by Germany.

Meanwhile, the debate in the Bulgarian media continued as proponents and opponents of the deal tried to win public support. The anti-*Fulcrum* papers either coyly referred to 'information from reliable sources' or launched

MiG-29UB '04 White'
Bulgarian Air Force, 2/3 IAE, Graf Ignatievo AB

MiG-29 *Fulcrum-A* '54 Red' (c/n 2960535404, f/n 4712)
Chinese People's Liberation Army Air Force, CFTE

MiG-29 *Fulcrum-A* '911 Black'
Cuban Air Force/Air Defence Force, 231º Escuadrón de Caza, San Julian

The sole Chinese MiG-29. The serial '54 Red' is the fighter's original Romanian serial.


via Internet

obvious canards, such as Western businessmen allegedly expressing an interest in the Plovdiv aircraft overhaul facility with a view to upgrading it to overhaul US military transport aircraft. Another rumour circulated by the press was that the Su-25TK attack aircraft was regarded as a possible competitor to the MiG-29. Imagine a subsonic 'tank killer' competing with an agile supersonic fighter!

President Petr Stoyanov did not authorise the purchase of new warplanes because of Bulgaria's difficult economic situation. The TEREM facility began upgrading the Bulgarian MiG-29s to NATO standards; the first example was finally test flown on 15th August 2003. Eventually a deal with RSK MiG to upgrade 18 aircraft was signed on 1st March 2006.

China

The **People's Liberation Army Air Force** of China (PLAAF, or *Chung-kuo Shan Min Taie Fang Tsun Pu-tai*) bought one of the Romanian single-seat MiG-29s ('54 Red', c/n 2960535404, f/n 4712) for evaluation purposes. The fighter was obviously operated by the China Flight Test Establishment (CFTE)

Congo-Brazzaville

The **Congo Air Force** (*Force Aérienne Congolaise*) is reportedly the latest customer for the MiG-29, ordering five MiG-29SEs (*izdeliye* 9.13SE) and one MiG-29UB in 2001.

Cuba

Cuba became a Soviet ally after the 1958 revolution and still enjoys 'friendly nation' status with Russia. Hence the **Cuban Air Force and Air Defence Force** (DAAFAR – *Defensa Anti-Aérea y Fuerza Aérea Revolucionaria*) received the state-of-the-art MiG-29 even before the collapse of the Soviet Union. The first aircraft arrived at San Antonio de los Baños AB in October 1989 and made its checkout flight following reassembly on 19th April 1990.

The DAAFAR currently has one squadron of MiG-29s – 231º *Escuadrón de Caza* (Fighter

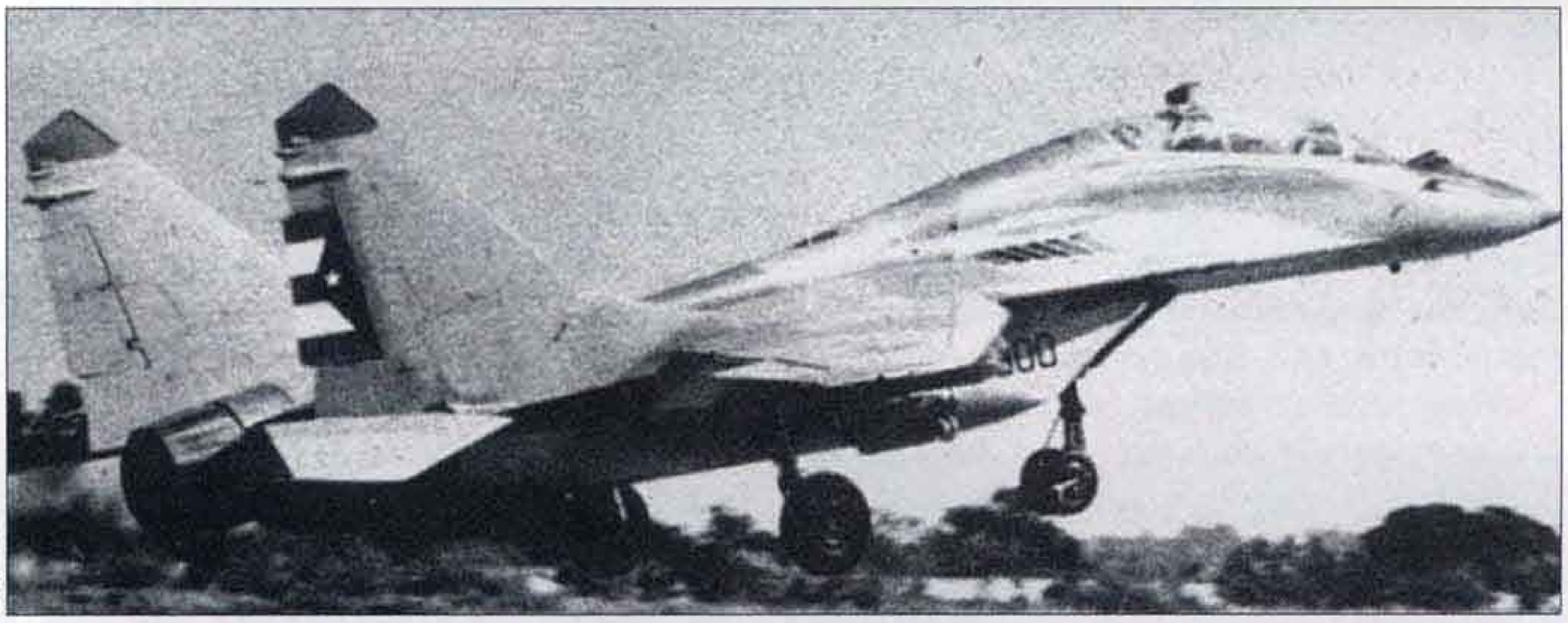

via RART

'911 black', a Cuban Air Force (DAAFAR) MiG-29, taxies out for a sortie.


via RART

A row of MiG-29s, including '910 black', at San Julian AB. Unlike the DAAFAR's MiG-23s, one of which is visible beyond, the Fulcrums did not receive the garish blue/green camouflage.

via RART



via RART

▲
MiG-29UB '901 Black' in the DAAFAR Museum in Havana in company with a MiG-21 and an Ilyushin IL-14 airliner. The blue/grey camouflage is apparently non-authentic and applied at the museum.

◄
Another DAAFAR MiG-29UB, '900', takes off. This one appears to be in standard factory finish.

Squadron) 'Playa Girón' of the 23º *Grupo de Caza* (Fighter Group) based at San Julian AB. The number in service was estimated as twelve singe-seaters and two MiG-29UBs, although some sources say at least 36 *Fulcrums* have been delivered. Unlike the Cuban MiG-21s and MiG-23s, which wear a rather shocking 'bluebottle fly' camouflage, the *Fulcrum-As* (*izdeliye* 9.12B standard) and MiG-29UBs retain their two-tone grey factory finish.

Known Cuban Air Force/Air Defence Force MiG-29s

Serial	Version	C/n	Notes
900 Red (?)	MiG-29UB		Serial may be black
901 Black	MiG-29UB	N50903014717	Preserved DAAFAR museum, Havana, in an unusual blue/grey camouflage (possibly fake)
910 Black	MiG-29		
911 Black	MiG-29		
912 Black	MiG-29		
913 Black	MiG-29		
917 Red (?)	MiG-29UB		Serial may be black

Czech Republic

The country then known as Czechoslovakia was one of the first socialist states to receive the MiG-29 (*izdeliye* 9.12A) and MiG-29UB. In 1988 fifteen carefully selected **Czechoslovak Air Force** (ČVL – *Československé Vojenské Létectvo*) pilots were sent to Loogovaya AB near Frunze, the capital of the Kirghiz Soviet Socialist Republic, to take their training. Deliveries to 11.SLP (*stíhací létecký pluk* – fighter regiment) based at Žatec in the north-west began in the spring of 1989. The first aircraft to arrive was MiG-29UB '4401 Black' test flown by Col. Vaček and Lt. Col. Hackel on 24th April 1989. This was followed by the first nine single-seaters serialled '7501 Black', '7702 Black', '8003 Black', '8304 Black', '8605 Black', '8906 Black', '9207 Black', '9308 Black' and '3709 Black' in June.

Note: Generally the serials of Czechoslovak (and later Czech and Slovak respectively) military aircraft match the last four digits of the c/n. However, there are exceptions, and the MiG-29 is one of them; CzAF Flanker serials consists of the last two digits of the c/n, followed by two digits indicating the delivery sequence number. Thus, '8605 Black' (c/n 2960526386) was the fifth single-seat MiG-29 delivered.

Nine more MiG-29s ('3810 Black', '3911 Black', '4012 Black', '5113 Black', '5414 Black', '5515 Black', '5616 Black', '5817 Black', '5918 Black') and a second MiG-29UB ('4402 Black')

▶ '9207 Black' of 11.SLP displays the three-tone tactical camouflage worn by the type in CzAF service. Note the tiger stripes on the fins.

Martin Baumann

were delivered in September, increasing the total to 20, and that was it. In January 1990 Defence Minister Miroslav Vaček announced that no further MiG-29 purchases were planned.

The 11.SLP comprised two squadrons; the first of these was known as *'Tigrí' létka* (Tiger squadron) because some of its aircraft sported tiger stripes on the fins and stabilators and participated in NATO Tiger Meets. Unlike most *Fulcrums*, Czech MiG-29s wore a so-called East European tactical camouflage (dark green/ foliage green/dark earth/tan upper surfaces and light grey undersurfaces).

The MiG-29s were used primarily in the air defence role. In 1991 CzAF pilots flew to Akhtoobinsk to train at the GK NII VVS firing range.

Came 1992, and the 'gentle revolution' of 1989 that put an end to socialism in Czechoslovakia was followed by an equally gentle divorce. Quietly and without fuss the Federal Republic of Czechoslovakia split into the Czech Republic and Slovakia, and the *Fulcrum* fleet was divided equally between the two (usually the ratio was 2:1 in favour of the Czech Republic). With two exceptions, the odd-numbered aircraft went to Slovakia and the even-numbered ones to the Czech Republic. In late 1993 the 11.SLP at Žatec was disbanded and the aircraft of Sqn 1 were transferred to Sqn 2 of 1.SLP at České Budějovice which had previously operated the MiG-23MF *Flogger-Bs*.

In late June 1994 the MiG-29s of 1.SLP engaged in mock combat with visiting French Air Force Mirage 2000s, demonstrating the Russian fighter's superiority. Yet a few days later, on 30th June, this unit was disbanded as well and the aircraft were grounded. The big question remained: what to do with them?

Farewell to the *Fulcrum*: the CzAF's MiG-29 fleet grounded in the snow at České Budějovice. Here they would remain until they were sold to Poland. ▼

Ryszard Jaxa-Małachowski

MiG-29 *Fulcrum-A* '7702 Black' (c/n 2960526377; f/n 3902?)
Czech Air Force, 11.SLP/1. 'Tigrí' létka, Žatec

MiG-29 *Fulcrum-A* '7501 Black' (c/n 2960526375, f/n 3901)
Slovak Air Force, 1.SLP, Sliač

The Ten MiG-29s Taken Over by the Czech Air Force (České Vojenské Létectvo)

Serial	Version	C/n	F/n	Notes
3810 Black	MiG-29 (*izdeliye* 9.12A)	2960532038	4203	Sold to Polish Air Force as '38 Red'
4012 Black	MiG-29 (*izdeliye* 9.12A)	2960532040	4205	Sold to Polish Air Force as '40 Red'
4402 Black	MiG-29UB	N50903014528*	?	Sold to Polish Air Force as '28 Red
5414 Black	MiG-29 (*izdeliye* 9.12A)	2960532354	4214	Sold to Polish Air Force as '54 Red'
5616 Black	MiG-29 (*izdeliye* 9.12A)	2960532356	4301	Sold to Polish Air Force as '56 Red'
5918 Black	MiG-29 (*izdeliye* 9.12A)	2960532359	4304?	Sold to Polish Air Force as '59 Red'
7702 Black	MiG-29 (*izdeliye* 9.12A)	2960526377	3902?	Sold to Polish Air Force as '77 Red'
8304 Black	MiG-29 (*izdeliye* 9.12A)	2960526383	3904?	Sold to Polish Air Force as '83 Red'
8906 Black	MiG-29 (*izdeliye* 9.12A)	2960526389	3906?	Sold to Polish Air Force as '86 Red'
9207 Black	MiG-29 (*izdeliye* 9.12A)	2960526392	3907?	Sold to Polish Air Force as '92 Red'

* The serial was probably allocated in error and should have been '2802 Black', as the last two digits do not match the first two digits of the serial.

▲ **The badge of the 11th Fighter Regiment based at Žatec.**

▲ **The unit's Sqn 1 was known as the 'Tiger squadron' and had a badge of its own.**

Having decided to join NATO, the Czech government was eager to dispose of Soviet military hardware, which did not conform to NATO standards, and acquire US fighters instead. Thus on 22nd December 1995 a contract was signed with Poland and all ten Czech MiG-29s were transferred to the Polish Air Force in exchange for new PZL Świdnik W-3 Sokól (Falcon) utility helicopters – which, incidentally, saved the *Fulcrums* from the breaker's torch. The fighters had been in open storage, with a consequent deterioration in their condition, and there was no point in spending money on repairing aircraft which were phased out. Eventually the Czech Air Force selected the SAAB/British Aerospace JAS 39C/D Gripen as the MiG-29's successor.

Ecuador

The **Ecuador Air Force** (FAE – *Fuerza Aérea Ecuatoriana*) ordered ten MiG-29Ss and two MiG-29UBs for US$ 40 million. No further details are known.

Eritrea

The **Eritrean Air Force** (ERAF) reportedly purchased a few MiG-29s from Moldova and subsequently bought a further ten from MAPO in

Eritrean Air Force MiG-29s ERAF 502 and ERAF 504.

One of the Eritrean two-seat *Fulcrums*, ERAF 501.

via Internet

via Internet

via Internet

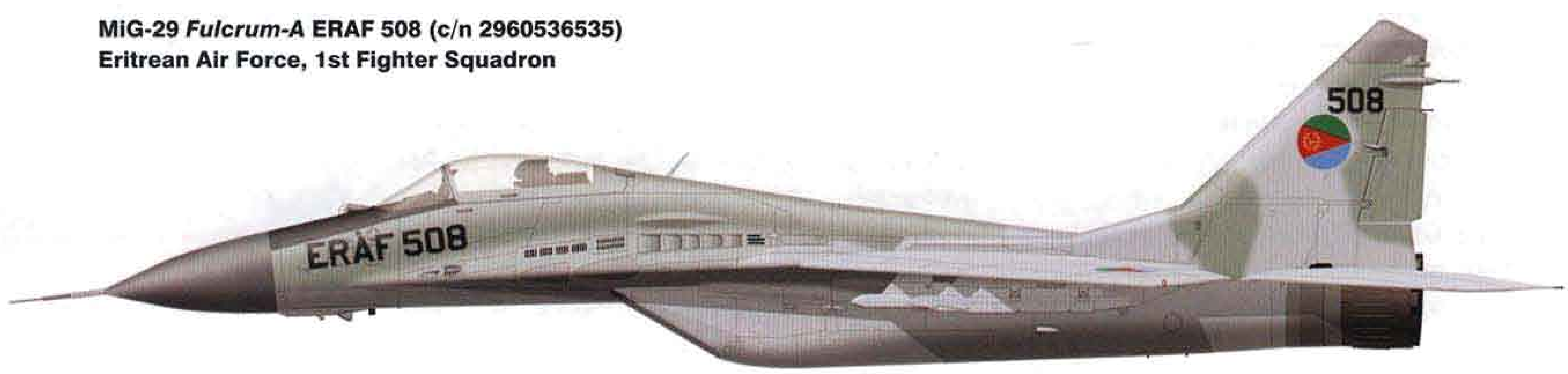
Known Eritrean Air Force (1st Fighter Squadron) MiG-29s			
Serial	**Version**	**C/n**	**Notes**
ERAF 501	MiG-29UB		
ERAF 502	MiG-29 (*izdeliye* 9.12B)		
ERAF 503?	MiG-29 (*izdeliye* 9.12B)?		Existence not proved but likely
ERAF 504	MiG-29 (*izdeliye* 9.12B)		
ERAF 505	MiG-29UB		Also reported as a single-seater
ERAF 506	MiG-29 (*izdeliye* 9.12B)		
ERAF 507	MiG-29 (*izdeliye* 9.12B)		
ERAF 508	MiG-29 (*izdeliye* 9.12B)	2960536535	
ERAF 509	MiG-29 (*izdeliye* 9.12B)		

the summer of 1998. These were sold directly by the manufacturer, not the Rosvo'oroozheniye agency, and used in the war with Ethiopia over the disputed Badme district. The contract included sending a team of Russian maintenance specialists to Eritrea to assist in fixing any technical problems. The pilots, on the other hand, were local ones – if the Eritrean government is to be believed; the opposing side (Ethiopia) is known to employ mercenary pilots actively.

Germany

East Germany was the first of the Warsaw Pact countries to re-equip with the *Fulcrum*. The first

MiG-29 *Fulcrum-A* ERAF 508 (c/n 2960536535)
Eritrean Air Force, 1st Fighter Squadron



indication of this came in 1984 when East German Minister of Defence Gen. Heinz Hoffmann announced his intention to order the MiG-29 to his Swedish colleague visiting Peenemünde AB. Between March 1988 and May 1989 the **East German Air Force** (EGAF, or LSK/LV – *Luftstreitkräfte und Luftverteidigung der Deutschen Demokratischen Republik*, Air Force and Air Defence Force of the German Democratic Republic) received 20 MiG-29s (*izdeliye* 9.12A standard) and four MiG-29UBs. LSK/LV pilots had taken their conversion training in the Soviet Union in 1987. Contract worth was stated as one billion East German Marks.

The aircraft were operated by JG 3 (*Jagdfliegergeschwader* – fighter wing) 'Wladimir Komarow' at Preschen AB near Forst in the Cottbus district. The unit was named after Soviet cosmonaut Vladimir Komarov who died on 24th April 1967 when his spacecraft's heat shield failed during re-entry. The first of two squadrons (*Staffeln*) of JG 3 became operational in May 1988 (some sources state 5th April). There have been claims, however, that service entry was slow because of the need to upgrade the airbases from which the MiG-29s would operate.

Operations from Preschen had a quirk: the base was located so close to the Polish border that the aircraft had to enter Polish airspace during their landing pattern. This was made possible by an agreement between East Germany and Poland, under which Polish military aircraft could also fly into German airspace when operating from bases at Sczecin and Jelenia Góra.

Additional MiG-29 purchases were contemplated to re-equip JG 1 at Holzdorf AB and other fighter units but they never materialised because of East Germany's inflexible state-planned economy. However, JG 3 *Fulcrums* occasionally deployed to Holzdorf. A MiG-29 flight simulator was also bought but never became operational because the building at Preschen intended for it was not yet built; trainees had to make do with a full-scale cockpit mock-up, which could be opened up for inspection.

Some sources state that LSK/LV MiG-29s had some locally produced avionics developed by the *Militärtechnisches Institut* at Wuhlheide near Dresden. These included parts of the radar set and the entire IFF system.

Like the Czech MiG-29s, the East German *Fulcrum-As* wore the East European tactical camouflage; typically of East German fighters, they had red serials. Conversely, the trainers came in standard two-tone grey camouflage and, like all other LSK/LV non-combat types, they wore black serials. The serials were not allocated consecutively, presumably so as to confuse spies. For instance, '181 Black' and '185 Black' were MiG-29UBs while the intervening serials '182 Black' through '184 Black' belonged to Tu-134AK VIP aircraft operated by TFG 44 (*Transportfliegergeschwader* – air transport wing) at Marxwalde AB. Curiously, the serial '181 Black' originally belonged to another TFG 44 Tu-134AK (c/n (53)35180, f/n 3006) and was reallocated to MiG-29UB c/n N50903006604 after the airliner had been registered DDR-SDC on 9th March 1982.

Additionally, for security reasons the serials were often changed on aircraft intended for public view. There are publicity photos of East German *Fulcrum-As* '28 Red' and '70 Red' – actually '628 Red' and '670 Red' with the first digit of the serial overpainted.

When Germany reunited on 3rd October 1990, the LSK/LV and the West German Air Force (*Luftwaffe der Bundesrepublik Deutschland*) merged into a single air arm with the rather less cumbersome name of Luftwaffe. Thus, most of the East German military aircraft were, at least temporarily, taken on strength by the united armed forces (Bundeswehr) and received four-digit Luftwaffe serials pending a decision on their ultimate fate. It should be noted here that the first two digits of Luftwaffe serials denote the type (for example, 43 through 46 = Panavia Tornado IDS, 50 and 51 = Transall C.160 and so on). The MiG-29s were conveniently allocated serials in the '29+...' block. Incidentally, the serials 29+01 through 29+21 were re-used, having been previously allocated to Lockheed F-104G Starfighters.

One of the single-seaters, '604 Red', was painted in special markings with a yellow lightning bolt and the inscription '27.09.1990' below the cockpit to commemorate the type's last flight in East German service on 27th September 1990 at the hands of *Oberstleutnant* (Lt. Col.) Günther Fichte. It was also the first MiG-29 to be repainted in Luftwaffe markings and the inscription below the cockpit was duly changed to '19.10.1990' to mark the first flight in reunited Germany. This particular *Fulcrum* was referred to as *die Traditionsmaschine* (the traditional aircraft)!

The serial 29+13 was not allocated to any aircraft for superstitious reasons (purely LSK/LV superstition, it should be noted; the 'old' Luftwaffe had no reservations about using 13 as the final two digits). Instead, it was applied to a

Flieger Revue

▶ East German Air Force MiG-29s '628 Red' and '670 Red' pose for a publicity photo. In keeping with security requirements the first digit of the serials has been temporarily overpainted.

Martin Baumann

▶ MiG-29 '661 Red' armed with two R-73s and two R-27Rs looks almost like a scale model in a diorama, but it *is* real.

'604 Red' received this special scheme to mark the MiG-29's last flight in LSK/LV service on 27th September 1990 prior to German reunification (note the JG 3 badge). ▶

via RART

▲ The badge of JG 3, the EGAF's only MiG-29 unit. The eagle is the symbol of Sachsen (Saxony).

via RART

▶ Unlike the single-seaters, the EGAF's MiG-29UBs wore grey camouflage. Note the 'winged Q' (for *Qualität*) maintenance award badge and the yellow rescue stencils on the nose.

MiG-29 *Fulcrum-A* '679 Red' (c/n 2960525132, f/n 3509)
East German Air Force, JG 3, Preschen

MiG-29 *Fulcrum-A* '604 Red' (c/n 2960525106, f/n 3412)
East German Air Force, JG 3, Preschen

car – a bright blue IFA Trabant 601S East German-built sedan owned by the unit and nicknamed 'Rudi'. Guests of honour were given a ride in this tiny, farting and smoky vehicle, finally signing their name on the inside of the passenger door!

After the reunification there was much debate as to whether Soviet aircraft should be retained. Since the MiG-29 was the most modern of these the German government decided to evaluate the type. To this end two single-seaters (29+19 and 29+21) and two trainers (29+22 and 29+25) were transferred in late October to WTD 61 (*Wehrtechnische Dienststelle 61 für Luftfahrzeuge* – military technical support unit, or rather Aircraft Test Centre No.61) at Manching AB near Ingolstadt, Bayern, which also evaluated other Soviet military aircraft. WTD 61 has a tradition of using the 98+... serial range, but only the *Fulcrum-As* were properly reserialled, regaining their former serials after the trials. The others remained at Preschen with JG 3, which was transformed into *Erprobungsgeschwader MiG-29* (MiG-29 Test Wing) in early 1991; this was to support the trials at Manching and perform proficiency training.

The trials programme comprising nearly 200 items was jointly developed by the Luftwaffe and the Federal Military Equipment Procurement Office. Performance, operational flexibility and reliability of the weapons system as a whole and its various components were investigated. Operating and maintenance/overhaul costs were calculated. Equally important was how the MiG-29 would fare against NATO fighters in air-to-air combat. The latter came as a rude shock for USAF F-15 and F-16 pilots who often found themselves 'shot down' in mock combat before they even got the *Fulcrum* on their radar screen! This was partly due to the MiG-29's agility and partly because the fighter's N019 radar proved to be far more capable and resistant to ECM than expected.

To ensure adequate flight safety during trials Rheine-Hopsten, Wittmund and Manching airbases were equipped with Soviet RSBN landing aid (***rah**diotekh**nich**eskaya sis**tem**a **blizh**ney navi**gah**tsii* – SHORAN) beacons used by the LSK/LV. Accordingly the Luftwaffe retained the specially equipped Antonov An-26M navaids calibration aircraft (52+09, ex-'369 Black', c/n 11402) for checking the landing aids at the airbases used by the MiG-29s. East German emergency barriers typical of LSK/LV bases were also installed at both ends of the runway at Wittmund and Manching.

Meanwhile, the German government addressed the Soviet Union, seeking aid in modifying the MiG-29s to make them compatible with NATO standards. The Soviet government authorised the Mikoyan OKB to do the job. The Luftwaffe proposed that Mikoyan check and authorise all the changes, and the company did.

The fighters were fitted with new IFF, communications and tactical area navigation (TACAN) equipment, flight instruments marked in feet and knots, an 'English-speaking' version of the *Ek**rahn*** (Screen) ground test equipment,

Yefim Gordon archive

Yefim Gordon archive

▲ **ANPK MiG engineering staff and Luftwaffe technical staff pose with a Luftwaffe MiG-29 (29+07) being upgraded to NATO requirements.**

► **A technical discussion is in progress. Mikhail R. Val'denberg is fourth from right.**

The Old and New Identities of the German MiG-29s

LSK/LV Serial	Version	C/n	F/n	D/D	L/waffe Serial	Notes
604 Red	MiG-29	2960525106	3412	4-88	29+01	To Polish AF 4-8-04 (as '06 Red'?)
607 Red	MiG-29	2960525108	3413	4-88	29+02	To Polish AF 14-4-04 (as '08 Red'?)
615 Red	MiG-29	2960525110	3414	3-88	29+03	Preserved Laage AB as a gate guard
628 Red	MiG-29	2960525111	3415	3-88	29+04	To Polish AF 4-8-04 as '4111 Red'
635 Red	MiG-29	2960525113	3502	6-88	29+05	To Polish AF 4-8-04 as '4118 Red'
661 Red	MiG-29	2960525114	3503	4-88	29+06	To Polish AF 11-12-03 (as '14 Red'?)
668 Red	MiG-29	2960525115	3504	4-88	29+07	To Polish AF 26-9-03* (as '5115 Red'?)
669 Red	MiG-29	2960525118	3505	4-88	29+08	To Polish AF 14-4-04 (as '18 Red'?)
670 Red	MiG-29	2960525121	3506	4-88	29+09	Crashed 50 km from Laage AB 25-6-96
676 Red	MiG-29	2960525124	3507	4-88	29+10	Special colour scheme. To Polish AF 4-8-04 (as '24 Red'?)
677 Red	MiG-29	2960525128	3508	8-88	29+11	To Polish AF 26-9-03* (as '128 Red'?)
679 Red	MiG-29	2960525132	3509	5-88	29+12	To Polish AF 4-8-04 as '4113 Red'
684 Red	MiG-29	2960525800	3703	11-88	29+14	To Polish AF 14-4-04 (as '800 Red'?)
686 Red	MiG-29	2960526319	3713	1-89	29+21	Reserialled as, see next line
					98+06	WTD 61. To 1./JG 73 as 29+21 by 8-93 To Polish AF 14-4-04 as '22 Red'
693 Red	MiG-29	2960526300	3704	11-88	29+15	To Polish AF 11-12-03 (as '300 Red'?)
699 Red	MiG-29	2960526301	3705	1-89	29+16	To Polish AF 26-9-03* (as '01 Red'?)
745 Red	MiG-29	2960526302	3706	1-89	29+17	To Polish AF 26-9-03* (as '02 Red'?)
777 Red	MiG-29	2960526310	3710	1-89	29+18	To Polish AF 4-8-04 (as '310 Red'?)
778 Red	MiG-29	2960526314	3711	5-89	29+19	Reserialled as, see next line
					98+08	WTD 61. To 1./JG 73 as 29+19 by 8-93 To Polish AF 11-12-03 (as '314 Red'?)
785 Red	MiG-29	2960526315	3712	1-89	29+20	Special colour scheme. To Polish AF 8-04 (as '315 Red'?)
148 Black	MiG-29UB	N50903006448	?	4-88	29+22	To Polish AF 11-12-03 (as '48 Red'?)
179 Black	MiG-29UB	N50903006526	?	4-88	29+23	To Polish AF 4-8-04 as '4115 Red'
181 Black	MiG-29UB	N50903006604	?	4-88	29+24	To Polish AF 26-9-03* (as '04 Red'?)
185 Black	MiG-29UB	N50903011408	?	11-88	29+25	To Polish AF 4-8-04 (as '408 Red'?)

* The delivery date of 29+07, 29+11, 29+16, 29+17 and 29+24 has also been stated as 30th September.

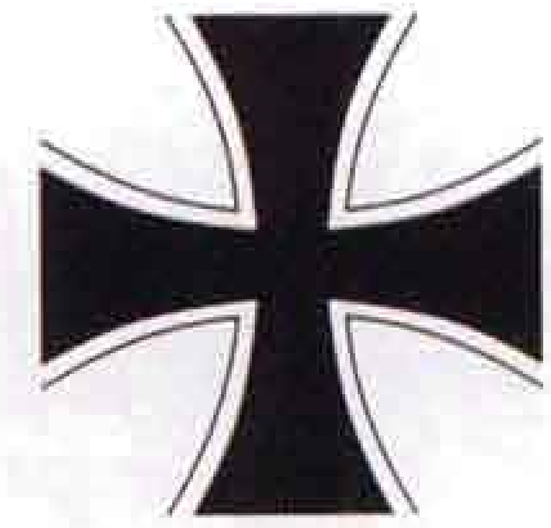
red anti-collision strobe lights on the fuselage spine and under the port engine nacelle and so on – even the colours of the artificial horizon were changed to suit NATO requirements. The instruments were altered in Moscow and delivered to Germany for installation, the rest of the changes were made on site. The modified aircraft bore the unofficial designations MiG-29G ('German') and MiG-29GT ('German trainer').

Post-modification trials were held in April and May 1991 in Italy at the now-closed Air Combat Manoeuvring Installation (ACMI) at Decimomannu AB, Sardinia. The *Fulcrums* won all mock combat sessions against various NATO fighters. As part of the evaluation programme, four MiG-29s were detached to Wittmund AB near Wilhelmshaven, Niedersachsen (home of JG 71 'Richthofen') on 4th-27th March 1991.

Evaluation was completed in June 1991 and on 25th July that year Germany's Minister of Defence Dr. Gerhard Stoltenberg ruled that the MiG-29 would remain in service for a 12-year period. Thus the *Fulcrum* gained the distinction of being the only Soviet type to serve on with the Luftwaffe after German reunification; all other ex-LSK/LV aircraft were soon sold (mostly to East European air forces or CIS airlines), donated to museums or scrapped.

After this, *Erprobungsgeschwader MiG-29* was reorganised once again, becoming 1/JG 73 (Sqn 1 of JG 73 'Steinhoff') and moving to Laage AB. (2./JG 73 operated McDonnell Douglas F-4F Phantom IIs and was based at Pferdsfeld AB.) Initially the aircraft retained their Central European tactical camouflage and the former LSK/LV serial on the dielectric fin caps. In 1992,

Marcus Fülber



Luftwaffe

▲◄ MiG-29G 29+05 (ex-'635 Red') in the new grey air superiority camouflage. Note the JG 73 badge on the tail.

◄ MiG-29Gs 29+10 and 29+14 formate with two visiting USAF/944th FW/302nd FS F-16Cs prior to a DACT session.

however, they received the new overall light grey air superiority finish introduced on the F-4F. MiG-29 29+11 was the first to be repainted in this fashion, attracting considerable attention from photographers when it appeared in the static park at the ILA'92 airshow at Berlin-Schönefeld airport on 15th-21st June 1992.

Col. Manfred Menge, the then Commanding Officer of JG 73, went to great lengths to praise the aircraft. Mikhail R. Val'denberg, who still was MiG-29 project chief at the time, recalls that the German pilots demonstrated perfect landings of two aircraft at a time; the flight leader would touch down in the middle of the runway and his wingman at the beginning of the runway. When asked about this, Col. Menge commented that 'a good commander has to teach his men everything the aircraft allows them to do'. The evaluation programme was taking rather long, and Col. Menge told Val'denberg that, should the MiG-29 be rejected by the Luftwaffe, he would write an open letter to Chancellor Helmut Kohl, protesting the decision. Fortunately this was not necessary.

Since mid-1995 two MiG-29s were on ready alert as part of NATO's quick-reaction forces. On 25th-28th September 1995, in the course of the NATO Tactical Air Meet '95, four Luftwaffe MiG-29s became the first Soviet (Russian) combat aircraft to safeguard the skies of Western

MiG-29Gs and MiG-29GTs on the flight line at Laage AB. ▼

Martin Baumann


Marcus Fülber


Marcus Fülber

▲ **When the Luftwaffe finally phased out the type, MiG-29G 29+10 received this farewell colour scheme incorporating the colours of Germany and the new operator, Poland. The starboard fin features a list of NATO exercises in which the type participated.**

Another striking *Abschiedsbemalung* on MiG-29G 29+20. The port and starboard fins were painted differently. ▼

Europe (specifically, north-eastern France); this exercise proved once more the MiG-29's efficiency and compatibility with the NATO's air defence structure.

The fighters were mostly flown by former LSK/LV pilots; only six '*Fulcrum* drivers' converted to the MiG-29 from Western types, coming from JG 71 'Richthofen', JG 72 'Westfalen' and JG 74 'Mölders'. Col. Menge, commander of JG 73, was likewise an officer of the 'old' Luftwaffe, having formerly commanded JG 72 at Rheine-Hopsten AB, while his next in command was a former East German officer. The MiG-29 pilots were, in fact, among the very small number of East German personnel to be employed by the united Bundeswehr – the military standards and doctrines of East and West Germany were simply too different. Training the East German personnel to new standards would be excessively costly and unnecessary, as the Bundeswehr would be overstaffed.

Besides filling the air defence role, German MiG-29s were sometimes used as 'aggressor' aircraft during NATO exercises (such as *Red Flag*). The first such case was in 1999 when five MiG-29s deployed to Nellis AFB, Nevada, via Goose Bay (Canada) to participate in *Red Flag*


Marcus Fülber

MiG-29 *Fulcrum-A* 29+20 (ex-'785 Red', c/n 2960526315, f/n 3712)
Luftwaffe, 1./JG 73, Laage, original post-reunification colours

00-1 as part of the OPFOR (Opposing Force). The German detachment, which included 12 pilots and more than 200 technicians, was commanded by Col. Knut Rutze, the new CO of JG 73. He characterised the *Red Flag* exercise as one of the best in the NATO combat training system, saying that 'participation in this exercise where we are able to work with the most experienced pilots is the best training you can receive in the Luftwaffe'.

Since there were debates in Germany as to what aircraft would be the backbone of the Luftwaffe's fighter force in the near future, Russia suggested that the Luftwaffe purchase additional MiG-29s. The offer sounded attractive; an analysis by Germany's Federal Accounting Office (BRH – *Bundesrechnungshof*) which had leaked into the press showed that buying additional MiGs would be a better solution than building the Eurofighter EF2000 Typhoon. Of

MiG-29G 29+10 (ex-'676 Red', c/n 2960525124, f/n 3507)
Luftwaffe, 1./JG 73, Laage, farewell colour scheme

MiG-29G 29+20 in a farewell colour scheme
See picture above for details of the badge in the starboard fin

▲ **This shoulder patch was worn by Luftwaffe MiG-29 drivers. F-16 pilots, eat that!**

course the MiG-29 had its share of detractors – namely those who lobbied for the expensive and prestigious Eurofighter programme.

Some Western observers believed that Russia would offer the MiG-29 for about DM 20 million, which was three to five times less than the Typhoon's selling price. Thus a possible contract for the delivery of *Fulcrums* would cost DM 2 billion, decreasing Russia's DM 80 billion foreign debt to Germany.

Yet a decision to rely on MiGs could make the Luftwaffe dependent on spares deliveries and maintenance, which Western experts deemed to be unreliable; to quote Luftwaffe C-in-C Lt. Gen. H.-J. Kübart who had made a single flight in a MiG-29UB and was generally pleased with the aircraft, 'it's hard to understand who is responsible for the production and sales of spares for these aircraft in Russia'.

Another argument against buying more *Fulcrums* was the relatively low engine and airframe life. The RD-33 engines of early-model MiG-29s had an MTBO of only 350-400 hours and a service life not exceeding 600 hours. Combat readiness was low at first; only six of the Luftwaffe's 24 MiG-29s were fully operational in early 1991 but this increased to 12 by January 1992. Russia sent a group of specialists from an overhaul plant dealing with the RD-33 and measures were developed to extend engine life by 50-100 hours.

Last but not least, buying Russian military aircraft was not very acceptable politically. Therefore the German government finally selected the EF2000 after all. This was primarily a political decision; among other things, it would create jobs in the German aerospace industry since DASA (Deutsche Aerospace) participated in the Eurofighter consortium.

In early 1997 the Luftwaffe successfully tested a modification enabling the German MiG-29s to carry three drop tanks – a feature previously found only on the *Fulcrum-C*. As originally delivered the *Fulcrum-A/Bs* could only carry a single centreline drop tank. The upgrade extended the fighter's range to 2,900 km (1,800 miles), amounting to an 800-km (496-mile) increase. Prototype modification work was performed by the Russian-German joint venture MAPS (MiG Aircraft Product Support GmbH) based at Manching AB, as agreed to by MAPO MiG.

In late 1997 JG 73 detached four MiG-29s – three single-seaters (29+05, 29+20 and 29+21) and MiG-29UB 29+23 – to Decimomannu AB for a dissimilar air combat training (DACT) session against four Panavia Tornado F.3s of the RAF's XI(F) Squadron from RAF Leeming, including ZE763/'DG' and ZE780. The Tornados flew a simulated strike profile while the MiGs flew defensive combat air patrol (CAP).

During air combat sessions the Tornados tried to pick the *Fulcrums* off at long range, using their BVR attack capability. According to *Air Forces Monthly*, the German pilots found the Tornado a difficult opponent to get to grips with, thanks to the tri-national fighter's superior avionics (primarily the powerful Ferranti Blue Fox radar) and the aggressive tactics employed by the British pilots.

This accounts for the 2 to 1 'kill' ratio in favour of the Tornados. For example, on one occasion when a Tornado pilot saw a MiG-29 closing in for the kill, *'the decision to retreat bravely was taken, with the F.3 flying at Mach 1.5 and trying to shake off the* Fulcrum. *The MiG-29 took up the pursuit, only to be shot down by a second Tornado that had joined the chase'*. (It should be noted that the Luftwaffe did not inform the Mikoyan OKB of the reasons for this apparent defeat.)

However, the British pilots also found the MiG-29 a formidable adversary at close quarters because, unlike the Tornado F.3, the *Fulcrum* was designed as a 'dogfighter', not a low-speed penetrator adapted for the air defence role. On one occasion when a Tornado was at its turning limits, trying to stay behind the MiG, *'the German fighter rolled its wings level, pulled into a vertical climb, went over the top of the Tornado and dropped in behind for a perfect* Archer *kill'*.

Luftwaffe MiG-29s had their share of accidents as well. JG 73 lost one of its single-seaters, 29+09, on 25th June 1996; the pilot ejected safely. One more MiG-29G was reported in error as lost in a fatal crash, but all other Luftwaffe MiG-29s have been accounted for.

The *Fulcrum* stayed in service with the Luftwaffe until 2003. After that, the surviving examples (except 29+03, which was in such poor condition that it was no longer flyable) were transferred to the Polish Air Force for a token payment of 1.00 euro, as JG 73 had started re-equipping with the Typhoon. The handover ceremony took place at Laage AB on 26th September 2003 when an agreement was signed by German Defence Minister Peter Struck and his Polish counterpart Jerzy Szmajdziński; the first five aircraft were flown to their new home five days later. Before that, MiG-29Gs 29+10 and 29+20 were painted in flashy farewell colour schemes featuring the German flag colours of black, red and yellow.

Hungary

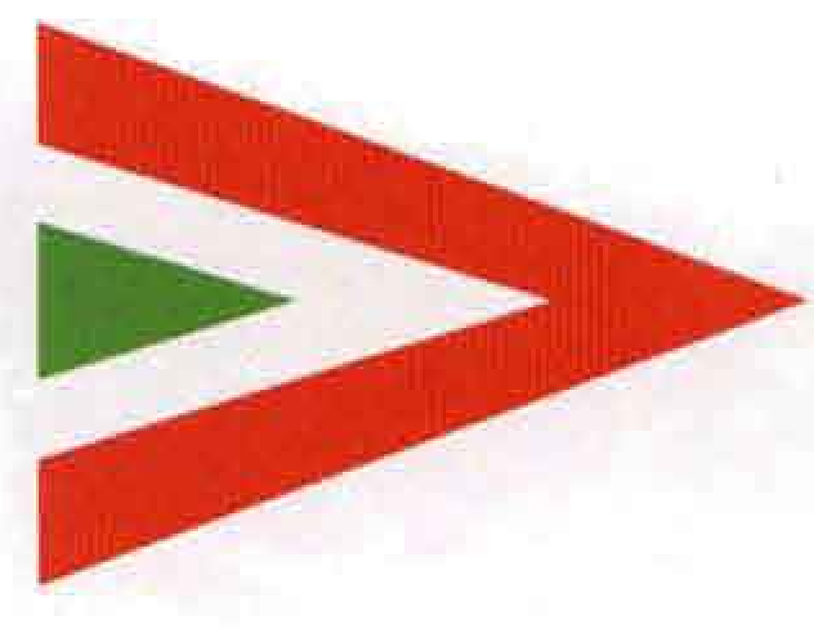
The **Hungarian Air Force** (MHRC – *Magyar Honvedseg Repülö Csapatai*) was originally to receive the MiG-29 in 1988-89, but political changes foiled these plans. It was not until 18th June 1993 that an agreement was signed whereby Russia was to transfer 22 single-seat MiG-29s (*izdeliye* 9.12A standard) and six MiG-29UB trainers to Hungary as foreign debt payment.

The Hungarian pilots took their training at the Krasnodar Combined Pilot and Tech Staff College (KVOLTU). On 15th October 1993 the first eight MiG-29s destined for Hungary arrived in Krasnodar, followed by eight more on 26th October and the final 12 on 4th November. The fighters were assigned to the 59th HVE (*Honi Vadaszrepülö Ezred* – Fighter Regiment) in Kecskemét. The unit consisted of two squadrons – 1. *'Puma' Század* (No.1 'Puma' Sqn) and 2. *'Dongó' Század* (No.2 'Bee' Sqn). After the fall of communism in Hungary the original star-type insignia had given place to chevrons in the Hungarian national colours of red, white and green; these were applied as stickers over the original red stars, and the new insignia were properly painted on after the machines arrived in Kecskemét.

No.2 Sqn became operational on 1st December 1994. The other squadron followed a full year later, its pilots taking their conversion training in Hungary.

On 22nd September 1997 a group of young American businessmen, members of the Young Businessmen Association, were given rides in a MiG-29UB at Kecskemét in what was described as 'the first and last chance to fly the *Fulcrum*' before Hungary joined the NATO (implying the type would be phased out thereafter – which, incidentally, it was not). A Hungarian MoD spokesman said the money raised in this fashion – and the ride was no cheap experience, the fee being US$ 5,000 per person per hour – would be used to develop the Air Force. It says a lot for the plight the MHRC was in at the time!

In 1998 MiG-29 '22 Red' received a special colour scheme on occasion of the Hungarian Air Force's 60th anniversary. The aircraft was sky blue all over and star-spangled, with stripes in the national flag colours beating the numerals



Hungarian Air Force MiG-29s and APA-5DMs on the flight line at Kecskemét. The fighters still have the original two-tone camouflage and red serials. ▼

Ryszard Jaxa-Małachowski

MiG-29UB '27 Red' (c/n N50903027268)
Hungarian Air Force, 59th Fighter Regiment (old colours)

Showing off its new 'NATO style' camouflage and 'HuAF/59TH TFW' titles, MiG-29 '04 Black' taxies out for a display flight at the RIAT-2003, RAF Fairford.

Carlo Kuit

Hungarian Air Force MiG-29s

Serial	Version	C/n	F/n	Notes
'01 Red'	MiG-29	2960535116	4504	1st TFS. Stored Kecskemét AB
'02 Red'	MiG-29	2960535117	4505	1st TFS. To '02 Black'. Crashed Kecskemét AB 11-5-05
'03 Red'	MiG-29	2960535124	4507	1st TFS
'04 Red'	MiG-29	2960535127	4508	1st TFS. To '04 Black'
'05 Red'	MiG-29	2960535148	4513	1st TFS. Stored Kecskemét AB
'06 Red'	MiG-29	2960535149	4514	1st TFS
'07 Red'	MiG-29	2960535150	4515	C/n sometimes reported in error as 2960535120. 1st TFS
'08 Red'	MiG-29	2960535151	4601	1st TFS
'09 Red'	MiG-29	2960535157	4602	1st TFS
'10 Red'	MiG-29	2960535158	4603	1st TFS
'11 Red'	MiG-29	2960535161	4604	1st TFS
'12 Red'	MiG-29	2960535181	4605	2nd TFS. Stored Kecskemét AB
'14 Red'	MiG-29	2960535162	4606	F/n order reversed, see previous line! 2nd TFS. Stored Kecskemét AB
'15 Red'	MiG-29	2960535182	4701	2nd TFS
'16 Red'	MiG-29	2960535184	4702	2nd TFS
'17 Red'	MiG-29	2960535188	4703	2nd TFS. Crashed near Kecskemét 23-7-98
'18 Red'	MiG-29	2960535189	4704	2nd TFS
'19 Red'	MiG-29	2960535190	4705	2nd TFS
'20 Red'	MiG-29	2960535191	4706	2nd TFS
'21 Red'	MiG-29	2960535192	4707	2nd TFS. To '21 Black'
'22 Red'	MiG-29	2960535193	4708	2nd TFS. Temporarily painted in special anniversary colours in 1998 as '1938 Red'
'23 Red'	MiG-29	2960535198	4709	2nd TFS. Stored Kecskemét AB
'24 Red'	MiG-29UB	N50903027135	?	1st TFS. Stored Kecskemét AB
'25 Red'	MiG-29UB	N50903027146	?	1st TFS. Stored Kecskemét AB
'26 Red'	MiG-29UB	N50903027257	?	1st TFS
'27 Red'	MiG-29UB	N50903027268	?	2nd TFS. To '27 Black'
'28 Red'	MiG-29UB	N50903027279	?	2nd TFS
'29 Red'	MiG-29UB	N50903027380	?	2nd TFS

'60' slanted upwards over the fins. After the airshow held at Kecskemét on 22nd-23rd August to celebrate the occasion the aircraft reverted to its normal colours.

In early 2002 RSK MiG was awarded a contract for a service life extension programme (SLEP) on 14 Hungarian MiG-29s (12 single-seaters and two MiG-29UBs). The work was completed in 2003. The fighters already had NATO-standard avionics fitted during a previous upgrade. The remaining 13 aircraft were placed in storage, to be cannibalised for spares or sold.

When the coveted NATO membership was attained, Hungary reorganised its air force under the new indigenous name of *Magyar Légierö*. The 59th HVE became the 59. *'Szentgyörgyi Dezsö' Harcàszati Repülö Bázis* or, in keeping with NATO terminology, 59th Tactical Fighter Wing 'St. George', while the two squadrons were now called 1. *'Puma' Harcàszata Repülöszàzad* (No.1 'Puma' Tactical Fighter Sqn) and 2. *'Dongó' Harcàszata Repülöszázad* (No.2 'Bee' TFS). At the same time the fighters' two-tone camouflage gave way to a uniform grey finish with 'HuAF/59TH TFW' titles on the fins and black serials instead of the red ones worn hitherto.

Over the years the Hungarian Air Force lost two MiG-29s in accidents. The crash of '17 Red' on 23rd July 1998 was attributed to pilot error; the other one was caused by materiel failure. On 11th May 2005 pilot Zoltan 'Topi' Szabo was practising for an air display scheduled to take place at Kecskemét AB on the weekend. As the fighter was making a wide left turn, the port engine exploded and a fire erupted; the pilot did not eject until he was sure that he was clear of built-up areas. The fighter crashed and burned in an open field outside the airfield perimeter; the pilot was unhurt.

Currently Hungary is introducing 14 SAAB/BAe JAS 39C/D Gripen fighters which are leased from the manufacturer for a 12-year period from 2006 onwards. Hence the Hungarian MiG-29s may be due for retirement shortly.

India

The **Indian Air Force** (IAF, or *Bharatiya Vayu Sena*) was the first foreign operator of the MiG-29. Being traditionally on friendly terms with the Soviet Union (and at odds with neighbouring Pakistan because of a territorial dispute over Kashmir), India addressed the Soviet government in the early 1980s, requesting the delivery of the latest Soviet fighters. The reason was the recent delivery of F-16s to the Pakistani Air Force, which could topple the balance of power in the region.

When Marshal Dmitriy F. Ustinov, the then Soviet Minister of Defence, visited India in February 1984 he agreed that the Soviet Union would supply 44 MiG-29s (40 *Fulcrum-As* and four *Fulcrum-Bs*) to the IAF at a price of US$ 11 million apiece. Licence production of a further 110 MiG-29s by Hindustan Aeronautics Ltd. (HAL) was also discussed. HAL already had some experience with Mikoyan designs, having built the MiG-21FL/M/*bis Fishbed-D/J/N* under licence for the IAF at its facility in Nasik, Maharashtra, since 1966 and the MiG-27 *Flogger-J* since 1984.

Indian MiG-29 pilots took their training at Loogovaya AB near Frunze. In December 1986 the first 12 aircraft were delivered in the form of semi-knocked-down (SKD) kits to HAL's Nasik factory. Assembly was completed in May 1987 and the aircraft were delivered to two squadrons previously operating the MiG-21*bis* – 28 Sqn 'First Supersonics' and 47 Sqn 'Black Archers'; both were then based at Poona (Pune) AB near Bombay, Maharashtra, and belonged to the South-Western Air Command headquartered at Jodhpur. The official handover ceremony took place at Poona AB a full year after the initial deliveries, on 6th December 1987, marking the beginning of the *Fulcrum*'s career with the IAF.

47 Sqn was later transferred to the Western Air Command headquartered at Delhi, relocating to Adampur AB. In May 1989 a third unit, 223 Sqn 'Trishul' ('Tridents' in Hindi) based at the same location, re-equipped with 20 MiG-29s. Finally, by 2004 the 28 Sqn was likewise transferred to the Western Air Command, which thus came to include all three MiG-29 units, and relocated to Leh AB.

By early 1997 the IAF had taken delivery of 70 (or is it 72?) single-seat MiG-29s (*izdeliye* 9.12B standard) and eight MiG-29UBs. These were reportedly distributed as follows between the three squadrons: 46 *Fulcrum-As* and four MiG-29UBs with 47 Sqn, 18 single-seaters and two trainers with 28 Sqn, and eight single-seaters and two trainers with 223 Sqn, although this very unequal distribution seems rather strange. (There have been allegations, however, that 90 *Fulcrum-As* were delivered – 40 in 1987, 20 in 1989, another 20 in 1994 (?!) and a final ten ordered in December 1994 as attrition replacements.) Some sources claim that India refused to accept the downgraded export version and persuaded the Soviet Union to deliver the fully capable *izdeliye* 9.12! The planned licence production, after much ado, never materialised because India preferred to manufacture the more capable Su-30MKI under licence.

The aircraft were delivered in standard Soviet two-tone grey camouflage. Soon after service entry squadron badges appeared on the air intakes. Later some IAF *Fulcrums* sported non-standard paint jobs with highly colourful tails for participation in war games.

▲ The badge of the Indian Air Force's 28 Sqn 'First Supersonics'.

Simon Watson

◄ MiG-29 KB3297, one of the newest in the Indian Air Force, is operated by 28 Sqn 'First Supersonics'. Note the characteristic position of the IAF roundel.

World Air Power Journal

▲ **The Indian MiG-29s often wore colourful tail markings (presumably for quick recognition in war games), as illustrated by blue-tailed KB707 and red-tailed KB713.**

Indian Air Force MiG-29s			
Serial	Version	Unit	Notes
KB701	MiG-29		
KB702	MiG-29	47 Sqn	
KB703	MiG-29	47 Sqn	
KB704	MiG-29		
KB705	MiG-29		
KB706	MiG-29		
KB707	MiG-29	47 Sqn	Star-spangled blue tail surfaces
KB708	MiG-29	47 Sqn	
KB709	MiG-29	28 Sqn?	
KB710	MiG-29		
KB711	MiG-29	47 Sqn	Red/white striped vertical tails
KB712	MiG-29		
KB713	MiG-29	28 Sqn	Red/orange/white tail surfaces
KB714	MiG-29		
KB715	MiG-29	28 Sqn	Grey overall
KB716	MiG-29	47 Sqn	
KB717	MiG-29		
KB718	MiG-29	28 Sqn	
KB719	MiG-29	28 Sqn	
KB720	MiG-29	28 Sqn	Red/yellow tail surfaces
KB721	MiG-29	28 Sqn	
KB722	MiG-29	28 Sqn	Dark green/white tails; named *Foxhound*
KB723	MiG-29		
KB724	MiG-29	28 Sqn	
KB725	MiG-29		
KB726	MiG-29	28 Sqn	

Indian pilots praised the MiG-29, especially the final ten aircraft delivered in 1995 or 1996. These fighters had increased airframe and engine life, improved armament and an upgraded fire control radar which could track ten targets at a time while guiding missiles to two priority threats.

The IAF has a habit of giving indigenous names to aircraft it operates – even those that already have a popular name. For example, the Aérospatiale SA 316B Alouette III utility helicopter was built under licence in Bangalore as the HAL Chetak; the MiG-27 was called Bahadur ('Valiant' in Hindi) and the Ilyushin IL-76MD transport was named Gajraj (King Elephant). The MiG-29 is known locally as the Baaz (Eagle).

India also discussed the possibility of ordering the MiG-29M (which never materialised for obvious reasons) and retrofitting existing aircraft with in-flight refuelling probes. General Designer Rostislav A. Belyakov told the engineers to make the probe non-retractable and install it on the starboard side, as is customary in the West, rather than on the port side, as on

Soviet aircraft. A mock-up of the fixed probe installation was actually built, but a contract was never signed and the idea was abandoned.

Over the years the IAF lost at least four MiG-29s in accidents. Two aircraft crashed after a mid-air collision in 1994. The IAF never acknowledged the fact of the collision, stating to MAPO MiG that one of the fighters 'lost a fin in mid-air'. This was tantamount to an accusation of defective workmanship. However, the Mikoyan experts who analysed the flight data recorder (FDR) readouts proved this was not so. The FDR showed unambiguously that the fighter was pulling 0.8 Gs immediately before the fin disintegrated; then the G force abruptly increased to 2.0 and then fell back to 0.8 one-tenth of a second later. The side force likewise increased abruptly from 4 to 8 Gs, going back to 4 Gs immediately afterwards. This cannot be achieved by applying full throttle or making a sharp manoeuvre; the only possible explanation was that the fighter had been hit by another aircraft. Still, the Indians stuck rigidly to their 'structural failure' story. Perhaps they were simply too ashamed to admit the crash had been caused by pilot error, India's appalling flight safety statistics being the way they are.

The latest crash was at Poona AB on 21st January 1997. The base commander was making a training sortie in one of the single-seaters (KB738) when an engine fire warning lamp lit up. The pilot headed back to base for an emergency landing but the aircraft overran, killing the pilot.

MAPO MiG proposed upgrading the Indian Air Force's *Fulcrum-A* fleet to MiG-29SM configuration. This upgrade would facilitate the use of electro-optically guided weapons and two-target engagements using active air-to-air missiles. Not to be outdone, HAL developed its own upgrade. On 5th January 2000 Chairman of the Board of Directors Dr C. G. Krishnadas Nair announced that HAL was proposing a set of measures aimed at enhancing the performance, flight safety and operational reliability of the MiG-21, MiG-27ML and MiG-29.

The **Indian Naval Aviation**, which has not operated Soviet/Russian fighters until now, reached agreement with the Russian government in January 2004 over a US$ 700 million contract for 16 MiG-29K/KUB shipboard fighters to equip the recently acquired aircraft carrier INS *Vikramaditya*. The Indian Navy will receive 12 single-seat MiG-29Ks and four two-seat MiG-29KUBs by 2008, and has options on a further 30 aircraft to be delivered before 2015.

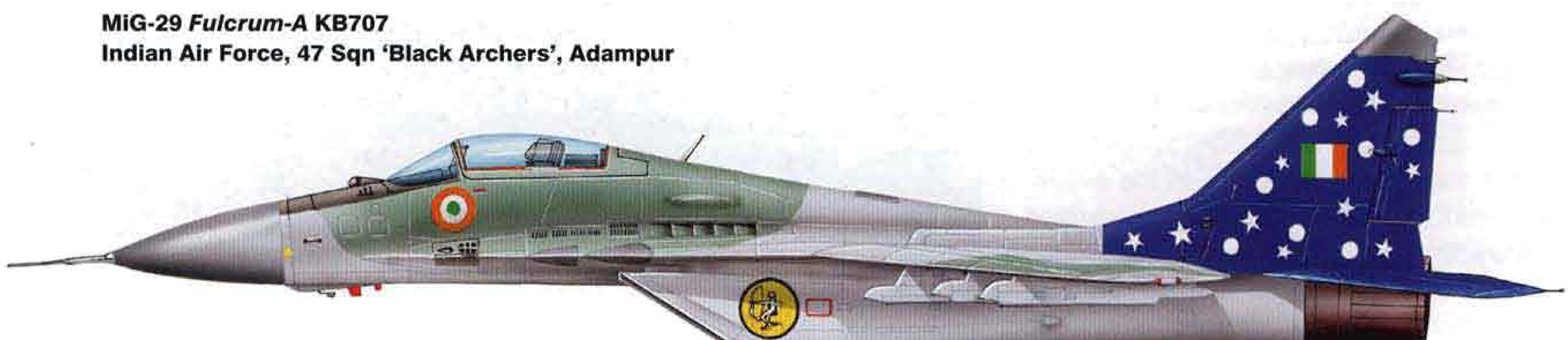
KB727	MiG-29		
KB728	MiG-29	28 Sqn	
KB729	MiG-29	28 Sqn	
KB730	MiG-29	28 Sqn	
KB731	MiG-29		
KB732	MiG-29		
KB733	MiG-29		
KB734	MiG-29		
KB735	MiG-29	47 Sqn	
KB736	MiG-29	28 Sqn	
KB737	MiG-29		
KB738	MiG-29	47 Sqn?	Crashed 21-1-97
KB739	MiG-29	223 Sqn	
KB740	MiG-29		
KB741	MiG-29		
KB742	MiG-29	47 Sqn	
KB744	MiG-29		Red 'war game' markings; based (?) Lohegaon AB
KB3107	MiG-29	223 Sqn	
KB3108	MiG-29	28 Sqn	
KB3109	MiG-29	28 Sqn	
KB3110	MiG-29		
KB3111	MiG-29		Grey overall
KB3112	MiG-29		
KB3113	MiG-29		
KB3114	MiG-29		
KB3115	MiG-29		
KB3116	MiG-29		
KB3117	MiG-29		
KB3118	MiG-29		
KB3119	MiG-29		
KB3120	MiG-29	28 Sqn	
KB3121	MiG-29		
KB3122	MiG-29		
KB3123	MiG-29		
KB3124	MiG-29		
KB3125	MiG-29		
KB3126	MiG-29	223 Sqn	Crashed 11-4-02
KB3297	MiG-29	28 Sqn	
KB3298	MiG-29	28 Sqn	
KB3299	MiG-29	28 Sqn	
KB3300	MiG-29	28 Sqn	
KB3301	MiG-29	28 Sqn	
KB3302	MiG-29	28 Sqn	
KB3303	MiG-29	28 Sqn	
KB3304	MiG-29	28 Sqn	
KS901	MiG-29UB	28 Sqn	
KS902	MiG-29UB	28 Sqn	
KS903	MiG-29UB	28 Sqn	
KS904	MiG-29UB	28 Sqn	
KS905	MiG-29UB	47 Sqn	
KS906	MiG-29UB		
KS907	MiG-29UB		
KS908	MiG-29UB		
KS3305	MiG-29UB	28 Sqn	

MiG-29 KB703 painted in standard two-tone grey camouflage wears the badge of 28 Sqn 'Black Archers'.

World Air Power Journal

MiG-29 *Fulcrum-A* KB711
Indian Air Force, 47 Sqn 'Black Archers', Adampur

MiG-29 *Fulcrum-A* KB707
Indian Air Force, 47 Sqn 'Black Archers', Adampur



MiG-29 *Fulcrum-A* KB703
Indian Air Force, 47 Sqn 'Black Archers', Adampur

MiG-29 *Fulcrum-A* KB713
Indian Air Force, 28 Sqn 'First Supersonics', Leh

Iran

When the bloody eight-year war with Iraq ended in 1988, Iran decided to follow the example of its warlike neighbour and order the MiG-29; a contract for the delivery of 20 MiG-29s (*izdeliye* 9.12B standard) and four MiG-29UBs was signed on 25th November 1989. The **Islamic Republic of Iran Air Force** (IRIAF; formerly IIAF – Imperial Iranian Air Force, *Nirou Havai Shahanshahiye Iran*) took delivery of the first batch of *Fulcrums* in 1988 after President Hashemi Rafsanjani had paid a visit to Moscow. The aircraft were declared operational with the 11th Tactical Fighter Squadron at Tehran-Mehrabad airport, which is also a major air force base (TAB1), on 7th October 1990. The type is also operated by the 23rd TFS at Tabriz (TAB2).

Air Forces Monthly

◄ **Two Islamic Republic of Iran Air Force MiG-29s (3-6111 and 3-6115) pass over an ancient fortress in Iran. 3-6111 apparently carries live R-27R1 and R-60MK missiles, while the other aircraft has the dummy versions.** ▼

Air Forces Monthly

Air Forces Monthly

MiG-29 3-6103 and M iG-23UB 3-6305 in formation flight. IRIAF *Fulcrums* wear a variety of camouflage schemes featuring a pale shade of blue.

MiG-23UB 3-6306 on display at an arms exhibition in Iran.

via Simon Watson

One aircraft crashed on the delivery flight when the Soviet pilot lost his way, ejecting when the aircraft ran out of fuel. Another Iranian *Fulcrum* crashed fatally when the pilot became disorientated at low altitude. The IRIAF tried to blame the crash on a mechanical failure but MAPO MiG experts proved the aircraft was OK; the cause was obviously controlled flight into terrain – or, more plainly, pilot error. In 1992 Iran placed another order for 48 MiG-29s (40 single-seaters and eight trainers) but Russian President Boris N. Yeltsin blocked the deal when the USA put pressure on Russia, threatening to impose sanctions. Yet a single MiG-29 was delivered after all as an attrition replacement.

According to RSK MiG, Iran also retained nine ex-Iraqi MiG-29s which were flown to Iran during the Gulf War to escape destruction. The aircraft are painted in a desert camouflage scheme. IRIAF examples identified so far are *Fulcrum-As* serialled 3-6103 (23 TFS), 3-6105, 3-6107, 3-6111, 3-6114, 3-6115 and 3-6117, plus MiG-29UBs 3-6302, 3-6305 (23 TFS) and 3-6306; the intervening serials starting from 3-6101 and 3-6301 respectively were probably used as well.

On 1st-10th February 1996 the IRIAF staged an unprecedented display of its aircraft at Mehrabad International airport. The static park included one of the single-seat MiG-29s. 3-6114 was on display at a similar event in 2003.

In the mid-1990s the Iranians started upgrading the MiG-29 on their own. Project *Talle* added fixed IFR probes, and new retractable probes are to be fitted eventually. Project *Khorsheed* saw the development of indigenous 1,000- and 1,200-litre (220 and 264 Imp gal) external tanks.

Iraq

Iraq was the second Middle Eastern state to express an interest in the MiG-29, ordering 42 of the type – 36 single-seaters (*izdeliye* 9.12B standard) and six MiG-29UBs – in 1987. The first 18 (some sources say 25) aircraft were delivered to the **Iraqi Air Force** (*al Quwwat al-Jawwiya al-Iraqiya*) late that year. The Iraqi *Fulcrums* were used in the air defence role, operating from the bases at Al Habbaniya (No.6 Sqn) and Tammuz.

Unconfirmed reports state that 35 *Fulcrum-As* and six *Fulcrum-Bs* were on strength as of August 1990, one aircraft having been struck off charge. Four single-seaters serialled 29056 and 29059 through 29061 have been identified so far

MiG-29UB 3-6305
Islamic Republic of Iran Air Force, 23 Tactical Fighter Sqn, Tabriz

(29060 was on display at Baghdad-Saddam Hussein International airport in early 1990). The first 18 aircraft reportedly wore desert camouflage; the rest, including 29060, were delivered in standard Soviet two-tone grey camouflage.

Iraqi *Fulcrums* were used operationally in the Gulf War that followed Iraq's invasion of Kuwait on 2nd August 1990. It is thought that they were controlled and directed by the three AWACS derivatives of the IL-76MD named *Baghdad-1*, *Adnan-1* and *Adnan-2* which operated from Baghdad-Saddam Hussein International airport.

Five aircraft were reportedly shot down in dogfights by USAF F-15s and US Navy F/A-18s during Operation Desert Storm which began in February 1991 (ANPK MiG confirms two aircraft shot down at long range) and another eight were destroyed on the ground. Allied pilots reported an incident in the opening stage of the war when an Iraqi MiG-29 flight leader accidentally shot down his wingman, then became disoriented and crashed into the desert.

When Saddam Hussein realised he was losing the war, seven MiG-29s, along with many other Iraqi Air Force aircraft, were reportedly flown to neighbouring Iran (with which Iraq had conveniently entered a truce in 1988) to save them from being destroyed. This was logical enough, since Iraqi fighter pilots were no match for the Allied pilots. Some sources say only four aircraft reached their destination, the other three crashing en route. Anyway, in Iran the aircraft and pilots were interned; subsequently Iran took possession of the *Fulcrums* by way of reparations for damage done during the Iran-Iraq War. Still, some Western observers believed that if Iraq had actively used its MiG-29 fleet in the war it would have complicated things for the Allies a good deal and caused heavy losses of Allied aircraft.

One of the MiG-29s that survived the Gulf War was shot down by a USAF F-15C in 1993; another example was lost under unknown circumstances in 1995. Due to the lack of spares eight of the remaining 18 MiG-29s (including one MiG-29UB) were mothballed; the other ten continued in service until 1999 or 2000.

Israel

In April 1997 the **Israeli Defence Force/Air Force** (*Tsvah Haganah le Israel – Heyl Ha'Avir*) loaned two MiG-29s from the Polish Air Force for two weeks for evaluation. These included *Fulcrum-A* '105 Red' (c/n 2960535105, f/n 4414).

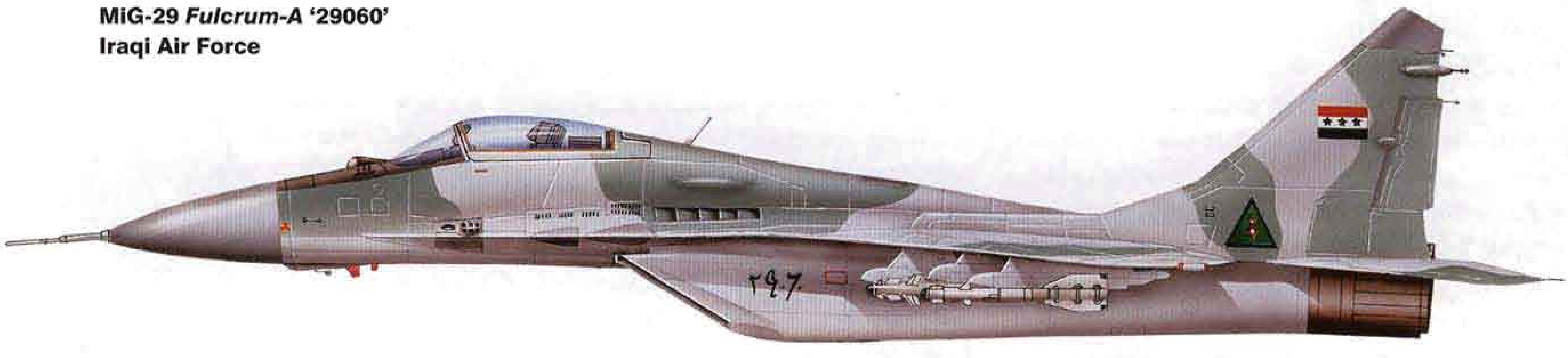
The trials took place at Sedom airbase in the Negev Desert, southern Israel. The two units

via RART

An Iraqi Air Force MiG-29 serialled 29060 at a military hardware display at Baghdad-Saddam Hussein International airport in 1990.

via RART

Fulcrum-A 29060 takes off. Some Iraqi MiG-29s had desert camouflage; others, including this one, were delivered in the standard grey scheme.



MiG-29 *Fulcrum-A* '29060'
Iraqi Air Force

conducting the trials were No.601 Sqn (the IDF/AF Flight Test Centre) and No.253 'Negev' Sqn operating the F-16A/B Fighting Falcon (called Netz by the Israelis). No.601 Sqn examined the MiG-29's systems and explored its flight envelope, while No.253 Sqn was responsible for DACT evaluation. The aircraft retained the standard two-tone grey camouflage with the Polish 'chequerboard' insignia and the unit badge of the 1st Fighter Regiment (1.PLM) painted over in a lighter shade of grey; the red/white badge of No.253 Sqn was carried on the fins but the IDF/AF roundels were not applied.

The tests posed a fair share of problems at the preparatory stage. All the technical manuals had to be translated into Hebrew and the warning lights and critical switches in the cockpit provided with Hebrew-worded labels; the messages issued by the audio warning system could not be translated, of course. After a session of lead-in training, each of the Israeli pilots involved flew 20 DACT sorties in the MiG-29 against the McDonnell Douglas F-4E (known locally as the Kurnass), the F-15A/B (known locally as the Baz) and the F-16A/B. The Israeli pilots rated the *Fulcrum* as excellent and a dangerous opponent in a dogfight; the Shchel'-1UM helmet-mounted sight proved to be on a par with the ones developed in Israel for the F-16C Barak/F-16D Brakeet and the F-15.

An Israeli military spokesman has been quoted as saying that the IDF/AF was not planning to buy the type; the objective of the evaluation was to consider upgrade possibilities for Israel Aircraft Industries (IAI). Elbit Electronics, a division of IAI, had some experience with Soviet/CIS aircraft by then, having successfully upgraded the MiG-21MF *Fishbed-J* for Romania (known as the Lancer in upgraded form) and the Antonov An-72P *Coaler-C* border patrol aircraft. However, the real objective was to develop anti-*Fulcrum* tactics in case Israel would find itself at war with any of the Arab nations operating the type. As a result, the IDF/AF fielded new models of helmet-mounted sights which, together with the Rafael Python 4 and AIM-120 AMRAAM missiles, would enable Israeli pilots to emerge victorious from dogfights with the latest Russian fighters.

Israeli experts believe that the MiG-29 is at least as good as – and in some respects better than – the F-15 and F-16 as far as aerodynamics and performance are concerned; they are also

Scale Aircraft Modeling

▶ **MiG-29 '105 Red' was loaned by the IDF/AF from the Polish Air Force in 1997. Note the badge of the No.253 'Negev' Sqn on the fin and the overpainted Polish AF insignia below it.**

impressed by its rugged design and low maintenance requirements. The avionics suite, on the other hand, is less capable than that of Western fighters. IAI is said to be discussing possible upgrade programmes with many MiG-29 operators, including Poland, Romania, Slovakia and the Ukraine.

There have also been unconfirmed reports that in 1990 the IDF/AF took possession of a Syrian Air Force MiG-29 whose pilot defected to Israel.

Malaysia

On 7th June 1994 Russia and Malaysia signed a US$ 560 million contract for the delivery of 16 single-seat MiG-29s and two MiG-29UB trainers to the **Royal Malaysian Air Force** (RMAF, or TUDM – *Tentera Udara Diraja Malaysia*). The contract stated that the aircraft were to be delivered with a higher gross weight (increased ordnance load) and more capable avionics, including radar; after delivery the single-seaters were to be retrofitted with refuelling probes. These aircraft are referred to by the unofficial designations MiG-29N and MiG-29NUB.

The Malaysian *Fulcrums* were not purpose-built under the contract; they were, to use a commercial aviation term, 'white-tails' – aircraft not ordered by any customer and placed in storage fresh off the production line. For years these fighters, manufactured in 1988-1990, had been languishing at Lookhovitsy-Tret'yakovo, unclaimed and unpaid for by the Soviet (and since Russian) Air Force. Thus there was no need to wait for the aircraft to be built and the deliveries were made on schedule.

The fighters were airlifted to Langkawi airbase near Kuala Lumpur by Russian Air Force An-124 Ruslan (*Condor*) strategic freighters. After reassembly the MiG-29s entered service with 17 Skn (*Skuadron* – Squadron) 'Typhoons' and 19 Skn 'Cobra', both based at Kuantan AB (aka Ahmed Shah AB) and belonging to the 1st Air Division headquartered in Kuala Lumpur.

Victor Drushlyakov

◄ **M43-03 and M43-04, the first two single-seat MiG-29s for the Royal Malaysian Air Force, are readied for loading into a Russian Air Force An-124 Ruslan heavy transport for delivery to Malaysia. Note the low-visibility insignia.**

Victor Drushlyakov

◄ **MiG-29 M43-14 is pictured at Lookhovitsy-Tret'yakovo in company with one of MAPO's MiG-29 demonstrators. The XIX on the dielectric fin caps denotes the RMAF's 19th Squadron.**

MiG-29N M43-09 (c/n 2960536596, f/n 5305)
Royal Malaysian Air Force, 19 Skn 'Cobra', Kuantan AB


Yefim Gordon archive

▶ **Royal Malaysian Air Force MiG-29N M43-13 displays the squadron badge of 19 Skn 'Cobra' replacing the original lightning bolt.**

In the spring of 1996 the MiG-29s participated in the RMAF exercise *Jagukh* (a kind of Malay knife?), earning high praise from military experts. On 22nd-30th June 1996 MiG-29N M43-05 was displayed at an airshow at Soekarno-Hatta International airport, Jakarta, Indonesia.

Royal Malaysian Air Force MiG-29s

Serial	Version	C/n	F/n	Notes
M43-01	MiG-29NUB	?	5212	19 Skn
M43-02	MiG-29NUB	?	5213	17 Skn
M43-03	MiG-29N	2960536587	5214	17 Skn
M43-04	MiG-29N	2960536590	5215	17 Skn
M43-05	MiG-29N	2960536591	5301	17 Skn
M43-06	MiG-29N	2960536592	5302	17 Skn
M43-07	MiG-29N	2960536593	5303	19 Skn
M43-08	MiG-29N	296053659...	5304	19 Skn
M43-09	MiG-29N	2960536596	5305	19 Skn
M43-10	MiG-29N	2960536598	5306	19 Skn
M43-11	MiG-29N	2960536599	5307	17 Skn
M43-12	MiG-29N	2960538310	5308	19 Skn
M43-13	MiG-29N	2960538311	5309	19 Skn
M43-14	MiG-29N	2960538312	5310	17 Skn
M43-15	MiG-29N	2960538313?	5311	17 Skn
M43-16	MiG-29N	2960538314	5312	19 Skn
M43-17	MiG-29N	?	?	Crashed 3-9-98
M43-18	MiG-29N	2960538317	531...	19 Skn

On 12th-30th April 1997 the *Flying Fish '97* exercise was staged in the South China Sea by the navies and air forces of the UK, Australia, New Zealand, Singapore and Malaysia. This was the largest single exercise in the history of the SEATO military block, involving more than 12,000 men and officers, 39 warships and 164 aircraft, including RMAF MiG-29s and Northrop F-5E Tigers. The scenario of the exercise was joint action by the five states to repel an attack on Malaysia and Singapore, including concerted action by various aircraft types and in-flight refuelling. Observers at the exercise were particularly impressed by the MiG-29's performance. RMAF pilots and technical staff were quite pleased with the fighter's performance, handling and serviceability, stating that the aircraft had fulfilled its objectives completely.

14 of the RMAF's 16 *Fulcrum-As* were ready for action at the time of the exercise. At the debriefing the commanders of the two RMAF operating the MiGs thanked the Russian specialists from VPK MAPO who provided support and maintenance during the exercise.

Long-standing plans to upgrade the MiG-29N fleet resulted in a requirement for a 'glass cockpit' and avionics upgrade for the fleet

via Internet

▲
Myanmar Air Force MiG-29 '2702' taxies at Rangoon displaying a blue camouflage scheme similar to that of MAPO's MiG-29S '999 Silver'. Note the 'Danger, ejection seat' sign below the cockpit.

formulated in 2003. This gives greater commonality within the RMAF fighter fleets in light of the order for 18 Su-30MKM multi-role fighters announced in May 2003.

Myanmar

The **Myanmar Air Force** (*Tamdaw Lay*) started negotiating the purchase of an unspecified number of MiG-29s back in 1996. An order was eventually placed in 2001 for what was variously reported as ten (eight *Fulcrum-As* and two MiG-29UBs) or 12 aircraft. Deliveries were completed by 15th March 2003.

The aircraft are in service with a single squadron based at Shante AB near Meiktila. Three aircraft – *Fulcrum-As* serialled 2701 and 2702 and a *Fulcrum-C* serialled 2709 – have been identified so far.

Nigeria

The **Federal Nigerian Air Force** (FNAF) reportedly started negotiating the purchase of MiG-29s in 1999, eventually ordering five single-seaters (*izdeliye* 9.12B standard) and one MiG-29UB in 2001.

North Korea
(Korean People's Democratic Republic)

North Korea became the second Asian country to order the MiG-29. The type was purchased in response to the threat posed by South Korea's new F-16C/Ds.

The **Korean People's Army Air Force** (KPAAF) is unique among foreign MiG-29 operators in two respects. Firstly, North Korea is the only country to have purchased a manufacturing licence for the type; secondly, it was the only country outside the Soviet Union/CIS to buy brand-new *Fulcrum-Cs*. Six were delivered as SKD kits and assembled on site, augmenting the 20 *izdeliye* 9.12Bs and four MiG-29UBs. Unlike Soviet Air Force *Fulcrum-Cs*, the North Korean aircraft (referred to in some sources as *izdeliye* 9.13B) do not have the L203B (Gardeniya-1FU)

MiG-29 *Fulcrum-A* 2702, Myanmar Air Force, Shante AB

active jammer. A further ten *Fulcrum-As* and two MiG-29UBs were ordered in 1999.

The first fighters were assembled in May-June 1988 and delivery of the entire order was completed by the end of the year. The fighters are in service with the 55th Air Regiment of the 1st Air Combat Division at Sunchon AB (some sources say the 57th Fighter Regiment at Onchon) comprising two squadrons.

This poor-quality shot is the only available photo of a North Korean MiG-29 *Fulcrum-C*.

Peru

After losing in a border conflict with Ecuador in 1996 Peru decided to bolster its military power with MiG-29 fighters. Initially the Peruvian government approached Russia on this subject, but then the **Peruvian Air Force** (FAP – *Fuerza Aérea del Peru*) unexpectedly bought sixteen ex-Belorussian MiG-29s – 14 *Fulcrum-Cs* and two MiG-29UBs – together with a supply of R-27, R-60 and R-73 AAMs, S-8 unguided rockets, incendiary bombs and support equipment.

Interestingly, the single-seaters have been reported in the Western press as MiG-29Ss (*izdeliye* 9.13S). It should be noted that the MiG-29S was extremely scarce in the Soviet Air Force, and it seems rather strange that Belorussia should sell the more advanced fighters and retain the less capable ones. Yet, it is just possible that the Peruvians, having learned that Belorussia had the MiG-29S, had put their foot down ('we want the MiG-29S, or the deal is off') – and the Belorussians, who needed money badly, had no choice but to sell the best fighters they had.

Press reports said Peru was to buy twelve aircraft at US$ 11-14 million apiece; however, President Alberto Fujimori speaking on Peruvian television said the quantity and the price was a state secret. Yet there must have been a leak at the top level; it has been reported that the contract was worth about US$ 80 million. If this is true the *Fulcrums* were sold at about US$ 4 million apiece, which is extremely cheap for a fighter in this class, even considering their far-from-perfect condition.

The first four aircraft were delivered soon after the contract was signed. The FAP officially accepted the fighters at Las Palmas AB near Lima on 29th July 1997, which is a national holiday in Peru (Fatherland Day). This was not their home base; the MiG-29s entered service with *Escuadrón de Caza-Bombardero* 612 (612th Fighter-Bomber Squadron) of *Grupo Aéreo* 6 (6th Air Group) and, according to some reports, *Escuadrón de Caza* 611, both stationed at Capitán Jose Abelardo Quinones Gonzales AB in Chiclayo.

However, Belorussia was unable to provide product support (spares, ammunition and so on). The ensuing scandal led President Fujimori to fire his current Minister of Defence; still, surprisingly perhaps, the deal was not cancelled. The FAP now found itself in a tight spot, as Russia (probably annoyed at being bypassed by 'little brother' Belorussia) had warned in advance that it would not service aircraft sold by third parties. Only four of the FAP's MiG-29s remained operational in the autumn of 1997.

Still, when there's a will to resolve the conflict there's a way. In August 1998 the Peruvian government and the Rosvo'oroozheniye arms export agency signed a deal for the delivery of three new MiG-29s 'within seven months'. The contract included product support not only for these three aircraft but also for the 18 ex-Belorussian MiG-29s, which were thus 'legalised'. The deal came as a real breakthrough for MAPO MiG, which had not sold a single new *Fulcrum* since the Malaysian order.

Two Peruvian MiG-29s were lost in accidents. '031' is one; it was lost due to birdstrike during a demonstration flight for the government top brass. The other fighter, which crashed on 2nd December 1997, is '032', '034', '036' or '039'. In both cases the pilots ejected safely.

Poland

The **Polish Air Force** (originally known as PWL – *Polskie Wojsko Lotnicze*) ordered 12 *Fulcrums*, and deliveries began in 1989 after a group of PWL pilots took their training in the Soviet Union the preceding year. The first four single-seat MiG-29s (*izdeliye* 9.12A standard) arrived at Mińsk-Mazowiecki AB near Warsaw in late July, though some sources say June. They were followed by three MiG-29UBs on 1st August 1989 and five more *Fulcrum-As* on 30th October 1990.

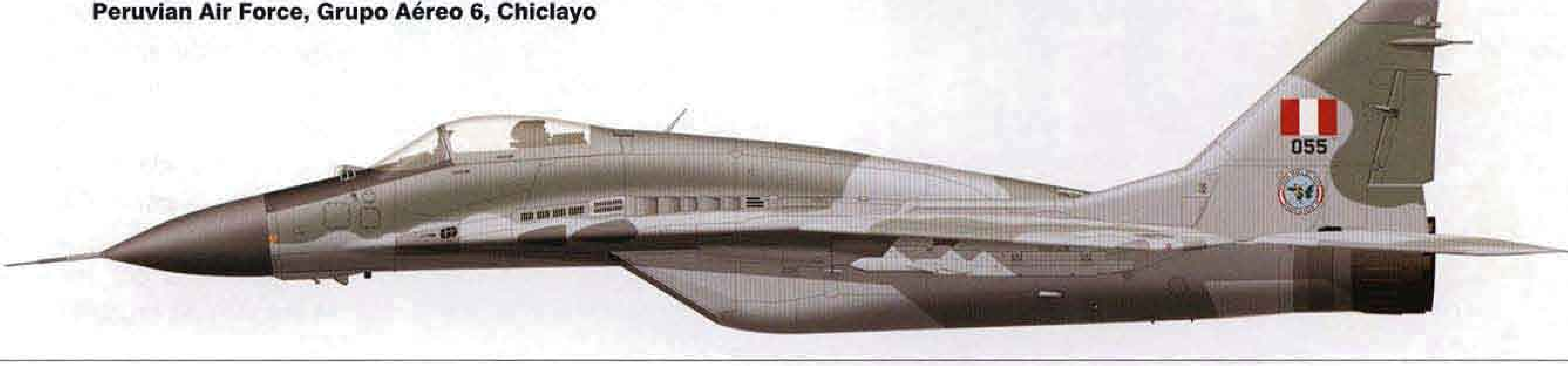
Chris Lofting

▲
The apron at Chiclayo with four of the Peruvian Air Force's *Fulcrum-Cs*; each aircraft is painted differently. Note the 6th Air Group badge on the tails.

Peruvian Air Force MiG-29s				
Serial	**Version**	**C/n**	**F/n**	**Notes**
030	MiG-29 (*izdeliye* 9.13)	2960715535	?	Ex-Belorussian Air Force '04 White'
031	MiG-29 (*izdeliye* 9.13)	2960715161	?	Ex-Belorussian Air Force '15 White'. Crashed 13-1-01.
032	MiG-29 (*izdeliye* 9.13)	?	?	
033	MiG-29 (*izdeliye* 9.13)	?	?	
034	MiG-29 (*izdeliye* 9.13)	?	?	
035	MiG-29 (*izdeliye* 9.13)	?	?	
036	MiG-29 (*izdeliye* 9.13)	?	?	
037	MiG-29 (*izdeliye* 9.13)	?	?	
038	MiG-29 (*izdeliye* 9.13)	?	?	
039	MiG-29 (*izdeliye* 9.13)	?	?	
040	MiG-29 (*izdeliye* 9.13)	?	?	
041	MiG-29 (*izdeliye* 9.13)	?	?	
042	MiG-29 (*izdeliye* 9.13)	2960717900	?	
043	MiG-29 (*izdeliye* 9.13)	2960717913 ?	?	
044	MiG-29 (*izdeliye* 9.13)	?	?	
045	MiG-29 (*izdeliye* 9.13)	2960717946	3427?	Ex-Belorussian AF '32 Red'
046	MiG-29UB	N50903012547	?	Ex-Belorussian AF '63 Red'
047	MiG-29UB	N50903027002	?	
048	MiG-29SE (*izdeliye* 9.13SE)	2960731690	562…	D/D 1999
049	MiG-29SE (*izdeliye* 9.13SE)	2960731693	5626	D/D 1999
055	MiG-29SE (*izdeliye* 9.13SE)	2960731694	5627?	D/D 1999

▲
The badge of the Peruvian Air Force's 6th Air Group.

MiG-29SE *Fulcrum-C* '055' (c/n 2960731694; f/n 5627?)
Peruvian Air Force, Grupo Aéreo 6, Chiclayo



Chris Lofting

Chris Lofting

◀◀
'045', the last of the single-seaters acquired in Belorussia.

The airmen of Grupo Aéreo 6 with one of their aircraft.
▼◀◀

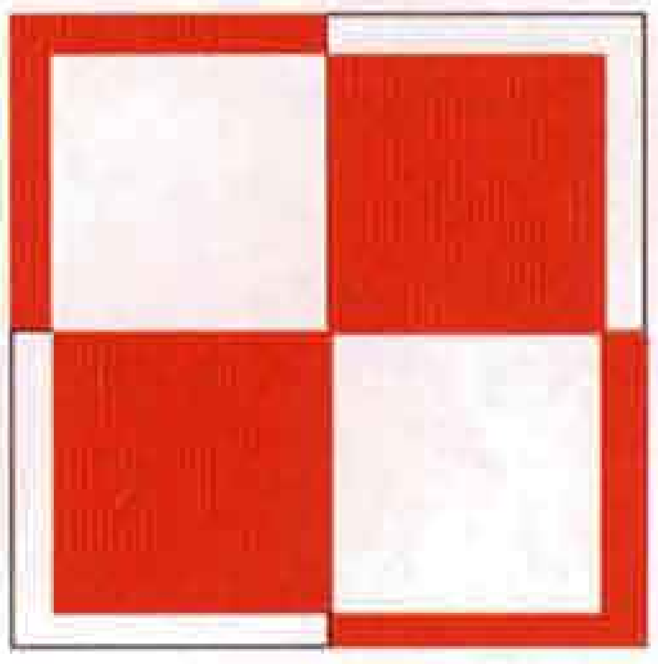
Chris Lofting

The badge worn by Peruvian Air Force MiG-29 pilots.
▼

◀
MiG-29 '037' pulls up into an afterburner climb.

'055' taxies past two sister ships and a UPG-300 ground power unit on a ZiL-131 6x6 chassis.
▼

Chris Lofting



Note: Polish military aircraft of Soviet or local origin usually have four-digit serials tying in with the aircraft's batch number and its number in the batch. For instance, PZL Mielec (Antonov) An-2TD '0851 White' is c/n 1G10851 – that is, the WSK Mielec aircraft factory (code 1), An-2 (product code G), batch 108, 51st aircraft in the batch. With some types, however, including the *Fulcrum*, simply the last two or three digits of the c/n were used as the serial. This is perfectly logical with Western types where production is not split into batches; with the MiG-29 it would be more logical to use the fuselage numbers but these were probably unknown to the Poles.

The aircraft entered service with 1 ELM (*eskadra lotnictwa myśliwskiego* – Fighter Squadron) of 1 PLM 'Warszawa' (Warsaw; PLM = *pułk lotnictwa myśliwskiego* – Fighter Regiment); this unit was traditionally the first to operate new fighter types. 1 PLM is tasked with air defence of the Polish capital; hence Warsaw's city crest (known as *Syrenka* – 'Little Mermaid') was adopted as the unit badge. Its colour varies, denoting the squadron (yellow for Sqn 1, red for Sqn 2 and blue for Sqn 3).

After the dissolution of the Warsaw Pact Poland began pushing for NATO membership. This meant introduction of NATO standards and Poland decided not to buy Russian equipment

Wacław Hołyś

One of the original 12 MiG-29s bought new from the manufacturer taxies at Minsk-Mazowiecki, showing the factory finish.

Wacław Hołyś

Three single-seaters and a MiG-29UB on the flight line display the 'mermaid' unit badge of the 1. PLM 'Warsaawa'.

any more, switching to Western hardware. Thus, the original intention was that the **Polish Air Force & Air Defence Force** (WLiOP – *Wojska Lotnicze i Obrony Powietrznej*), as the former PWL was now called, would gradually phase out the *Fulcrum*; the F-16, F/A-18 and Mirage 2000 were considered as possible replacements. (This was undoubtedly a political decision – partly at least. There have always been tensions between Poland and Russia which go back a long way historically. A Cold War-era survey of the Soviet Union's allies cited East Germany as the best and Poland as the worst: *'the Soviets can never be quite sure which side they would take in a conflict'*.)

Yet, economics outweigh politics: the Polish government realised it could not afford to throw away the Soviet aircraft and re-equip with Western ones – at least immediately. Thus, the Czech Republic's decision to phase out the MiG-29 came as a real (and probably unexpected) gift to the PWL. The ten CzAF aircraft were traded profitably for WSK-Świdnik W-3 Sokół helicopters, bringing the total in PWL service to 22, and Poland was quite happy to strike the deal, NATO membership plans notwithstanding. Thus the *Fulcrum* received a new lease of life.

The contract for the purchase of nine single-seaters and a single MiG-29UB was signed on 20th December 1995 by a civilian Polish-Czech trade company. Still wearing CzAF roundels and serials, the first five ex-Czech aircraft were ferried to Mińsk-Mazowiecki AB by Polish pilots two days later. Another aircraft arrived on 29th December; the remainder were to follow on 8th January 1996 but actually arrived on 16th January.

The Czech MiGs had been in open storage and water had leaked into the systems and equipment, rendering them unserviceable. Hence some electrical components had to be 'borrowed' from the PWL's own MiG-29s and installed on the Czech aircraft for the delivery flight. Nevertheless, the Polish technicians found the aircraft to be in far better condition than they had anticipated; also, they were low-time aircraft as compared to the original PWL machines.

The newly acquired aircraft needed refurbishment but Russia demanded sky-high prices for spares. Therefore it was decided to buy only top-priority components, which *had* to be replaced, and repair the rest in-house. Repair costs were estimated at approximately US$ 2 million per aircraft. When the former Czech MiG-29s entered service, 1 PLM was finally able

Polish Air Force MiG-29s

Serial	Version	C/n	F/n	Unit	Notes
01 Red?	MiG-29G	2960526301	3705		Ex-Luftwaffe 29+16, D/D 30-9-03
02 Red?	MiG-29G	2960526302	3706		Ex-Luftwaffe 29+17, D/D 30-9-03; was '4104 Red' for a while
04 Red?	MiG-29GT	N50903006604	?		Ex-Luftwaffe 29+24, D/D 30-9-03
06 Red?	MiG-29G	2960525106	3412		Ex-Luftwaffe 29+01, D/D 4-8-04
08 Red?	MiG-29G	2960525108	3413		Ex-Luftwaffe 29+02, D/D 14-4-04
14 Red?	MiG-29G	2960525114	3503		Ex-Luftwaffe 29+06, D/D 11-12-03
15 Red	MiG-29UB	N50903014615	?	1.ELT	D/D 1-8-89
18 Red?	MiG-29G	2960525118	3505		Ex-Luftwaffe 29+08, D/D 14-4-04
22 Red	MiG-29G	2960526319	3713		Ex-Luftwaffe 29+21, D/D 4-04
24 Red?	MiG-29G	2960525124	3507		Ex-Luftwaffe 29+10, D/D 4-8-04
28 Red	MiG-29UB	N50903014528	?	1.ELT	Ex-CzAF '4402 Black'. D/D 22-12-95
38 Red	MiG-29	2960532038	4203	1.ELT	Ex-CzAF '3810 Black'. D/D 22-12-95
40 Red	MiG-29	2960532040	4205	1.ELT	Ex-CzAF '4012 Black'. D/D 16-1-96
42 Red	MiG-29UB	N50903014642	?	1.ELT	D/D 1-8-89
48 Red?	MiG-29GT	N50903006448	?		Ex-Luftwaffe 29+22, D/D 11-12-03
54 Red	MiG-29	2960532354	4214	1.ELT	Ex-CzAF '5414 Black'. D/D 16-1-96
56 Red	MiG-29	2960532356	4301	1.ELT	Ex-CzAF '5616 Black'. D/D 16-1-96
59 Red	MiG-29	2960532359	4304?	1.ELT	Ex-CzAF '5918 Black'. D/D 22-12-95
64 Red	MiG-29UB	N50903014664	?	1.ELT	D/D 1-8-89
65 Red	MiG-29	2960526365	3812?	1.ELT	D/D ?-7-89. 'Skrzydlata Polska 65 lat' titles
66 Red	MiG-29	2960526366	3813?	1.ELT	D/D ?-7-89
67 Red *	MiG-29	2960526367	3814?	1.ELT	D/D ?-7-89
70 Red *	MiG-29	2960526370	3815	1.ELT	D/D ?-7-89
77 Red	MiG-29	2960526377	3902?	1.ELT	Ex-CzAF '7702 Black'. D/D 22-12-95
83 Red	MiG-29	2960526383	3904?	1.ELT	Ex-CzAF '8304 Black'. D/D 16-1-96
89 Red *	MiG-29	2960526389	3906?	1.ELT	Ex-CzAF '8906 Black'. D/D 29-12-95
92 Red	MiG-29	2960526392	3907?	1.ELT	Ex-CzAF '9207 Black'. D/D 22-12-95
105 Red *	MiG-29	2960535105	4414	1.ELT	D/D 30-10-90
108 Red *	MiG-29	2960535108	4415	1.ELT	D/D 30-10-90
111 Red *	MiG-29	2960535111	4501	1.ELT	D/D 30-10-90
114 Red *	MiG-29	2960535114	4502	1.ELT	D/D 30-10-90
115 Red *	MiG-29	2960535115	4503	1.ELT	D/D 30-10-90
128 Red?	MiG-29G	2960525128	3508	1.ELT	Ex-Luftwaffe 29+11, D/D 30-9-03
408 Red?	MiG-29GT	N50903011408	?		Ex-Luftwaffe 29+25, D/D 4-8-04
800 Red?	MiG-29G	2960525800	3703		Ex-Luftwaffe 29+14, D/D 14-4-04
300 Red?	MiG-29G	2960526300	3704		Ex-Luftwaffe 29+15, D/D 11-12-03
310 Red?	MiG-29G	2960526310	3710		Ex-Luftwaffe 29+18, D/D 4-8-04
314 Red?	MiG-29G	2960526314	3711		Ex-Luftwaffe 29+19, D/D 11-12-03
315 Red?	MiG-29G	2960526315	3712		Ex-Luftwaffe 29+20, D/D 4-8-04
4111 Red †	MiG-29G	2960525111	3415	41.ELT	Ex-Luftwaffe 29+04, D/D 4-8-04, TOC 7-7-05
4113 Red †	MiG-29G	2960525132	3509	41.ELT	Ex-Luftwaffe 29+12, D/D 4-8-04, TOC 7-7-05
4115 Red †	MiG-29GT	N50903006526	?	41.ELT	Ex-Luftwaffe 29+23, D/D 4-8-04, TOC 7-7-05
4118 Red †	MiG-29G	2960525113	3502	41.ELT	Ex-Luftwaffe 29+05, D/D 4-8-04, TOC 7-7-05
5115 Red?	MiG-29G	2960525115	3504		Ex-Luftwaffe 29+07, D/D 30-9-03

Notes: * '67', '70', '89', '105', '108', '111', '114' and '115' were the first lot to be upgraded to NATO standards by WZL-2.
† Serials of the ex-German MiG-29s commencing 41 do not correlate with the c/ns; 41 is the number of the unit (41.ELT).

to withdraw its last remaining MiG-21*bis* fighters. Originally the fighters retained their dark green/dark earth 'tactical' camouflage but subsequently exchanged it for a pale grey/slate grey scheme.

On 11th September 1994 a group of *Armée de l'Air* Mirage 2000s of EC 01.002 'Cicognes' from Dijon-Longvic made a friendly visit to Mińsk-Mazowiecki. For the occasion MiG-29 '115 Red' was adorned with a large EC 01.002 squadron badge (a flying stork on a blue shield) on the top of the fuselage, while one of the Mirages carried the 1 PLM's *Syrenka* badge across the underside of the wings.

Together with their sister ships from Germany and Hungary, the Polish MiG-29s participated in the *Co-operative Chance '96* exercise held on 20th-25th July 1996 as part of the NATO's Partnership for Peace (PfP) programme. The fighters were guided towards their designated targets by a NATO Airborne Early Warning Force (NAEWF) Boeing E-3C Sentry AWACS aircraft.

In 2004 the Polish Air Force was rebranded again after a reorganisation. The current name is

▲
Ever heard of a *flying* mermaid? Or an *armed* mermaid? The badge of the 1.PLM is both! The letters 'plm' at the bottom are barely recognisable.

Andrzej Rogucki

►
Still in its CzAF tactical camouflage, MiG-29 '77 Red' (ex-'7702 Black') makes an interesting comparison with '89 Red', one of the original Polish machines.

Luftwaffe

▲
The badge of the 41.ELT based at Malbork, the Polish Air Force's second MiG-29 unit, features the tail of the MiG-21, the type previously flown by the unit.

►▲
MiG-29G 29+17 briefly became '4104 Red' but was not delivered to the 41.ELT and was reserialled.

Norbert Czajkowski

►
'4113 Red' (ex-29+12), one of the first ex-Luftwaffe MiG-29Gs to enter Polish service, displays its new dark grey camouflage at its home base, Malbork.

MiG-29 *Fulcrum-A* '115 Red' (c/n 2960535115, f/n 4503)
Polish Air Force, 1.PLM 'Warszawa', Mińsk-Mazowiecki AB
with special markings on occasion of a courtesy visit by EC 01.002
11th September 1994

MiG-29 *Fulcrum-A* '92 Red' (ex-CzAF '9207 Black', c/n 2960526392; f/n 3907?)
Polish Air Force, 11.ELT 'Warszawa', Mińsk-Mazowiecki AB, 2004

Air Force of the Republic of Poland (SPRP – *Sily Powietrzne Rzeczypospolitej Polski*). The former regiments were now called squadrons, in keeping with NATO standards; thus the former 1.PLM became the 1.ELT (*Eskadra Lotnictwa Taktycznego* – Tactical Air Squadron).

Another windfall of *Fulcrums* came in 2003 when the affluent Luftwaffe, which was introducing the Eurofighter Typhoon, offered its MiG-29s to Poland free of charge. Thus, 17 MiG-29Gs and four MiG-29GTs were transferred to the Polish Air Force between September 2003 and August 2004 for a nominal payment of 1 euro made on 24th June. After a minor overhaul at the WZL-2 overhaul facility in Bydgoszcz the ex-German fighters entered service on 7th June 2005 with a different unit, the 41.ELT at Malbork (22. *Baza Lotnicza*). This unit, which is part of the 1.BLT (*Brygada Lotnictwa Taktycznego* – Tactical Air Brigade), was established on 1st January 2001 as the successor of the disbanded 41.PLM. Like the ex-Czech machines, the MiG-29G/GTs wear a new pale grey/slate grey camouflage which follows no set standard – each aircraft has an individual pattern. The 41.ELT is to receive 14 *Fulcrums* by 2007.

It is anticipated that only 14 or 16 of the 22 ex-Luftwaffe aircraft will enter service with the SPRP, the others being cannibalised for spares. It has been agreed with RSK MiG that the aircraft will be operated in terms of their technical condition. Agreements have been signed with RSK MiG to determine the scale of overhaul work and the required spares/support package.

The Polish MiG-29 fleet has undergone an upgrade at WZL-2. This included ICAO Cat II blind landing capability, a GPS receiver, 'wet' wing pylons for underwing fuel tanks, an airframe TBO extended from 800 flying hours (or 9 years) to 1,300 hours (or 15 years) and extended engine TBO. The upgraded Polish aircraft have a new F-16A (ADF)-type SB-14 IFF antenna ahead of the windscreen and a new, darker two-tone grey camouflage.

At the end of 2003 RSK MiG held negotiations with the Polish Air Force, offering to supply new-build MiG-29s in a trade-in arrangement against at least 50 MiG-21*bis* fighters and MiG-21UM trainers phased out by the WLiOP. However, it is highly unlikely that Poland, as a NATO member, will purchase any more new Russian hardware.

Romania

In 1989 a group of **Romanian Air Force** (*Forţele Aeriene Române*) pilots completed their conversion training at the Kiev Air Force Academy. In November-December they ferried their new mounts – ten single-seat MiG-29s (*izdeliye* 9.12A standard) and two MiG-29UBs – to Mihail Kogălniceanu airbase near Constanţa, home of *Grupul 57 Aviaţie Vânătoare* (57th Fighter Group). Later deliveries brought the total up to about 30 aircraft. Later the unit moved to Giarmata AB near Timişoara while reconstruction work was in progress at Mihail Kogălniceanu AB but subsequently returned to Constanţa.

The final aircraft ordered by Romania arrived only a few days before the 1989 revolution which ended the rule of the Romanian dictator Nicolae Ceauşescu. Since the unit was not yet fully operational it did not participate in the fighting between regular army units, which supported the revolution, and the infamous secret service, Securitate, which remained loyal to Ceauşescu.

Two aircraft were lost in a mid-air collision in 1990 while practising for an aerobatics display at Baneasa AB near Bucharest, killing both pilots and a ground crewman. Another aircraft, a MiG-29UB, crashed after making a barrel roll at low altitude, killing the pilot. The cause was probably *G-loc*, as the Romanian pilot was trying to repeat a high-G manoeuvre demonstrated by

► **Romanian Air Force MiG-29 '75 Red' shares the hardstand at Mihail Kogălniceanu AB with an Aero L-29 Delfin advanced trainer.**

Guido Buehlmann

via Internet

◄ **'53 Red', the Romanian Air Force's sole *Fulcrum-C*. Traces of the Soviet red star are discernible underneath the roundel.**

a MAPO MiG test pilot – without wearing a G suit. A single *Fulcrum-C* (the only one in the fleet) was purchased from neighbouring Moldova as an attrition replacement.

In 2001 the Romanian Air Force underwent a reorganisation; the *Grupul* designation was dropped and the various Groups were organisationally united with the airfields from which they operated, becoming Air Bases. Thus, Mihail Kogălniceanu AB and the former *Grupul* 57 became *Baza Aeriana* 57.

The Romanian Air Force had planned to upgrade its 18 remaining MiG-29s to 'Sniper' standard with the assistance of Israel Aircraft Industries. However, integration problems reportedly arose during the trials of the MiG-29 Sniper demonstrator. Then, in March 2003 the Romanian Air Force grounded its entire MiG-29 fleet, scrapping any upgrade plans. The base was closed in April 2004 and the *Fulcrums* are now in storage, pending sale.

Slovakia

Unlike the Czech Republic, Slovakia still regarded Russia as a prime trade partner and military ally. Therefore the Slovak Air Force (*Slovenské Vojenské Létectvo*) retained the nine *Fulcrum-As* and single MiG-29UB received after the division of Czechoslovakia. In the autumn of 1992 they were flown to their new base at Šliač, home of the SVL's 1st Fighter Regiment (1. SLP).

Romanian Air Force MiG-29s

Serial	Version	C/n	F/n	Notes
'15 Red'	MiG-29UB	N50903016215	?	Stored Constanța
'22 Red'	MiG-29UB	N50903016222	?	Damaged ?-02, stored Bacău
'23 Red'	MiG-29UB	N50903016223	?	Stored Constanța
'27 Red'	MiG-29UB	N50903016227?	?	Fate unknown
'29 Red'	MiG-29UB	N50903016229	?	Crashed 6-7-92
'33 Red'	MiG-29 (*izdeliye* 9.12A)	2960535133	4511	Stored Constanța
'35 Red'	MiG-29 (*izdeliye* 9.12A)	2960536075	4911	C/n previously reported in error as 2960531035. Stored Constanța
'38 Red'	MiG-29 (*izdeliye* 9.12A)	2960535138	4512	C/n previously reported in error as 2960531538. Stored Constanța
'41 Red'	MiG-29 (*izdeliye* 9.12A)	2960532041	4206	Crashed 1-3-94
'46 Red'	MiG-29 (*izdeliye* 9.12A)	2960532046	4207	Stored Constanța
'47 Red'	MiG-29 (*izdeliye* 9.12A)	2960532047	4208	Crashed 9-9-91
'48 Red'	MiG-29 (*izdeliye* 9.12A)	2960532048	4209	Stored Bacău
'49 Red'	MiG-29 (*izdeliye* 9.12A)	2960532049	4210	Stored Constanța
'50 Red'	MiG-29 (*izdeliye* 9.12A)	2960532350	4211	Stored Constanța
'53 Red'	MiG-29 (*izdeliye* 9.13)	2960717453	3126	Ex-Moldovan Air Force '01 Red'. C/n also reported as 2960721943, possibly read off pylons coming from another aircraft! Stored Constanța
'54 Red'	MiG-29 (*izdeliye* 9.12A)	2960535404	4712	Sold to China (CFTE)
'67 Red'	MiG-29 (*izdeliye* 9.12A)	2960532367	4305	Transferred to Aerostar S.A. and converted as, see next line
'67 White'	MiG-29 Sniper			Stored Bacău
'68 Red'	MiG-29 (*izdeliye* 9.12A)	2960532368	4306	Stored Constanța
'69 Red'	MiG-29 (*izdeliye* 9.12A)	2960532369	4307	Stored Constanța
'70 Red'	MiG-29 (*izdeliye* 9.12A)	2960532370	4308	Stored Constanța
'75 Red'	MiG-29 (*izdeliye* 9.12A)	2960532375	4309	Stored Constanța
'76 Red'	MiG-29 (*izdeliye* 9.12A)	2960532376	4310	Stored Constanța

MiG-29 *Fulcrum-A* '49 Red' (c/n 2960532049, f/n 4210)
Romanian Air Force, Grupul 57, Mihail Kogălniceanu AB

Later, the Slovakian air arm was reorganised as the *Armady Slovenskej Republiky/Velitelstvo Vzdušnych Sil* (Slovak Republic Armed Forces/ Air Force Command). The base at Šliač was designated 1. LZ (*Letecká Zàkladna* – Air Base), while the 1 SLP became the 31. SLK (*Stihaci Letecké Křidlo* – Fighter Wing) on 1st January 1995. The MiG-29s were on strength with the unit's 1st Squadron, the 2nd Squadron operating Aero L-39ZA and L-39C combat trainers. The 31 SLK also included a communications squadron operating Let L-410 feederliners and Mil' Mi-17 helicopters and a search and rescue (SAR) detachment with more Mi-17s.

The original MiG-29UB inherited from the CzAF crashed in March 1994 (unconfirmed reports state that the crash was caused by uncontained failure of the engine accessory gearbox and ensuing engine failure). However, in December 1993 Slovakia took delivery of five single-seat *Fulcrum-As* and a single MiG-29UB (1303 Black); the latter became the personal 'hack' of Slovak Air Force C-in-C Gen. Stefán Gombik. Eight more single-seaters featuring 'wet' wing pylons and modified avionics were supplied by Russia in 1995-96 as foreign debt payments, bringing total deliveries to 24.

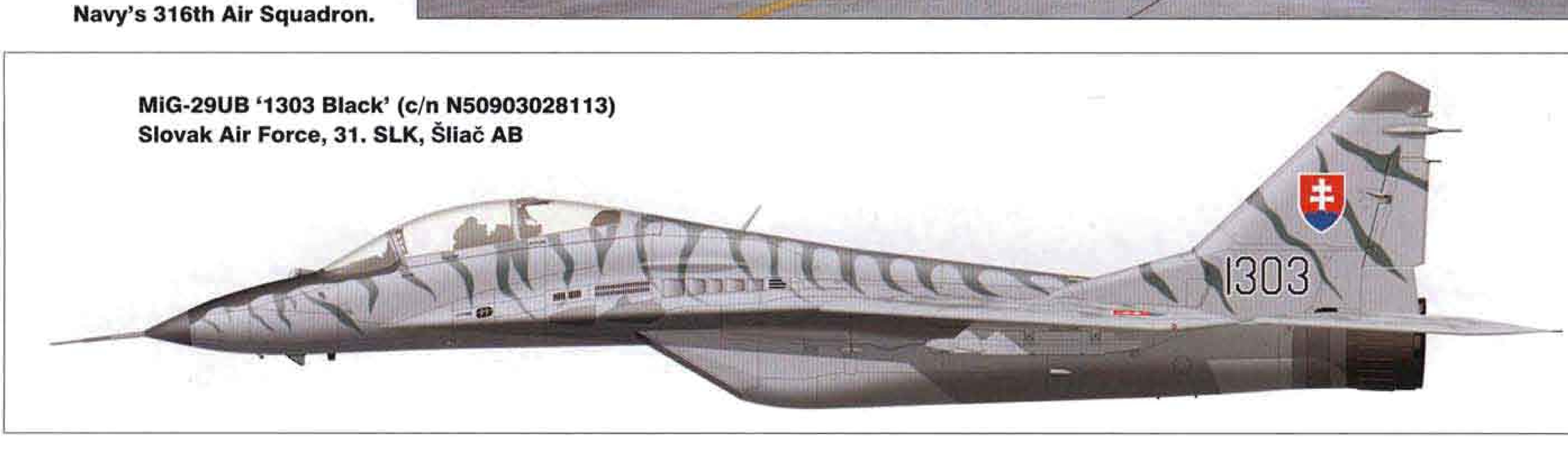
Slovak MiG-29s became regular participants of various airshows at home and abroad. For example, MiG-29 '7501 Black' performed at České Budějovice on Aviation Day (17th June 1994) wearing Slovakia's national colours (white, blue and red) on the nose, air intakes, fins and wings. Aircraft performing at RAF Mildenhall on

▶ **Tiger-striped MiG-29UB '1303 Black' was the mount of Slovak Air Force C-in-C Gen. Stefán Gombik.**

via RART

▶ **Slovak Air Force MiG-29 '7501 Black' received this special colour scheme for an airshow performance in 1993. Note the badge on the air intake marking the 50th anniversary of the Royal Navy's 316th Air Squadron.**

via RART



MiG-29UB '1303 Black' (c/n N50903028113)
Slovak Air Force, 31. SLK, Šliač AB

25th-26th May 1996 included a Slovak Air Force MiG-29. One of the new Slovak *Fulcrum-As*, '6829 Black', was displayed at the Royal International Air Tattoo (RIAT) at RAF Fairford in June 1996. On 28th-29th June 1997 a pair of SVL MiG-29s accompanied by an An-26 *Coke* twin-turboprop transport visited RAF Waddington.

In 2005 Slovakia began upgrading its MiG-29 fleet with new Russian and Western avionics. The first two of the 18 single-seaters and two trainers to be upgraded ('6728 Black' and '5304 Black') were redelivered in November 2005.

Sudan

The **Sudanese Air Force** (*Silakh al-Jawwiya as-Sudaniya*) took delivery of ten new MiG-29SEs and two MiG-29UBs in July 2004; the fighters were delivered by Russian Air Force An-124 freighters. (Some sources, though, claim the MiG-29s are former Ukrainian machines.) The aircraft are operated by the No.2 Fighter Sqn; only one aircraft, a MiG-29SE (*izdeliye* 9.13SE) serialled 623, has been identified.

Syria

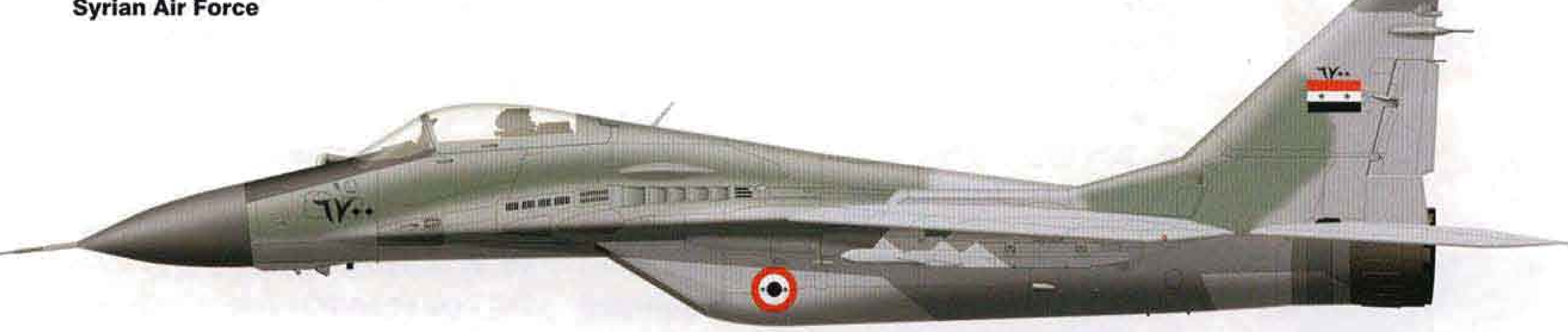
The Syrian Arab Republic became the second export customer for the MiG-29. This Middle Eastern country traditionally operated Soviet military hardware and needed new fighters to replace the aircraft lost in the wars with Israel. Besides, the Syrian MiG-21MF *Fishbed-J* and MiG-23MS *Flogger-E* fighters were getting long in the tooth. Hence in April 1987 Syrian Minister

Slovak Air Force MiG-29s

Serial	Version	C/n	F/n	Notes
'0619 Black'	MiG-29 (*izd.* 9.12A)	2960535406	4713	D/D 21-12-93
'0820 Black'	MiG-29 (*izd.* 9.12A)	2960535408	4714	D/D 21-12-93; stored
'0921 Black'	MiG-29 (*izd.* 9.12A)	2960535409	4715	D/D 21-12-93; stored
'1303 Black'	MiG-29UB	N50903028113		D/D 21-12-93; grey 'tiger' camouflage
'2022 Black'	MiG-29 (*izd.* 9.12A)	2960536020	480...	D/D 21-12-93. Destroyed by fire Sliač AB 19-6-02
'2123 Black'	MiG-29 (*izd.* 9.12A)	2960536021	480...	D/D 21-12-93
'3709 Black'	MiG-29 (*izd.* 9.12A)	2960532037	4202	
'3911 Black'	MiG-29 (*izd.* 9.12A)	2960532039	4204	
'4401 Black'	MiG-29UB	N50903013244	?	Dark green/dark earth camouflage. Crashed ?-3-94
'5113 Black'	MiG-29 (*izd.* 9.12A)	2960532351	4212	Stored
'5304 Black'	MiG-29UB	N50903028253	?	Upgraded cockpit
'5515 Black'	MiG-29 (*izd.* 9.12A)	2960532355	4215	Stored
'5817 Black'	MiG-29 (*izd.* 9.12A)	2960532358	4303?	Stored
'6124 Black'	MiG-29SE (*izd.* 9.12SE)?	2960536061	490...	Grey camouflage
'6425 Black'	MiG-29SE (*izd.* 9.12SE)?	2960536064	4905?	Grey camouflage
'6526 Black'	MiG-29SE (*izd.* 9.12SE)?	2960536065	4906?	Grey camouflage
'6627 Black'	MiG-29SE (*izd.* 9.12SE)?	2960536066	4907?	Grey camouflage
'6728 Black'	MiG-29SE (*izd.* 9.12SE)?	2960536067	4908	Grey camouflage; upgraded cockpit
'6829 Black'	MiG-29SE (*izd.* 9.12SE)?	2960536068	4909	2 Sqn. Grey camouflage. Crashed 7-11-02, collision with '6930 Black'
'6930 Black'	MiG-29SE (*izd.* 9.12SE)?	2960536069	4910	1 Sqn. Grey camouflage. Crashed 7-11-02, collision with '6829 Black'
'7501 Black'	MiG-29 (*izd.* 9.12A)	2960526375	3901	Dark green/dark earth camouflage/ special colours. Stored
'8003 Black'	MiG-29 (*izd.* 9.12A)	2960526380	3903?	
'8605 Black'	MiG-29 (*izd.* 9.12A)	2960526386	3905?	Stored
'9308 Black'	MiG-29 (*izd.* 9.12A)	2960526393	3908?	1 Sqn. Dark green/dark earth camouflage. Stored

MiG-29SE *Fulcrum-C* '623', Sudanese Air Force, No.2 Fighter Sqn

MiG-29 *Fulcrum-A* '6700'
Syrian Air Force



of Defence Mustaf Tlass signed an order for 150 *Fulcrums*.

Deliveries commenced quickly; the first aircraft – single-seat MiG-29s (*izdeliye* 9.12B standard) and two-seat MiG-29UBs – were handed over to the **Syrian Air Force** (*al Quwwat al-Jawwiya al Arabiya as-Suriya*) in July 1987. The first MiG-29 squadron became operational in October 1988. A second batch was delivered by the end of the year, bringing the total strength to one regiment (three squadrons). These include the 699 Sqn and probably the 698 Sqn, both based at Saiqal AB.

In 1988 military co-operation between the Soviet Union and Syria was interrupted, with the result that half the MiG-29 fleet became unserviceable during the following decade. There have been no confirmed reports of Syrian *Fulcrums* in action against Israeli jets. Rumour has it that a Syrian pilot defected to Israel in a MiG-29 in 1990 and that at least one more example was lost in a shootout with IDF/AF fighters in early 1991.

What *is* known, however, is that Syria never received the 150 MiG-29s ordered originally. It is generally believed that deliveries stopped at 80; these included 48 MiG-29s (*izdeliye* 9.12B) and MiG-29UBs in the first shipment delivered in the late 1980s, plus 14 more aircraft (12 *izdeliye* 9.12Bs and two MiG-29UBs) diverted from an embargoed Iraqi order in 2000 (after the resumption of military co-operation with Russia) and 22 second-hand examples in 2001-02.

Only one Syrian MiG-29, a single-seater serialled 6700, has been identified so far.

RSK MiG/Pavel Novikov

▲ **A superb pre-delivery shot of Sudanese Air Force MiG-29SE '623' at Lookhovitsy-Tret'yakovo.**

United States of America

The **United States Air Force** got its first chance to evaluate the MiG-29 when one of the Luftwaffe's *Fulcrum-As*, 29+06, was loaned to the Air Force Systems Command (AFSC; now Air Force Materiel Command) in 1990. The objectives included development of anti-MiG-29 tactics and countermeasures for the impending Operation *Desert Storm*, during which USAF and US Navy fighters were expected to be opposed by the *Fulcrum*. The aircraft remained in the US at least until August 1992.

In late 1997, as mentioned earlier, the USAF bought 21 ex-Moldovan MiG-29s – six *Fulcrum-As*, 14 *Fulcrum-Cs* and a single MiG-29UB. The deal was part of the Co-operative Threat Reduction Program initiated in 1993. The aircraft were delivered to Wright-Patterson AFB, Ohio, by Military Airlift Command McDonnell Douglas C-17A Globemaster IIIs.

Having thus placed the MiGs beyond the reach of Iran and other 'bad guys', the USAF uses them to study the type's performance and technical details. While the *Fulcrum-A* is nothing new, the nuclear-capable 'fatback' is of special interest to the US. The MiGs may be used as 'aggressor aircraft' during *Red Flag* exercises after restoration to airworthy status; the 'Red Eagles', a secretive unit at Groom Lake and Tonopah in Nevada operating MiG-21s and MiG-23s/-27s in the Cold War years, might even be reinstated. Having real MiG-29s sure beats using the time-honoured 'aggressor' Northrop F-5 Tigers and T-38 Talons, or even F-16Ns and F/A-18s masquerading as *Fulcrums*!

Still in its nondescript Moldovan camouflage, one of the USAF's *Fulcrum-Cs* ('16 White') is seen here at Nellis AFB in 2005.

MiG-29s Acquired by the US Air Force			
C/n	F/n	Version	Notes
2960507622	?	MiG-29 (*izdeliye* 9.12)	Coded '32 Blue' (code probably fake)
2960512124	?	MiG-29 (*izdeliye* 9.12)	Ex-Moldovan Air Force '27 White'. Preserved Goodfellow AFB as 'Soviet Air Force 17 Blue'
2960512140	?	MiG-29 (*izdeliye* 9.12)	Ex-Moldovan Air Force '28 White'
2960516753	?	MiG-29 (*izdeliye* 9.12)	Ex-Moldovan Air Force '20 White'
2960516755	?	MiG-29 (*izdeliye* 9.12)	Ex-Moldovan Air Force '21 White'
2960516761	?	MiG-29 (*izdeliye* 9.12)	Ex-Moldovan Air Force '25 White'
2960516766	?	MiG-29 (*izdeliye* 9.12)	Ex-Moldovan Air Force '22 White'
2960526305	3707?	MiG-29 (*izdeliye* 9.12)	Coded '51 Blue' (code probably fake). F/n may be 3708 or 3709
2960707750	?	MiG-29 (*izdeliye* 9.13)	Ex-Moldovan Air Force '24 White'
2960707753	?	MiG-29 (*izdeliye* 9.13)	Ex-Moldovan Air Force '29 White'
2960710828	?	MiG-29 (*izdeliye* 9.13)	Ex-Moldovan Air Force '09 White'
2960717456	312...?	MiG-29 (*izdeliye* 9.13)	Ex-Moldovan Air Force '03 White'. Preserved Tyndall AFB, FL, as 'Soviet Air Force 53 Blue'
2960717458	3129?	MiG-29 (*izdeliye* 9.13)	Ex-Moldovan Air Force '10 White'
2960717459	3130?	MiG-29 (*izdeliye* 9.13)	Ex-Moldovan Air Force '11 White'
2960717464	320...?	MiG-29 (*izdeliye* 9.13)	Ex-Moldovan Air Force '12 White'
2960717469	32...?	MiG-29 (*izdeliye* 9.13)	Ex-Moldovan Air Force '04 White'
2960717473	32...?	MiG-29 (*izdeliye* 9.13)	Ex-Moldovan Air Force '06 White'. Preserved Nellis AFB as 'Soviet Air Force 30 Red'
2960717940	3424?	MiG-29 (*izdeliye* 9.13)	Ex-Moldovan Air Force '02 White'
2960721907	?	MiG-29 (*izdeliye* 9.13)	Ex-Moldovan Air Force '08 White'
2960721930	?	MiG-29 (*izdeliye* 9.13)	Ex-Moldovan Air Force '41 White'
2960721940	?	MiG-29 (*izdeliye* 9.13)	Ex-Moldovan Air Force '46 White'
2960721945	?	MiG-29 (*izdeliye* 9.13)	Ex-Moldovan Air Force '48 White'
N50903012038	?	MiG-29UB	Ex-Moldovan Air Force '61 White'
?	?	MiG-29 (*izdeliye* 9.13)	Ex-Moldovan Air Force '16 White'

Incidentally, to quote *Air Forces Monthly*, *'some say Uncle Sam has created a precedent that will allow any country trying to find a few extra dollars to suggest the possibility of selling hardware to countries like Syria, Iraq or Iran in order to secure a better deal. Just mention the fact that Damascus, Baghdad or Tehran is interested, and you will get a bundle of dollars, say the opponents. And this is a realistic scenario, bearing in mind how many of those countries that emerged from the former Soviet Union have an enormous pile of dual capable weaponry – be it aircraft, subs or artillery.'*

Additionally, two Russian Air Force MiG-29s – '32 Blue' (c/n 2960507662) and '09 Red' (c/n 2960520155) – were purchased by **a warbird dealer** in Quincy, Illinois and placed on the US civil register by July 2000 as N6394K and N6394G respectively. Both were still with them in 2006 despite having been offered on e-bay!

Yemen

The Soviet Union had supplied military hardware to South Yemen (the People's Democratic Republic of Yemen) for a long time. In 1991 North Yemen (the Yemen Arab Republic) and South Yemen merged into a single 'simply Yemen'. Since Yemen had defaulted on payments for Russian arms exports, in 1992 Russia stopped all further arms deliveries to this country, forcing the Yemeni government to seek alternative suppliers. This did not take long; in mid-1993 Moldova sold four of its MiG-29s – three *Fulcrum-Cs* and one MiG-29UB (some sources say eight single-seat MiG-29s and two MiG-29UBs, or even 12 *Fulcrums*) – to the **Yemen Air & Air Defence Force** via a third party. The aircraft operated from Al-Rayan AB.

However, it turned out that the aircraft were delivered incomplete and two were in non-airworthy condition. In 1994 a violent civil war broke out in which the greater part of the MiG-29 fleet was destroyed; the survivors were eventually returned to Moldova.

Later the financial issues with Russia were apparently sorted out. This allowed Yemen to order up to 24 new MiG-29s from Russia in August 2001. These were MiG-29SEs (*izdeliye* 9.12SE) and MiG-29UBs. Under the terms of contract the single-seaters were to be upgraded to MiG-29SMT (*izdeliye* 9.18) multi-role fighters with a 'glass cockpit', new weapons and IFR capability but with a *Fulcrum-A* style concave spine (known as 'the Yemeni version' whose prototype is the RSK MiG demonstrator coded '918 White'). The first aircraft were delivered in June 2000. No serials are known.

Yugoslavia/Serbia and Montenegro

Yugoslavia became the first European export customer for the *Fulcrum* in 1987 – that is, the big confederacy of old (the Socialist Federal Republic of Yugoslavia), not the remnant that is now left under the same name after the civil war.

By early 1988 the **Yugoslav Air Force** (JRV – *Jugoslovensko Ratno Vazduhoplovstvo*) had taken delivery of 14 single-seaters (*izdeliye* 9.12A standard) and two MiG-29UB trainers. They were operated by the 127th LAE 'Vitezovi' ('Knights' in Serbian; LAE = *Lovacka Aviacijska Eskadrila* – fighter squadron)/204th LAP (*Lovacki Aviacijski Puk* – fighter regiment) at Batajnica airbase near Belgrade. An immediate problem arose when the *Fulcrums* arrived: they were too big to fit into the underground hardened aircraft shelters (HAS) built for the smaller MiG-21s they supplemented, and new above-ground HASs had to be constructed.

▲ **The Yugoslav Air Force insignia of the Socialist Federal Republic of Yugoslavia.**

Yugoslavia traditionally allocated indigenous designations to new types included into the JRV inventory; thus, the MiG-29 became L-18 (L = *lovac* – 'fighter' in Serbian) and the MiG-29UB was known locally as the NL-18 (*nastavni lovac* – 'training fighter'). Yugoslav *Fulcrums* were displayed publicly for the first time during the 'open house' at Batajnica AB on 15th May 1988. Another 16 aircraft were due for delivery that year but no additional MiG-29s were supplied before the long and bitter civil war between the Christian Serbs and the Bosnian Moslems broke out and all weapons sales were embargoed.

After the break-up of the federation into five separate states in the wake of the war the fighters were retained by the present Yugoslavia, alias Serbia & Montenegro (SCG – *Srbija i Crna Gora*), whose air force was now called RViPVO (*Ratno Vazduhoplovstvo i Protiv-Vazdušna Odbrana*). Accordingly the federal-era red-starred roundels and Yugoslav flag fin stripes gave way to new roundels with horizontal red, white and blue stripes and fin flashes. MiG-29 '18113' made the type's public debut in this new look at Vršac AB on 9th May 1998.

This RViPVO was decimated during Operation *Allied Force* (the NATO offensive in response to the bloody war in the Kosovo enclave), which began on 24th March 1999 and ultimately resulted in the unseating and arrest of President Slobodan Milošević, who faced trial in the Hague Tribunal on war crime charges. Hostilities ended on 10th June 1999 when NATO and the new government in Belgrade signed a peace accord. By then 11 of the original 16 had been either shot down or destroyed on the ground by bomb and cruise missile strikes.

After the war the five surviving MiG-29s stayed on the ground most of the time due to fuel shortages and the lack of spares (product support had been cut off with the outbreak of the civil war). The last live exercise in which they participated was in 2001. The aircraft cannot be overhauled on site, and the Russian Air Force's 121st ARZ has charged US$ 7.5 million for the refurbishment of each aircraft, which amounts to US$ 37.5 million for the lot; US$ 18.5 million is needed just to return the aircraft to airworthy condition, and even that is too steep a price in the present conditions. Thus, the RViPVO now relies solely on the 'old but gold' MiG-21 to fill the counter-air role. Both types are eventually to be replaced by a new multi-role aircraft when funds become available.

Yugoslav (Federal) and Yugoslav (SCG) Air Force MiG-29s
(For the sake of convenience all the aircraft originally delivered are listed below)

Serial	Version	C/n	F/n	Notes
18101	MiG-29 (*izdeliye* 9.12A) (L-18)	2960525005	?	
18102	MiG-29 (*izdeliye* 9.12A) (L-18)	?	?	
18103	MiG-29 (*izdeliye* 9.12A) (L-18)	?	?	Destroyed Batajnica AB 27-4-99
18104	MiG-29 (*izdeliye* 9.12A) (L-18)	?	?	Destroyed Niś AB 11-5-99
18105	MiG-29 (*izdeliye* 9.12A) (L-18)	?	?	
18106	MiG-29 (*izdeliye* 9.12A) (L-18)	2960525096	340...?	Shot down 24-3-99
18107	MiG-29 (*izdeliye* 9.12A) (L-18)	2960525098	34...?	Destroyed Batajnica AB 26-3-99
18108	MiG-29 (*izdeliye* 9.12A) (L-18)	?	?	
18109	MiG-29 (*izdeliye* 9.12A) (L-18)	2960525102	34...?	Destroyed 4-5-99
18110	MiG-29 (*izdeliye* 9.12A) (L-18)	2960525112?	3501?	Destroyed 26-3-99
18111	MiG-29 (*izdeliye* 9.12A) (L-18)	2960525136	3510?	Shot down 24-3-99
18112	MiG-29 (*izdeliye* 9.12A) (L-18)	2960525139?	3511?	Shot down 24-3-99
18113	MiG-29 (*izdeliye* 9.12A) (L-18)	?	?	Shot down 26-3-99
18114	MiG-29 (*izdeliye* 9.12A) (L-18)	?	?	Shot down 26-3-99
18301	MiG-29UB (NL-18)	?	?	
18302	MiG-29UB (NL-18)	N50903006406	?	Destroyed Batajnica AB 24-4-99

via RART

◄ A Yugoslav Air Force MiG-29 (18112) in socialist-era markings. Note how the last three digits of the serial are repeated on the nose.

via RART

◄ A Yugoslav Air Force MiG-29 (18108) in socialist-era markings. Note how the last three digits of the serial are repeated on the nose.

via RART

◄ 18302, one of the two MiG-29UBs delivered to the Yugoslav Air Force, in the original markings.

Alexandar Radić

MiG-29 18108 in the insignia of the 'abbreviated' Yugoslavia (Serbia and Montenegro); note the position of the roundel.

The modern Yugoslav (Serbia and Montenegro) Air Force roundel.

Alexandar Radić

This view of 18108 shows the old-style Yugoslav Air Force insignia visible beneath the grey paint above the new fin flashes.

MiG-29 *Fulcrum-A* '18112' (c/n 2960525139, f/n 3511?)
Yugoslav Air Force, 127 LAE/204 LAP, Batajnica AB, 1989

MiG-29 *Fulcrum-A* '18108'
Yugoslav (SCG) Air Force, 127 LAE/204 LAP, Batajnica AB, 1999

APPENDIX

Production List

Known MiG-29s identified by construction number and/or fuselage number (line number) are listed here in the sequence of the 'famous last five' allocated to each version. The split presentation is purely for the sake of convenience. Crashed or destroyed aircraft are marked by 'RIP crosses' followed by the date of the accident or shootdown.

On single-seat versions the last five digits of the c/n are normally stencilled on the outer faces of the fins, on the IRCM flare launcher housings ahead of the fins, on the inside of the canopy frame at the rear and under the starboard wing root, and sometimes on the ejection seat headrest. On the MiG-29UB the full c/n is stencilled on the rear bulkhead of the nosewheel well and on the rear fuselage (the stabilator root fairings). The 'famous last five' are also stencilled on the wing pylons, but spotters beware – the pylons may come from another aircraft! It is also a good idea to check the air intake and exhaust covers (which also may be 'borrowed' from another aircraft, though).

C/n	F/n	Version	Built	Tactical Code / Serial / Registration
039.05.01625	0101	MiG-29 (*izd.* 9.12)		Soviet AF '24 Blue' (924)
039.05.02017	0102	MiG-29 (*izd.* 9.12)		Soviet AF '12 Blue'
039.05.02020	0103	MiG-29 (*izd.* 9.12)		Soviet AF '03 Blue'
?	0203	MiG-29 (*izd.* 9.12)		not known (Soviet AF) † 14-12-1987
296.05.05533	0405	MiG-29 (*izd.* 9.12)		Soviet AF '05 Blue'
		MiG-29 (*izd.* 9.13		Soviet/Russian AF '331 Blue'
		MiG-29SMT (*izd.* 9.17)		Russian AF '405 Blue'
296.05.05534	0406	MiG-29 (*izd.* 9.12)		not known, Ukrainian AF '06 White'
296.05.05561	?	MiG-29 (*izd.* 9.12)		Russian AF '23 Blue'
296.05.06160	?	MiG-29 (*izd.* 9.12)		Russian AF '37 Blue'
296.05.07622	?	MiG-29 (*izd.* 9.12)		Russian AF '32 Blue', N6394K
296.05.07641	?	MiG-29 (*izd.* 9.12)		Soviet AF '07 Orange', Russian AF '20 Red'
296.05.07649	?	MiG-29 (*izd.* 9.12)		Russian AF '09 Red'
296.05.07657	?	MiG-29 (*izd.* 9.12)		Soviet AF '15 Orange'
296.05.07668	0705?	MiG-29 (*izd.* 9.12)		Russian AF '19 White'
296.05.07670	0706	MiG-29 (*izd.* 9.12)	31-12-1983	Russian AF '33 White'
296.05.07682	0707	MiG-29 (*izd.* 9.12)		Soviet AF '07 Blue'?
		MiG-29 (*izd.* 9.14		Soviet/Russian AF '407 Blue'
296.05.07683	0708	MiG-29 (*izd.* 9.12)	31-12-1983	Russian AF '52 White'
296.05.07687	07...	MiG-29 (*izd.* 9.12)		not known (Soviet AF)
296.05.07693	?	MiG-29 (*izd.* 9.12)		Soviet AF '02', Russian AF '23 Red'
296.05.07747	?	MiG-29 (*izd.* 9.12)		not known (Soviet AF)
296.05.08101?	?	MiG-29 (*izd.* 9.12)		Soviet AF '23', Russian AF '08 Red'
296.05.08161?	?	MiG-29 (*izd.* 9.12)		Russian AF '32 Red'
296.05.09151	?	MiG-29 (*izd.* 9.12)		Russian AF '27 Red'
296.05.09162	?	MiG-29 (*izd.* 9.12)		Russian AF '21 Red'
296.05.09165?	?	MiG-29 (*izd.* 9.12)?		no code
296.05.09177	?	MiG-29 (*izd.* 9.12)		Soviet AF '21', Russian AF '53 Blue'
296.05.09184	?	MiG-29 (*izd.* 9.12)		Soviet AF '25', Soviet AF '11', Russian AF '11 Red'
296.05.09199	?	MiG-29 (*izd.* 9.12)		Russian AF '37 Blue'
296.05.10107	?	MiG-29 (*izd.* 9.12)		Soviet/Russian AF '39 Red'
296.05.10176	?	MiG-29 (*izd.* 9.12)		Soviet/Russian AF '09 Red'
296.05.10179	?	MiG-29 (*izd.* 9.12)		Soviet/Russian AF '10 Red'
296.05.10180	?	MiG-29 (*izd.* 9.12)		Soviet/Russian AF '11 Red'
296.05.10181	?	MiG-29 (*izd.* 9.12)		Soviet/Russian AF '20 Red'
296.05.10183	?	MiG-29 (*izd.* 9.12)		Soviet/Russian AF '21 Red'
296.05.10184	?	MiG-29 (*izd.* 9.12)		Soviet/Russian AF '22 Red'
296.05.10186	?	MiG-29 (*izd.* 9.12)		Soviet/Russian AF '24 Red'
296.05.10188	?	MiG-29 (*izd.* 9.12)		Russian AF '04 Red'
296.05.10194	?	MiG-29 (*izd.* 9.12)		Soviet/Russian AF '25 Red'
296.05.10195	?	MiG-29 (*izd.* 9.12)		Soviet/Russian AF '26 Red'
296.05.10197	?	MiG-29 (*izd.* 9.12)		Soviet/Russian AF '12 Red'
296.05.10592?	?	MiG-29 (*izd.* 9.12)		Russian AF '29 Red'
296.05.12102	?	MiG-29 (*izd.* 9.12)		Soviet/Russian AF '23 Red'
296.05.12107	?	MiG-29 (*izd.* 9.12)		Soviet/Russian AF '27 Red'
296.05.12111	?	MiG-29 (*izd.* 9.12)?		not known (Soviet AF), Ukrainian AF '26 White'
296.05.12120	?	MiG-29 (*izd.* 9.12)		Soviet/Russian AF '21 Red', Russian AF '29 Red'
296.05.12124	?	MiG-29 (*izd.* 9.12)		Soviet/Moldovan AF '27 White' (to USAF), 'Russian AF 17 Blue' (fake markings)
296.05.12125	?	MiG-29 (*izd.* 9.12)		not known (Soviet AF), Soviet/Russian AF '24 White'
296.05.12126	?	MiG-29 (*izd.* 9.12)		Soviet/Russian AF '25 White'
296.05.12140	?	MiG-29 (*izd.* 9.12)		Soviet/Moldovan AF '28 White' (to USAF)
296.05.12149	?	MiG-29 (*izd.* 9.12)		Soviet/Russian AF '23 White'
296.05.12155	?	MiG-29 (*izd.* 9.12)		Russian AF '34 Red'
296.05.15035	?	MiG-29 (*izd.* 9.12)		Russian AF '73 Blue'
296.05.15071	?	MiG-29 (*izd.* 9.12)		Russian AF '11 Blue'
296.05.15104	?	MiG-29 (*izd.* 9.12)		Ukrainian AF '22 Blue'
296.05.15118	?	MiG-29 (*izd.* 9.12)		not known (Ukrainian AF)
296.05.15125	?	MiG-29 (*izd.* 9.12)		Soviet/Russian AF '21 White', Russian AF '11 Blue'
296.05.15137?	?	MiG-29 (*izd.* 9.12)?		not known
296.05.15147	?	MiG-29 (*izd.* 9.12)		Ukrainian AF '28 Blue'
296.05.15380	?	MiG-29 (*izd.* 9.12)		Russian AF '03 Red'
296.05.15389	?	MiG-29 (*izd.* 9.12)		Russian AF '101 White'
296.05.15803	?	MiG-29 (*izd.* 9.12)		Russian AF '01 White'
296.05.15824	?	MiG-29 (*izd.* 9.12)		Soviet AF '22', Russian AF '55 Blue'
296.05.15835	?	MiG-29 (*izd.* 9.12)		Russian AF '73 Blue'
296.05.15840	?	MiG-29 (*izd.* 9.12)		Russian AF '22 White'
296.05.16505	?	MiG-29 (*izd.* 9.12)	30-6-1985	Russian AF '45 White'

296.05.16515	?	MiG-29 (*izd.* 9.12)	10-6-1985	Russian AF '49 White'
296.05.16532	?	MiG-29 (*izd.* 9.12)		Russian AF '29 Red'
296.05.16552	?	MiG-29 (*izd.* 9.12)		Russian AF '10 Red'
296.05.16557	?	MiG-29 (*izd.* 9.12)		Russian AF '12 Blue'
296.05.16740?	?	MiG-29 (*izd.* 9.12)		Soviet AF '54 Blue'
296.05.16753	?	MiG-29 (*izd.* 9.12)		Soviet/Moldovan AF '20 White'
				(to USAF)
296.05.16755	?	MiG-29 (*izd.* 9.12)		Soviet/Moldovan AF '21 White'
				(to USAF)
296.05.16761	?	MiG-29 (*izd.* 9.12)		Soviet/Moldovan AF '25 White'
				(to USAF)
296.05.16766	?	MiG-29 (*izd.* 9.12)		Soviet/Moldovan AF '22 White'
				(to USAF)
296.05.16767	?	MiG-29 (*izd.* 9.12)		Soviet AF '10 Blue',
				Soviet AF '303 Blue' † 8-6-1989
296.05.16768	?	MiG-29 (*izd.* 9.12)		not known (Soviet AF),
				Soviet/Russian AF '26 White',
				Russian AF '21 Blue'
296.05.16773	?	MiG-29 (*izd.* 9.12)	24-9-1985	Russian AF '55 White'
296.05.16785	?	MiG-29 (*izd.* 9.12)	10-9-1985	Soviet/Russian AF '40 Red',
				Russian AF '40 White'
296.05.16793	?	MiG-29 (*izd.* 9.12)		Russian AF '44 Blue'
296.05.17024?	?	MiG-29 (*izd.* 9.12)		Russian AF '27 Red'
296.05.18051	?	MiG-29 (*izd.* 9.12)		Soviet AF '50', Russian AF '31 White'
		MiG-29SMT (*izd.* 9.17A)		Russian AF '51 White'
296.05.18063	?	MiG-29 (*izd.* 9.12)		Russian AF '03 White'
296.05.18064	?	MiG-29 (*izd.* 9.12)		Russian AF '02 White', '36 Red'
296.05.18070	?	MiG-29 (*izd.* 9.12)		Russian AF '05 White'
296.05.18073	?	MiG-29 (*izd.* 9.12)		Russian AF '07 White'
296.05.18074	?	MiG-29 (*izd.* 9.12)		Russian AF '08 White'
296.05.18079	?	MiG-29 (*izd.* 9.12)		Russian AF '11 White'
296.05.18081	?	MiG-29 (*izd.* 9.12)		Russian AF '35 White'
296.05.18082	?	MiG-29 (*izd.* 9.12)		Russian AF '04 White'
296.05.18084	?	MiG-29 (*izd.* 9.12)		Russian AF '01 White', '01 Blue'
296.05.18091	?	MiG-29 (*izd.* 9.12)		Russian AF '09 White'
296.05.18094	?	MiG-29 (*izd.* 9.12)		Russian AF '12 White'
296.05.18450	?	MiG-29 (*izd.* 9.12)		Russian AF '22 White', '62 White'
296.05.18454	?	MiG-29 (*izd.* 9.12)		Soviet/Russian AF '23 White'
296.05.18457	?	MiG-29 (*izd.* 9.12)		Soviet/Russian AF '25 Blue'
296.05.18458	?	MiG-29 (*izd.* 9.12)		Soviet/Russian AF '26 Blue'
296.05.18462	?	MiG-29 (*izd.* 9.12)		Soviet/Russian AF '27 Blue'
296.05.18463	?	MiG-29 (*izd.* 9.12)		Soviet/Russian AF '28 Blue'
296.05.18464	?	MiG-29 (*izd.* 9.12)		Soviet/Russian AF '29 Blue'
296.05.18465	?	MiG-29 (*izd.* 9.12)		Soviet/Russian AF '12 Red'
296.05.18471	?	MiG-29 (*izd.* 9.12)		Russian AF '32 Blue'
296.05.18473	?	MiG-29 (*izd.* 9.12)		Russian AF '33 Blue', '33 White',
				'43 Blue'
296.05.18479	?	MiG-29 (*izd.* 9.12)		Soviet AF '41', Russian AF '37 White'
296.05.18751	?	MiG-29 (*izd.* 9.12)		Soviet AF '40', Russian AF '36 White'
296.05.18755	?	MiG-29 (*izd.* 9.12)		Soviet/Russian AF '22 Red'
296.05.19270?	?	MiG-29 (*izd.* 9.12)		Ukrainian AF '?? Yellow'
296.05.20115	?	MiG-29 (*izd.* 9.12)		Soviet/Russian AF '35 Red'
296.05.20145	?	MiG-29 (*izd.* 9.12)		Russian AF '06 White', '47 White'
296.05.20149	?	MiG-29 (*izd.* 9.12)		Russian AF '10 White', '48 White'
296.05.20155	?	MiG-29 (*izd.* 9.12)		Soviet/Russian AF '09 Red', N6394G
296.05.20165	?	MiG-29 (*izd.* 9.12)		Soviet/Russian AF '01 Red', '12 Blue'
		MiG-29SMT (*izd.* 9.17)		Russian AF '01 Blue'

296.05.20561	181...?	MiG-29 (*izd.* 9.12)	Soviet AF '14 Blue'
			Soviet/Russian AF '34 White'
296.05.20565	1817?	MiG-29 (*izd.* 9.12)	Soviet/Russian AF '20 White'
			† 15-8-1993
296.05.20568	181...?	MiG-29 (*izd.* 9.12)	Soviet/Russian AF '21 Blue',
			Russian AF '71 White'
296.05.20571	18...?	MiG-29 (*izd.* 9.12)	Soviet/Russian AF '24 Blue',
			Russian AF '64 White'
296.05.20572	18...?	MiG-29 (*izd.* 9.12)	Soviet/Russian AF '30 White'
296.05.22971	?	MiG-29 (*izd.* 9.12)	Russian AF '10 Blue'
296.05.23439?	?	MiG-29 (*izd.* 9.12)	Russian AF '17 Blue'
296.05.25005	?	MiG-29 (*izd.* 9.12B)	Yugoslav AF 18101
296.05.25078	3315?	MiG-29 (*izd.* 9.12)	Soviet AF '10 Blue',
			Soviet/Russian AF '315 Blue'
296.05.25096	340...?	MiG-29 (*izd.* 9.12B)	Yugoslav AF 18106 † 24-3-1999
296.05.25098	340...?	MiG-29 (*izd.* 9.12B)	Yugoslav AF 18107 † 26-3-1999
296.05.25...?	34...?	MiG-29 (*izd.* 9.12B)	Yugoslav AF 18108
296.05.25102	34...?	MiG-29 (*izd.* 9.12B)	Yugoslav AF 18109 † 4-5-1999
296.05.25106	3412	MiG-29 (*izd.* 9.12A)	East German AF '604 Red'
		MiG-29G	Luftwaffe 29+01, Polish AF ('06 Red'?)
296.05.25108	3413	MiG-29 (*izd.* 9.12A)	East German AF '607 Red'
		MiG-29G	Luftwaffe 29+02, Polish AF '08 Red'
296.05.25110	3414	MiG-29 (*izd.* 9.12A)	East German AF '615 Red'
		MiG-29G	Luftwaffe 29+03
296.05.25111	3415	MiG-29 (*izd.* 9.12A)	East German AF '628 Red'
		MiG-29G	Luftwaffe 29+04, Polish AF '4111 Red'
296.05.25112	3501	MiG-29 (*izd.* 9.12)	Yugoslav AF 18110? † 26-3-1999
296.05.25113	3502	MiG-29 (*izd.* 9.12A)	East German AF '635 Red'
		MiG-29G	Luftwaffe 29+05, Polish AF '4118 Red'
296.05.25114	3503	MiG-29 (*izd.* 9.12A)	East German AF '661 Red'
		MiG-29G	Luftwaffe 29+06, Polish AF ('14 Red'?)
296.05.25115	3504	MiG-29 (*izd.* 9.12A)	East German AF '668 Red'
		MiG-29G	Lw 29+07, Polish AF ('5115 Red'?)
296.05.25118	3505	MiG-29 (*izd.* 9.12A)	East German AF '669 Red'
		MiG-29G	Luftwaffe 29+08, Polish AF ('18 Red'?)
296.05.25121	3506	MiG-29 (*izd.* 9.12A)	East German AF '670 Red'
		MiG-29G	Luftwaffe 29+09 † 25-6-1996
296.05.25124	3507	MiG-29 (*izd.* 9.12A)	East German AF '676 Red'
		MiG-29G	Luftwaffe 29+10, Polish AF ('24 Red'?)
296.05.25128	3508	MiG-29 (*izd.* 9.12A)	East German AF '677 Red'
		MiG-29G	Luftwaffe 29+11, Polish AF ('128 Red'?)
296.05.25132	3509	MiG-29 (*izd.* 9.12A)	East German AF '679 Red'
		MiG-29G	Luftwaffe 29+12, Polish AF '4113 Red'
296.05.25136	3510?	MiG-29 (*izd.* 9.12B)	Yugoslav AF 18111 † 24-3-1999
296.05.25139?	3511?	MiG-29 (*izd.* 9.12B)	Yugoslav AF 18112 † 24-3-1999
296.05.25772	3611	MiG-29 (*izd.* 9.12)	Soviet/Russian AF '48 White'
296.05.25800	3703	MiG-29 (*izd.* 9.12A)	East German AF '684 Red'
		MiG-29G	Luftwaffe 29+14, Polish AF ('800 Red'?)
296.05.26300	3704	MiG-29 (*izd.* 9.12A)	East German AF '693 Red'
		MiG-29G	Luftwaffe 29+15, Polish AF ('300 Red'?)
296.05.26301	3705	MiG-29 (*izd.* 9.12A)	East German AF '699 Red'
		MiG-29G	Luftwaffe 29+16, Polish AF ('01 Red'?)
296.05.26302	3706	MiG-29 (*izd.* 9.12A)	East German AF '745 Red'
		MiG-29G	Luftwaffe 29+17, Polish AF ('02 Red'?)
296.05.26305	3707?	MiG-29 (*izd.* 9.12)	RusAF '51 Blue' F/n may be 3708/3709
296.05.26310	3710	MiG-29 (*izd.* 9.12A)	East German AF '777 Red'
		MiG-29G	Luftwaffe 29+18, Polish AF ('310 Red'?)

296.05.26314	3711	MiG-29 (*izd*. 9.12A) MiG-29G	East German AF '778 Red' Luftwaffe 29+19, Polish AF ('314 Red'?)
296.05.26315	3712	MiG-29 (*izd*. 9.12A) MiG-29G	East German AF '785 Red' Luftwaffe 29+20, Polish AF ('315 Red'?)
296.05.26319	3713	MiG-29 (*izd*. 9.12A) MiG-29G	East German AF '686 Red' Luftwaffe 98+06, Luftwaffe 29+21, Polish AF '22 Red'
296.05.26321	3714	MiG-29 (*izd*. 9.12A)	Bulgarian AF '15 White'
296.05.26322	3715	MiG-29 (*izd*. 9.12A)	Bulgarian AF '16 White'
296.05.26324	3801	MiG-29 (*izd*. 9.12A)	Bulgarian AF '17 White'
296.05.26325	3802	MiG-29 (*izd*. 9.12A)	Bulgarian AF '18 White'
296.05.26333	3803	MiG-29 (*izd*. 9.12A)	Bulgarian AF '19 White'
296.05.26334	3804	MiG-29 (*izd*. 9.12A)	Bulgarian AF '20 White'
296.05.26365	3812?	MiG-29 (*izd*. 9.12A)	Polish AF '65 Red'
296.05.26366	3813?	MiG-29 (*izd*. 9.12A)	Polish AF '66 Red'
296.05.26367	3814?	MiG-29 (*izd*. 9.12A)	Polish AF '67 Red'
296.05.26370	3815	MiG-29 (*izd*. 9.12A)	Polish AF '70 Red'
296.05.26375	3901	MiG-29 (*izd*. 9.12A)	Czechoslovak/Slovak AF '7501 Black'
296.05.26377	3902?	MiG-29 (*izd*. 9.12A)	Czechoslovak/Czech AF '7702 Black', Polish AF '77 Red'
296.05.26380	3903?	MiG-29 (*izd*. 9.12A)	Czechoslovak/Slovak AF '8003 Black'
296.05.26383	3904?	MiG-29 (*izd*. 9.12A)	Czechoslovak/Czech AF '8304 Black', Polish AF '83 Red'
296.05.26386	3905?	MiG-29 (*izd*. 9.12A)	Czechoslovak/Slovak AF '8605 Black'
296.05.26389	3906?	MiG-29 (*izd*. 9.12A)	Czechoslovak/Czech AF '8906 Black', Polish AF '89 Red'
296.05.26392	3907?	MiG-29 (*izd*. 9.12A)	Czechoslovak/Czech AF '9207 Black', Polish AF '92 Red'
296.05.26393	3908?	MiG-29 (*izd*. 9.12A)	Czechoslovak/Slovak AF '9308 Black'
296.05.30002	3912	MiG-29 (*izd*. 9.12)	Russian AF '40 White'
296.05.30005	3913?	MiG-29 (*izd*. 9.12)	Russian AF '42 White'
296.05.3000...	3914?	MiG-29 (*izd*. 9.12)?	not known
296.05.30010	3915	MiG-29 (*izd*. 9.12)	Russian AF '43 White'
296.05.30011	4001	MiG-29 (*izd*. 9.12)	Russian AF '44 Blue', 44 White'
296.05.3001...	4002	MiG-29 (*izd*. 9.12)?	not known
296.05.30015	4003	MiG-29 (*izd*. 9.12)	Soviet/Russian AF '46 Blue', Russian AF '46 White'
296.05.32035	4115	MiG-29 (*izd*. 9.12A)	Bulgarian AF '21 White'
296.05.32036	4201	MiG-29 (*izd*. 9.12A)	Bulgarian AF '22 White'
296.05.32037	4202	MiG-29 (*izd*. 9.12A)	Czechoslovak/Slovak AF '3709 Black'
296.05.32038	4203	MiG-29 (*izd*. 9.12A)	Czechoslovak/Czech AF '3810 Black', Polish AF '38 Red'
296.05.32039	4204	MiG-29 (*izd*. 9.12A)	Czechoslovak/Slovak AF '3911 Black'
296.05.32040	4205	MiG-29 (*izd*. 9.12A)	Czechoslovak/Czech AF '4012 Black', Polish AF '40 Red'
296.05.32041	4206	MiG-29 (*izd*. 9.12A)	Romanian AF '41 Red' † 1-3-1994
296.05.32046	4207	MiG-29 (*izd*. 9.12A)	Romanian AF '46 Red'
296.05.32047	4208	MiG-29 (*izd*. 9.12A)	Romanian AF '47 Red' † 9-9-1991
296.05.32048	4209	MiG-29 (*izd*. 9.12A)	Romanian AF '48 Red'
296.05.32049	4210	MiG-29 (*izd*. 9.12A)	Romanian AF '49 Red'
296.05.32350	4211	MiG-29 (*izd*. 9.12A)	Romanian AF '50 Red'
296.05.32351	4212	MiG-29 (*izd*. 9.12A)	Czechoslovak/Slovak AF '5113 Black'
296.05.3235...?	4213	MiG-29 (*izd*. 9.12)?	not known
296.05.32354	4214	MiG-29 (*izd*. 9.12A)	Czechoslovak/Czech AF '5414 Black', Polish AF '54 Red'
296.05.32355	4215	MiG-29 (*izd*. 9.12A)	Czechoslovak/Slovak AF '5515 Black'
296.05.32356	4301	MiG-29 (*izd*. 9.12A)	Czechoslovak/Czech AF '5616 Black', Polish AF '56 Red'
296.05.32357?	4302?	MiG-29 (*izd*. 9.12)?	not known
296.05.32358	4303?	MiG-29 (*izd*. 9.12A)	Czechoslovak/Slovak AF '5817 Black'
296.05.32359	4304?	MiG-29 (*izd*. 9.12A)	Czechoslovak/Czech AF '5918 Black', Polish AF '59 Red'
296.05.32367	4305	MiG-29 (*izd*. 9.12A) MiG-29 Sniper	Romanian AF '67 Red' Romanian AF '67 White'
296.05.32368	4306	MiG-29 (*izd*. 9.12A)	Romanian AF '68 Red'
296.05.32369	4307	MiG-29 (*izd*. 9.12A)	Romanian AF '69 Red'
296.05.32370	4308	MiG-29 (*izd*. 9.12A)	Romanian AF '70 Red'
296.05.32375	4309	MiG-29 (*izd*. 9.12A)	Romanian AF '75 Red'
296.05.32376	4310	MiG-29 (*izd*. 9.12A)	Romanian AF '76 Red'
296.05.32377	4311	MiG-29 (*izd*. 9.12A)	Bulgarian AF '23 White'
296.05.32379	4312	MiG-29 (*izd*. 9.12A)	Bulgarian AF '24 White'
296.05.3238...	4313	MiG-29 (*izd*. 9.12A)	Bulgarian AF '25 White' † 28-9-1994
296.05.32382	4314	MiG-29 (*izd*. 9.12A)	Bulgarian AF '26 White'
296.05.32383	4315?	MiG-29 (*izd*. 9.12A)	Bulgarian AF '27 White'
296.05.35100	4409	MiG-29 (*izd*. 9.12A)	Bulgarian AF '28 White'
296.05.35101	4410	MiG-29 (*izd*. 9.12A)	Bulgarian AF '29 White'
296.05.35102	4411	MiG-29 (*izd*. 9.12A)	Bulgarian AF '30 White'
296.05.35103	4412	MiG-29 (*izd*. 9.12A)	Bulgarian AF '31 White'
296.05.35104	4413	MiG-29 (*izd*. 9.12A)	Bulgarian AF '32 White'
296.05.35105	4414	MiG-29 (*izd*. 9.12A)	Polish AF '105 Red' (was loaned to Israeli Defence Force/Air Force)
296.05.35108	4415	MiG-29 (*izd*. 9.12A)	Polish AF '108 Red'
296.05.35111	4501	MiG-29 (*izd*. 9.12A)	Polish AF '111 Red'
296.05.35114	4502	MiG-29 (*izd*. 9.12A)	Polish AF '114 Red'
296.05.35115	4503	MiG-29 (*izd*. 9.12A)	Polish AF '115 Red'
296.05.35116	4504	MiG-29 (*izd*. 9.12A)	Hungarian AF '01 Red'
296.05.35117	4505	MiG-29 (*izd*. 9.12A)	Hungarian AF '02 Red', '02 Black' † 11-5-2005
296.05.35121	4506	MiG-29 (*izd*. 9.12)	Soviet AF '31 White'?, Soviet/Russian AF '506 Blue', Russian AF '332 Blue'
296.05.35124	4507	MiG-29 (*izd*. 9.12A)	Hungarian AF '03 Red'
296.05.35127	4508	MiG-29 (*izd*. 9.12A)	Hungarian AF '04 Red', '04 Black'
296.05.35133	4511	MiG-29 (*izd*. 9.12A)	Romanian AF '33 Red'
296.05.35138	4512	MiG-29 (*izd*. 9.12A)	Romanian AF '38 Red'
296.05.35148	4513	MiG-29 (*izd*. 9.12A)	Hungarian AF '05 Red'
296.05.35149	4514	MiG-29 (*izd*. 9.12A)	Hungarian AF '06 Red'
296.05.35150	4515	MiG-29 (*izd*. 9.12A)	Hungarian AF '07 Red'
296.05.35151	4601	MiG-29 (*izd*. 9.12A)	Hungarian AF '08 Red'
296.05.35157	4602	MiG-29 (*izd*. 9.12A)	Hungarian AF '09 Red'
296.05.35158	4603	MiG-29 (*izd*. 9.12A)	Hungarian AF '10 Red'
296.05.35161	4604	MiG-29 (*izd*. 9.12A)	Hungarian AF '11 Red'
296.05.35162	**4606!**	MiG-29 (*izd*. 9.12A)	Hungarian AF '12 Red'
296.05.35181	**4605!**	MiG-29 (*izd*. 9.12A)	Hungarian AF '14 Red'
296.05.35182	4701	MiG-29 (*izd*. 9.12A)	Hungarian AF '15 Red'
296.05.35184	4702	MiG-29 (*izd*. 9.12A)	Hungarian AF '16 Red'
296.05.35188	4703	MiG-29 (*izd*. 9.12A)	Hungarian AF '17 Red' † 23-7-1998
296.05.35189	4704	MiG-29 (*izd*. 9.12A)	Hungarian AF '18 Red'
296.05.35190	4705	MiG-29 (*izd*. 9.12A)	Hungarian AF '19 Red'
296.05.35191	4706	MiG-29 (*izd*. 9.12A)	Hungarian AF '20 Red'
296.05.35192	4707	MiG-29 (*izd*. 9.12A)	Hungarian AF '21 Red'
296.05.35193	4708	MiG-29 (*izd*. 9.12A)	Hungarian AF '22 Red', '22 Black'
296.05.35198	4709	MiG-29 (*izd*. 9.12A)	Hungarian AF '23 Red'
296.05.35400	4710	MiG-29S (*izd*. 9.12S)	Russian AF '555 Silver'

		MiG-29SMT (*izd.* 9.17)	Russian AF '917 Blue'
296.05.35403	4711	MiG-29S (*izd.* 9.12S)	Russian AF '777 Silver'
		MiG-29SM (*izd.* 9.12SM)	Russian AF '777 Blue'
		MiG-29SMT2 (*izd.* 9.18)	Russian AF '777 Green'
296.05.35404	4712	MiG-29 (*izd.* 9.12A)	Romanian AF '54 Red', PLAAF '54 Red'
296.05.35406	4713	MiG-29 (*izd.* 9.12A)	Slovak AF '0619 Black'
296.05.35408	4714	MiG-29 (*izd.* 9.12A)	Slovak AF '0820 Black'
296.05.35409	4715	MiG-29 (*izd.* 9.12A)	Slovak AF '0921 Black'
296.05.36004	480...	MiG-29 (*izd.* 9.12)?	not known
296.05.36020	480...	MiG-29 (*izd.* 9.12A)	Slovak AF '2022 Black' † 19-6-2002
296.05.36021	480...	MiG-29 (*izd.* 9.12A)	Slovak AF '2123 Black'
296.05.36034	4808	MiG-29 (*izd.* 9.12)	no code, Russian AF '357 Blue'
296.05.36044	481...	MiG-29 (*izd.* 9.12)?	not known
296.05.36050	4815	MiG-29 (*izd.* 9.12)	not known
		MiG-29SMT2 (*izd.* 9.18)	Russian AF '918 White'
296.05.36061	490...	MiG-29 (*izd.* 9.12A)	Slovak AF '6124 Black'
296.05.36064	4905?	MiG-29 (*izd.* 9.12A)	Slovak AF '6425 Black'
296.05.36065	4906?	MiG-29 (*izd.* 9.12A)	Slovak AF '6526 Black'
296.05.36066	4907?	MiG-29 (*izd.* 9.12A)	Slovak AF '6627 Black'
296.05.36067	4908	MiG-29 (*izd.* 9.12A)	Slovak AF '6728 Black'
296.05.36068	4909	MiG-29 (*izd.* 9.12A) ?-3-1996	Slovak AF '6829 Black' † 7-11-2002
296.05.36069	4910	MiG-29 (*izd.* 9.12A)	Slovak AF '6930 Black' † 7-11-2002
296.05.36075	4911	MiG-29 (*izd.* 9.12A)	Romanian AF '35 Red'
296.05.36093	?	MiG-29S (*izd.* 9.12S)	Russian AF '333 Silver'
296.05.36100	?	MiG-29S (*izd.* 9.12S)	Bangladesh AF 36100
296.05.36190	?	MiG-29 (*izd.* 9.12)?	not known
296.05.36501	?	MiG-29S (*izd.* 9.12S)	Russian AF '999 Silver', Bangladesh AF 36501
296.05.36502	?	MiG-29S (*izd.* 9.12S)	Bangladesh AF 36502
296.05.36503	?	MiG-29S (*izd.* 9.12S)	Bangladesh AF 36503
296.05.36506	?	MiG-29S (*izd.* 9.12S)	Bangladesh AF 36506
296.05.36507	?	MiG-29S (*izd.* 9.12S)	Bangladesh AF 36507
296.05.36510	?	MiG-29 (*izd.* 9.12)?	not known
296.05.36535	?	MiG-29SE (*izd.* 9.12SE)?	Eritrean AF 508
296.05.36581	5211	MiG-29SM (*izd.* 9.12SM)	Russian AF '299 Blue'
296.05.36587	5214	MiG-29N	Royal Malaysian AF M43-03
296.05.36590	5215	MiG-29N	Royal Malaysian AF M43-04
296.05.36591	5301	MiG-29N	Royal Malaysian AF M43-05
296.05.36592	5302	MiG-29N	Royal Malaysian AF M43-06
296.05.36593	5303	MiG-29N	Royal Malaysian AF M43-07
296.05.3659...?	5304	MiG-29N	Royal Malaysian AF M43-08
296.05.36596	5305	MiG-29N	Royal Malaysian AF M43-09
296.05.36598	5306	MiG-29N	Royal Malaysian AF M43-10
296.05.36599	5307	MiG-29N	Royal Malaysian AF M43-11
296.05.38310	5308	MiG-29N	Royal Malaysian AF M43-12
296.05.38311	5309	MiG-29N	Royal Malaysian AF M43-13
296.05.38312	5310	MiG-29N	Royal Malaysian AF M43-14
296.05.38313	5311	MiG-29N	Royal Malaysian AF M43-15
296.05.38314	5312	MiG-29N	Royal Malaysian AF M43-16
296.05.3831...?	531...?	MiG-29N	Royal Malaysian AF M43-17 † 3-9-1998
296.05.38317	531...?	MiG-29N	Royal Malaysian AF M43-18

296.07.05560	1616	MiG-29 (*izd.* 9.13)	Soviet AF '26 Blue'
296.07.05561	1617	MiG-29 (*izd.* 9.13)	Russian AF '09 White'
296.07.05565	1618?	MiG-29 (*izd.* 9.13)	Soviet AF '11 White', Russian AF '34', Russian AF '67 White'
296.07.05566	1619?	MiG-29 (*izd.* 9.13)	Russian AF '06 Red'
296.07.05568	1620?	MiG-29 (*izd.* 9.13)	Russian AF '04 White'
296.07.05570	1621?	MiG-29 (*izd.* 9.13)	Russian AF '36 Red'
296.07.05571	1622?	MiG-29 (*izd.* 9.13)	Soviet AF '05 White', Russian AF '43', Russian AF '65 White'
296.07.05577	162...	MiG-29 (*izd.* 9.13)	Russian AF '07 White'
296.07.05578	162...	MiG-29 (*izd.* 9.13)	Russian AF '42', Russian AF '36 Red'
296.07.05580	162...	MiG-29 (*izd.* 9.13)	Soviet AF '39 White', Russian AF '43', Russian AF '69 White'
296.07.05585	162...	MiG-29 (*izd.* 9.13)	Russian AF '44 White'
296.07.05587	16...	MiG-29 (*izd.* 9.13)	Russian AF '45 White', '49 White'
296.07.05588	16...	MiG-29 (*izd.* 9.13)	Russian AF '46 White'
296.07.05589	16...	MiG-29 (*izd.* 9.13)	Russian AF '47 White'
296.07.07701	?	MiG-29 (*izd.* 9.13)	Soviet AF '48', Russian AF '38 White' † 17-9-1992
296.07.07702	?	MiG-29 (*izd.* 9.13)	Soviet AF '49', Russian AF '25 Red'
296.07.07703	?	MiG-29 (*izd.* 9.13)	Russian AF '51 White'
296.07.07706	?	MiG-29 (*izd.* 9.13)	Russian AF '52 White'
296.07.07707	?	MiG-29 (*izd.* 9.13)	Russian AF '53 White'
296.07.07710	?	MiG-29 (*izd.* 9.13)	Russian AF '54 White'
296.07.07714	?	MiG-29 (*izd.* 9.13)	Russian AF '01 White'
296.07.07717	?	MiG-29 (*izd.* 9.13)	Russian AF '02 White'
296.07.07721	?	MiG-29 (*izd.* 9.13)	Russian AF '03 Blue', '11 Red'
296.07.07727	?	MiG-29 (*izd.* 9.13)	Russian AF '04 White'
296.07.07731	?	MiG-29 (*izd.* 9.13)	Russian AF '05 White'
296.07.07740	?	MiG-29 (*izd.* 9.13)	Russian AF '06 White'
296.07.07750	?	MiG-29 (*izd.* 9.13)	Soviet/Moldovan AF '24 White' (to USAF)
296.07.07753	?	MiG-29 (*izd.* 9.13)	Soviet/Moldovan AF '29 White' (to USAF)
296.07.07766	?	MiG-29 (*izd.* 9.13)	Russian AF '07 White'
296.07.07769	?	MiG-29 (*izd.* 9.13)	Russian AF '08 White'
296.07.10039	?	MiG-29 (*izd.* 9.13)	Soviet AF '70 Blue'
296.07.10801	?	MiG-29 (*izd.* 9.13)	Russian AF '09 White'
296.07.10810	?	MiG-29 (*izd.* 9.13)	Russian AF '10 White'
296.07.10813	?	MiG-29 (*izd.* 9.13)	Russian AF '06 Red'
296.07.10828	?	MiG-29 (*izd.* 9.13)	Soviet/Moldovan AF '09 White' (to USAF)
296.07.10829	?	MiG-29 (*izd.* 9.13)	Russian AF '02 White'
296.07.10833	?	MiG-29 (*izd.* 9.13)	Russian AF '03 Red'
296.07.10835	?	MiG-29 (*izd.* 9.13)	Russian AF '10 White'
296.07.10836	?	MiG-29 (*izd.* 9.13)	Russian AF '01 White', '25 Blue'
296.07.10941	?	MiG-29 (*izd.* 9.13)	Russian AF '03 White'
296.07.10944	?	MiG-29 (*izd.* 9.13)	Soviet AF '43', Russian AF '08 Red'
296.07.10963	?	MiG-29 (*izd.* 9.13)	Russian AF '40 Red'
296.07.10964	?	MiG-29 (*izd.* 9.13)	Soviet AF '54', Russian AF '09 Red'
296.07.14320	?	MiG-29 (*izd.* 9.13)	Russian AF '08 Red'
296.07.14325	?	MiG-29 (*izd.* 9.13)	Russian AF '41 Red', '03 Red'
296.07.14329	?	MiG-29 (*izd.* 9.13)	Russian AF '42 Red'
296.07.14345	?	MiG-29 (*izd.* 9.13)	Soviet AF '06 Red'
		MiG-29BM	Belorussian AF '03 Red'
296.07.14444?	?	MiG-29 (*izd.* 9.13)	not known (Soviet AF), Belorussian AF '24 Red'
296.07.14622	?	MiG-29 (*izd.* 9.13)	not known (Soviet AF), Russian AF '31 Blue'
296.07.14626	?	MiG-29 (*izd.* 9.13)	Russian AF '49 White', '61', '14 White'
296.07.14627	?	MiG-29 (*izd.* 9.13)	Russian AF '27 White', '62', '24 White'

296.07.14907	?	MiG-29 (*izd.* 9.13)	Soviet AF '67 Red', Russian AF '72 White', Belorussian AF '23 Red'
296.07.14909	?	MiG-29 (*izd.* 9.13)	Soviet AF '69 Red', Russian AF '70 White'
296.07.14928	?	MiG-29 (*izd.* 9.13)	Soviet AF '74 Red', Russian AF '74 White'
296.07.14930	?	MiG-29 (*izd.* 9.13)	Soviet AF '64 Red', Russian AF ' 73 White'
296.07.14933	?	MiG-29 (*izd.* 9.13)	Soviet AF '75 Red', Russian AF '75 White'
296.07.14935	?	MiG-29 (*izd.* 9.13)	not known (Soviet AF), Russian AF '76 White'
296.07.15130	?	MiG-29 (*izd.* 9.13)	Soviet AF '77 Red', Russian AF '77 White'
296.07.15133	?	MiG-29 (*izd.* 9.13)	Soviet AF '76 Red', Russian AF '78 White'
296.07.15135	?	MiG-29 (*izd.* 9.13)	not known (Soviet AF), Belorussian AF '28 Red', '28 Black'
296.07.15136	?	MiG-29 (*izd.* 9.13)	Soviet AF '79 Red', Russian AF '79 White'
296.07.15150	?	MiG-29 (*izd.* 9.13)	Soviet AF '62 Red', Russian AF '41 White', '34 White'
296.07.15151	?	MiG-29 (*izd.* 9.13)	Russian AF '83 White'
296.07.15154	?	MiG-29 (*izd.* 9.13)	Russian AF '84 White'
296.07.15156	?	MiG-29 (*izd.* 9.13)	Russian AF '85 White'
296.07.15157	?	MiG-29 (*izd.* 9.13)	Russian AF '66 Red', '69 White'
296.07.15158	?	MiG-29 (*izd.* 9.13)	Russian AF '87 White'
296.07.15159	?	MiG-29 (*izd.* 9.13)	Russian AF '68 White'
296.07.15161	?	MiG-29 (*izd.* 9.13)	Russian AF '89 White', Belorussian AF '15 White', Peruvian AF 031 † 13-3-2001
296.07.15164	?	MiG-29 (*izd.* 9.13)	Soviet AF '70 Red', Russian AF '80 White'
296.07.15165	?	MiG-29 (*izd.* 9.13)	Russian AF '71 White'
296.07.15168	?	MiG-29 (*izd.* 9.13)	Soviet AF '72 Red', Russian AF '42 White', '06 White'
296.07.15173	?	MiG-29 (*izd.* 9.13)	Soviet/Belorussian AF '03 Red'
296.07.15177	?	MiG-29 (*izd.* 9.13)	Soviet AF '06 Red'
		MiG-29BM	Belorussian AF '06 Black'
296.07.15178	?	MiG-29 (*izd.* 9.13)	Soviet AF '27 Red'
		MiG-29BM	Belorussian AF '07 Red'
296.07.15535	?	MiG-29 (*izd.* 9.13)	Soviet AF '28 Red', Belorussian AF '04 White', Peruvian AF 030
296.07.15540	?	MiG-29 (*izd.* 9.13)	Soviet AF '31 Red', Belorussian AF '11 Red'
296.07.15564	2925?	MiG-29 (*izd.* 9.13)	Soviet AF '08 Red', Russian AF '925 Black' † 24-7-93
296.07.17453	3126	MiG-29 (*izd.* 9.13)	Soviet/Moldovan AF '01 Red', Romanian AF '53 Red'
296.07.17456	312...?	MiG-29 (*izd.* 9.13)	Soviet/Moldovan AF '03 White' (to USAF), 'Russian AF 53 Blue' (fake markings)
296.07.17458	3129?	MiG-29 (*izd.* 9.13)	Soviet/Moldovan AF '10 White' (to USAF)
296.07.17459	3130?	MiG-29 (*izd.* 9.13)	Soviet/Moldovan AF '11 White' (to USAF)
296.07.17464	320...?	MiG-29 (*izd.* 9.13)	Soviet/Moldovan AF '12 White' (to USAF)
296.07.17469	32...?	MiG-29 (*izd.* 9.13)	Soviet/Moldovan AF '04 White' (to USAF)
296.07.17473	32...?	MiG-29 (*izd.* 9.13)	Soviet/Moldovan AF '06 White' (to USAF), 'Russian AF 30 Red' (fake markings)
296.07.17475	32...?	MiG-29 (*izd.* 9.13)	Russian AF '16 Red'
296.07.17491	?	MiG-29 (*izd.* 9.13)	Soviet AF '48 Red'?, '08 Red', Russian AF '33 Red'
296.07.17501	?	MiG-29 (*izd.* 9.13)	Russian AF '12 White'
296.07.17502	?	MiG-29 (*izd.* 9.13)	Russian AF '38 Red'
296.07.17900	?	MiG-29 (*izd.* 9.13)	not known (Soviet/Belorussian AF), Peruvian AF 042
296.07.17911	?	MiG-29 (*izd.* 9.13)	Soviet AF '35 Red', Belorussian AF '25 Red'
296.07.17913?	?	MiG-29 (*izd.* 9.13)	not known (Soviet/Belorussian AF), Peruvian AF 043
296.07.17940	3424?	MiG-29 (*izd.* 9.13)	Soviet/Moldovan AF '02 White' (to USAF)
296.07.17941	3425	MiG-29SM (*izd.* 9.12SM)	no code
296.07.17944	3426?	MiG-29 (*izd.* 9.13)	not known
296.07.17946	3427?	MiG-29 (*izd.* 9.13)	Soviet/Belorussian AF '32 Red', Peruvian AF 045
296.07.18034	?	MiG-29 (*izd.* 9.13)	Russian AF '03 White', '47', '04 White'
296.07.18121	?	MiG-29 (*izd.* 9.13)	Russian AF '51 Blue'
296.07.18706	?	MiG-29 (*izd.* 9.13)	Russian AF '40 Blue'
296.07.19164	?	MiG-29 (*izd.* 9.13)	Soviet AF '70 Red', Belorussian AF '80 Red'
296.07.20187	?	MiG-29 (*izd.* 9.13)	Russian AF '3... Red'
296.07.21907	?	MiG-29 (*izd.* 9.13)	Soviet/Moldovan AF '08 White' (to USAF)
296.07.21930	?	MiG-29 (*izd.* 9.13)	Soviet/Moldovan AF '41 White' (to USAF)
296.07.21940	?	MiG-29 (*izd.* 9.13)	Soviet/Moldovan AF '46 White' (to USAF)
296.07.21943	?	MiG-29 (*izd.* 9.13)	not known (Soviet/Moldovan AF)
296.07.21945	?	MiG-29 (*izd.* 9.13)	Soviet/Moldovan AF '48 White' (to USAF)
296.07.25887	3526?	MiG-29 (*izd.* 9.13)	Soviet AF '26 Red', Russian AF '526 Black' † 24-7-1993
296.07.25893	?	MiG-29 (*izd.* 9.13)	Belorussian AF '11 Red'
296.07.25951	?	MiG-29 (*izd.* 9.13)	Russian AF '47 Blue'
296.07.25953	?	MiG-29 (*izd.* 9.13)	Soviet AF '21', Russian AF '11 Red'
296.07.25975?	?	MiG-29 (*izd.* 9.13)	Soviet AF '04 Blue' (404)
296.07.27413	?	MiG-29 (*izd.* 9.13)	Russian AF '20 Red'
296.07.27415	?	MiG-29 (*izd.* 9.13)	Russian AF '21 Red'
296.07.27420	?	MiG-29 (*izd.* 9.13)	Russian AF '22 Red', '04 Red'
296.07.27421	?	MiG-29 (*izd.* 9.13)	Russian AF '01 Red'
296.07.27422	?	MiG-29 (*izd.* 9.13)	Russian AF '02 Red'
296.07.27423	?	MiG-29 (*izd.* 9.13)	Russian AF '03 Red'
296.07.27424	?	MiG-29 (*izd.* 9.13)	Russian AF '04 Red'
296.07.27429	?	MiG-29 (*izd.* 9.13)	Russian AF '05 Red'
296.07.27430	?	MiG-29 (*izd.* 9.13)	Russian AF '06 Red'
296.07.27436	?	MiG-29 (*izd.* 9.13)	Russian AF '07 Red'

296.07.27437	?	MiG-29 (*izd.* 9.13)		Russian AF '08 Red'
296.07.27438	?	MiG-29 (*izd.* 9.13)		Russian AF '09 Red'
296.07.27439	?	MiG-29 (*izd.* 9.13)		Russian AF '10 Red', '27 Blue'
296.07.27440	?	MiG-29 (*izd.* 9.13)		Russian AF '11 Red'
296.07.27443	?	MiG-29 (*izd.* 9.13)		Russian AF '23 Red'
296.07.27444	?	MiG-29 (*izd.* 9.13)		Russian AF '24 Red'
296.07.27448	?	MiG-29 (*izd.* 9.13)		Russian AF '02 Blue'
296.07.27450	?	MiG-29 (*izd.* 9.13)		Russian AF '25 Red'
296.07.28070	?	MiG-29 (*izd.* 9.13)		not known
296.07.28100	?	MiG-29 (*izd.* 9.13)		Russian AF '26 Red'
296.07.28101	?	MiG-29 (*izd.* 9.13)		Russian AF '27 Red'
296.07.28102	?	MiG-29 (*izd.* 9.13)		Russian AF '28 Red'
296.07.28105	?	MiG-29 (*izd.* 9.13)		Russian AF '29 Red'
296.07.28106	?	MiG-29 (*izd.* 9.13)		Russian AF '30 Red'
296.07.28107	?	MiG-29 (*izd.* 9.13)		Russian AF '31 Red'
296.07.28108	?	MiG-29 (*izd.* 9.13)		Russian AF '32 Red'
296.07.28109	?	MiG-29 (*izd.* 9.13)		Russian AF '33 Red'
296.07.28110	?	MiG-29 (*izd.* 9.13)		Russian AF '34 Red'
296.07.28111	?	MiG-29 (*izd.* 9.13)		Russian AF '35 Red', '26 Red'
296.07.28114	?	MiG-29 (*izd.* 9.13)		Russian AF '36 Red'
296.07.28115	?	MiG-29 (*izd.* 9.13)		Russian AF '38 Red'
296.07.28116	?	MiG-29 (*izd.* 9.13)		not known
296.07.28117	?	MiG-29 (*izd.* 9.13)		Russian AF '39 Red'
296.07.28120	4717	MiG-29 (*izd.* 9.13)		Ukrainian AF '106 White'
296.07.28139	?	MiG-29 (*izd.* 9.13)		Russian AF '33 White'
296.07.28140	?	MiG-29 (*izd.* 9.13)		Russian AF '05 Red'
296.07.28142	?	MiG-29 (*izd.* 9.13)		Soviet AF '12', Russian AF '15 Blue'
296.07.28143	?	MiG-29 (*izd.* 9.13)		Russian AF '01 Red'
296.07.28152	?	MiG-29 (*izd.* 9.13)		Soviet AF '02 Red', Russian AF '26',
				'14 Red'
296.07.28156	?	MiG-29 (*izd.* 9.13)		Soviet AF '10', Russian AF '20 Red',
				'62 Blue'
296.07.28159	?	MiG-29 (*izd.* 9.13)		Russian AF '03 Red', '15 Red'
296.07.28160	?	MiG-29 (*izd.* 9.13)		Soviet AF '11', Russian AF '21 Red',
				'57 White'
296.07.28170	?	MiG-29 (*izd.* 9.13)		Russian AF '04 Red'
296.07.28185	?	MiG-29 (*izd.* 9.13)		Russian AF '02 Blue'
296.07.28186	?	MiG-29 (*izd.* 9.13)		Russian AF '05 Red'
296.07.28187	?	MiG-29 (*izd.* 9.13)		Russian AF '3... Red', '23 Blue'
296.07.28188	?	MiG-29 (*izd.* 9.13)		Soviet AF '45', Russian AF '03 Blue'
296.07.28196	?	MiG-29 (*izd.* 9.13)		Ukrainian AF '108 White'
296.07.29019	?	MiG-29 (*izd.* 9.13)	27-4-1990	Russian AF '23 White',
				Russian AF '23 Blue'
296.07.29024	?	MiG-29 (*izd.* 9.13)		Soviet AF '45', Russian AF '12 Red'
296.07.29025	?	MiG-29 (*izd.* 9.13)	31-5-1990	Russian AF '47 White'
296.07.29031	?	MiG-29 (*izd.* 9.13)	31-5-1990	Russian AF '51 White'
296.07.29359	?	MiG-29 (*izd.* 9.13)		Soviet AF '29 Blue',
				Russian AF '29 Red'
296.07.29363	?	MiG-29 (*izd.* 9.13)		Soviet AF '57', Russian AF '24 Red'
296.07.29387	?	MiG-29 (*izd.* 9.13)		Soviet AF '07', Russian AF '05 Blue'
296.07.31207	5318	MiG-29 (*izd.* 9.13)		Russian AF '56 White'
296.07.312...?	5319	MiG-29 (*izd.* 9.13)?		not known
296.07.3121...?	5320	MiG-29 (*izd.* 9.13)?		not known
296.07.3121...?	5321	MiG-29 (*izd.* 9.13)?		not known
296.07.3121...?	5322	MiG-29 (*izd.* 9.13)?		not known
296.07.312...?	5323	MiG-29 (*izd.* 9.13)?		not known
296.07.31222	5324	MiG-29 (*izd.* 9.13)		Ukrainian AF '101 Blue', '105 White'

296.07.3122...?	5325	MiG-29 (*izd.* 9.13)?	not known
296.07.31225	5326	MiG-29 (*izd.* 9.13)	Ukrainian AF '102 White'
296.07.31227	5327	MiG-29 (*izd.* 9.13)	Ukrainian AF '103 White'
296.07.3122...?	5328	MiG-29 (*izd.* 9.13)?	not known
296.07.31230	5329?	MiG-29 (*izd.* 9.13)	Ukrainian AF '44 White'
296.07.31232	5330	MiG-29 (*izd.* 9.13)	Ukrainian AF '101 White'
296.07.31239	5420	MiG-29 (*izd.* 9.13)	Ukrainian AF '108 White', '104 White'
296.07.31631	?	MiG-29 (*izd.* 9.13)	Russian AF '23 Red'
296.07.31640	?	MiG-29S (*izd.* 9.13S)	Soviet/Russian AF '52 Red',
			Russian AF '02 Blue', '02 Red'
296.07.31641	?	MiG-29 (*izd.* 9.13)	not known (Ukrainian AF)
296.07.31646	?	MiG-29S (*izd.* 9.13S)	Soviet/Russian AF '50 Red',
			Russian AF '04 Blue', '04 Red'
296.07.31659	?	MiG-29S (*izd.* 9.13S)	Soviet/Russian AF '55 Red',
			Russian AF '05 Blue', '05 Red'
296.07.31660	?	MiG-29S (*izd.* 9.13S)	Soviet/Russian AF '64 Red',
			Russian AF '14 Blue', '03 Red'
296.07.31667	?	MiG-29 (*izd.* 9.13)	Soviet AF '57 Red',
			Russian AF '31 Red'
296.07.31668	?	MiG-29S (*izd.* 9.13S)	Soviet AF '58', Russian AF '32 Red'
296.07.31670	?	MiG-29S (*izd.* 9.13S)	Soviet AF '60', Russian AF '10 Red'
296.07.31677	?	MiG-29S (*izd.* 9.13S)	Soviet AF '62', Russian AF '08 Red'
296.07.31690	562...?	MiG-29SE (*izd.* 9.13SE)	Peruvian AF 048
296.07.31693	5626	MiG-29SE (*izd.* 9.13SE)	Peruvian AF 049
296.07.31694	5627?	MiG-29SE (*izd.* 9.13SE)	Peruvian AF 055

27578?	?	MiG-29K (*izd.* 9.31)	Soviet/Russian Navy '311 Blue'
27579?	?	MiG-29K (*izd.* 9.31)	Soviet/Russian Navy '312 Blue'

[296.09.]05551	?	MiG-29M (*izd.* 9.15)	Soviet AF '151 Blue'
[296.09.]05552	?	MiG-29M (*izd.* 9.15)	Soviet AF '152 Blue'
[296.09.]05553	?	MiG-29M (*izd.* 9.15)	Soviet AF '153 Blue'
[296.09.]05554	?	MiG-29M (*izd.* 9.15)	Soviet AF '154 Blue'
		MiG-29M2	Russian AF '154 White'
[296.09.]05555	?	MiG-29M (*izd.* 9.15)	Soviet AF '155 Blue'
[296.09.]05556	?	MiG-29M (*izd.* 9.15)	Soviet AF '156 Blue',
			Russian AF ' 301 Blue'
		MiG-29OVT	no code, Russian AF '156 White'

40.296.92486	?	MiG-29UB	Soviet AF '53 Blue';
			Soviet/Russian AF '304 Blue' ?
		MiG-29UBT?	'304 Blue' (see c/n N50903008134)
N509030.01024	?	MiG-29UB	not known (Soviet/Ukrainian AF)
N509030.01052	?	MiG-29UB	Russian AF '80 White'
N509030.01408	?	MiG-29UB	not known
N509030.03127	?	MiG-29UB	not known (Soviet/Ukrainian AF)
N509030.03593	?	MiG-29UB	Russian AF '71 White outline'
N509030.05494	?	MiG-29UB	Russian AF '72 White'
N509030.05603	?	MiG-29UB	Russian AF '73 White', '74 White',
			'82 White'
N509030.06406	?	MiG-29UB	Yugoslav AF 18302 † 24-4-1998
N509030.06448	?	MiG-29UB	East German AF '148 Black'
		MiG-29GT	Luftwaffe 29+22, Polish AF ('48 Red'?)
N509030.06526	?	MiG-29UB	East German AF '179 Black'
		MiG-29GT	Luftwaffe 29+23, Polish AF '4115 Red'
N509030.06604	?	MiG-29UB	East German AF '181 Black'
		MiG-29GT	Luftwaffe 29+24, Polish AF ('04 Red'?)

N509030.073...	?	MiG-29UB		Soviet/Belorussian AF '17 Red'
N509030.07603	?	MiG-29UB		Soviet/Russian AF '55 Blue', Russian AF '55 Black outline'
N509030.08094	?	MiG-29UB		Soviet/Russian AF '64 Orange', Russian AF '64 Black outline'
N509030.08134	?	MiG-29UB MiG-29UBT?		Soviet/Russian AF '304 Blue' ? (rep. as such; see c/n 4029692486)
N509030.08303	?	MiG-29UB		Russian AF '66 Blue'
N509030.08467	?	MiG-29UB		not known (Soviet AF), Russian AF '82 Red'
N509030.08893	?	MiG-29UB		not known (Soviet AF), Russian AF '37 Red'
N509030.10376	?	MiG-29UB		not known (Soviet AF), Russian AF '71 White'
N509030.11408	?	MiG-29UB MiG-29GT		East German AF '185 Black' Luftwaffe 29+25, Polish AF ('408 Red'?)
N509030.12038	?	MiG-29UB		Soviet/Moldovan AF '61 White' (to USAF)
N509030.12547	?	MiG-29UB		Soviet/Belorussian AF '63 Red', Peruvian AF 046
N509030.13244	?	MiG-29UB		Czechoslovak/Slovak AF '4401 Black' † ?-3-1994
N509030.13375	?	MiG-29UB		Bulgarian AF '01 White', '11 White'
N509030.13394	?	MiG-29UB		Bulgarian AF '02 White', '12 White'
N509030.13569	?	MiG-29UB		Russian AF '04'
N509030.13814	?	MiG-29UB		Russian AF '71 Red'
N509030.13912	?	MiG-29UB		Russian AF '11 White', '19 Red'
N509030.14007	?	MiG-29UB		Russian AF '33 White'
N509030.14019	?	MiG-29UB		not known (Soviet AF), Russian AF '06 Blue'
N509030.14144	?	MiG-29UB		not known (Soviet AF), Russian AF '08 Blue'
N509030.14165	?	MiG-29UB		not known (Soviet AF), Russian AF '10 Blue'
N509030.14414	?	MiG-29UB		not known (Soviet AF), Russian AF '16 Blue'
N509030.14528	?	MiG-29UB		Czechoslovak/Czech AF '4402 Black', Polish AF '28 Red'
N509030.14615	?	MiG-29UB		Polish AF '15 Red'
N509030.14642	?	MiG-29UB		Polish AF '42 Red'
N509030.14664	?	MiG-29UB		Polish AF '64 Red'
N509030.14717	?	MiG-29UB		Cuban AF '901 Black'
N509030.14905	?	MiG-29UB		Russian AF '33 White'
N509030.14938	?	MiG-29UB		not known (Soviet AF), Russian AF '20 Blue'
N509030.15148	?	MiG-29UB		not known (Soviet AF), Russian AF '40 Blue'
N509030.15406	?	MiG-29UB		not known (Soviet AF), Russian AF '48 Blue'
N509030.15479	?	MiG-29UB		not known (Soviet AF), Russian AF '89 Blue'
N509030.16215	?	MiG-29UB		Romanian AF '15 Red'
N509030.16222	?	MiG-29UB		Romanian AF '22 Red'
N509030.16223	?	MiG-29UB		Romanian AF '23 Red'
N509030.16227?	?	MiG-29UB		Romanian AF '27 Red'
N509030.16229	?	MiG-29UB		Romanian AF '29 Red' † 6-7-1992
N509030.16527	?	MiG-29UB		Russian AF '32 White'
N509030.16584	?	MiG-29UB		Russian AF '71 Red', '34 White'
N509030.17048	?	MiG-29UB		Russian AF '70 Red'
N509030.17124	?	MiG-29UB		Russian AF '91 Red'
N509030.18908	?	MiG-29UB		Bulgarian AF '03 White', '13 White', '33 White'
N509030.18945	?	MiG-29UB		Bulgarian AF '04 White', '14 White'
N509030.19347	?	MiG-29UB		Soviet AF '26 Blue', Russian AF '74 Red'
N509030.21006	?	MiG-29UB		Ukrainian AF '02'
N509030.21336	?	MiG-29UB		not known (Soviet AF), Russian AF '33 Red'
N509030.21583	?	MiG-29UB		not known (Soviet AF), Russian AF '37 Red'
N509030.21629	?	MiG-29UB		not known (Soviet AF), Russian AF '75 Red'
N509030.21704	?	MiG-29UB		not known (Soviet AF), Russian AF '38 Red'
N509030.23006	?	MiG-29UB		not known (Soviet AF), Russian AF '86 White'
N509030.23774	?	MiG-29UB		not known (Soviet AF), Russian AF '102 White'
N509030.23893	?	MiG-29UB		not known (Soviet AF), Russian AF '81 White'
N509030.24019	?	MiG-29UB		not known (Soviet AF), Russian AF '74 White'
N509030.24113	?	MiG-29UB		not known (Soviet AF), Russian AF '56 Blue', '20 Blue'
N509030.24155	?	MiG-29UB		Ukrainian AF '104 White'
N509030.24156	?	MiG-29UB		Ukrainian AF '111 Blue'
N509030.25235	?	MiG-29UB		not known (Soviet AF), Russian AF '84 Red'
N509030.25982	?	MiG-29UB MiG-29UBT		not known (Soviet AF) Russian AF '52 Blue'/952
N509030.26004	?	MiG-29UB		Russian AF '82 Blue'
N509030.26013	?	MiG-29UB		Belorussian AF '63 Red'
N509030.26146	?	MiG-29UB		Soviet AF '25 Red'
N509030.26414	?	MiG-29UB		Russian AF '84 Blue'
N509030.26539	?	MiG-29UB		Russian AF '86 Blue'
N509030.26767	?	MiG-29UB	16-4-1992	Russian AF '74 White'
N509030.26848	?	MiG-29UB		Russian AF '90 Blue'
N509030.26969	?	MiG-29UB	16-10-1992	Russian AF '75 White'
N509030.27002	?	MiG-29UB		not known (Belorussian AF), Peruvian AF 047
N509030.27135	?	MiG-29UB		Hungarian AF '24 Red'
N509030.27146	?	MiG-29UB		Hungarian AF '25 Red'
N509030.27257	?	MiG-29UB		Hungarian AF '26 Red'
N509030.27268	?	MiG-29UB		Hungarian AF '27 Red', '27 Black'
N509030.27279	?	MiG-29UB		Hungarian AF '28 Red'
N509030.27380	?	MiG-29UB		Hungarian AF '29 Red'
N509030.28113	?	MiG-29UB		Slovak AF '1303 Black'
N509030.28253	?	MiG-29UB		Slovak AF '5304 Black'
N509030.28264	?	MiG-29UB		Bangladesh AF 28264
?	1607	MiG-29UB		not known (Soviet AF)
?	2410	MiG-29UB		not known (Soviet AF)
?	5212	MiG-29NUB		Royal Malaysian AF M43-01
?	5213	MiG-29NUB		Royal Malaysian AF M43-02

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