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History, Development and Structure of the Mikoyan MiG-29 Fighter

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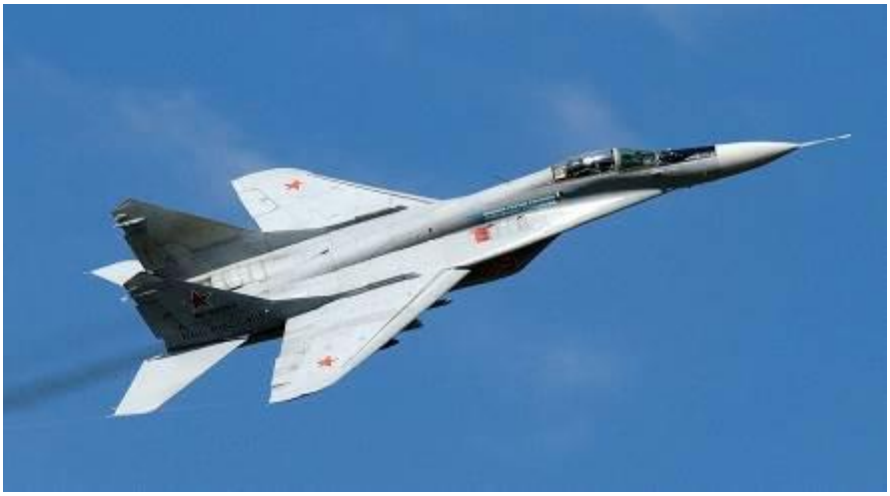
Abstract: The **Mikoyan MiG-29** (Russian: Микоян МиГ-29; NATO reporting name: **Fulcrum**) is a twin-engine fighter aircraft designed in the Soviet Union. Developed by the Mikoyan design bureau as an air superiority fighter during the 1970s, the MiG-29, along with the larger Sukhoi Su-27, was developed to counter new U.S. fighters such as the McDonnell Douglas F-15 Eagle and the General Dynamics F-16 Fighting Falcon. The MiG-29 entered service with the Soviet Air Forces in 1983.

Keywords: *MiG-29, Fulcrum, air superiority fighter, TSAGI.*

While originally oriented towards combat against any enemy aircraft, many MiG-29s have been furnished as multirole fighters capable of performing a number of different operations, and are commonly outfitted to use a range of air-to-surface armaments and precision munitions. The MiG-29 has been manufactured in several major variants, including the multirole Mikoyan MiG-29M and the navalised Mikoyan MiG-29K; the most advanced member of the family to date is the Mikoyan MiG-35. Later models frequently feature improved engines, glass cockpits with HOTAS-compatible flight controls, modern radar and infrared search and track (IRST) sensors, and considerably increased fuel capacity; some aircraft have also been equipped for aerial refueling.

Following the dissolution of the Soviet Union, the militaries of multiple ex-Soviet republics have continued to operate the MiG-29, the largest of which is the Russian Aerospace Forces. The Russian Aerospace Forces wanted to upgrade its existing fleet to the modernised MiG-29SMT configuration, but financial difficulties have limited deliveries. The MiG-29 has also been a popular export aircraft; more than 30 nations either operate or have operated the aircraft to date.



Pic.1 Air Force MiG-29

Development

Origins

In the mid–1960s, the United States Air Force (USAF) encountered difficulties over the skies of Vietnam. Supersonic fighter bombers that had been optimized for low altitude bombing, like the F-105 Thunderchief, were found to be vulnerable to older MiG-17s and more advanced MiGs which were much more maneuverable. In order to regain the limited air superiority enjoyed over Korea, the US refocused on air combat using the F-4 Phantom multirole fighter, while the Soviet Union developed the MiG-23 in response. Towards the end of the 1960s, the USAF started the "F-X" program to produce a fighter dedicated to air superiority, which led to the McDonnell Douglas F-15 Eagle being ordered for production in late 1969.

At the height of the Cold War, a Soviet response was necessary to avoid the possibility of a new American fighter gaining a serious technological advantage over existing Soviet fighters. Thus the development of a new air superiority fighter became a priority. In 1969, the Soviet General Staff issued a requirement for a *Perspektivnyy Frontovoy Istrebitel* (*PFI*, roughly "Advanced Frontline Fighter"). Specifications were extremely ambitious, calling for long range, good short-field performance (including the ability to use austere runways), excellent agility, Mach 2+ speed, and heavy armament. The Russian aerodynamics institute TSAGI worked in collaboration with the Sukhoi design bureau on the aircraft's aerodynamics.

Pic.2 MiG-29 parked after a display flight at the Abbotsford Air Show, 1989

There have been several upgrade programmes conducted for the MiG-29. Common upgrades include the adoption of standard-compatible avionics, service life extensions to 4,000 flight hours, safety enhancements, greater combat capabilities and reliability.

Replacement

On 11 December 2013, Russian deputy prime minister Dmitry Rogozin revealed that Russia was planning to build a new fighter to replace the MiG-29. The Sukhoi Su-27 and its derivatives were to be replaced by the Sukhoi Su-57, but a different design was needed to replace the lighter MiGs. A previous attempt to develop a MiG-29 replacement, the MiG 1.44 demonstrator, failed in the 1990s. The concept came up again in 2001 with interest from India, but they later opted for a variant of the Su-57. Air Force commanders have hinted at the possibility of a single-engine airframe that uses the Su-57's engine, radar, and weapons primarily for Russian service. This has since been revealed to be the Sukhoi Su-75 Checkmate.

Design

MiG-29UB of the Swifts aerobatic team

Sharing its origins in the original PFI requirements issued by TSAGI, the MiG-29 has broad aerodynamic similarities to the Sukhoi Su-27, but with some notable differences. The MiG-29 has a mid-mounted swept wing with blended leading-edge root extensions (LERXs) swept at around 40°; there are swept tailplanes and two vertical fins, mounted on booms outboard of the engines. Automatic slats are mounted on the leading edges of the wings; they are four-segment on early models and five-segment on some later variants. On the trailing edge, there are maneuvering flaps and wingtip ailerons.

The MiG-29 has hydraulic controls and a SAU-451 three-axis autopilot but, unlike the Su-27, no fly-by-wire control system. Nonetheless, it is very agile, with excellent instantaneous and sustained turn performance, high-alpha capability, and a general resistance to spins. The airframe consists primarily of aluminum with some composite materials, and is stressed for up to 9 g (88 m/s^2) maneuvers. The controls have "soft" limiters to prevent the pilot from exceeding g and alpha limits, but the limiters can be disabled manually.

Pic.3 MiG-29UB of the Swifts aerobatic team

Powerplant and range

The MiG-29 has two widely spaced Klimov RD-33 turbofan engines, each rated at 50 kilonewtons (11,200 lbf) dry and 81.3 kilonewtons (18,300 lbf) in afterburner. The space between the engines generates lift, thereby reducing effective wing loading, hence improving maneuverability. The engines are fed through intake ramps fitted under the leading-edge extensions (LERXs), which have variable ramps to allow high-Mach speeds. Due to their relatively short combustor, the engines produce noticeably heavier smoke than their contemporaries. As an adaptation to rough-field operations, the main air inlet can be closed completely and the auxiliary air inlet on the upper fuselage can be used for takeoff, landing and low-altitude flying, preventing ingestion of ground debris. Thereby the engines receive air through louvers on the LERXs which open automatically when intakes are closed. However the latest variant of the family, the MiG-35, eliminated these dorsal louvers, and adopted the mesh screens design in the main intakes, similar to those fitted to the Su-27.

Pic.4 RD-33 on display at the Luftwaffenmuseum of the Bundeswehr

The MiG-29 has a ferry range of 1,500 km (930 mi) without external fuel tanks, and 2,100 km (1,300 mi) with external tanks. The internal fuel capacity of the original MiG-29B is 4,365 L (960 imp gal; 1,153 US gal) distributed between six internal fuel tanks, four in the fuselage and one in each wing. For longer flights, this can be supplemented by a 1,500 L (330 imp gal; 400 US gal) centreline drop tank and, on later production batches, two 1,150 L (250 imp gal; 300 US gal) underwing drop tanks. In addition, newer models have been fitted with port-side inflight refueling probes, allowing much longer flight times by using a probe-and-drogue system.

Pic.5 MiG-29B inflight with its Klimov RD-33 turbofan engines on full afterburner

Cockpit

The cockpit features a conventional centre stick and left hand throttle controls. The pilot sits in a Zvezda K-36DM ejection seat.

The cockpit has conventional dials, with a head-up display (HUD) and a Shchel-3UM helmet mounted display, but no HOTAS ("hands-on-throttle-and-stick") capability. Emphasis seems to have been placed on making the cockpit similar to the earlier MiG-23 and other Soviet aircraft for ease of conversion, rather than on ergonomics. Nonetheless, the MiG-29 does have substantially better visibility than most previous Soviet jet fighters, thanks to a high-mounted bubble canopy. Upgraded models introduce "glass cockpits" with modern liquid-crystal (LCD) multi-function displays (MFDs) and true HOTAS.

Pic.6 MiG-29 cockpit, 1995

Sensors

The baseline MiG-29B has a Plastron RLPK-29 radar fire control system which includes the N019 *Sapfir 29* look-down/shoot-down coherent pulse-Doppler radar and the Ts100.02-02 digital computer.

Pic.7 MiG-29 nose showing radome and S-31E2 KOLS IRST

The N019 radar was not a new design, but rather a development of the Sapfir-23ML architecture used on the MiG-23ML. During the initial design specification period in the mid-1970s, Phazotron NIIR was tasked with producing a modern radar for the MiG-29. To speed development, Phazotron based its new design on work undertaken by NPO Istok on the experimental "*Soyuz*" radar program. Accordingly, the N019 was originally intended to have a flat planar array antenna and full digital signal processing, for a detection and tracking range of at least 100 km (62 mi) against a fighter-sized target. Prototype testing revealed this could not be attained in the required timeframe and still fit within the MiG-29's nose. Rather than design a new radar, Phazotron reverted to a version of the Sapfir-23ML's twisted-polarization cassegrain antenna and traditional analog signal processors, coupled with a new NII Argon-designed Ts100 digital computer to save time and cost. This produced a working radar system, but inherited the weak points of the earlier design, plaguing the MiG-29's ability to detect and track airborne targets at ranges available with the R-27 and R-77 missiles.

Pic.8 MiG-29UB on display, showing gunport

The N019 was further compromised by Phazotron designer Adolf Tolkachev's betrayal of the radar to the CIA, for which he was executed in 1986. In response to all of these problems, the Soviets hastily developed a modified N019M *Topaz* radar for the upgraded *MiG-29S* aircraft. However, *VVS* was reportedly still not satisfied with the performance of the system and demanded another upgrade. The latest upgraded aircraft offered the N010 *Zhuk-M*, which has a planar array antenna rather than a dish, improving range, and a much superior processing ability, with multiple-target engagement capability and compatibility with the Vympel R-77 (or RVV-AE)

Armament

Pic.9 MiG-29B showing its full underbelly. Note the six underwing pylons carrying R-27 and R-73 air-to-air missiles. The centerline fuel tank is seen with an APU exhaust duct.

Armament for the MiG-29 includes a single GSh-30-1 30 mm (1.18 in) cannon in the port wing root. This originally had a 150-round magazine, which was reduced to 100 rounds in later variants, which only allows a few seconds of firing before running out of ammo. Original production MiG-29B aircraft cannot fire the cannon when carrying a centerline fuel tank as it blocks the shell ejection port. This was corrected in the MiG-29S and later versions.

Three pylons are provided under each wing (four in some variants), for a total of six (or eight). The inboard pylons can carry either a 1,150 L (250 imp gal; 300 US gal) fuel tank, one *Vympel* R-27 (AA-10 "Alamo") medium-range air-to-air missile, or unguided bombs or rockets. Some Soviet aircraft could carry a single nuclear bomb on the port inboard station. The outer pylons usually carry R-73 (AA-11 "Archer") dogfight air to air missiles, although some users still retain the older R-60 (AA-8 "Aphid"). A single 1,500 L (330 imp gal; 400 US gal) tank can be fitted to the centerline, between the engines.

The US has supplied AGM-88 HARM missiles to Ukraine. It appears that they are fired from MiG-29s. It was only disclosed after Russian forces showed footage of a tail fin from one of these missiles. U.S. Under Secretary of Defense for Policy Colin Kahl has said this: "I would just point to two things. One, you know, a lot was made about the MiG-29 issue several months ago, not very much has been noticed about the sheer amount of spare parts and other things that we've done to help them actually put more of their own MiG-29s in the air and keep those that are in the air flying for a longer period of time. And then also, in recent PDA [Presidential Drawdown Authority] packages we've included a number of anti-radiation missiles that can be fired off of Ukrainian aircraft. They can have effects on Russian radars and other things." Soviet era aircraft don't have the computer architecture to accept NATO standard weapons. The interface would be difficult; however with a "crude modification", such as an e-tablet, it would be possible.

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