DIGITAL COMBAT SIMULATOR

Mi-8MTV2

Magnificent Eight

РУКОВОДСТВО ПИЛОТА

belsimtek

THE FIGHTER COLLECTION

Eagle Dynamics

DCS SERIES

This document is a user manual for *DCS: Mi-8MTV2 Magnificent Eight* PC flight simulation game. The manual provides descriptions and instructions required for successful operation of the subject aircraft in the simulation world. The *DCS* user interface and mission editor are described in a separate document included with the product and found in the installation folder.

For additional information and community discussion of the product, please see the official online forums: http://forums.eagle.ru/.

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MI-8 HISTORY

1. MI-8 HISTORY

In the late 1950s, Mikhail Mil, then chief design engineer of OKB-329 experimental design bureau, began to consider the development of a second generation of light and medium class helicopters to be powered by gas turbine powerplants to replace the previous Mi-1 and Mi-4 models, which were then in serial production. Single and twin-engine designs were envisioned to replace the Mi-1 and Mi-4, respectively.

Fig. 9.1. Mi-4, the precursor to the Mi-8

At the preliminary design phase, the new helicopter was proposed as a further modification of the Mi-4 to be powered by a gas turbine powerplant. The main and tail rotors, tail boom and stabilizer, transmission, landing gear, control system and many other components were kept almost unchanged. The forward and mid fuselage were redesigned: the powerplant was moved to the top of the cargo cabin and the cockpit took the place of the Mi-4's engine compartment at the front of the fuselage. The fuselage was redesigned to increase passenger and cargo capacity. The helicopter was designed to carry oversized equipment or up to 20 passengers. In addition to basic civilian and military personnel carrying models, combat transport, anti-submarine and VIP models were planned.

On the insistence of the Soviet Ministry of Civil Aviation, the Council of Ministers of the USSR decreed on February 20, 1958, that a helicopter designated as the V-8 shall be developed to provide a cargo lifting capacity of 1.5 - 2 tons, powered by a single AI-24 gas turbine engine originally designed by A. Ivchenko for fixed-wing aircraft. About a year later, the V-8 project also gained the support of the Soviet Air Force command. Development of the V-8 was headed by deputy chief design engineer V. Kuznetsov. G. Remezov was appointed as the lead engineer (later he was followed by V. Nikiforov). In 1959, after approval of the concept design and full-scale mock-up, the team proceeded with detailed design of a single-engine V-8 model.

The AI-24V engine produced 1900 horsepower, which allowed the V-8 to retain the transmission of the Mi-4. However, performance of the AI-24V, especially specific fuel consumption requirements, was short of expectations. Furthermore the designers felt a need to move to a safer and more reliable twin-engine design. Several aircraft engine design bureaus were tasked with creating a 1250 horsepower turboshaft engine. The engine design challenge was taken with enthusiasm by a young experimental design bureau, OKB-117, headed by chief designer S. Izotov. This same team was also assigned the development of a new twin-shaft main transmission. The resulting increase in overall output of the powerplant provided a greater lifting capacity for the new helicopter. The contractor approved the proposed design and on May 30, 1960, a decision was made to build a twin-engine V-8A demonstrator in parallel with the single-engine V-8.

During the concept and detailed design phases, engineers of the Mil design bureau improved not only the transmission, but also other components and systems of the V-8. For example the quadricycle landing gear was replaced by a tricycle system with a castering nose gear, hydraulic vertical hinge friction dampers were integrated in the main rotor assembly, the alcohol-based anti-icing system was replaced by an electric heating system; the hydraulic actuators of all four control channels were to be installed as a single hydraulic unit, the control system was enhanced with trimmers and artificial feel mechanisms, the landing gear and vertical stabilizer were covered with aerodynamic fairings, etc. The designers planned to retrofit most of their novelties on the Mi-4 as well to maximize commonality between existing and new helicopter models. Gradually Mikhail Mil and his team were moving from a deep upgrade of the Mi-4 to a conceptually new and promising helicopter design.

For the first time the fuselage was designed with die forgings and weld-bonded joints. The nose section featured a comfortable and unrestrictive cockpit providing an excellent view and a battery compartment underneath the floor. The helicopter had a crew of three: commander ("pilot"), navigator ("copilot"), and flight engineer ("crew chief").

The central fuselage featured a 5.34 x 2.34 x 1.8 m cargo cabin ending with rear clamshell doors, the engine and gearbox compartments placed on top, and a service fuel tank to serve as the main fuel source for the powerplant. The cargo cabin of the V-8 was designed to transport cargo and equipment with an overall weight of up to 2 tons. For rescue missions, the helicopter was equipped with a 150 kg capacity hoist, mounted outside and above the passenger cabin access door. To transport oversized cargo, an original hinge-pendulum external stores support system was developed with a carrying capacity of 2500 kg. The engine and gearbox cowlings allowed maintenance personnel to inspect all of the components in the upper part of the helicopter without using ladders. Two main fuel tanks were attached externally on both sides of the fuselage with steel straps. The tail boom featured a horizontal stabilizer, the deflection angle for which was preset on the ground.

The single-engine V-8 made its maiden flight on June 24, 1961, piloted by B. Zemskov. In December of the same year, the first V-8 was presented for joint state trials. However, the single-engine V-8 was not fated to be the prototype for the future serial production model and from 1963 onward it was only used as a testbed. The manufacturer and contractor would place their stakes on the twin-engine design. Assembled in November 1961, the second prototype of the single-engine V-8 was used for ground tests only and became the original conversion airframe into the twin-engine V-8A model.

The new TV2-117 turboshaft engines and the VR-8 main transmission developed by S. Izotov's team were manufactured in the summer of 1962. The engines developed a takeoff power rating of 1500 horsepower each and demonstrated impressive performance characteristics. The twin-engine powerplant provided a sufficiently high power-to-weight ratio to allow the helicopter to maintain level flight with one engine inoperative. The VR-8 was a three-stage planetary reduction gear with a transmission ratio of 1:62.6.

On August 2, 1961, test pilot N. Levshin lifted the twin-engine version off the ground for the first time and on September 17 the helicopter performed its first untethered flight. In March 1963, the V-8A proceeded to the first phase of joint state trails, which were generally successful, although at times flights were suspended and the helicopter was grounded to address defects or retrofit equipment. In the summer of 1963, trials were suspended for nearly two months while additional work was done on the engines and main transmission.

The design of the prototype was continually modified, over time resembling its Mi-4 predecessor less and less. In particular a new five-blade main rotor was created to reduce the intensity of vibrations. The blades were of solid metal construction like those of the Mi-4, but some of the joints were reinforced. A new electric anti-icing system was installed. The original wooden tail rotor blades were replaced with all-metal blades. Monotube landing gear struts were replaced with twin-tube oleo struts that eliminated the likelihood of dynamic instability. The design of the tail strut was also changed. The landing gear and wheels were covered with fairings. An automatic flight control system centered on a four-channel AP-34 autopilot system was introduced into the control system and significantly improved handling.

As development tests and improvements continued, the new powerplant was equipped with an automatic governor system that adjusted engine power output as required to maintain main rotor speed (RPM) within normal limits and synchronized the operation of the two engines. In case of a single engine failure in flight, the system automatically commanded the remaining engine to increase power.

All of the improvements were quickly implemented on the third prototype in the process of assembly. This prototype was built as a troop carrying version and was designated V-8AT. It featured twenty folding seats arranged along the walls inside the cargo cabin. Meanwhile the mockup was used to test the loading and securing of various types of combat and engineering equipment, as well as fitting of an armament system identical to that of the Mi-4AV. The external appearance of the V-8AT was somewhat altered compared to the V-8A: side cockpit doors were replaced with sliding blisters and a sliding door was implemented in the cargo cabin.

Assembly of the V-8AT prototype was completed in the summer of 1963 and it replaced the V-8A in joint state trials, while the latter continued to be used for flight and ground fatigue tests. During flight testing on April 19, 1964, the test crew commanded by B. Koloshenko set two world records on the V-8AT: a closed circuit distance record (2465.7 km) and a 2000 km straight course speed record (201.8 kph). Later, in the period of 1967-1969, crews commanded by I. Kopets and I. Isaeva would set five female world records on the Mi-8.

In May, 1964, assembly of the passenger V-8AP model was completed, featuring a VIP cabin for official use. It was almost identical to the V-8AT and became the testbed for tests of an upgraded AP-34B autopilot system and main rotor speed synchronizer. The same year in September, test flights of the V-8AP initiated the second phase of joint state trials. One month later, the V-8AT joined this test phase. The helicopters demonstrated excellent characteristics. In November 1964, the acceptance committee made a decision to recommend the helicopter for serial production and its troop carrying version was approved for military service.

In the winter of 1964-1965, the V-8AP was converted into a standard passenger version with 20 upholstered seats, coat stowage, thermal and sound insulation, heating, ventilation, air conditioning, and some interior styling. In March 1965, tests at the GosNIIGA research facility were completed and the passenger version was recommended for serial production for use by the Aeroflot state airliner. When the helicopter entered serial production, the troop transport version was designated as Mi-8T and the passenger version as Mi-8P. By the end of 1965, the Kazan assembly plant produced the first serial airframes. The serial production Mi-8T differed from the prototype in having circular windows in the cargo cabin. The rectangular windows were kept on the Mi-8P and its future modifications.

In 1968, the armed Mi-8TV model completed testing. The Mi-8TV featured an external weapons assembly with two hardpoints on each side of the fuselage designed to carry UB-16-57 rocket launchers armed with KARS-57 (S-5) unguided rockets or 50 to 500 kg free-fall bombs. The designers had planned to add a cockpit operated machine gun mount in the nose of the helicopter, but had to forego this in favour of allowing a higher bomb payload.

When armament tests were completed in 1968, the Mi-8T light troop transport helicopter was officially accepted for service by the Soviet Air Force. By this time the helicopter's major parts had accumulated a 1000-hour service life. For its wonderful performance characteristics, handling, and ease of flight and maintenance operations, personnel transitioning from the Mi-4 to the Mi-8 dubbed the new helicopter "Vasilissa the Beautiful".

By 1969, the Mi-8 completely replaced the Mi-4 on the production line. Its production rates grew year by year reaching several hundred helicopters per year. From 1965 to 1996, the Kazan Helicopter Plant manufactured, in different modifications, a total of four and a half thousand Mi-8s powered by TV2-117 engines. In 1970, the Ulan-Ude Helicopter Plant started production of the Mi-8 in parallel with Kazan. To date this facility has produced more than 3700 Mi-8s powered by TV2-117 engines.

Designs of the helicopter's component systems were continually improved throughout its lifespan. Engineers of the Mil Moscow Helicopter Pant together with their colleagues from Kazan and Ulan-Ude significantly improved the design and extended the service life of the helicopter's systems. The service life of modern Mi-8 models exceeds 20000 hours. In 1980, the Mi-8 obtained its first airworthiness certificate under American FAR-29 standards to allow operations in Japan. Between 1970s and 1990s, Mi-8s were equipped with efficient mast-mounted vibration dampers, weather radar, a sling load system (in place of the earlier hinge-pendulum system) with a 3 ton lifting capacity, battle damage tolerance was improved, armouring added, armament enhanced, various equipment was repeatedly upgraded, etc. Meeting demands by the Polish Ministry of Defense, a version with 37 troop seats was developed. The improvements to helicopter components were not made by the Soviet engineers alone, but also by some foreign operators. For example Egyptian airframes were equipped with a British particle separator system ("dust protectors") and Finland installed a navigation radar o their machines. In the second half of the 1980s, a series of experimental research efforts were conducted by the Moscow Helicopter Plant for the purpose of improving the helicopter's aerodynamic performance – external fuel tanks were removed, new cargo doors installed, swashplate and exhaust nozzle fairings added, etc.

Upgrades to the powerplant played a key role in further improving helicopter performance. Soon after launching serial production, helicopters were equipped with improved TV2-117A engines. Starting in 1973, airframes delivered to southern hemisphere countries were equipped with a special modification of the engine designed for operations in hot weather conditions. By the late 70s, an enhanced performance TV2-117F engine model was developed, producing 1700 horsepower in emergency power mode. This engine was installed on the Mi-8PA model. In the 1980s, the TV2-117A engine was replaced by the higher lifespan TV2-117AG, which featured carbon seals in the turbo compressor assembly supports. Helicopters equipped with this engine were again designated as Mi-8AT and are used to this day as a basis for the development of different new, mainly civilian, modifications. Mi-8ATs equipped with relatively low cost TV2-117AG engines are widely used in areas of flat terrain and moderate air temperatures. In 1987, the Mi-8TG prototype model was created to test the TV2-117TG engine, for the first time in the world fuelled by liquid methane. To enhance powerplant reliability, particle separator systems of various designs were developed. The so called "mushroom" type separators were eventually preferred, entering serial production and first being fielded in 1977.

A critical event in the Mi-8 development history was the upgrade of the powerplant to a more powerful engine. By the late 60s, S. Izotov's team in Leningrad had developed the TV3-117 engine, which produced 1900 horsepower. A version of this engine was also planned to be installed on the Mi-24 gunship helicopter as the designers focused on maximizing commonality in the powerplants, transmission, and rotors on all three production helicopter types.

In 1971, the TV2-117 engines and transmission of the Mi-8T were replaced by TV3-117MT engines, a new VR-14 main gearbox and a reinforced transmission. The upgraded helicopter was also equipped with the AI-9 auxiliary power unit (APU) with a starter generator, and a redesigned tail rotor. The tail rotor design was changed from a "pushing" to a "pulling" rotor. This change, where the lower blade now moved towards instead of away from the main rotor downwash, combined with increased tail rotor blade chord, significantly improved yaw control.

The Mi-4 began to be withdrawn from service in the early 1970s, but the TV2-117 powered Mi-8 was not yet able to completely replace it for "hot and high" operations. The designers had to work fast provide a solution. An upgraded helicopter was built by the summer of 1975 and performed its maiden flight on August 17 of the same year. Flight tests demonstrated a significant improvement in performance, in particular in ceiling and climb rate. The number of weapons stations was increased from two to three on each side. The helicopter was approved for military service and designated as Mi-8MT, entering serial production at the Kazan Helicopter Plant in 1977. Starting the following year, it was built with the upgraded TV3-117MT Series III engines. Initially the production rate of TV3-117-powered helicopters was considerably lower than that of previous models, but the war in Afghanistan demanded a revision of the order portfolio and by the mid-80s, the Mi-8MT and its modifications dominated the assembly lines. From 1977 to 1997, the Kazan Helicopter Plant produced more than 3500 helicopters with TV3-117MT and TV3-117VM engines.

In 1981, the Mi-8MT debuted at the Paris air show. For promotional reasons it was designated Mi-17, which became its export designation on the world market. A passenger version in its interior styling similar to the Mi-8P was designated Mi-17P. The basic Mi-8MT model, like its predecessor, gave rise to numerous civilian and military variants.

The next important step in the evolution of the Mi-8 was equipping it with high-altitude TV3-117VM engines, the first prototypes of which were tested in 1985. It took the Mikhail Mil Design Bureau two years to create the new Mi-8MTV model (and its export version, Mi-17-1V). A high-altitude engine allowed the helicopter to take off and land at altitudes of up to 4000 m and maintain level flight at 6000 m. In addition to a higher ceiling, other characteristics were also improved: climb rate, range, etc. The new model included advanced equipment such as weather radar, a long range radio navigation system, armouring, self-sealing fuel tanks with a urethane foam filler, nose and tail PKT machine gun mounts, six external weapons stations and cabin gun mounts for the troops. Having analyzed the experience in Afghanistan, the designers enhanced the durability of helicopter parts and components. To improve operational safety, the Mi-8MTV was equipped with an emergency ditching system. The Mi-8MTV (Mi-8MTV-1) entered serial production in 1988. The basic model is available in transport, troop transport, air assault, ambulance, and ferry versions, as well as fire support and a minelaying modifications.

In 1991, the Mi-8MTV also entered serial production at the Ulan-Ude Helicopter Plant with some minor equipment modifications designated Mi-8AMT (Mi-171). This helicopter is produced in transport, troop transport, ambulance, and passenger versions. The Mi-171A obtained a type certificate in Russia in 1997. In 1999, the passenger and cargo versions of the Mi-171 obtained a type certificate in China under American FAR-29 standards for operations over land and water.

Following the Mi-8MTV-1 (Mi-17-1V), the Kazan Helicopter Plant received new Mi-8MTV-2 and Mi-8MTV-3 model specifications in the 1990s. These increased the number of transportable troops to 30, featured better armouring and upgraded systems. For the Mi-8MTV-3, only four of six weapons stations were kept, but the number of supported payload combinations (profiles) was increased from 8 to 24. The chord of the tail rotor blades was increased and tail rotor control cables reinforced. A rope deployment system for assault troops was added, as well as a higher capacity hoist. In 1991, the Mi-8MTV-3 became the prototype for the Mi-172 export model, which became certified by the Indian aviation register under American FAR-29 standards in 1994. In Russia, it was certified as the Mi-172A.

In 1992, all of the improvements were integrated in a new demonstrator model, the Mi-17M. The latter also had an international navigation system and improved radar, bigger side doors, rear cargo doors similar to those of the Mi-26 (utilizing smaller doors and a folding ramp). Under a contract with a Canadian company, a Mi-17KF joint modification was created featuring a western avionics suite and a glass cockpit design.

In 1997 in Kazan, the Mi-17M demonstrator became the basis for a new basic model: Mi-8MTV-5 (Mi-17V-5). The new model features an improved layout and airframe structure, including an additional passenger/troop access door on the right side of the cargo cabin and a wider left door. The clamshell rear cargo doors are replaced by a hydraulically actuated ramp, and the number of troop seats is increased to 36. Troops can now egress from the helicopter in three directions through the two doors and the ramp in just 15 seconds. The wider left door also made it possible to fit a new rescue hoist with a 300 kg lifting capacity, allowing it to lift up to three people simultaneously. A large hatch in the floor allows for use of an external stores support system with a 4.5 ton carrying capacity. The nose section is completely redesigned, featuring a nose fairing to cover a weather radar and new radio equipment (resulting in the distinctive "dolphin-nosed" namesake of this model variety). The Mi-8MTV-5 also features an upgraded navigation system. The cockpit is adopted for night-vision goggles so the helicopter can be used in any time of the day in all seasons and in a broader range of weather conditions. The design of other equipment has also been improved, in particular the electrical power system, which now features new brushless generators.

Information for the history chapter taken from the publications of the Mikhail Mil Moscow Helicopter Plant (http://www.Mi-Helicopter.Ru).

2 GENERAL DESIGN AND PURPOSE

2. GENERAL DESIGN AND PURPOSE

2.1 HELICOPTER DIMENSIONS

Length:	
nose to vertical fin trailing edge	18.424 m
with turning rotors	25.352 m
Height:	
less tail rotor	4.756 m
with tuning tail rotor	5.321 m
Ground clearance at lowest point of fuselage	0.445 m
Horizontal stabilizer surface area	2.0 m^2
Cargo cabin interior dimensions:	
length (floor)	5.34 m
width	2.3 m
height	1.8 m
Clamshell door clearance	
height	1.620 m
width (at waterline)	2.288 m
Sliding door clearance:	
height	1.405 m
width	0.825 m
Main rotor:	
diameter	21.294 m
number of blades	5
direction of turn	forward, right, back
Tail rotor:	
type	universal joint
diameter	3.908 m
direction of turn	down, forward, up
number of blades	3
Tail rotor blade pitch (R = 0.7):	
minimum (full left pedal)	–7°50'±45'
maximum (full right pedal)	20°30'±20'
Landing gear:	
type	tricycle, non-retractable
main wheel track	4.510 m
wheel base	4.281 m
Wheel dimensions:	
nose wheels	595 X 185 mm
main wheels	865 X 280 mm
Static ground angle (forward and up)	4°10'
Tail strut	shock absorbing

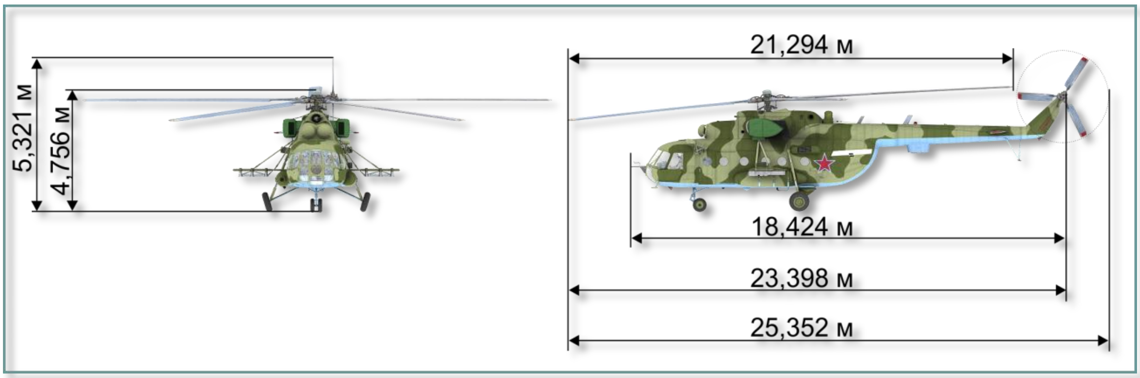


Fig. 9.2. Mi-8 dimensions

2.2 PERFORMANCE SPECIFICATIONS

Normal takeoff weight	11100 kg
Maximum takeoff weight	13000 kg
Cargo capacity:	
normal	2000 kg
maximum (with full main fuel tanks)	4000 kg
troops	21 – 24
medical stretchers	12
Maximum level flight speed at altitudes 0 – 1000 m:	
normal takeoff weight	250 kph
maximum takeoff weight	230 kph
Cruising speed at altitudes 0 – 1000 m:	
normal takeoff weight	220–240 kph
maximum takeoff weight	205–215 kph
Hover ceiling with normal takeoff weight OGE (standard atmosphere)	3960 m
Service ceiling:	
normal takeoff weight	5500 m
maximum takeoff weight	3900 m
Time required to reach altitude at nominal engine power and ideal climbing speed (120 kph), anti-iciding system disabled:	
normal takeoff weight	
1000 m	$1.8^{+0,5}$ min
3000 m	6^{+1} min
4000 m	9.5^{+2} min
maximum takeoff weight	
1000 m	$2.4^{+0,5}$ min
3000 m	10.9^{+1} min
Service range at an altitude of 500 m and cruising speed with full main fuel tanks before 5% fuel reserve reached:	
cargo load 2117 kg	495 km
cargo load 4000 kg	465 km
one full internal auxiliary fuel tank	725 km
two full internal auxiliary fuel tanks (ferry range)	950 km

2.3 PURPOSE AND MISSIONS

The Mi-8MTV2 is designed to enhance mobility of ground forces and provide fire support on the battlefield.

The primary missions performed by the helicopter include:

- tactical air assault
- air mobility of ground forces
- transport of internal and external cargo
- destruction of ground targets in the forward edge of the battle area (FEBA) and within tactical depth, such as: infantry, lightly armored vehicles, anti-tank positions, artillery positions, surveillance and reconnaissance positions, air defense positions, forward command posts, helicopters and other aircraft positioned on the ground
- destruction of deployed hostile airborne (naval) assault forces
- support (escort) of friendly airborne assault forces to the deployment area and subsequent combat support
- airborne reconnaissance
- airborne minelaying
- search and rescue operations
- medical evacuation
- search and destruction of air reconnaissance balloons

The Mi-8MTV2 can be configured as follows to meet mission requirements:

1. Transport:
   - no auxiliary fuel tanks (internal cargo capacity up to 4000 kg)
   - single auxiliary fuel tank (cargo cabin)
   - two auxiliary fuel tanks (cargo cabin)
   - transport of external load up to 3000 kg
2. Air assault:
   - transport up to 24 armed troops
3. Medevac:
   - up to twelve patients on stretchers plus medical assistant
   - mixed configuration (up to 20 men – 3 stretchers and 17 seats or 15 seats and one auxiliary fuel tank)
4. Airborne minelaying:
   - equipped with VSM-1 minelaying system
5. Combat support (up to six B8-V20A rocket launchers or bombs, cannon pods, GUV universal machine gun or automatic grenade launcher pods)
6. Ferry configuration

To facilitate transportation of special and oversize cargo (such as main rotor blades) as well as parachute jump training, the rear cargo clamshell doors can be maintained partially open or removed entirely.

The Mi-8MTV2 is capable of operating in day or night time conditions, visual or instrument meteorological conditions, from prepared or unprepared airfields.

The helicopter crew consists of three crew members: pilot, copilot, and crew chief.

3 HELICOPTER AERODYNAMICS

3. HELICOPTER AERODYNAMICS

3.1 GENERAL PRINCIPLES

If developing vertical flight had been as simple as the idea itself, the helicopter would have undoubtedly been the first practical aircraft. In its earliest form, the helicopter was conceived by Leonardo da Vinci in the early 1500's. In his notes, da Vinci used the Greek word "helix", meaning a spiral, and combined this word with the Greek word "pteron", meaning wing. It is from this combination of Greek words that our word helicopter is derived.

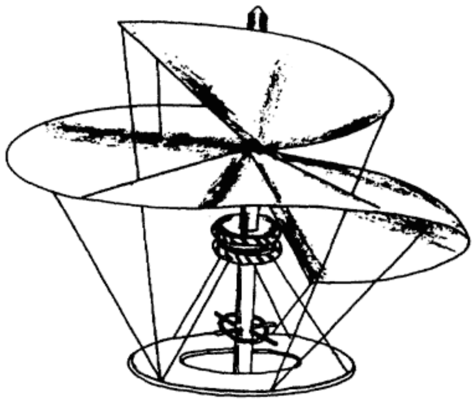


Fig. 9.3. Da Vinci Sketch of the Helixpteron

Development proved too difficult and complicated for the early experimenters because they did not have an engine of sufficient power to ensure flight. When larger, lighter, and more reliable engines were developed hundreds of years later, the dream of a helicopter became a reality.

The same laws of force and motion that apply to fixed wing aircraft also apply to the helicopters. Controls for the helicopter are complex; torque, gyroscopic precession, and dissymmetry of lift must be dealt with. Retreating blade stall also limits the helicopter's forward airspeed.

This chapter provides a basic explanation of helicopter controls, velocity, torque, gyroscopic precession, dissymmetry of lift, retreating blade stall, settling with power, pendular action, hovering, ground effect, translational lift, and autorotation.

THE FORCES ACTING ON A HELICOPTER

Weight (G) and drag (Q) act on a helicopter as they do on any aircraft; however, lift (T_y) and thrust (T_x) for a helicopter are obtained from the main rotor (T_{rotor}). In a very basic sense, the helicopter's main rotor does what wings and a propeller do for a fixed-wing aircraft. Moreover, by tilting the main rotor, the pilot can make the helicopter fly to either side, forward, or backwards.

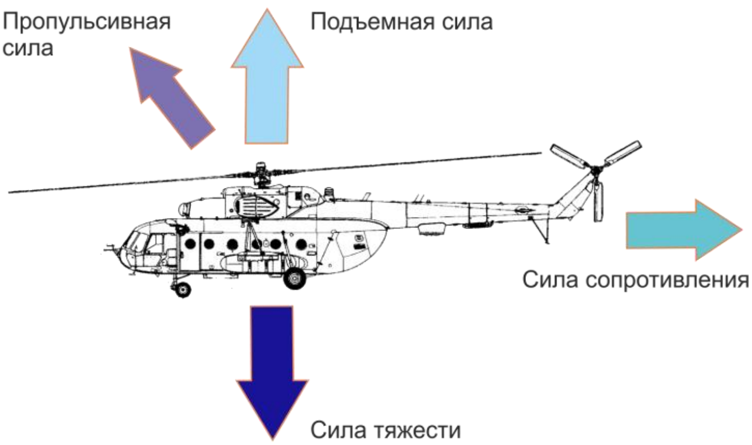


Fig. 9.4. Forces acting on a helicopter

CONTROLS

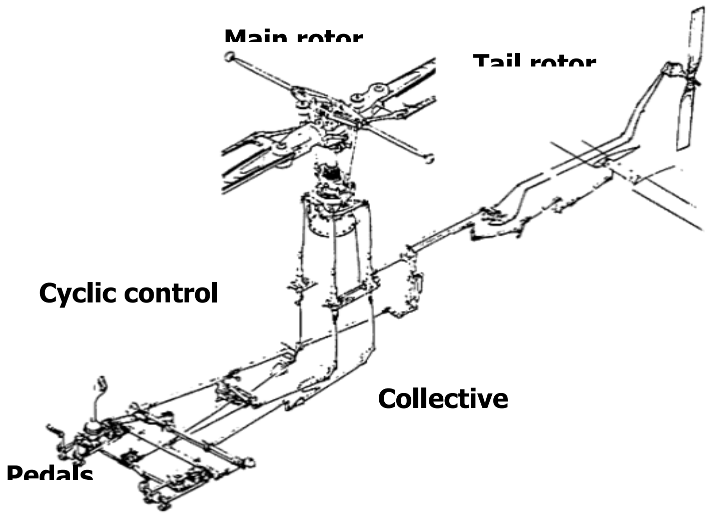


Fig. 9.5. Helicopter Controls

The sketch in Figure 3.3 shows the main rotor, cyclic and collective, anti-torque pedals, and anti-torque (tail) rotor. Basically, the cyclic control is a mechanical linkage used to change the pitch of the main rotor blades. Pitch change is accomplished at a specific point in the plane of rotation to tilt the main rotor disc. Most current military helicopters now have hydraulic assistance in addition to the mechanical linkages. The collective changes the pitch of all the main rotor blades equally and simultaneously. The anti-torque pedals are used to adjust the pitch in the anti-torque rotor blades to compensate for main rotor torque.

VELOCITY

A helicopter's main rotor blades must move through the air at a relatively high speed in order to produce enough lift to raise the helicopter and keep it in the air. When the main rotor reaches required takeoff speed and generates a great deal of torque, the anti-torque rotor can negate fuselage rotation.

The helicopter can fly forward, backward, and sideways according to pilot control inputs. It can also remain stationary in the air (hover) with the main rotor blades developing enough lift to hover the helicopter.

TORQUE

The torque problem is related to a helicopter's single-main-rotor design. The reason for this is that the helicopter's main rotor turns in one direction while the fuselage wants to turn in the opposite direction. This effect is based on Newton's third law that states "To every action there is an opposite and equal reaction." The torque problem on single-rotor helicopters is counteracted and controlled by an anti-torque (tail) rotor.

On coaxial helicopters, the main rotors turn in opposite directions and thereby eliminate the torque effect.

ANTI-TORQUE ROTOR (TAIL ROTOR)

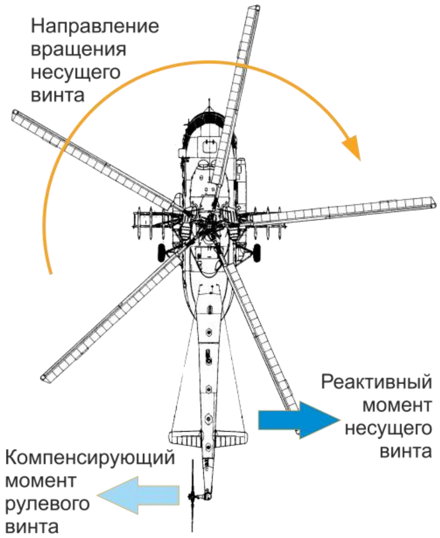


Fig. 9.6. Tail rotor and thrust

Figure 3.4 shows the direction of travel of the main rotor, the direction of torque of the fuselage, and the location of the anti-torque (tail) rotor.

An anti-torque rotor located on the end of a tail boom provides torque compensation for single-main-rotor helicopters. The tail rotor, driven by the engine at a constant speed, produces thrust in a horizontal plane opposite to the torque reaction developed by the main rotor.

GYROSCOPING PRECESSION

Controlling the rotor lift vector through gyroscoping precession is only applicable for rotor systems utilizing a single blade hinge.

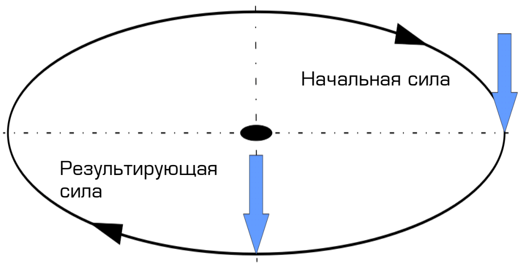


Fig. 9.7. Gyroscoping precession

The result of applying force against a rotating body occurs at 90° in the direction of rotation from where the force is applied. This effect is called gyroscopic precession and it is illustrated in Figure 3.5. For example: if a downward force is applied at the 9 o'clock position in the diagram, then the result appears at the 6 o'clock position as shown. This will result in the 12 o'clock position tilting up an equal amount in the opposite direction.

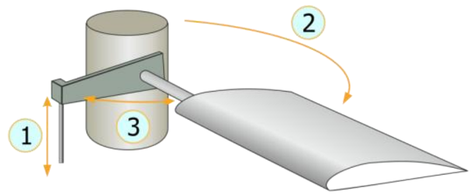


Fig. 9.8. Offset control linkage:

1 – direction of control link input and cyclic blade pitch adjustment; 2 – direction of blade turn; 3 – 90 degree position ahead of the current blade position.

Error! Reference source not found. illustrates the offset control linkage needed to tilt the main rotor disc in the direction the pilot inputs with the cyclic. If such a linkage were not used, the pilot would have to move the cyclic 90° ahead of the desired direction along the direction of turn. For example to move the helicopter forward, he would need to move the stick to the right. The offset control linkage is attached to a lever extending 90° in the direction of rotation from the main rotor blade.

DISSYMETRY OF LIFT

The area within the circle made by the rotating blade tips of a helicopter is known as the disc area or rotor disc. When hovering in still air, lift generated by the rotor blades is equal within all parts of the disc. Dissymmetry of lift is the difference in lift that exists between the advancing half of the disc and the retreating half; this is created by horizontal flight and/or wind.

When a helicopter is hovering in still air, the tip speed of the advancing blade is approximately 600 feet per second (~ 183 m/s) and the tip speed of the retreating blade is the same. Dissymmetry of lift is created by the movement of the helicopter in forward flight. The advancing blade has the combination of blade speed velocity and that of the helicopter's forward airspeed. The retreating blade however loses speed in proportion to the forward speed of the helicopter.

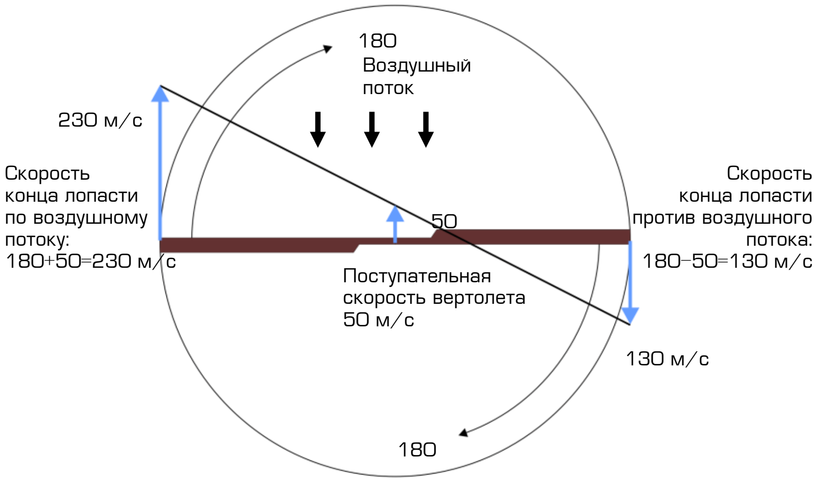


Fig. 9.9. Dissymmetry of lift. (ROTATIONAL VELOCITY) ± (HEL FORWARD SPEED) = (AIRSPEED OF BLADE)

Error! Reference source not found. illustrates dissymmetry of lift and shows the arithmetic involved in calculating the differences between the velocities of the advancing and retreating blades. In the figure, the helicopter is moving forward at a speed of 50 m/s, the velocity of the rotor disc is equal to approximately 180 m/s, and the advancing blade speed is 230 m/s. The speed of the retreating blade is 130 m/s. This speed is obtained by subtracting the speed of the helicopter (50 m/s) from the tip speed of 180 m/s. As can be seen from the difference between the advancing and retreating blade velocities, a large speed and lift variation exists.

Cyclic pitch control, a design feature that permits changes in the angle of attack during each revolution of the rotor, compensates for the dissymmetry of lift. As the forward speed of the helicopter is increased, the pilot must apply more and more cyclic to hold a given rotor disc attitude. The mechanical addition of more pitch to the retreating blade and less to the advancing blade is continued throughout the helicopter's range.

RETREATING BLADE STALL

Retreating blade stall is the tendency of a helicopter's retreating blades to stall in forward flight. This is a major factor in limiting a helicopter's maximum forward airspeed. Just as the stall of a fixed wing aircraft wing limits the low-airspeed flight envelope, the stall of a rotor blade limits the high-speed potential of a helicopter. The airspeed of a retreating blade slows down as forward airspeed is increased. The retreating blade must produce an amount of lift equal to that of the advancing blade. As the airspeed of the retreating blade is decreased with forward airspeed, the blade angle of attack must be increased to equalize lift throughout the rotor disc area. As this angle of attack is increased, the blade will eventually stall at some high, forward airspeed as shown in **Error! Reference source not found.**.

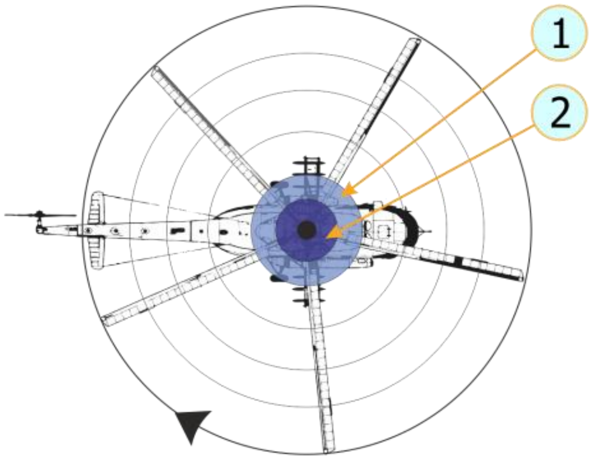


Fig. 9.10. Hovering lift pattern:

1 – no lift area; 2 – blade root area.

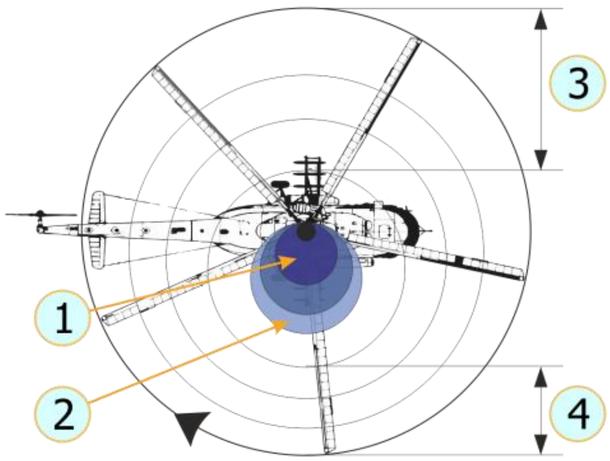


Fig. 9.11. Normal cruise lift pattern:

1 – reverse airflow area; 2 – no lift area; 3 – lift produced in this area requires low blade angle of attack; 4 – lift produced in this area requires greater blade angle of attack (lift must equal that of zone 3).

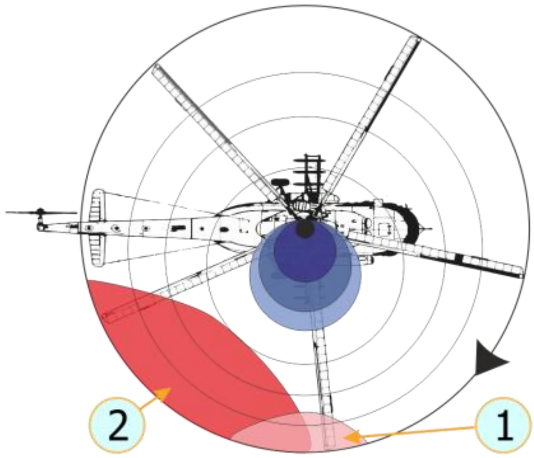


Fig. 9.12. Lift pattern at critical airspeed:

1 – area of blade tip stall, causes vibration and buffeting; 2 – if blade angle of attack continues to remain high, stall area increases. The helicopter pitches up and rolls right (stalling).

Upon entry into a retreating blade stall, the first noticeable effect is vibration of the helicopter. This vibration is followed by the helicopter's nose lifting with a rolling tendency. If the cyclic is held forward and the collective is not reduced, the stall will become aggravated and the vibration will increase greatly. Soon thereafter, the helicopter may become uncontrollable.

To recover from a stall:

- reduce collective pitch

- neutralize cyclic

- reduce airspeed

- increase rotor RPM

SETTLING WITH POWER (VORTEX RING STATE)

Settling with power is a condition of powered flight when the helicopter settles into its own main rotor downwash; this is also known as Vortex Ring State.

Conditions conducive to settling with power include a vertical, or nearly vertical, descent of at least 4 m/s with low forward airspeed. The rotor system must also be using some of the available engine power (from 20 to 100%) with insufficient power available to retard the sink rate. These conditions occur during approaches with a tailwind or during formation approaches when some aircraft are flying in the downwash of other aircraft.

Under the conditions described above, the helicopter may descend at a high rate that exceeds the normal downward induced flow rate of the inner blade sections. As a result, the airflow of the inner blade sections is upward relative to the disk. This produces a secondary vortex ring in addition to the normal tip vortex. The secondary vortex ring is generated at about the point on the blade where airflow changes from up to down. The result is an unsteady turbulent flow over a large area of the disk that causes loss of rotor efficiency, even though power is still applied.

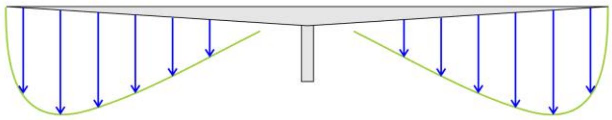


Fig. 9.13. Induced flow velocity during hovering flight

The downward velocity is highest at the blade tip where blade airspeed is highest. As blade airspeed decreases towards the center of the disk, downward velocity is less.

Error! Reference source not found.2 shows the induced airflow velocity pattern along the blade span during a descent conducive to settling with power.

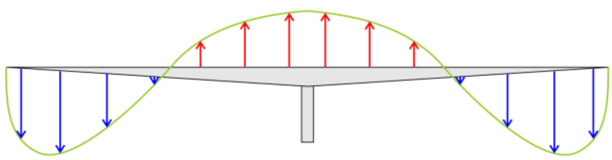


Fig. 9.14. Induced flow velocity during vortex ring state

The descent is so rapid that induced flow at the inner portion of the blades is upward rather than downward. The upward flow caused by the descent can overcome the downward flow produced by blade rotation.

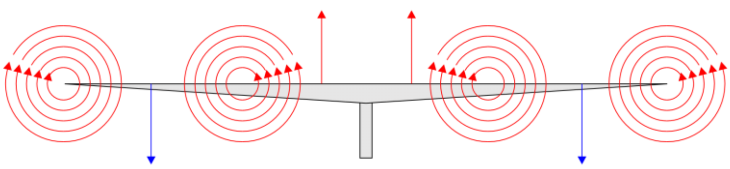


Fig. 9.15. vortex rotation flows along the blades during VRS

If the helicopter descends under these conditions, with insufficient power to slow or stop the descent, it will enter a vortex ring state.

During a vortex ring state, roughness and loss of control is experienced because of the turbulent rotational flow on the blades and the unsteady shifting of the flow along the blade span.

Power settling is an unstable condition, and if allowed to continue, the sink rate will reach sufficient proportions for the flow to be entirely up through the rotors. This can result in very high descent rates. Recovery may be initiated during the early stages of power settling by putting on a large amount of excess power. This excess power may be sufficient to overcome the upward flow near the center of the rotor disc. If the sink rate reaches a higher rate, power will not be available to break this upward flow and thus alter the vortex ring state of flow.

Normal tendency is for pilots to recover from a descent by application of collective pitch and power. If insufficient power is available for recovery, this action may aggravate power settling and result in more turbulence and a higher rate of descent. Recovery can be accomplished by lowering collective pitch and increasing forward speed (pushing the cyclic forward). Both of these methods of recovery require sufficient altitude to be successful.

HOVER

A helicopter hovers when it maintains a constant position over a point on the ground, usually a few feet above the ground. To hover, a helicopter's main rotor must supply lift equal to the total weight of the helicopter, including crew, fuel, and if applicable, passengers, cargo, and armaments. The necessary lift is generated by rotating the blades at high velocity and increasing the collective pitch angle of the rotor blades.

When hovering, the rotor system requires a large volume of air upon which to work. This air must be pulled from the surrounding air mass; this is an expensive maneuver that takes a great deal of engine horsepower. The air delivered through the rotating blades is pulled from above at a relatively high velocity, forcing the rotor system to work in a descending column of air.

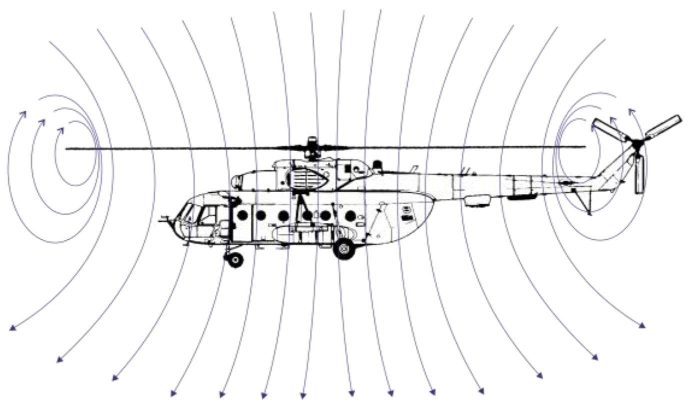


Fig. 9.16. Airflow when out of ground effect

The main rotor vortex and the recirculation of turbulent air add resistance to the helicopter while hovering. Such an undesirable air supply requires higher blade angles of attack and an expenditure of more engine power and fuel. Additionally, the main rotor is often operating in air filled with abrasive materials that cause heavy wear on helicopter parts while hovering in the ground effect.

GROUND EFFECT

Ground effect is a condition of improved performance found when hovering near the ground. The effect begins to occur when hovering at an altitude equal to approximately the radius of the main rotor (5-10 m for most helicopters) and increases as altitude decreases.

Fig. 9.17. Airflow when in ground effect

The improved lift and airfoil efficiency while operating in ground effect is due to a number of effects. First, and most importantly, the main rotor-tip vortex is reduced. When operating in the ground effect, the downward and outward airflow reduces the vortex. A vortex is an airflow rotating around an axis or center. This makes the outward portion of the main rotor blade more efficient. Reducing the vortex also reduces the turbulence caused by recirculation of the vortex.

The second important factor is a reduction in the downwash airflow velocity by the ground, which produces a zone of increased air pressure below the helicopter. This affects the rotor system and increases lift. The maximum lift coefficient produced by ground effect at zero altitude is 1.2.

TRANSLATIONAL LIFT

The efficiency of the hovering rotor system is improved by each knot of incoming wind gained by forward motion of the helicopter or by a surface headwind. As the helicopter moves forward, fresh air enters in an amount sufficient to relieve the hovering air-supply problem and improve performance. At approximately 40 kph, the rotor system receives enough free, undisturbed air to eliminate the air supply problem. At this time, lift noticeably improves and the helicopter begins to climb. This distinct change is referred to as translational lift. At the instant of translational lift, and as the hovering air supply pattern is broken, dissymmetry of lift is created. As airspeed increases, translational lift continues to improve up to the speed that is used for best climb.

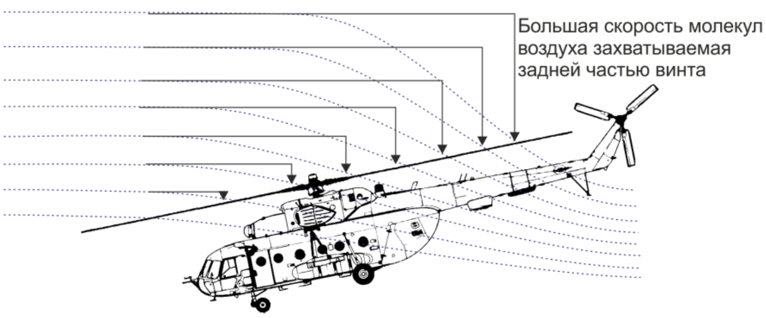


Fig. 9.18. Translational lift

In forward flight, air passing through the rear portion of the rotor disc has a higher downwash velocity than the air passing through the forward portion. This is known as transverse flow effect and is illustrated in Figure 3.16. This effect, in combination with gyroscopic precession, causes the rotor to tilt sideward and results in vibration that is most noticeable on entry into effective translation..

AUTOROTATION

If engine power fails, or other emergencies occur, autorotation is a means of safely landing a helicopter. The transmission in a helicopter is designed to allow the main rotor to turn freely in its original direction when the engine stops. **Error! Reference source not found.** illustrates how the helicopter is allowed to glide to earth and by using the main rotor rpm, make a soft landing.

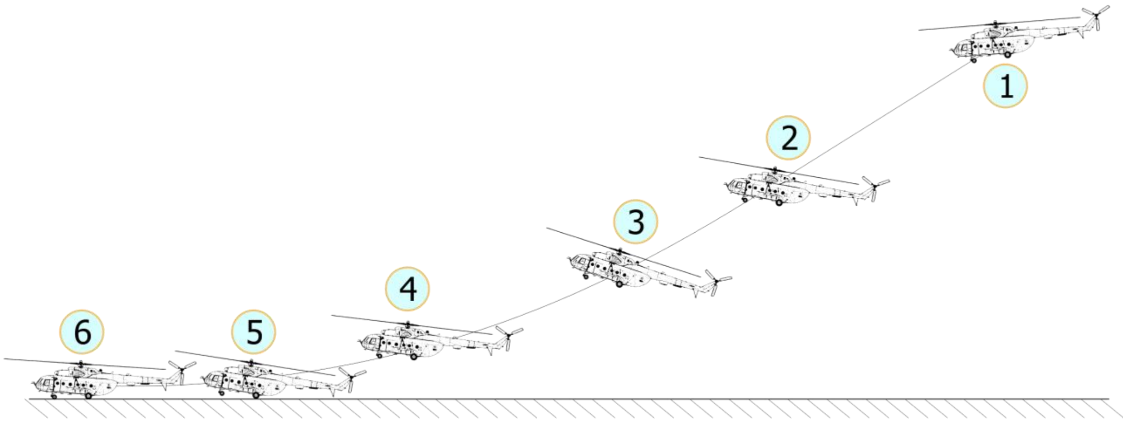


Fig. 9.19. Approach to landing, power off:

1 – while descending, establish 70-80 kph IAS, lower collective to maintain safe rotor RPM (collective full down); 2 – at 35-50 m altitude, increase pitch to 10 degrees above horizon; 3 – at 20-30 m altitude, raise collective to reduce rate of descent. This requires precise control and timing; 4 – at 4-6 m altitude, set landing pitch attitude; 5 – landing; 6 – short landing run to complete stop.

In autorotation, the helicopter pilot exchanges potential energy (altitude) for kinetic energy (speed) required to maintain rotor RPM. This is accomplished by establishing a gliding descent to provide sufficient continuous airflow for the rotor system.

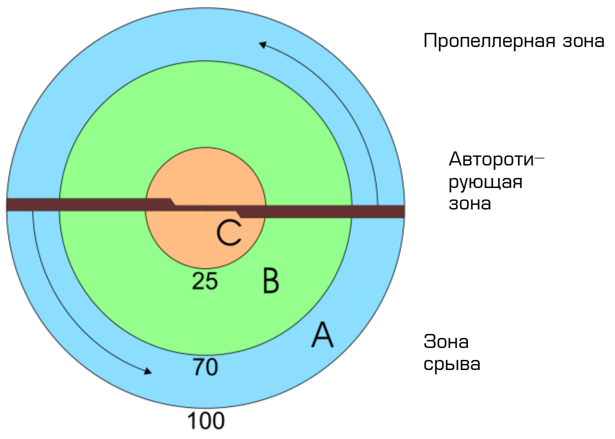


Fig. 9.20. The rotor blade autorotative regions

As shown in Figure 3.18, the rotor disc dynamics during autorotation can be broken into three regions: outboard, middle, and inboard.

A: The outboard blade area is known as the propeller or driven region. Analysis of blade region A indicates the aerodynamic force inclines slightly behind the rotating axis. This inclination causes a small drag force that tends to slow the tip portion of the blade.

B: The rotor blade autorotative driving region is the portion of the blade between 25 to 70 percent radius. Because this region operates at a comparatively high angle of attack, the result is a slight but important forward inclination of aerodynamic forces. This inclination supplies thrust slightly ahead of the rotating axis and tends to speed up this portion of the blade during autorotation.

C: The blade area inboard of the 25% circle is known as the stall region because it operates above its maximum angle of attack. This region contributes considerable drag that tends to slow the blade.

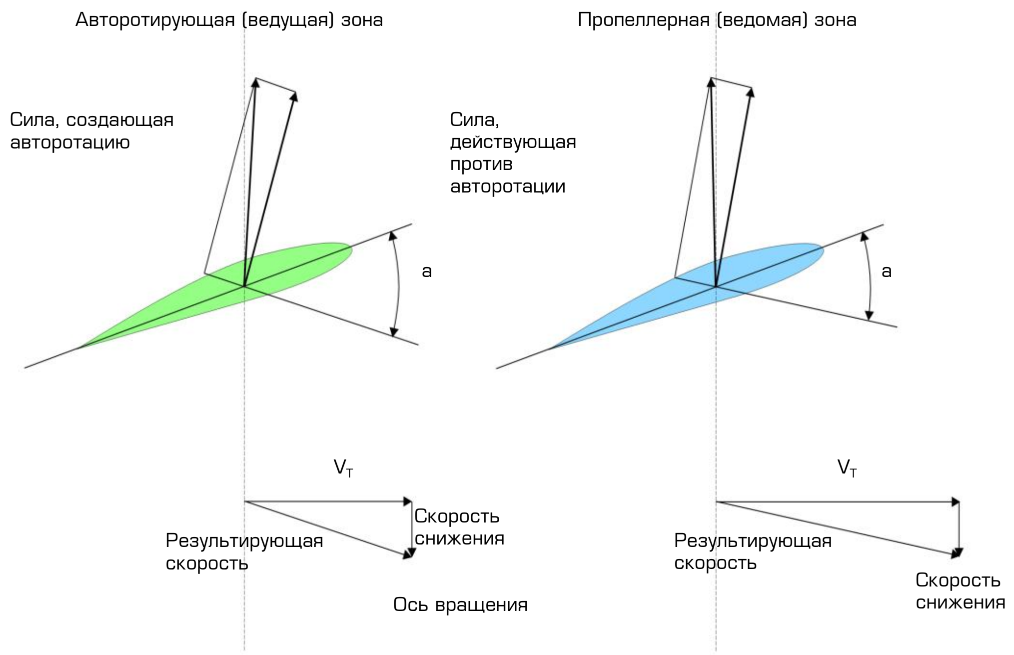


Fig. 9.21. Autorotation blade forces

When performing an autorotation landing, the pilot must maintain an efficient approach speed and glide slope of 14 – 16°. The approximate distance to the planned landing point can be estimated by multiplying current altitude by a factor of 4. Prior to touchdown, the descent rate must be arrested by increasing collective to ensure a safe landing. This "flare" requires precise timing. A useful rule of thumb is that the altitude of the flare is equal to the vertical velocity multiplied by a factor of 3 – 4. For example, if the vertical velocity equals 10 m/sec, the flare is performed at an altitude of 30 – 40 meters. If the flare is particularly aggressive, the initial flare altitude must be reduced by half.

All helicopters carry an operator's manual that has an airspeed versus altitude chart similar to the one shown in **Error! Reference source not found.**. The shaded areas on this chart must be avoided. This area is referred to as the "dead man's curve" and "avoid curve". The proper maneuvers for a safe landing during engine failure cannot be accomplished in these areas.

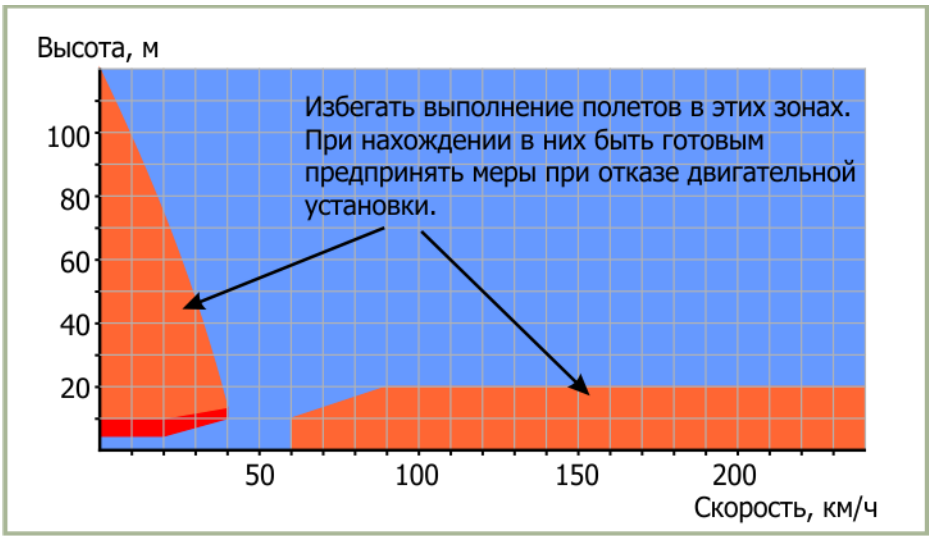


Fig. 9.22. Height-velocity diagram

SUMMARY

Weight, lift, thrust, and drag are the four forces acting on a helicopter. The cyclic for directional control, the collective pitch for altitude control, and the anti-torque pedals to compensate for main rotor torque are the three main controls used in a helicopter.

Torque is an inherent problem with single-main-rotor helicopters. Gyroscopic precession occurs at approximately 90° in the direction of rotation from the point where the force is applied. Dissymmetry of lift is the difference in lift that exists between the advancing and retreating halves of the rotor disc.

Settling with power can occur when the main rotor system is using from 20 to 100% of the available engine power, and the horizontal velocity is under 20 kph. At a hover, the rotor system requires a great volume of air upon which to generate lift. This air must be pulled from the surrounding air mass. This is a costly maneuver that takes a great amount of engine power.

Ground effect provides improved performance when hovering near the ground at a height of no more than approximately one-half the main rotor diameter. Translational lift is achieved at approximately 20 kph, and the rotor system receives enough free, undisturbed air to improve performance. At the instant translational lift is in effect and the hovering air-supply pattern is broken, dissymmetry of lift is created. Autorotation is a means of safely landing a helicopter after engine failure or other emergencies. A helicopter transmission is designed to allow the main rotor to turn freely in its original direction if the engine fails.

3.2 MI-8MTV2 AERODYNAMIC PARTICULARS

The Mi-8MTV2 is a conventional helicopter with a single clockwise rotating main rotor and a single anti-torque tail rotor.

The fuselage of the helicopter is a solid-metal semi-monocoque construction with a variable cross section. It consists of the forward and central parts, tail boom and vertical stabilizer.

The horizontal stabilizer installed on the tail boom is adjusted on the ground and is non-controllable in flight. The stabilizer improves longitudinal stability and controllability, and ensures that required pitch control authority is available throughout the flight envelope.

For takeoff and landing, the helicopter is equipped with non-retractable landing gear and a tail strut. These are equipped with hydro-pneumatic shock absorbers. The tail strut prevents the tail rotor from striking the ground in case of a landing with a large positive pitch angle.

A five-blade main rotor creates the lifting force and thrust required for the helicopter to perform forward flight. Additionally the main rotor is used to control the helicopter along the pitch and roll axes. The blades have a rectangular planform.

The tail rotor creates the side force to counter the torque from the main rotor and is used for yaw control. The three-blade tail rotor is a pulling type with variable blade pitch for yaw control. Rotation of the tail rotor is mechanically driven by the main rotor via the transmission system. The direction of rotation is forward – up – back. Tail rotor pitch is controlled from the cockpit by the anti-torque pedals operated by the pilot(s).

The helicopter is powered by two TV3-117VM turboshaft engines. From the two-stage power turbines, engine power is transmitted via two main power shafts to the main gearbox. The engines are positioned on top of the cabin in front of the main gearbox.

The helicopter has an external stores support system that allows transportation of cargo on an external sling.

These special features determine the helicopter's aerodynamic characteristics, stability and controllability.

POWER REQUIREMENT FOR LEVEL FLIGHT

The power requirements for level flight depend heavily on flight speed. Maximum power demand occurs at zero forward speed (for hovering out of ground effect) and in horizontal flight at maximum airspeed. In the speed range of 0 to 110-120 kph, power requirements for level flight decrease as airspeed increases, but further increases of airspeed demand increasing power.

MAIN ROTOR THRUST

With the PZU particle separator system switched off, the free thrust of the main rotor is 13200 kg with the engines operating in takeoff power mode (3800 hp) in standard atmosphere at sea level in calm winds. In the same conditions, in nominal engine power mode (3400 hp), the thrust is 12040 kg. Activation of the PZU particle separator system reduces thrust by approximately 200 – 300 kg.

Main rotor thrust varies strongly depending on atmospheric conditions: free air temperature (FAT), wind speed and direction, and barometric pressure at the altitude of the airfield. This variability necessitates performing a hover safety check prior to initiating any takeoff to ensure safe flight operations. For a take-off in ground effect (IGE), the hover check is performed at 3 m above gound at airfields located at altitudes of up to 3000 m and at least 4 m above ground at airfields located at altitudes higher than 3000 m. The height of the hover safety check for a takeoff out of ground effect (OGE) must be at least 10 m.

3.3 MI-8MTV2 PERFORMANCE PARTICULARS

Minimum flight speed with normal takeoff weight for altitudes below 4000 m and with maximum takeoff weight for altitudes below 3000 m is 60 kph. Maximum flight speed for altitudes below 1000 m is 250 kph with normal takeoff weight and 230 kph with maximum takeoff weight. The speed limit lowers as altitude increases up to the operational ceiling. Optimum climbing speeds are 120 kph for altitudes below 2000 m and 100 kph for altitudes of 4000 m and higher. Optimum cruising speed is 10 kph above optimum climbing speed.

The vertical rate of climb near the ground is 9 m/sec with normal takeoff weight (anti-icing system switched off) and 7 m/sec with maximum takeoff weight without the external weapons stations fitted. Activation of the anti-icing system reduces rate of climb by 1m/sec.

The operational ceiling with normal takeoff weight without external station racks is 5000 m (anti-icing system off), 4900 (anti-icing system on). With maximum takeoff weight it is 3900 m (anti-icing system off) and 3600 m (anti-icing system on).

Activation of the PZU particle separator system reduces the rate of climb by 0.6 m/sec.

Fitting of exhaust gas suppression (EGS) devices reduces the operational ceiling by 150 – 200 m and the rate of climb by 0.5 – 1 m/sec.

SAFE ALTITUDES AND AIRSPEEDS IN CASE OF A SINGLE ENGINE FAILURE IN FLIGHT

In case of a single engine failure in flight, a certain time is required to detect the failure and take corrective actions. During this time, the helicopter may lose about 10 m of altitude as the automatic control system cannot set the remaining engine into takeoff power mode immediately. If the helicopter is at a low altitude and high speed at the moment of failure, required crew actions are to quickly gain altitude, establish a safe flight attitude and, if necessary, find a suitable location for an emergency landing. Altitude is gained by a 10 – 15° pitch up maneuver and deceleration of the helicopter. For example initial level flight airspeed of 130 – 230 kph may result in a deceleration to 80 kph and an altitude gain of 30 – 100 m.

When performing a landing or hover approach, an altitude safety margin is required in case of an engine failure in order to provide sufficient time to perform a short ground run landing and correct any instability as a result of sudden changes in engine power output or landing gear ground contact.

3.4 MI-8MTV2 CONTROL PARTICULARS

The kinematic connection of the cyclic control stick with the swashplate is rigged such that the neutral position of the stick corresponds to a forward-left tilt of the swashplate. This is designed to minimize cyclic stick deflection from the neutral position in cruise flight. Similarly, the neutral position of the pedals corresponds to a positive pitch of the tail rotor blades, which allows the pilot to maintain the pedals in a position near neutral in cruise flight.

The pitch control system includes a hydraulic stop that restricts the aft deflection of the swashplate to 2°12'. Further deflection is possible only with application of greater aft cyclic stick force (about 15 kg). The hydraulic stop is activated by a weight-on-wheels microswitch and is designed to protect the tail boom from being struck by rotor blades in case of an an abrupt or large pull of the cyclic control during helicopter taxi.

The yaw control system includes the SPUU-52 tail rotor pitch limit system, which maintains required yaw authority in hovering flight in varying weather conditions (temperature and pressure). In a hover, the required right pedal application reduces as ambient air pressure increases. The SPUU-52 automatically adjusts the variable stop to restrict tail rotor pitch in order to prevent overloading of the transmission or overstressing the tail boom.

3.5 MI-8MTV2 TRIMMING AND BALANCING

GROUND TRIM

As the helicopter is initiated into motion on the ground, during taxi, ground run, and at the moments of takeoff and touchdown, conditions may develop in which the helicopter will tend to roll on its side with respect to an imaginary diagonal between the nose gear and one of the main gear wheels, a condition known as a dynamic rollover.

When positioned on the ground, the forces acting on the helicopter with running engines are gravity, main rotor thrust, tail rotor thrust and the ground reaction forces acting on the wheels. The tilting forces that may result in a dynamic rollover are tail rotor thrust, lateral components of ground reaction, lateral forces acting on the helicopter during taxi turns and, in case of incorrect pilot actions, a component of main rotor thrust. The corrective forces are the vertical components of ground reaction and, in case of correct pilot actions, a component of main rotor thrust.

As main rotor thrust increases, the vertical component of ground reaction forces is reduced and its stabilizing effect weakened. The addition of any roll angle shortens the arm of this force and further reduces its stabilizing effect. Crosswind, low stiffness of the landing gear, a high center of gravity (CG) position - all contribute to a potential dynamic rollover condition.

On a slippery or inclined surface with the main rotor turning, the helicopter may skid sideways. The likelihood of a rollover or skid increases as main rotor thrust increases.

For takeoff and landing on an incline, it is preferable to align the helicopter along the slope (nose to tail). If doing so is not possible, then the left side of the helicopter should be positioned facing the slope (so that the right side is below the left side), because tail rotor thrust tends to roll the helicopter left.

When taking off from an incline, rapidly increase collective pitch in the final phase up to the moment of takeoff; when landing, rapidly reduce collective pitch to minimize the duration of instability on the ground. In case of a sudden roll angle increase on the ground, i.e. at the start of a dynamic rollover, either quickly reduce collective to settle the helicopter on the ground or quickly increase collective to lift the helicopter off the ground.

HELICOPTER TENDENCIES AT LIFTOFF

In a vertical takeoff, increased power applied to the main rotor increases torque-induced yaw if rotor RPM is constant, resulting in a left yaw tendency.

If tail rotor thrust is not increased by right pedal application at the moment of takeoff, the helicopter yaws to the left due to torque-induced yaw.

In addition to exhibiting left yaw, at the moment of takeoff the helicopter tends to roll and drift to the left under the force of tail rotor thrust directed to the right. These tendencies are corrected by adjusting cyclic position to the right to direct the downward vector of main rotor thrust to the left to counteract tail rotor thrust.

Because the rotation axis of the tail rotor is below the plane of the main rotor hub, in a hover the helicopter is trimmed with 2 - 2.5° of roll.

When accelerating from a hover to 30 - 35 kph, balancing the helicopter requires moving the cyclic control significantly forward. Maximum required deflection is reached at 40 kph.

When accelerating from 40 - 45 kph to 90 - 100 kph, balancing the helicopter requires pulling the cyclic aft from the forward position reached during initial acceleration from a hover.

Between 100 - 130 kph, cyclic trim is almost unchanged. As airspeed increases beyond 120 kph, balancing the helicopter requires progressive forward cyclic. Maximum required deflection is reached at maximum airspeed.

This pattern of cyclic deflection versus airspeed is a result of the variations in pitch moments of the main rotor and the fuselage at different airspeeds.

The most significant balance shift occurs in a transition from a climb at maximum (takeoff) engine power to an autorotation glide.

Required collective pitch is reduced as airspeed increases from 0 - 100 kph, then begins to progressively increase as airspeed increases.

ROLL TRIM

In hover the helicopter is trimmed with 2 - 2.5° of roll with a slight right cyclic position.

Transitioning from a hover to forward flight up to maximum airspeed, the cyclic is trimmed progressively left to maintain balanced flight. Maximum left deflection is reached in a high speed autorotation glide.

YAW TRIM

Maximum stroke travel of the tail rotor shaft (maximum right pedal application) is required in a hover as maximum engine power output is demanded.

Tail rotor efficiency increases as airspeed increases, resulting in minimum required pedal deflection in level flight at airspeeds of 170 - 180 kph. Right pedal application increases as airspeed increases beyond 180 kph.

In autorotation, the friction forces in the gearbox and transmission create a turning moment that acts in the direction of the main rotor rotation (clockwise). In this case yaw trim requires left pedal application to maintain heading.

TRIMMING IN TURNS, SPIRALS, AND COORDINATED SIDESLIPS

Increased roll angles in turns and spirals, as well as the accompanying increases in vertical G loads, require considerable pulling of the cyclic control aft. In left turns and spirals the required pull is greater than in right turns and spirals. Reduced engine power modes reduce the required cyclic pull.

In spirals, roll and yaw trim do not change significantly.

Coordinated sideslips are executed with pedal application in the corresponding direction. Induced roll angles produced as a result of pedal application are corrected with opposite cyclic control deflection.

The Mi-8MTV2 helicopter has good static sideslip stability throughout the range of operating airspeeds. At large sideslip angles, the required opposite deflection of the cyclic to either side per unit of roll is reduced. At roll angles of 9 - 14°, the helicopter becomes statically neutral in the lateral axis.

3.6 MI-8MTV2 STABILITY PARTICULARS

Helicopter stability is the ability to automatically return to a steady flight attitude after an outside disturbance is neutralized. Helicopter stability can be static and dynamic.

Static stability is the ability of the helicopter to resist changes to current flight conditions (airspeed, angles of attack and sideslip).

Dynamic stability characterizes the helicopter's recovery to the reference flight condition. Dynamic stability is determined by a combination of static stability, damping characteristics, and relationship between longitudinal and lateral axes oscillations for current flight conditions.

Throughout the envelope of operating airspeeds, the Mi-8MTV2 demonstrates high static sideslip stability, but low angle of attack and airspeed static stability.

The damping characteristics of a single-rotor helicopter are much weaker than those of a fixed-wing aircraft. Besides, a helicopter has a strong dependence between the lateral-directional and longitudinal motion.

The helicopter's behaviour after a disturbance in the air has an oscillating character in terms of airspeed, bank and pitch angles. The amplitude of these parameters varies over time. Additionally, the helicopter has a slow aperiodic tendency to drift away from a trimmed flight condition. That is, like other helicopters, the Mi-8MTV2 demonstrates an acceptable dynamic instability throughout the range of airspeeds, including in hover, which is demonstrated by the relatively long duration (two and more minutes in the air with the autopilot disengaged) that it maintains a trimmed flight condition with the flight controls released in calm atmosphere conditions before roll angle changes reach 10°.

When the autopilot is engaged, the stability characteristics of the helicopter improve and piloting becomes easier.

3.7 MI-8MTV2 MANEUVERING PARTICULARS

The capability of the helicopter to change its attitude in space, i.e. the airspeed, altitude and flight direction, characterizes its maneuverability. To perform maneuvers on this helicopter, you need to be aware of some of its special characteristics.

ACCELERATION IN LEVEL FLIGHT

To accelerate, the main rotor (propulsive) thrust component directed along the flight path must be increased. To increase this force, pitch the helicopter nose down by pushing the cyclic control forward.

As the result of the increase of the tilt of the main rotor thrust together with the tilt of the helicopter, the vertical component of thrust reduces, and the helicopter tends to descend which must be compensated by increasing the collective pitch of the rotor.

To execute horizontal acceleration at maximum rate, engine power must be increased within 9-10 sec to takeoff power and helicopter pitch set to -15 to -20°.

While accelerating at constant engine power, maintain level flight by simultaneously reducing the helicopter pitch angle. The acceleration time at maximum rate from 60 to 220 kph is 26 - 36 sec. The maximum possible acceleration per second is 6-9 kph.

DECELERATION IN LEVEL FLIGHT

To decelerate in level flight, increase the pitch angle of the helicopter and reduce collective pitch.

To execute a strong level flight deceleration from airspeeds close to maximum, increase the pitch angle of the helicopter by 10 - 15° within 8-12 sec and simultaneously reduce collective pitch in order to maintain altitude. Collective pitch should be reduced by no more than 2.5 - 3° on the collective pitch indicator.

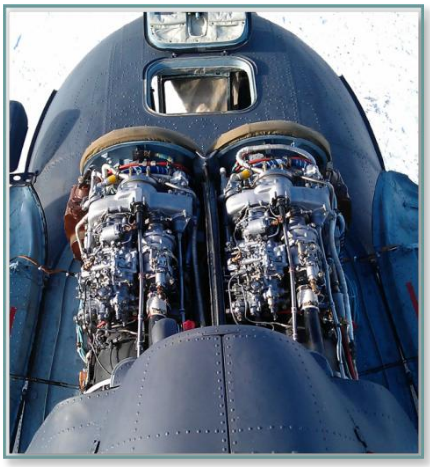
During deceleration, maintain level flight by controlling the pitch angle, and when minimum speed is approached at the end of deceleration, increase engine power and reduce helicopter pitch angle. The average time of horizontal deceleration from 220 to 60 kph at maximum rate is 28 sec.

4 POWERPLANT AND DRIVE SYSTEM

4. POWERPLANT AND DRIVE SYSTEM

4.1 ENGINES

The Mi-8MTV2 helicopter powerplant consists of two TV3-117VM turboshaft engines. The engines are installed on the fuselage deck in a common nacelle with the oil cooler fan of the air cooling system.



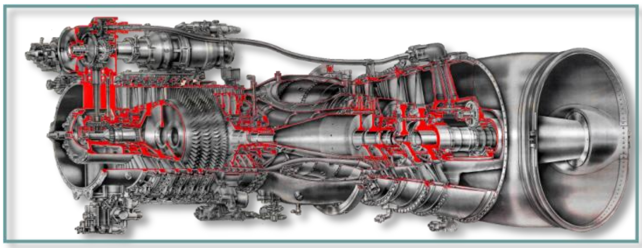


Рис. 9.23. Engine diagram and installation on the Mi-8MTV2

The engines are situated parallel to helicopter's longitudinal centerline at a distance of 600 mm from each other and are tilted downward, toward the front, at an angle of 4°30′ relative to the fuselage horizontal reference line. The rear output shafts of the engines are connected, via a uniball coupling, to the main transmission, which transmits power to the main rotor, AC generators, tail rotor, and accessories.

Utilizing a twin engine system increases operational safety as one engine can provide sufficient power for controlled flight in case of a single engine failure.

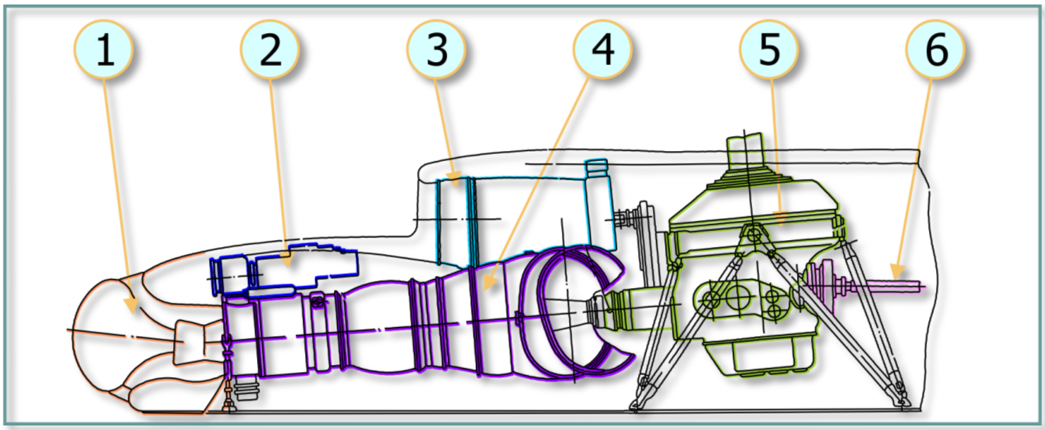


Рис. 9.24. Powertrain system diagram (side view):

1 – engine inlet and particle separator head ("PZU"); 2 – air starter and accessory gearbox; 3 – oil cooler fan; 4 – TV3-117VM engine; 5 – VR-14 main transmission; 6 – tail rotor driveshaft.

4.2 AIR INLET PARTICLE SEPARATOR SYSTEM ("PZU")

The "PZU" air inlet particle separator system protects the engine inlet during taxi, takeoff, and landing at unprepared airstrips and in sandy/dusty environments. In addition, the system provides electrical and bleed air anti-ice heating.

The system mounts on the front of the engine, in place of the nose cone assembly. Each engine has an independent particle separator system. The system begins to operate when bleed air is supplied to the ejector by opening the flow control valve.

When the system is running, suction pulls contaminated air into the inlet duct passages (1). Centrifugal forces throw the dust particles toward the aft dome surface (2) where they are driven by the air flow through the separator baffles (4). The main portion of the air, with the dust removed, passes through the duct to the engine air inlet (3). The contaminated air (dust concentrate) is pulled into the dust ejector duct (5) and discharged overboard (6).

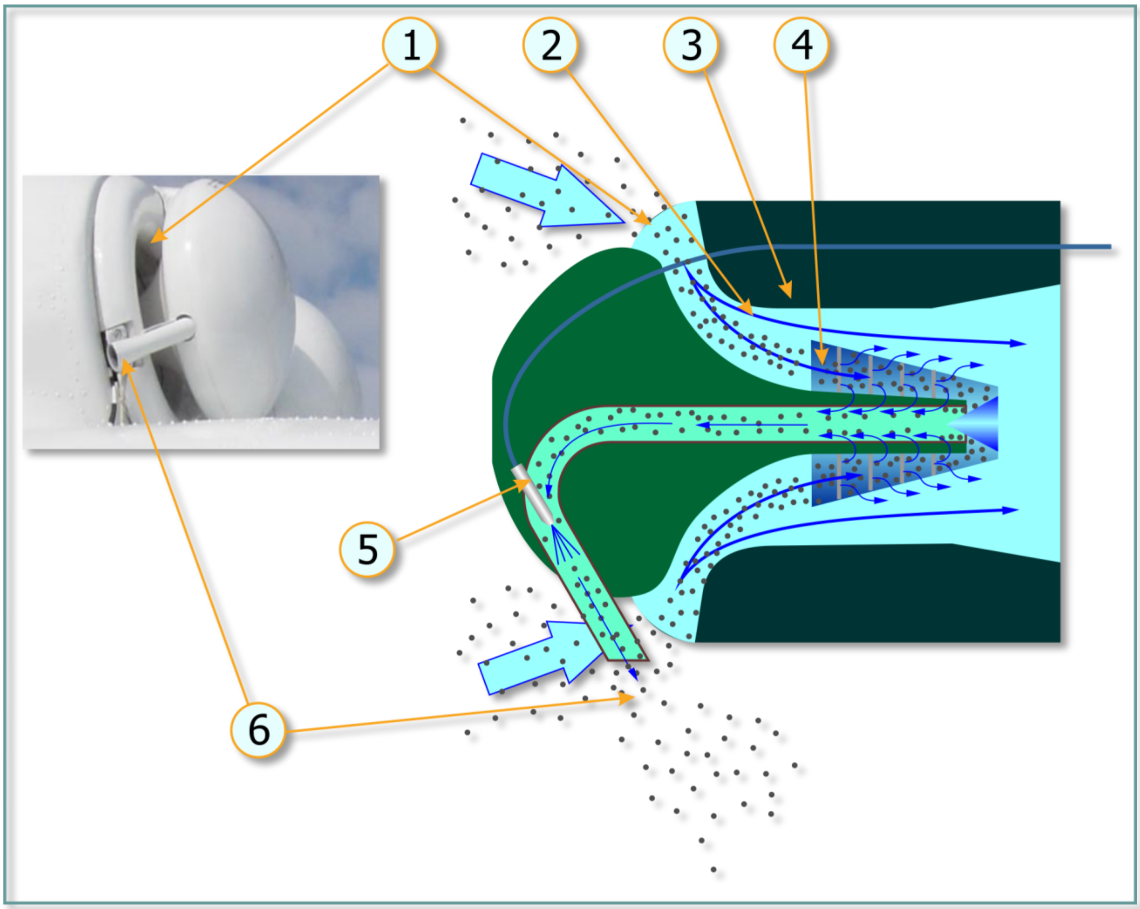


Рис. 9.25. Air inlet particle separator system functional diagram

The PZU anti-icing system utilizes a combination of heated air and electrical heating to provide deicing to various helicopter components. The heated air elements of the PZU deicing system are turned on simultaneously with the engine deicing system.

4.3 AUXILIARY POWER UNIT

The AI-9V auxiliary power unit (APU) supplies compressed air to crank the TV3-117VM main engine compressor rotors during engine start. It can also be used to supply 27 VDC power to the onboard electrical systems on the ground and in flight if the generators fail. The APU has its own fuel control, oil system, regulating system, starter-generator unit, and ignition unit. It consists of a centrifugal-type compressor, single stage axial turbine, ring-shaped combustion chamber, exhaust nozzle, drive housing, and integrated oil tank. The APU is mounted in the aft nacelle compartment. It is separated from the transmission compartment by a lateral firewall.

Рис. 9.26. AI-9V APU mounted on the helicopter

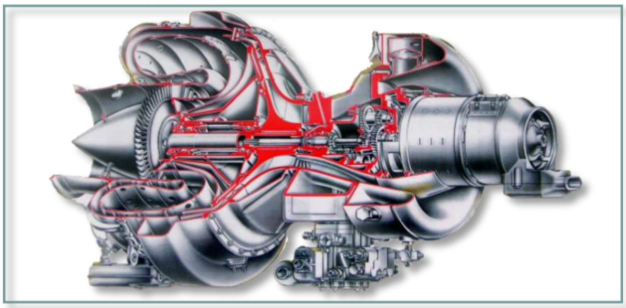


Рис. 9.27. AI-9V cutout

The start sequence is automated and controlled by the APD-9V start control box (located in the radio compartment), which produces control signals to engage and disengage components of the system according to the programmed sequence.

The APU start control box controls:

- APU ground start;
- APU false start;
- APU crank cycle;
- APU shutdown at any time during the start, false start or crank cycle.

The AI-9V starting circuits are protected by the START APU - "START" and "IGNIT" (ЗАПУСК ТУРБОАГРЕГАТ "ЗАПУСК" и "ЗАЖИГАН.") circuit breakers on the right circuit breaker console.

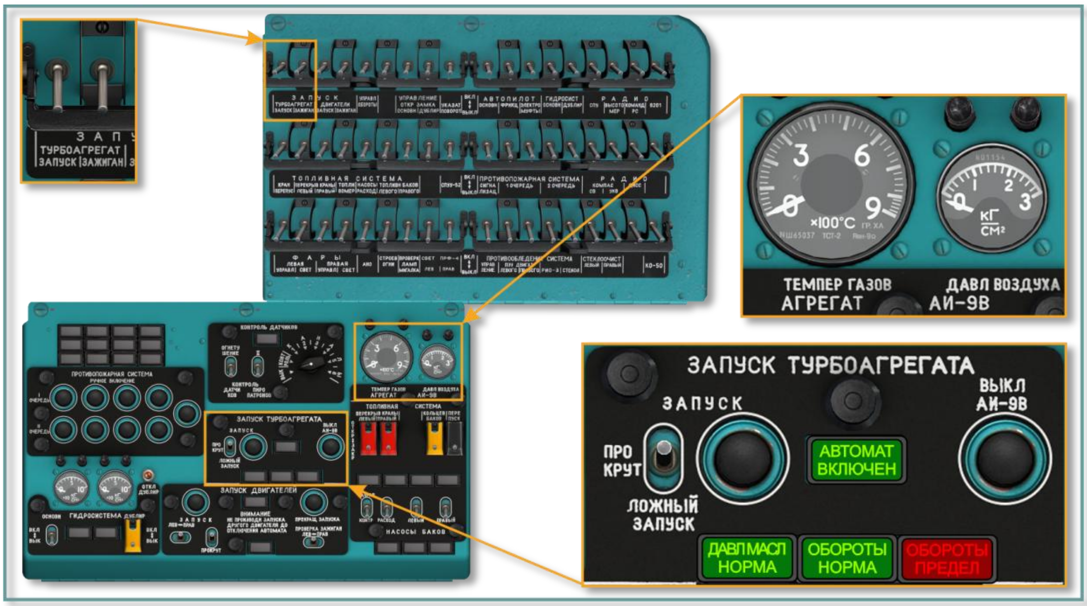


Рис. 9.28. APU start control panel and circuit breakers

The starting system is operated by the START-CRANK-FALSE START ("ЗАПУСК–ПРОКРУТ–ЛОЖНЫЙ ЗАПУСК") switch, the START ("ЗАПУСК") and APU OFF ("ВЫКЛ. АИ-9В") push buttons on the APU start control panel.

APU exhaust gas temperature is displayed by the APU EGT ("ТЕМПЕР. ГАЗОВ") gauge. The pressure in the APU main bleed air channel is displayed by the APU air pressure ("ДАВЛ. ВОЗДУХА") gauge.

The lamp indicators on the APU start control panel include the APU OIL PRESSURE NORMAL ("ДАВЛ. МАСЛА НОРМА") light, APU RPM NORMAL ("ОБОРОТЫ НОРМА") light, and APU OVERSPEED ("ОБОРОТЫ ПРЕДЕЛ") light.

When the starting sequence is engaged, the APU AUTOSTART ("АВТОМАТ. ВКЛЮЧЕН") light illuminates.

4.4 IGNITION–STARTING SYSTEM

The TV3-117VM engines are started by the SV-78B starter turbine, supplied with compressed air by the APU, which begins to turn the engine compressor rotor. The starter turbine also provides for engine cranking and false start.

The ignition-starting system includes the following components:

- SV-78B starter turbine;
- SK-22-2 ignition exciter;
- SP-26P3 igniters (two);
- APD-78A start control box (one for both engines);
- protection, multiplexing, control, and signal generating equipment.

The starter turbine, ignition exciter, and igniters are installed on the engines. The start control box, protection, multiplexing, control and signal generating equipment are installed separately in the helicopter.

Рис. 9.29. Engine start control panel

When starting the TV3-117VM engines, turn on the START ENGINES - “START” and “IGNIT” (ЗАПУСК – ДВИГАТЕЛИ – "ЗАЖИГАН." and "ЗАПУСК") circuit breakers. Set the MODE ("ЗАПУСК –ПРОКРУТ.") selector on the engine start control panel to the START (up) position and set the ENGINE (ЗАПУСК – "ЛЕВ. – ПРАВ.") selector to correspond to the engine being started (LH or RH).

To perform an engine crank or false start, set the MODE ("ЗАПУСК – ПРОКРУТ.") selector to the CRANK (down) position. A false start is performed with the fuel fire (shutoff) valve open, fuel shutoff lever full forward (open), and fuel service cell boost pump engaged. A crank is performed as a false start, except the fuel shutoff lever is held in the aft position (closed).

The start control program is engaged by pressing the START ("ЗАПУСК") push button and can be aborted manually at any time by pressing the ABORT START ("ПРЕКРАЩ. ЗАПУСКА") push button on the engine start control panel.

The AUTO IGNITION ON ("АВТОМАТ ВКЛЮЧЕН") light illuminates to advise that the start cycle is in progress. It is controlled by the engine start control box. The STARTER ON ("СТАРТЕР РАБОТАЕТ") light illuminates when sufficient air pressure is delivered to the engine starter.

If the engine has not attained an N1 (compressor) RPM of 55% within 55 second, the starting cycle is automatically aborted.

4.5 DRIVE SYSTEM

The VR-14 main transmission is mounted on top of the center fuselage deck. The mounting struts attach at four points to the fuselage. The transmission is essentially a reduction gearbox designed to transmit the sum power of both TV3-117VM engines to the main rotor, tail rotor, oil coller fan, and accessories (two hydraulic pumps, two AC generators, two rotor tachometers, and an air compressor) at a reduced and adjustable RPM. The drive system includes:

- intermediate gearbox;
- tail rotor gearbox;

– transmission driveshafts;
– rotor brake system.

The main transmission includes freewheeling clutches in the input quills to provide a quick-disconnect of one or both engines in case of a power failure. This allows for safe flight with one engine inoperative and allows main and tail rotors to rotate in order to accomplish a safe autorotation landing.

Magnetic chip detectors and warning lamps are provided to control accumulation of metal shavings in the transmission oil system. An oil temperature probe and an oil pressure sensor are incorporated.

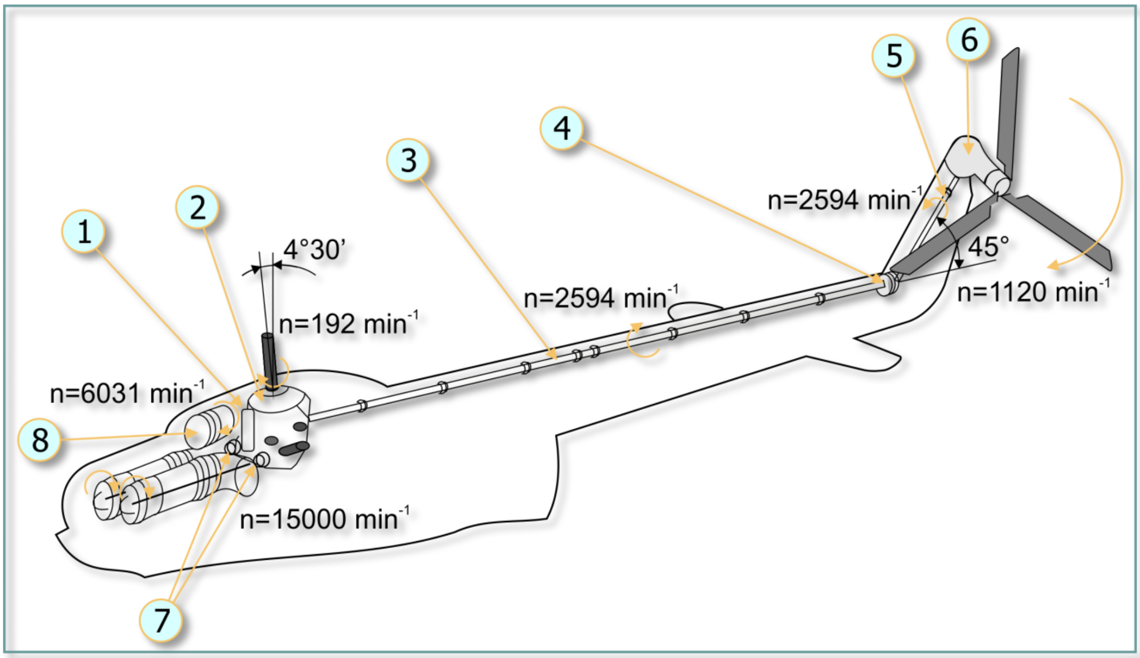


Рис. 9.30. Helicopter drive system:

1 – oil cooler driveshaft; 2 – VR-14 main transmission; 3 – tail rotor driveshaft; 4 – intermediate gearbox; 5 – rear tail rotor driveshaft section; 6 – tail rotor gearbox; 7 – TV3-117VM engine driveshafts; 8 – oil cooler fan.

The intermediate gearbox is designed to change the angle of the tail rotor driveshaft axis by 45° to conform with the angle between the tail boom and vertical stabilizer.

The tail rotor gearbox is designed to rotate the tail rotor at the required RPM. The last linked section of the tail rotor driveshaft is coupled to the tail rotor gearbox input flange. The tail rotor hub mounts on the tail rotor gearbox output flange. Tail rotor pitch is changed by the control rod, located inside the output shaft.

The transmission driveshafts include the tail rotor driveshaft and oil cooler fan driveshaft.

The tail rotor driveshaft is designed to pass the torque from the main transmission via the intermediate gearbox and the tail rotor gearbox to the tail rotor. The main transmission and intermediate gearbox are connected by the horizontal section of the tail rotor driveshaft. The intermediate gearbox and tail rotor gearbox are connected by the angled rear section of the tail rotor drive shaft housed inside the vertical stabilizer.

The oil cooler fan driveshaft transmits power from the transmission to the oil cooler fan. The driveshaft is bolted to the transmission offset quill at the front of the transmission. It connects to the oil cooler fan via a splined coupling.

The rotor brake reduces the time required to stop the main rotor. It is also used to block the transmission while the helicopter is parked and during maintenance operations.

Рис. 9.31. Rotor brake control lever

The rotor brake consists of a drum and shoes assembly mounted on the main transmission tail rotor output quill. The brake is operated by a cable linkage from the rotor brake control lever located to the right of the pilot's seat.

4.6 AIR COOLING SYSTEM

The air cooling system includes the oil cooler fan assembly, distribution lines, and cooling shrouds. The oil cooler fan cools the oil in the engine and transmission oil coolers, the AC generators, the hydraulic pumps, and the air compressor. The oil cooler fan assembly mounts over the rear section of the engine compartment as part of a common nacelle. The oil cooler fan collects air via a dedicated oil cooler fan inlet.

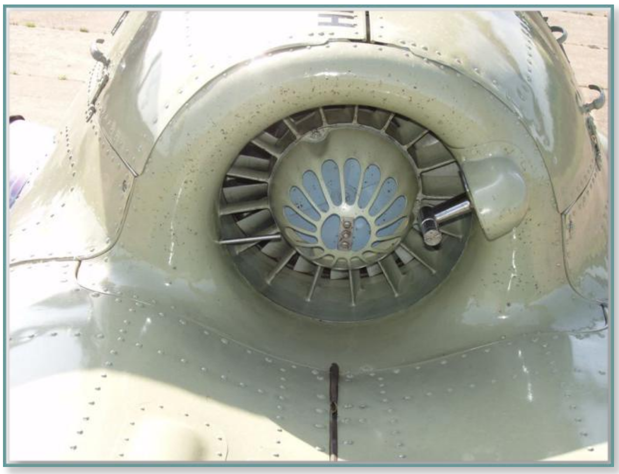


Рис. 9.32. Oil cooler fan

The fan cools the oil in the engine and transmission by blowing air directly through the oil coolers. Hot air vents from the transmission compartment via an exhaust shroud at the rear of the oil coolers. The remainder of the air passes through protective shrouds to flexible lines to cool the generators, hydraulic pumps, and the air compressor.

5 ONBOARD SYSTEMS

5. ONBOARD SYSTEMS

The helicopter's onboard systems suite provides for:

a) flight control and navigation in day and night time conditions in visual or instrument meteorological conditions;

b) control of engine, transmission, and flight performance.

The cockpit systems and controls suite includes:

– flight control and navigation systems;
– powerplant and drive system performance indicators and controls;
– helicopter systems performance indicators.

DCS provides pop-up "hints" to identify all of the interactive cockpit controls/switches to ease familiarization with helicopter systems. To see the hint for a particular control/switch, simply hover the mouse over it in the cockpit. Pop-up hints can be enabled/disabled in the OPTIONS menu.

In the simulation, the mouse can be use to perform the following actions:

- left-click to engage a switch/button;

- right-click or left-click to manipulate a multi-position switch;

- rotate the mouse wheel or left-click, hold and drag the mouse to turn a rotary switch/dial.

When the mouse cursor is placed over an interactive cockpit control, the yellow cross icon changes color to green to indicate the control is clickable and changes shape to indicate whether the control is discrete or rotary type. All of the mouse clickable controls are provided a keyboard shortcut, which can be found in the INPUT OPTIONS menu. Keyboard shortcuts are also provided in this manual in blue color.

5.1 COCKPIT LAYOUT

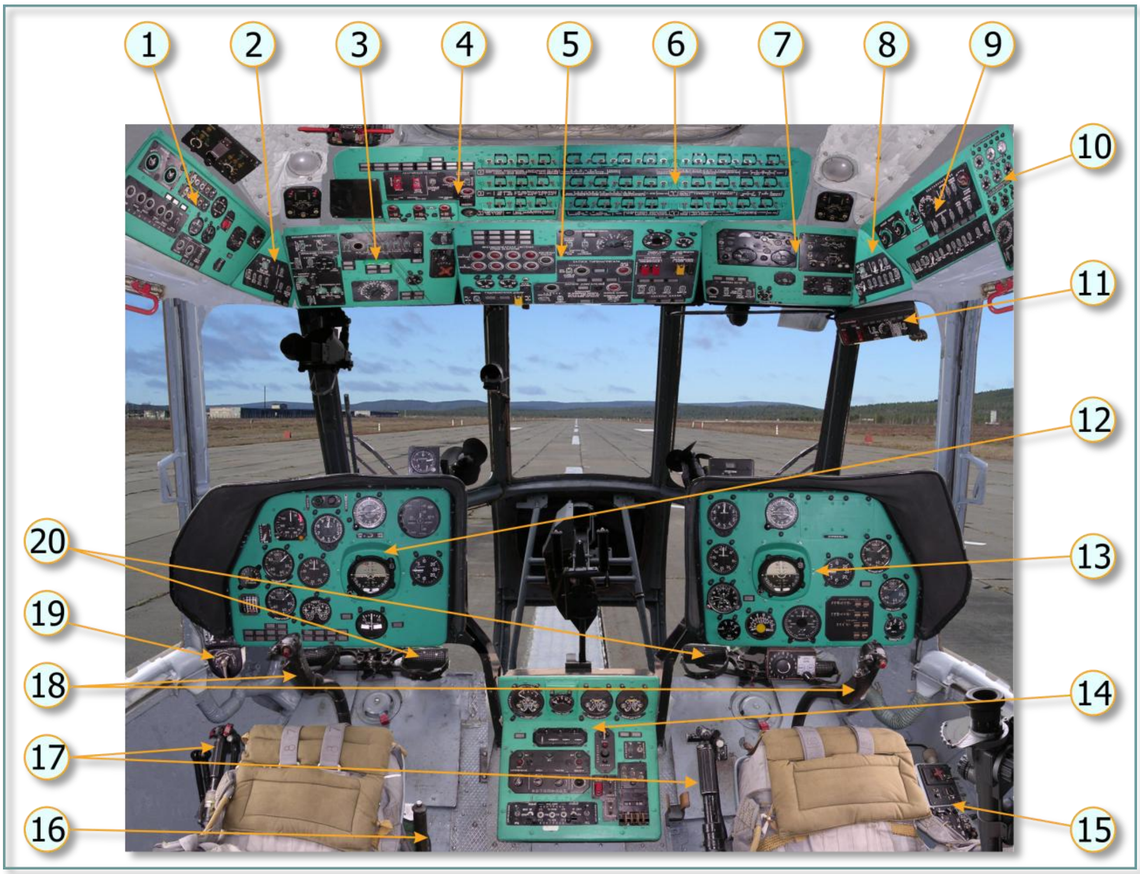


Рис. 9.33. Cockpit layout:

1. Left Side Console
2. Left Triangular Panel
3. Left Overhead Console
4. Left Circuit Breaker Console
5. Center Overhead Console
6. Right Circuit Breaker Console
7. Right Overhead Console
8. Right Triangular Panel
9. Right Side Console
10. Right Rear Console
11. Copilot's Weapons Control Panel
12. Left Instrument Panel
13. Right Instrument Panel
14. Center Console
15. Right Auxiliary Panel
16. Rotor brake lever
17. Collective control handle
18. Cyclic control stick
19. Pitot tube selector
20. Anti-torque pedals

5.1.1. LEFT INSTRUMENT PANEL (PILOT)

Рис. 9.34. Left instrument panel (pilot):

1. Pilot's landing/search and taxi light controls
2. УР-117М (UR-117M) Engine Pressure Radio (EPR) indicator
3. ИП-21 (IP-21) main rotor pitch angle indicator
4. ИТЭ-2Т (ITE-2T) two-pointer engine tachometer indicator
5. ИТЭ-1Т (ITE-1T) main rotor tachometer indicator
6. Radar altimeter switch
7. УС-450К (US-450K) airspeed indicator
8. УВ-5М (UV-5M) radar altimeter indicator
9. ВД-10ВК (VD-10VK) pressure altimeter indicator
10. ОПБ-1Р (OPB-1R) bomb sight course indicator
11. АРК СВ-УКВ (ADF HF-VHF) switch
12. УГР-4УК (UGR-4UK) directional gyro
13. АГБ-3К (AGB-3K) attitude indicator
14. Hover and low speed control indicator
15. ВР-30МК (VR-30MK) vertical velocity indicator
16. Annunciators (lights)
17. ЭУП-53 (EUP-53) turn indicator
18. "ОТАКАЗ 6201" ("6201 FAIL") light
19. Annunciators (lights)
20. 2УТ-6К (2UT-6K) exhaust gas temperature indicator
21. Annunciators (lights)
22. Pitot tube selector

5.1.2. RIGHT INSTRUMENT PANEL (COPILOT)

Рис. 9.35. Right instrument panel (copilot):

1. УС-450К (US-450K) airspeed indicator
2. ВД-10ВК (VD-10VK) pressure altimeter indicator
3. АГБ-3К (AGB-3K) attitude indicator
4. УГР-4УК (UGR-4UK) directional gyro
5. ВР-30МК (VR-30MK) vertical velocity indicator
6. "ДИСС ОТКАЗАЛ" Doppler system fail annunciator
7. ИТЭ-1Т (ITE-1T) main rotor tachometer indicator
8. ИТЭ-2Т (ITE-2T) two-pointer engine tachometer indicator
9. Copilot's landing/search light switch
10. ТВ-1 (TV-1) cabin temperature indicator
11. ДИСС-15 (DISS-15) Doppler system co-ordinate indicator
12. ДИСС-15 (DISS-15) Doppler system ground speed and drift indicator
13. БЭ-09К (BE-09K) fuel quantity indicator
14. Low Fuel (270 L) annunciator
15. П-8УК (P-8UK) fuel meter switch
16. АЧС-1 (AChS-1) clock

5.1.3. CENTER CONSOLE

Рис. 9.36. Center console:

1. УИЗ-6 (UIZ-6) main transmission oil temp, intermediate and tail rotor gearbox oil pressure indicator
2. ТУЭ-48 (TUE-48) main transmission oil temp indicator
3. УИЗ-3 (UIZ-3) left engine oil pressure and temp indicator
4. УИЗ-3 (UIZ-3) right engine oil pressure and temp indicator
5. Р-863 (R-863) VHF radio manual/preset selector
6. Р-863 (R-863) VHF radio control panel
7. Р-863 (R-863) VHF radio frequency select panel
8. Engine governor control panel
9. Lamp test and electrical system backup switches
10. АП-34Б (AP-34B) autopilot control panel
11. БУ-32-1 (BU-32-1) control unit for the СПУУ-52 (SPUU-52) pitch limit system
12. ИН-4 (IN-4) trim indicator of the automatic flight control system

5.1.4. LEFT SIDE CONSOLE

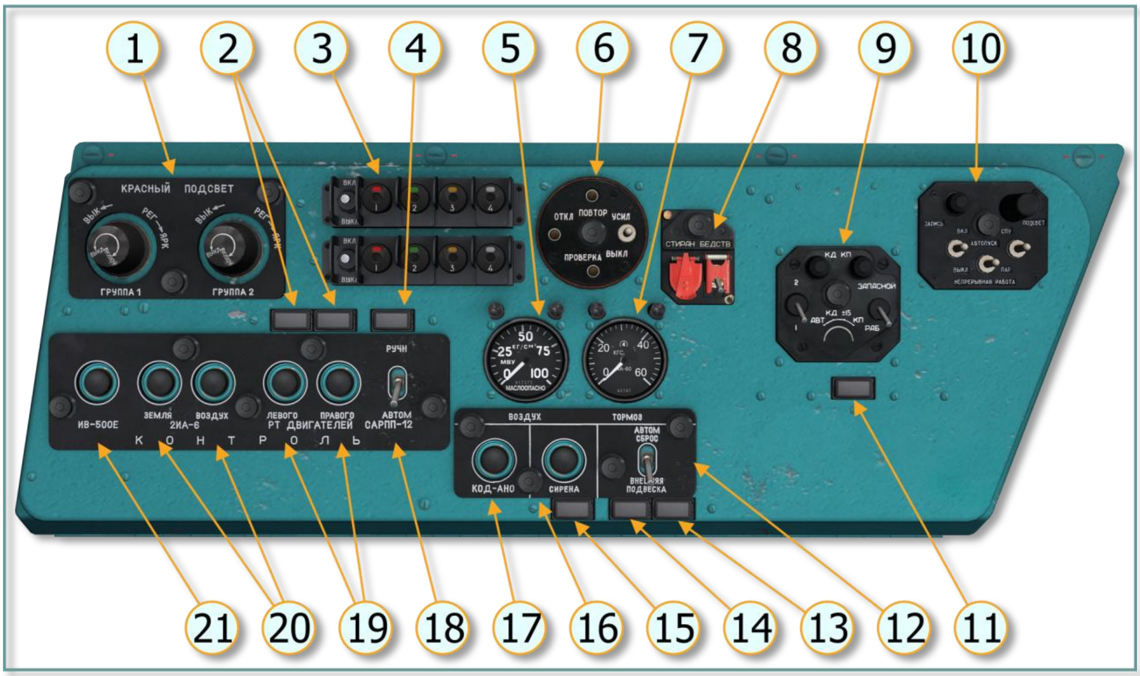


Рис. 9.37. Left side console:

1. Left side Group 1/2 red lighting dimmers
2. "РТ ЛЕВ РАБОТАЕТ" "РТ ПРАВ РАБОТАЕТ" LH/RH engine temp regulator operating annunciators
3. ЭП-662 (EP-662) signal flares control panel
4. "САРПП РАБОТАЕТ" Flight Data Recorder (FDR) operating annunciator
5. МВУ-10К (MVU-10K) pneumatic system air pressure gauge
6. РИ-65Б (RI-65B) Voice Warning System remote control panel
7. МА-60К (MA-60K) air pressure gauge for the Landing Gear Wheel Brake System
8. Control panel 484 of "device 6201" (IFF responder)
9. Control panel 485 of "device 6201" (IFF responder)
10. П-503Б (P-503B) cockpit voice recorder (CVR) control panel
11. "ВКЛЮЧИ ЗАПАСНОЙ" ("Set Reserve") annunciator
12. External cargo auto release switch
13. "СТВОРКИ ОТКРЫТЫ" ("Doors open") annunciator
14. "ЗАМОК ОТКРЫТ" ("Shackle open") annunciator
15. "СИРЕНА ВКЛЮЧЕНА" ("Horn on") annunciator
16. Air horn button
17. Code NAV lights button
18. FDR power switch
19. LH/RH engine temp regulator test buttons
20. EGT gauge ground and air test buttons
21. ИВ-500Е (IV-500E) engine vibration indicator test button

5.1.5. LEFT TRIANGULAR PANEL

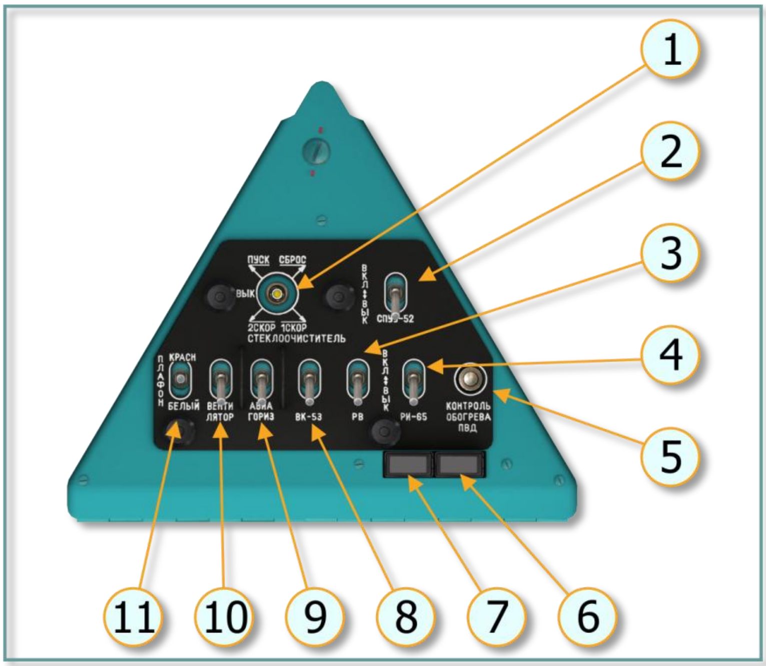


Рис. 9.38. Left triangular panel:

1. Windshield wiper switch
2. СПУУ-52 (SPUU-52) tail rotor pitch limit system power switch
3. Radar altimeter power switch
4. РИ-65 (RI-65) Voice Warning System (VWS) power switch
5. Pitot tube heating test switch
6. "ОБОГРЕВ ИСПРАВЕН" (Heater OK) annunciator
7. "ВКЛЮЧИ РИ-65" (Turn on VWS) annunciator
8. ВК-53 (VK-53) gyro correction cut-out power switch
9. Left attitude indicator power switch
10. Fan power switch
11. Dome light switch

5.1.6. LEFT OVERHEAD CONSOLE

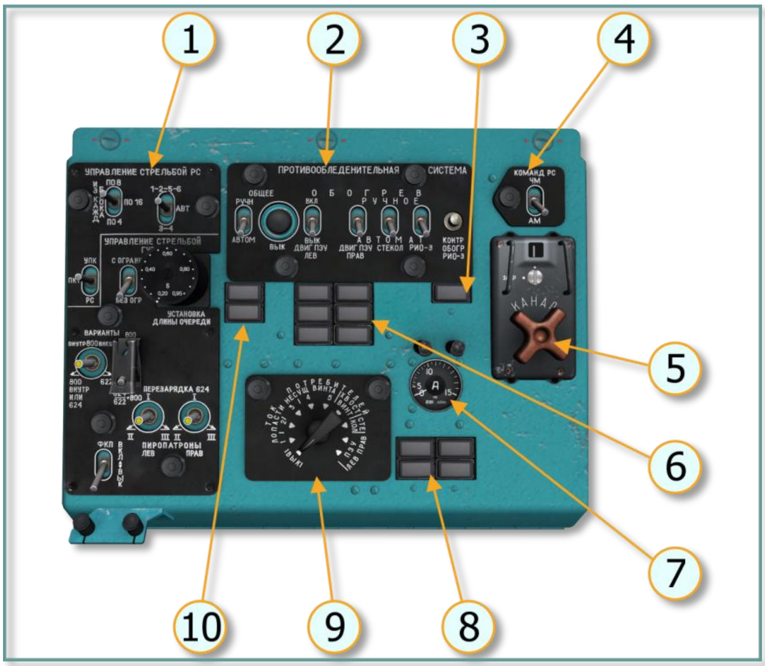


Рис. 9.39. Left overhead console:

1. Pilot’s weapons control panel
2. Anti-ice system control panel
3. “ОБОГРЕВ ИСПРАВЕН” (Anti-ice normal) annunciator
4. Р-863 (R-863) VHF radio FM/AM switch
5. Р-863 (R-863) VHF radio channel selector
6. Anti-ice system annunciator panel
7. АФ1-150 (AF1-150) ammeter
8. Section 1…4 annunciator panel
9. Ammeter load current selector switch
10. “ОБЛЕДЕН” (Icing) “ПОС ВКЛЮЧЕНА” (Anti-ice ON) annunciators

5.1.7. CENTER OVERHEAD CONSOLE

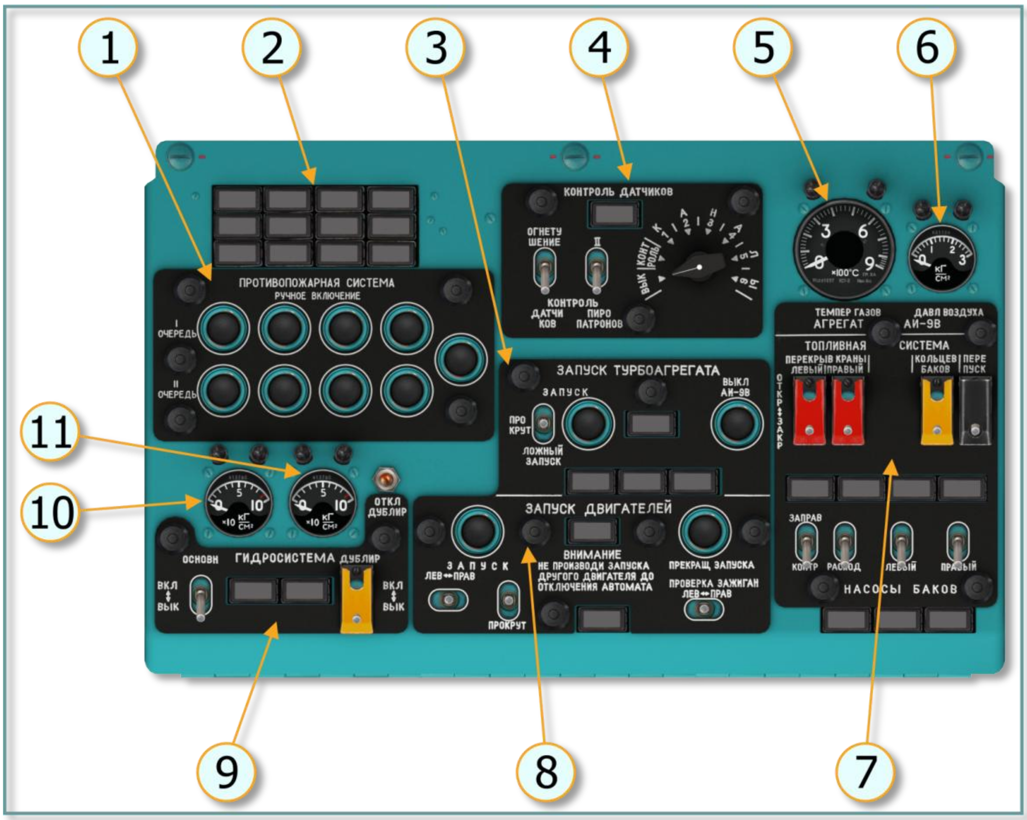


Рис. 9.40. Center overhead console:

1. Fire extinguisher system panel
2. Fire extinguisher system panel annunciators
3. APU start control panel
4. Fire extinguisher system test panel
5. APU EGT indicator
6. APU air pressure indicator
7. Fuel system control panel
8. Engine start control panel
9. Hydraulic system control panel
10. Main hydraulic system pressure indicator
11. Reserve hydraulic system pressure indicator

5.1.8. RIGHT OVERHEAD CONSOLE

Рис. 9.41. Right overhead console:

1. АРК-15 (ARK-15) ADF control panel
2. АРК-УД (ARK-UD) ADF control panel
3. ПУ-26 (PU-26) control panel of the ГМК-1А (GMK-1A) gyrocompass system
4. АРК-15 (ARK-15) frequency selector
5. КО-50 heater temp regulator switch
6. КО-50 heater control panel with annunciators

5.1.9. CIRCUIT BREAKER CONSOLES

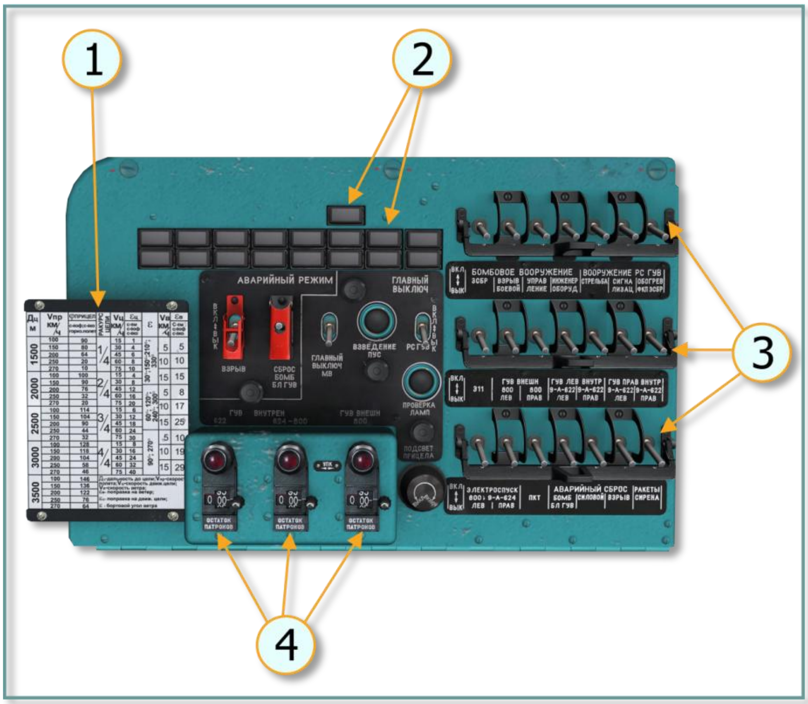


Рис. 9.42. Left circuit breaker console:

1. Aiming correction table
2. Weapons arming panel
3. Weapon systems circuit breakers
4. Remaining ammunition indicators

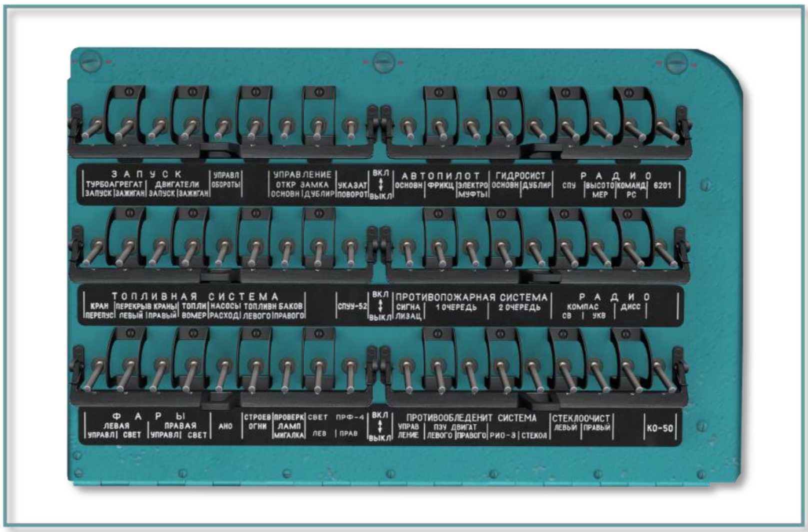


Рис. 9.43. Right circuit breaker console

5.1.10. RIGHT TRIANGULAR PANEL

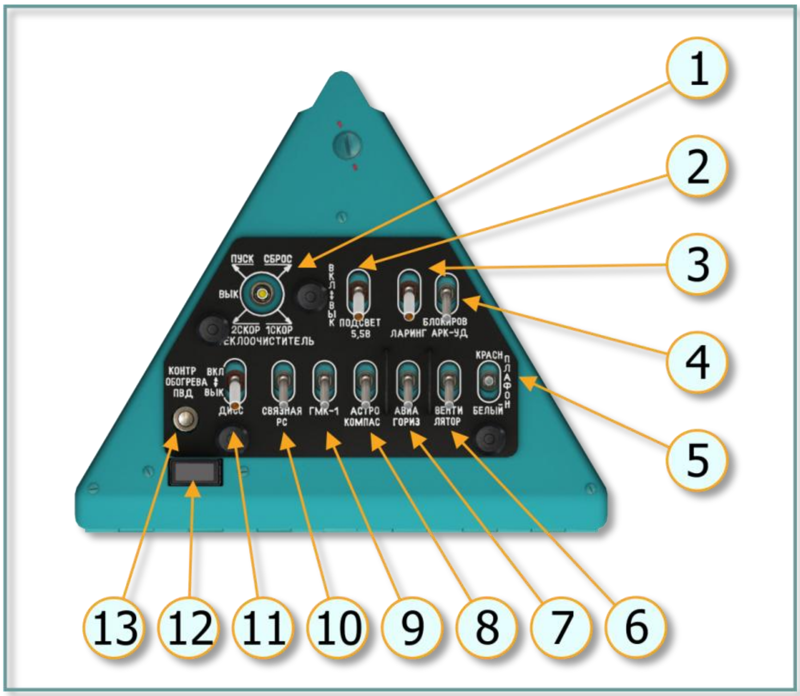


Рис. 9.44. Right triangular panel:

1. Windshield wiper switch
2. ДИСС-15 (DISS-15) Doppler system and ЯДРО-1А (Yadro-1A) radio control panel lighting switch
3. Microphone power switch
4. VHF-ADF Interlock switch
5. Dome light switch
6. Fan power switch
7. Right attitude indicator power switch
8. Astrocompass power switch
9. ГМК-1 (GMK-1) gyrocompass system power switch
10. Yadro-1A HF radio power switch
11. Doppler system power switch
12. “ОБОГРЕВ ИСПРАВЕН” (Heater OK) annunciator
13. Pitot tube heating test switch

5.1.11. RIGHT SIDE CONSOLE

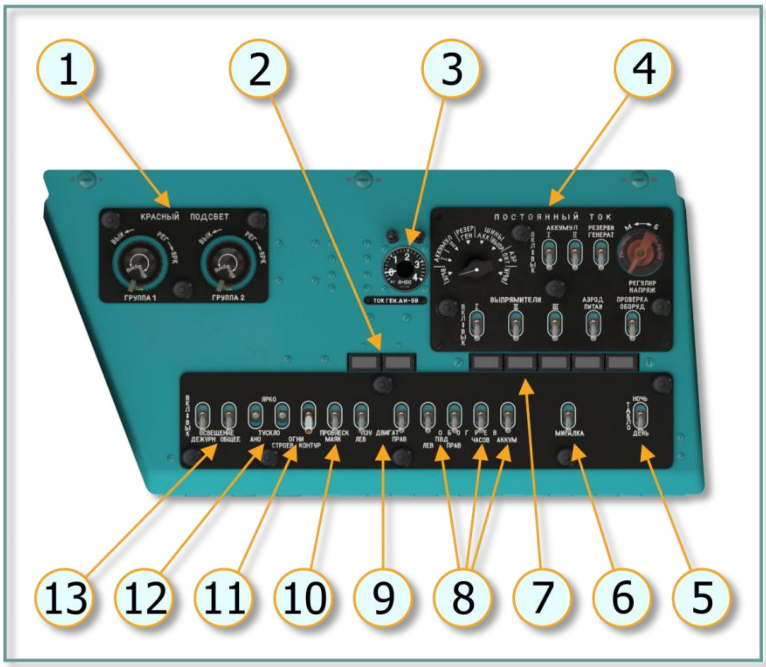


Рис. 9.45. Right side console:

1. Right side Group 1/2 red lighting dimmers
2. "ЛЕВ/ПРАВ ПЗУ ВКЛЮЧЕН"(L/R Dust Protection ON) annunciators
3. APU generator load indicator
4. DC power control panel
5. Annunciators brightness switch
6. Warning blinker switch
7. Rectifiers, external power, and BIT annunciators
8. LH/RH pitot tube, clock, and battery heating switches
9. L/R engine dust protection switches
10. Strobe light switch
11. Rotor tip and formation light switches
12. Navigation and formation lights brightness switches
13. General and standby cabin lighting switches

5.1.12. RIGHT REAR CONSOLE

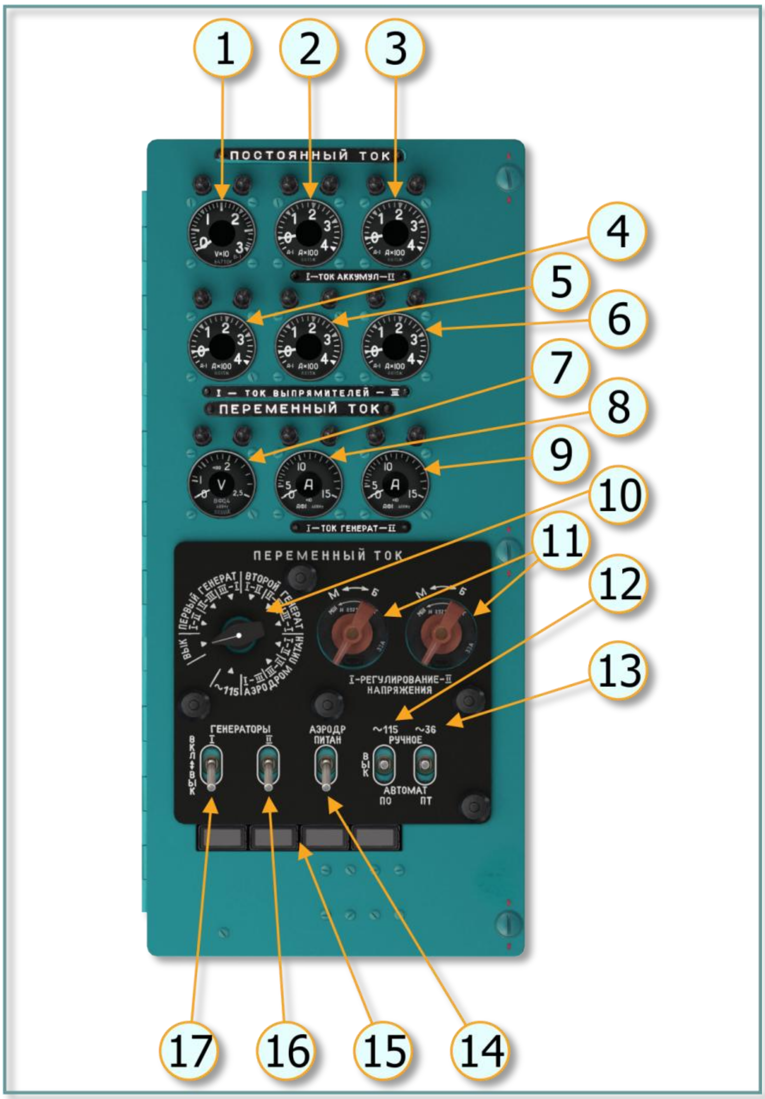


Рис. 9.46. Right rear console:

1. DC voltmeter
2. DC battery 1 ammeter
3. DC battery 2 ammeter
4. AC rectifier 1 voltmeter
5. AC rectifier 2 voltmeter
6. AC rectifier 3 voltmeter
7. AC generator voltmeter
8. AC generator 1 ammeter
9. AC generator 2 ammeter
10. AC power control panel
11. AC voltage control rotary 1/2
12. Inverter 1 MAN/AUTO switch
13. Inverter 2 MAN/AUTO switch
14. External power switch
15. Generator 1, 2 fail; External power, PO-500 heater annunciators
16. Generator 2 switch
17. Generator 1 switch

5.1.13. RIGHT AUXILIARY PANEL

Рис. 9.47. Right auxiliary panel:

1. Р-828 (R-828) radio control panel
2. Р-828 (R-828) radio power switch
3. Р-828 (R-828) ANT-ADF switch
4. УВ-26 (UV-26) countermeasures control panel
5. Yadro-1I HF radio set control panel

5.2 FLIGHT CONTROLS

The helicopter is equipped with lateral, longitudinal, integrated collective pitch-throttle, and directional flight control subsystems. Control inputs are transferred from the cockpit to the rotor blades by mechanical linkages and hydraulic servos. Cables are utilized in the rotor brake system and partially for tail rotor pitch control. Pilot control is assisted by an automatic flight control system (AFCS) with an integrated four channel autopilot, the hydraulic flight control servos, and pitch, roll, and yaw trim systems. Both the pilot and copilot have collective, cyclic, and directional controls, which are carried by mechanical linkage to the first and second stage control units which combine, sum, and couple the cyclic, collective, and yaw inputs. Resultant output signals are boosted and routed to the main and tail rotors through mechanical linkages with the hydraulic servos.

Force centering devices are incorporated in the cyclic control system. The devices furnish a force gradient or "feel" to the cyclic sticks. The farther the stick is deflected, the more force is applied. A TRIM DISENGAGE button is located on the pilot and copilot cyclic stick grips. Pressing and holding the TRIM DISENGAGE button will immediately reduce the forces on stick to zero. Releasing the button reengages the trim.

5.2.1. CYCLIC CONTROL SYSTEM

Lateral and longitudinal control of the helicopter is by movement of the cyclic sticks through push rods, bellcranks, and servos to the main rotor swashplate. Movement in any direction tilts the plane of the main rotor blades in the same direction, thereby causing the helicopter to move in that direction.

The pilot's (left) and copilot's (right) cyclic control sticks are nearly identical in design and construction and are installed symmetrically on the cockpit floor relative to the longitudinal axis of the helicopter.

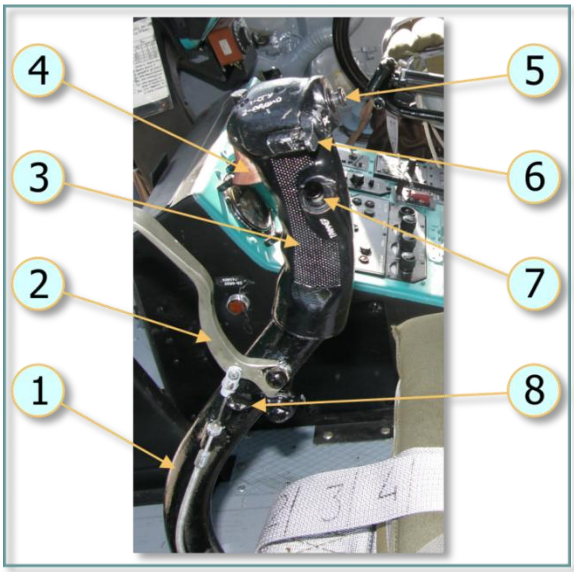


Рис. 9.48. Pilot's cyclic control stick

The cyclic control stick is constructed out of a shaped metal tube assembly (1) with a hard rubber hand grip (3), which includes four buttons: ICS/RADIO keying button (trigger position) (4), Autopilot OFF button (5), FIRE button (6), TRIM button (7). The pilot's (left) cyclic also includes a wheel brake control lever (2) and a latch to maintain it in the locked position (8).

Longitudinal stop: A hydraulic cylinder and mechanical stop are included in the longitudinal control linkage to limit swashplate aft tilt to a maximum of 2°12' when the helicopter is on the ground or taxiing. The stop is controlled by weight-on-wheels microswitches mounted on the main landing gear strut supports. As the pilot pulls back on the cyclic, the longitudinal stop causes a sharp increase in the force required to move the stick when the swashplate aft tilt reaches 2°12'. As the helicopter lifts off the ground, the microswitch contacts open and the stop disengages, releasing the limit on aft swashplate tilt.

5.2.2. DIRECTIONAL CONTROL SYSTEM

The directional control system is operated by the pilot or copilot pedal assemblies. From the pedals to the directional servo, the control linkage consists of a system of push/pull rods and bellcranks. Cables are used to pass control inputs to the tail rotor gearbox. The pitch change mechanism for the gearbox consists of a chain, sprocket, and worm gear, which extends or retracts the pitch control rod. Rod movement is transmitted via the pitch change links to the blade grips, resulting in a change of blade angle. Pushing the left pedal forward causes the pitch control rod to retract. The blade pitch angle decreases and the helicopter turns to the left. Pushing the right pedal forward extends the pitch control rod, increasing the blade pitch angle, and the helicopter turns to the right. Right pedal movement is limited by a moveable stop (pitch limiter) system which uses air density and temperature to adjust the maximum tail rotor pitch angle and prevent overloading the tail rotor and drive system.

The pedals are mounted on a bracket on the cockpit floor in front of the seat. Pedal adjusters are provided to adjust the pedal distance for individual comfort. The adjustment range is ±2.9 inches. Microswitches are mounted in each sub-pedal assembly to allow the pilot to introduce directional control inputs while the autopilot yaw channel is engaged.

Рис. 9.49. anti-torque pedals

Force centering devices are incorporated in the directional control system. The devices furnish a force gradient or "feel" to the pedals. The farther the pedals are deflected, the more force is applied. A TRIM DISENGAGE button is located on the pilot and copilot cyclic stick grips. Pressing and holding the TRIM DISENGAGE button will immediately reduce the forces on the pedals to zero. Releasing the button reengages the trim.

Tail rotor pitch limit system: the SPUU-52-1 tail rotor pitch limit system uses a linear actuator linked to a mechanical stop to adjust the maximum tail rotor blade pitch angle within a range of 16°20' to 20°30'. The adjustment is based on air temperature and density. Increased density results in a decrease in the maximum blade pitch angle. When the system is disengaged, the stop resets and allows full right pedal travel.

The tail rotor pitch limit system is controlled and monitored via the SPUU-52-1 control panel. The panel is located in the right center area of the cockpit center console. The main power switch for the system is located on the pilot's left triangular panel. When the system is disengaged, the red OFF lamp-button on the control panel will illuminate. To engage the system, set the SPUU-52-1 main power switch to the ON (up) position.

When the right pedal is pressed fully pressed in, the AFCS heading channel disengages.

Рис. 9.50. SPUU-51-1 cockpit controls

If the SPUU-52-1 system fails in flight, the red OFF lamp-button on the control panel will illuminate. In this case, the SPUU-52-1 main power switch on the left triangular panel should be set to the OFF (down) position. This will set the limiter needle on the SPUU-52-1 control panel to the full left position, indicating the removal of limits on right pedal travel. Hover and landing with the limiter disengaged should be performed as much as possible into the wind while avoiding large or sudden pedal inputs.

DIRECTIONAL CONTROL SYSTEM FAILURE IN FLIGHT

In case of directional control system failure in flight, the helicopter exhibits a strong tendency to yaw left and, if roll angle is maintained neutral, a tendency to sideslip right and turn left.

If the helicopter does not respond to pedal input, maintain an airspeed of 60-200 kph and establish a right roll angle to maintain forward flight. Optimal airspeed is approximately 150 kph, which produces minimal sideslip with a roll angle of 5-7° right in forward flight.

Test the helicopter response to pedal input throughout the pedal travel range in case limited control is possible within a specific input range. Attempt to find a suitable landing area allowing for a landing with an airspeed of 70-80 kph.

Perform transitional maneuvers with gradual adjustments of collective control. When raising collective, the cyclic requires adjustment to the right and increased right roll angle. When lowering collective (for example to make a landing attempt), the cyclic requires adjustment to the left and reduced right roll angle.

Perform turns and heading changes using roll control. Turns are best performed to the left.

Once a suitable landing area is selected, begin a descent maintaining an airspeed of 150 kph with 3-4 m/s descent rate.

At an altitude of 25 - 30 m, begin an aggressive deceleration. In the deceleration avoid left yaw by measured and if necessary progressive reductions in collective pitch.

At an altitude of 10 - 15 m, while continuing to decelerate, quickly reduce collective pitch by 1.5 - 2.5° and level out any present roll. As collective is reduced, the helicopter tends to yaw right and reduce slip (drift) angle. Control the rate of descent and slip visually by referencing the ground and using collective pitch.

At an altitude of 3 - 4 m, increase collective pitch to establish a rate of descent of 1 - 2 m/sec at touchdown. Keep in mind that yaw and slip/drift response occurs 1 - 2 sec after collective increase.

After touchdown reduce collective pitch to minimum.

5.2.3. COLLECTIVE PITCH CONTROL SYSTEM

The collective pitch control system includes integrated throttle and main rotor collective pitch control linkages. The collective inputs raise or lower the swashplate slide. This changes the pitch of the main rotor blades, causing an increase or decrease in lift on the entire rotor disc. When the collective stick is moved upward, main rotor collective pitch increases. At the same time, the engines increase to a higher power setting. When the collective stick is moved downward, main rotor pitch and engine power decreases. The collective control inputs reach the main engine throttle controls via a series of bellcranks and push rods. The collective inputs to the main rotor swashplate slide are routed via bellcranks and push rods to the collective flight control servo and collective lever/rocker.

The collective sticks are mounted on the cockpit floor to the left of the pilot’s and copilot's seats. A hydraulic clutch holds the stick securely in any position, allowing the pilot to make smooth pitch adjustments and preventing the stick from creeping. Ordinarily, the clutch is adjusted manually using the handwheel to allow the stick to be moved, without releasing the clutch, with a force of 45 to 55 lb. The CLUTCH RELEASE button activates the hydraulic clutch release system, allowing the stick to be moved with a force no greater than 3.3 lb. When the button is released, the clutch re-engages. The CLUTCH RELEASE button also disengages the autopilot altitude channel.

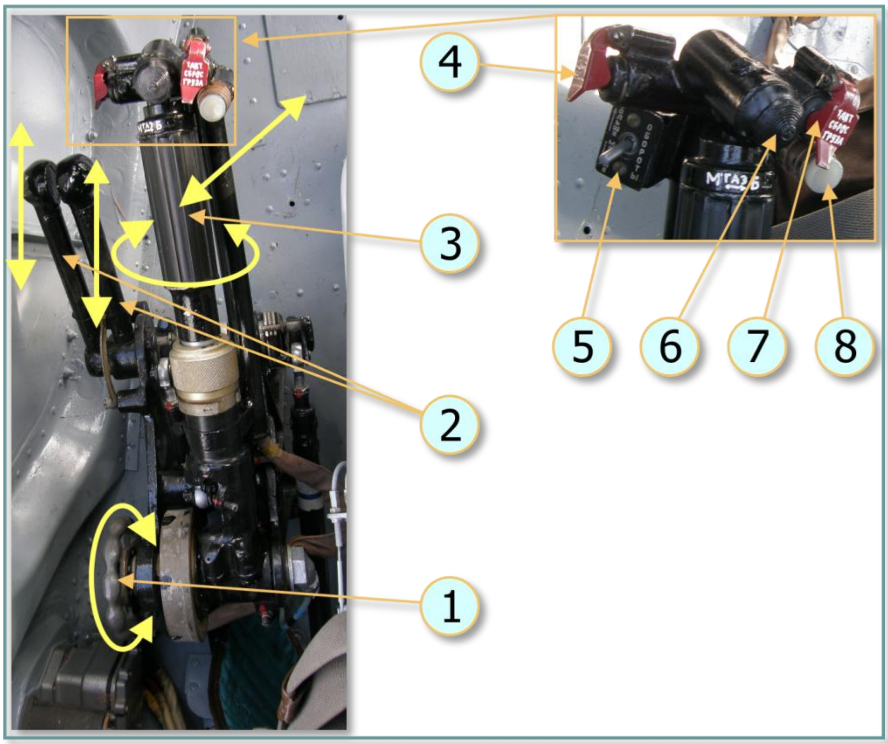


Рис. 9.51. Pilot's (left) collective control group:

1 – hand wheel (friction adjust); 2 – engine condition levers (ECLs); 3 – twist throttle; 4 – Emerg cargo release button; 5 – N2 trim INCR-DEC switch; 6 – searchlight control button; 7 – tactical external stores jettison button; 8 – CLUTCH RELEASE button.

The copilot's collective stick is located to the left of the copilot seat. It is similar in design to the pilot's collective, but does not include a friction clutch, cargo release buttons, or engine condition levers (ECLs).

Joint (dual) engine operation is controlled using the twist grip throttle control on the pilot or copilot collective sticks. The throttle is rotated right (clockwise) from the closed position through an idle detent, to fully open.

The engines are controlled individually by the pilot's ECLs. The ECLs vary the engine compressor (N1) control lever (throttle) settings from minimum to maximum power separately for each engine. They are used to control the engine power setting during ground testing and in special flight conditions, such as failure of one engine. The normal position of the ECLs is in the center detents. The engines can be brought to takeoff power by moving the engine condition levers to the maximum settings.

The collective control system is a reserve, manual method of rotor RPM control. Under normal conditions rotor RPM is maintained automatically by the engine governor system.

Transition between automatic and manual rotor RPM control is accomplished using the twist throttle. When the throttle is fully open, the governor system automatically maintains rotor RPM. Twisting the throttle left (counterclockwise) disengages automatic RPM control. The transition can be verified by reducing rotor RPM as the throttle is twisted further left.

To assist with setting a nominal rotor RPM of 95% for takeoff, the collective control handle features the N_2 trim INCR-DECR switch to allow for gradual adjustment of the engine power turbine RPM.

5.3 POWERPLANT AND HELICOPTER SYSTEMS CONTROLS AND INDICATORS

5.3.1. ИТЭ-2Т (ITE-2T) DUAL ENGINE TACHOMETER

The dual tachometer is used to monitor compressor (N1) RPM of each engine. Rotational speed is expressed as a percentage of maximum speed. The "1" needle indicates left engine RPM and the "2" needle indicates right engine RPM. The scale range is 0 - 110% graduated to 1%.

The tachometer is located in the bottom left area of the pilot's instrument panel. A second engine dual tachometer is located on the copilot's instrument panel. The tachometers receive power from the tachgenerators mounted on the engine accessory drives, one on each engine.

Рис. 9.52. Pilot's and copilot's dual engine tachometers

5.3.2. ИТЭ-1Т (ITE-1T) MAIN ROTOR TACHOMETER

The tachometer is located in the left center area of the pilot's instrument panel. The main rotor tachometer is used to monitor the main rotor RPM. Rotational speed is expressed as a percentage of maximum speed. A second main rotor tachometer is located in the right center area of the copilot's instrument panel. The tachometers receive power from the tachgenerators mounted on the main transmission.

The scale range is 0 - 110% graduated to 1%.

Рис. 9.53. Pilot's and copilot's main rotor tachometers

5.3.3. ЭМИ-3РИ (EMI-3RI) ENGINE OIL PRESSURE/TEMPERATURE GAUGE

The engine oil pressure/temperature gauges, one for each engine, are mounted on the center console.

The gauge has three scales. The upper scale is not used. The lower left scale displays the oil pressure on a scale of 0 to 8 kg/cm^2. The lower right scale displays the oil temperature in degrees centigrade on a scale of -70°C to +150°C.

Рис. 9.54. Oil pressure/temperature gauges, center console

5.3.4. ЭМИ-3РВИ (EMI-3RVI) THREE POINTER DRIVE SYSTEM OIL PRESSURE/TEMPERATURE GAUGE

The drive system oil pressure and temperature gauge is installed on the left of the upper section of the center console. The gauge has three scales. The upper scale displays the oil pressure in the main transmission in kg/cm2. The lower left scale displays the oil temperature in the intermediate gearbox while the lower right scale displays the oil temperature in the tail rotor gearbox.

Рис. 9.55. Three pointer drive system oil pressure/temperature gauge, center console

The gauges receive temperature indications from oil temperature probes installed the transmission gearboxes. Pressure indications are provided by a pressure transducer in the transmission oil system.

All temperature indications are in degrees centigrade. The pressure scale displays the oil pressure on a scale of 0 to 8 kg/cm^2, graduated to 0.5 kg/cm^2. The temperature scale displays the oil temperature in degrees centigrade on a scale of -70°C to +150°C, graduated to 10°C.

5.3.5. 2УТ-6К (2UT-6K) POWER TURBINE INLET TEMPERATURE (PTIT) GAUGE

The power turbine inlet temperature (PTIT) gauge is located in the lower center area of the pilot's instrument panel. The indicator receives temperature indications from the thermocouple probes mounted on the engine power turbine housings. The gauge has two scales for each engine. The large scales read in hundreds of degrees; the small scales read in 5 degree increments. The temperature indications are in degrees centigrade.

Рис. 9.56. PTIT gauge

The HOT ("ВОЗДУХ") and COLD ("ЗЕМЛЯ") test buttons, located on the pilot's left console, are used to confirm proper operation of the gauge. With the engines shut down, the needles should move toward 960° when the COLD button is pressed. The needles should return to zero when the COLD button is released. With the engines running, the needles should move toward zero when the HOT button is pressed and return to the actual PTIT readings when it is released.

5.3.6. ИР-117 (IR-117) ENGINE PRESSURE RATIO (EPR) INDICATOR

The engine pressure ratio indicator is located in the lower left area of the pilot's instrument panel. It is used to monitor the engine power settings. The indicator displays current engine compressor delivery pressure in reference to takeoff, nominal, and cruise power settings under current ambient atmosphere conditions.

Рис. 9.57. Engine pressure ratio (EPR) indicator

The indicator is connected to a pair of pressure tubes, an altitude sensor, and an outside air temperature probe. The power setting is determined by comparing the compressor delivery pressure pointers on the side indices (one for each engine - LH and RH) with the power setting pointers displayed in the center scale. The position of the power pointers in the center scale is proportional to the atmospheric pressure and ambient temperature. The center pointer marks "O", "H", and "K" correspond to takeoff, nominal, and cruise power settings, respectively. The indicator is scaled from 5 to 10 atmospheres.

The EPR indicates total power demand response to throttle, ECL, and collective input. Actual power output is determined by the alignment of the two outer markers with the center index, marked "O", "H", and "K".

The EPR indicator is used to monitor engine power settings in ambient air temperatures of up to +24°C. Above this temperature, the dual engine tachometer is used as the engine power settings indicator.

The reading error is ±1.5%, measured pressure range is 4.6 - 8.5 atmospheres, effective operational altitude range is 0.5 km (2.5 km).

Максимальная погрешность измерения ±1,5%; диапазон измерения избыточного давления 4,6…8,5 атм.; диапазон высот 0,5 км (2,5 км).

5.3.7. ТУЭ-48 (TUE-48) MAIN TRANSMISSION OIL TEMPERATURE GAUGE

Рис. 9.58. Main transmission oil temp gauge, center console

The main transmission oil temperature gauge displays the oil temperature in degrees centigrade. The gauge is scaled from -50°C to +150°C, graduated to 10°C.

5.3.8. ТВ-19 (TV-19) CARGO CABIN TEMPERATURE GAUGE

Рис. 9.59. Cargo cabin temp gauge

The cargo cabin temperature gauge display the cargo compartment temperature in degrees centigrade. The gauge is scaled from -60°C to +60°C, graduated to 5°C.

5.3.9. ТСТ-2 (TST-2) APU EXHAUST GAS TEMPERATURE (EGT) GAUGE

Рис. 9.60. APU EGT gauge, center overhead console

The APU exhaust gas temperature gauge is located in the upper right corner of the center overhead console, to the left of the APU air pressure gauge. The gauge reads in degrees centigrade. Gauge readings must be multiplied by 100 to obtain the correct temperature. The gauge is scaled from 0 to 900°C, graduated to 20°C.

During APU start, the EGT should not exceed 880°C. Normal EGT readings should be between 720° and 750°C.

5.3.10. УИ1-3 (UI1-3) APU AIR PRESSURE GAUGE

Рис. 9.61. APU air pressure gauge, center overhead console

The APU air pressure gauge is located in the upper corner of the center overhead console, to the right of the APU EGT gauge. The gauge displays the pressure in the main bleed air channel of the AI-9V APU feeding the SV-78B air starters of the TV3-117VM engines.

The gauge reads in kg/cm^2. The gauge is scaled 0 to 3 kg/cm^2, graduated to 0.2 kg/cm^2.

5.3.11. УИ1-100 (UI1-100) HYDRAULIC PRESSURE GAUGES

Рис. 9.62. Hydraulic pressure gauges, center overhead console

The MAIN and BACKUP system hydraulic pressure gauges are located in the lower left area of the center overhead console. The gauges display the system pressure in kg/cm^2. Scale indications must be multiplied by 10 to obtain the correct pressure reading. The gauges are scaled 0 to 100 kg/cm^2 graduated to 10 kg/cm^2. Normal readings should be in the range of 45 to 68 kg/cm^2.

5.3.12. УП-21-15 (UP-21-15) ROTOR PITCH INDICATOR

Рис. 9.63. Rotor pitch indicator

The rotor pitch indicator is used to display the collective pitch of the main rotor in degrees. It is located on the left side of pilot's instrument panel. The indicator is scaled 1° to 15°, graduated to 1°.

5.3.13. СКЭС-2027В (CKES-2027B) FUEL QUANTITY GAUGE

Рис. 9.64. Fuel quantity gauge

The fuel quantity gauge and selector are located in the lower right corner of the copilot's instrument panel. The gauge continuously indicates the quantity of fuel in the selected tank in liters. The fuel gauge is connected to the fuel sensors installed in the individual fuel cells. The gauge has two indicator scales. The outer scale displays the total quantity of fuel in all tanks. The inner scale shows the fuel quantity in the selected tank. The selector position controls the active scale. The selector positions, from left to right, include "ВЫК" (OFF), "СУММА" (TOTAL), "Дл" (LEFT MAIN), "Пл" (LEFT AUX), "Ппр" (RIGHT AUX), "РАСХ" (SVC CELL), "Дпр" (RIGHT MAIN) positions. The scale indications must be multiplied by 100 liters to obtain the correct quantity of fuel.

The "270 L FUEL" warning light is located on the copilot's instrument panel, above the fuel gauge. The low level transmitter activates when there is approximately 270 liters of fuel remaining in the cell.

5.3.14. ИВ-500Е (IV-500E) ENGINE VIBRATION MONITOR

The engine vibration monitor activates the caution and warning lights on the pilot's master caution panel if the vibration increases significantly or reaches a critical level. If the level of vibration reaches 45 mm/sec (1.8 in/sec), the system illuminates the yellow caution light labeled "ЛЕВ (ПРАВ) ДВ ВИБР ПОВ" (LEFT (RIGHT) ENG HIGH VIBE). It also sends a signal to the audio warning system which transmits an audio warning over the helicopter intercom system. If the level of vibration reaches 60 mm/sec (2.4 in/sec), it illuminates the red warning light labeled "ВЫКЛЮЧИ ЛЕВ (ПРАВ) ДВ" (SHUT OFF LEFT (RIGHT) ENG) and sends a signal to be recorded by the flight parameter recorder.

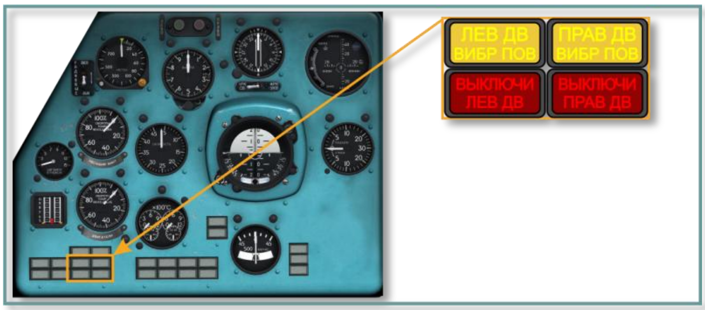


Рис. 9.65. Engine vibration monitor annunciators

The vibration monitor system includes a built-in test circuit. When the "КОНТРОЛЬ ИВ-500Е" (ENGINE VIBE TEST) button on the pilot's left side console is pressed, all four caution/ warning lights must illuminate.

If the "ВЫКЛЮЧИ ЛЕВ (ПРАВ) ДВ" (SHUT OFF LEFT (RIGHT) ENG) light illuminates, attempt to reduce vibration by lowering the engine power settings. If the warning extinguishes, maintain 130-140 kph and proceed to the nearest airfield.

If the warning persists, the faulty engine must be shut down. Flashing of both yellow and red annunciators is permissible in a power-on glide.

IV-500E technical specifications:

- monitored frequency range: 190 - 340 Gz
- monitored vibration speed range: 5 - 100 mm/sec
- continuous operating duration: 10 hrs

5.3.15. МВУ-100К (MVU-100K) PNEUMATIC SYSTEM PRESSURE GAUGE

Рис. 9.66. Pneumatic system pressure gauge, left side panel

The pneumatic system pressure gauge is located on the left side console next to the brake pressure gauge. The gauge displays pressure in the pneumatic system in kg/cm^2. Normal reading is 40-50 kg/cm^2. The gauge is scaled 0 kg/cm^2 to 100 kg/cm^2, graduated to 5 kg/cm^2.

5.3.16. МА-6К (MA-6K) BRAKE PRESSURE GAUGE

Рис. 9.67. Brake pressure gauge, left side panel

The brake pressure gauge is located on the left side console next to the pneumatic system pressure gauge. The gauge displays pressure in the main brake line in kg/cm^2. Normal reading is 30-36 kg/cm^2 when the brakes are applied.

The gauge is scaled 0 kg/cm^2 to 60 kg/cm^2, graduated to 2 kg/cm^2.

5.3.17. САРПП-12Д1М (SARPP-12D1M) FLIGHT DATA RECORDER (FDR) (NOT IMPLEMENTED)

The SARPP-12D1M flight data recorder is designed to record the flight parameters of the helicopter under normal and emergency conditions.

The system continuously records the helicopter's barometric altitude, indicated airspeed, the position (tilt and height) of the main rotor swashplate, the main rotor RPM, and the helicopter pitch and roll angles. The system also records nine event-driven parameters. The trigger events include low fuel emergency, failure of any fuel boost pump, engine emergency power engagement, detection of a fire in any deck compartment, main hydraulic system failure, backup hydraulic system failure, loss of oil pressure in the main transmission, engagement of engine and particle separator anti-ice system (right engine only), and engagement of rotor deice system. All data is provided to the recorder via sensors, pressure switches, and/or transducers installed in the monitored systems.

Рис. 9.68. SARPP-12D1M FDR power switch and indicator light, left side panel

The recorder may be turned on manually or set for automatic operation using the "САРПП-12Д1М "РУЧН – АВТОМ"" (FLIGHT RECORDER) switch on the pilot's left side panel. When the switch is placed in the AUTO (down) position, the system is turned on automatically just after takeoff, when the AM-800K microswitch in the left main landing gear strut is activated. The microswitch activates when the weight is removed from the main landing gear. If the film transport and light-beam in the K12-51DM data storage unit are operational, the "САРПП РАБОТАЕТ" (SARPP WORKING) indicator light, located near the switch, will blink. In AUTO mode, the system actives only if there is sufficient pressure in the main or reserve hydraulic system.

5.4 FLIGHT DATA AND NAVIGATION SYSTEMS CONTROLS AND INDICATORS

The avionics systems installed on the Mi-8MTV2 helicopter include communication, navigation, and flight data reporting systems. The communication systems have receiver/transmitter capabilities which can provide communication between aircraft, crew members, and ground stations on varying bandwidths. The signal dependent navigation systems utilize ADF, VHF, Doppler NAV and related instruments. The signal-providing navigation systems utilize a transponder. Non-signal dependent on-board navigation systems use both gyroscopic and magnetic instruments.

5.4.1. FLIGHT DATA SYSTEMS AND INDICATORS

Flight data systems include:

- pitot static system to provide dynamic and static pressure for operation of the differential pressure instruments: the pressure altimeters, vertical speed indicators, and the airspeed indicators;
- gyroscopic instruments to track and display the helicopter flight attitude.

PITOT STATIC SYSTEM

Рис. 9.69. Left and right pitot tubes

Two ПВД-6М (PVD-6M) pitot tubes are installed on the left and right side of the fuselage nose. The pitot tubes supply both dynamic (impact) pressure of the incidental airflow and static (ambient) air pressure. Static pressure is provided via a series of eight static pressure ports spaced around the aft circumference of the pitot tubes. To increase reliability, the static ports are connected to the instruments through a 3-position switch. The pitot tubes are equipped with electrical heaters to protect them from freezing.

Static port switching valve. The static port switching valve allows the pilot to select a specific port or both ports as the source of static pressure for the instruments. The static port switching valve is mounted at the lower left corner of the pilot’s instrument panel. With the lever set to the "O" (BOTH) (middle) position, static pressure from the left and right ports is combined by the valve and supplied to all of the connected instruments. When the lever is placed in the "Л" (LEFT) or "П" (RIGHT) position, static pressure is supplied only from the left or right port, respectively. The left pitot tube supplies only the left (pilot's) airspeed indicator. The right pitot tube supplies the right (copilot's) airspeed indicator and the ДАС (DAS) airspeed sensor and КЗСП (KZSP) airspeed correction unit.

The pitot tubes are equipped with heaters to prevent obstruction of the inlets by ice. The heaters are controlled by the "ОБОГРЕВ ПВД ЛЕВ (ПРАВ)" (LEFT (RIGHT) PITOT HEAT) switches on the copilot's right side console.

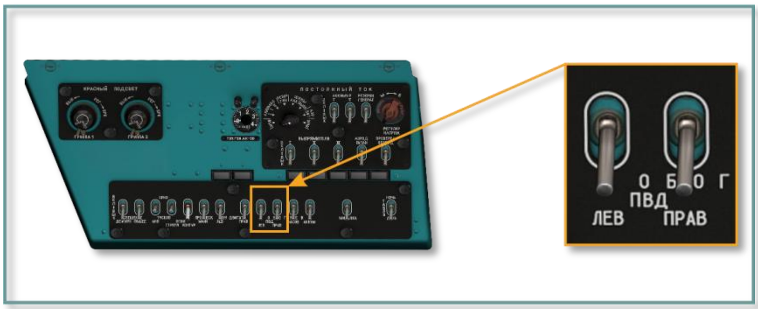


Рис. 9.70. Pitot tube heat switches, right side panel

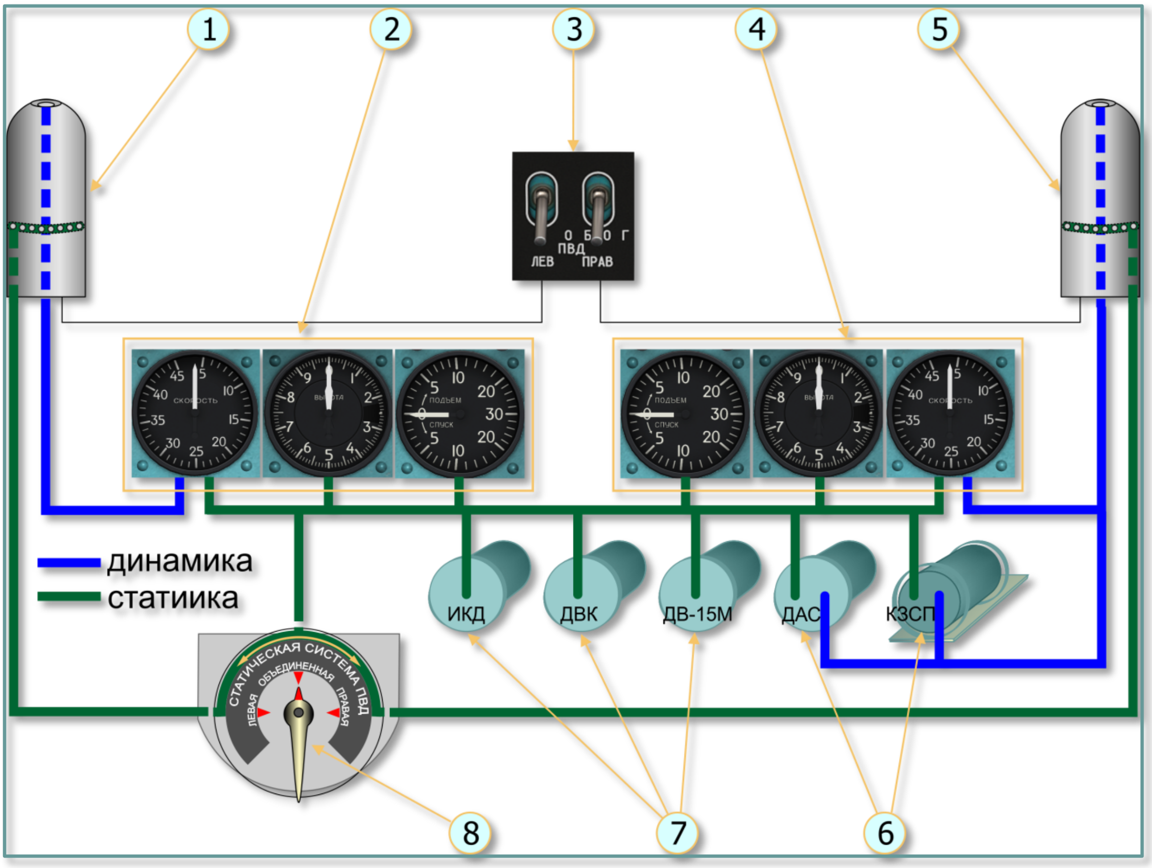


Рис. 9.71. Pitot static system diagram:

1 – left pitot tube; 2 – pilot's airspeed indicator, pressure altimeter, and vertical velocity indicator; 3 – pitot tube heat switches; 4 – copilot's airspeed indicator, pressure altimeter, and vertical velocity indicator; 5 – right pitot tube; 6 – pressure data consumers; 7 – pressure data consumers; 8 – static port switching valve.

The pitot heaters have a built-in test circuit consisting of a "КОНТРОЛЬ ОБОГРЕВА ПВД" (PITOT HEATER TEST) button, a "ОБОГРЕВ ИСПРАВЕН" (HEATER OK) indicator light, and a relay and microswitch for each pitot tube. The test buttons and lights are located on the left and right triangular panels in the cockpit.

Рис. 9.72. Pitot heat test buttons and HEATER OK annunciators

УС-450К (US-450K) AIRSPEED INDICATOR

Рис. 9.73. Airspeed indicators

Two airspeed indicators are installed on the helicopter, one on the pilot's instrument panel and one on the copilot's instrument panel. The airspeed indicators display the indicated airspeed in a range of 0 to 450 kph on a scale graduated to 10 kph.

ВД-10К (VD-10K) PRESSURE ALTIMETER

Two pressure altimeters are installed on the helicopter, one on the pilot's instrument panel and one on the copilot's instrument panel. The pressure altimeters display barometric altitude. The indicators utilize two arrows: the large arrow displays altitude in meters, the small arrow in thousands of meters (kilometers). The indicator reading range is 0 to 10,000 m. The scale is graduated to 10 m for the large arrow and 100 m for the small arrow.

Рис. 9.74. Pressure altimeters

Рис. 9.75. Pressure altimeter functin elements

The pressure altimeter adjustment knob is used to set the arrows to 0 altitude and adjust the reference barometric pressure. Turning the knob also moves the two triangular indexes around the altitude scale, one around the outside scale and one around the inside scale. The indexes are used to set the altitude difference for a landing point located at a higher elevation than the takeoff airfield in case the actual pressure at the landing field is unknown.

BP-30MK (VR-30MK) VERTICAL SPEED INDICATOR (VSI)

Рис. 9.76. Vertical speed indicator (VSI)

The vertical speed indicator (VSI) is mounted in the pilot's instrument panel It displays the helicopter's rate of ascent/descent in a range of ±30 meters per second (m/s) on a scale graduated to 1 m/s. The indicator is actuated by the rate of atmospheric pressure change. It is connected to the static pressure system.

5.4.2. GYROSCOPIC SYSTEMS AND INDICATORS

Gyroscoping instruments include two АГБ-3К (AGB-3K) attitude indicators, installed on both the pilot's and copilot's instrument panels and the ЭУП-53 (EUP-53) turn and slip indicator.

АГБ-3К (AGB-3K) ATTITUDE INDICATOR

Attitude indicators are installed on both the pilot's and copilot's instrument panels. The indicators display the attitude of the helicopter (roll and pitch angles) relative to the horizon and sideslip.

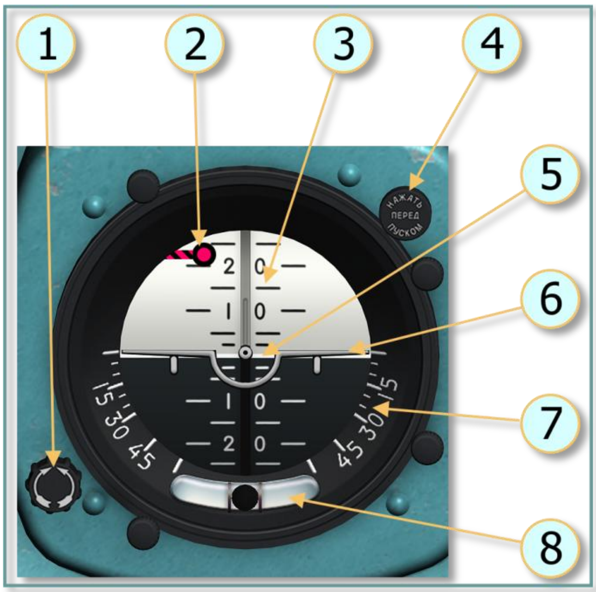


Рис. 9.77. AGB-3K attitude indicator:

1 – horizon elevation adjustment knob; 2 – warning flag; 3 – pitch scale; 4 – "АРРЕТИР" (CAGE) button (press before start); 5 – horizon line; 6 – aircraft symbol; 7 – roll scale; 8 – slip indicator.

The pilot's AGB-3K attitude indicator supplies pitch and roll data to the flight data recorder and to the DISS-15D Doppler system. The copilot's attitude indicator supplies pitch and roll data to the autopilot system.

The attitude indicators utilize a free-mounted gyroscope with a three-phase gyromotor. Roll angles of 85˚-87˚, will cause the gyromotor to gimbal lock (lose one of three degrees of freedom).

A warning flag appears at the top of the instrument face in the event of power failure.

The gyromotor is connected to the ВК-53РШ (VK-53RSh) gyro correction cutout switch to reduce accumulated error during prolonged unilateral acceleration (increasing speed, braking, and banked turns).

AGB-3K attitude indicator specifications:

- time to readiness, no more than: 1.5 min
- error:
  - up to 30° of deflection, no more than: ±1°
  - over 30° of deflection, no more than: ±2°

To test the AGB-3K attitude indicator:

- ensure AC and DC power is on
- press the "АРРЕТИР" (CAGE) button on the indicator (all three axes of the gyroscope are set perpendicular to each other);
- turn on the "АВИАГОРИЗОНТ" (GYRO HORIZON) switch on the left and right triangular panels;
- verify the indicator functionality (flags should stow away).

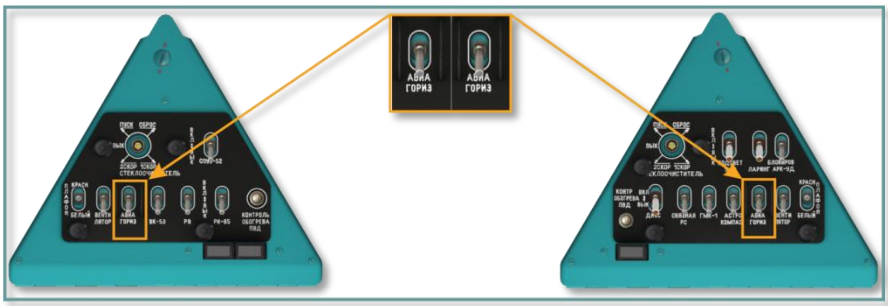


Рис. 9.78. "АВИАГОРИЗОНТ" (GYRO HORIZON) switches on the left and right triangular panels

A failure of the copilot's (right) attitude indicator will result in the failure of the АПБ-34Б (APB-34B) autopilot system. Use the pilot's (left) attitude indicator to continue the flight. The autopilot system is not designed to interact with the pilot's attitude indicator.

ЭУП-53 (EUP-53) TURN AND SLIP INDICATOR

Рис. 9.79. Turn and slip indicator:

1 – display scale; 2 – rate of turn needle; 3 – slip ball.

The turn and slip indicator is mounted on the pilot's instrument panel. The instrument scale displays in degrees with a range of ±45° in 15° increments.

The indicator displays the helicopter's angular velocity around the vertical axis. Below the center of the indicator is a slip ball tube.

When performing properly balanced (coordinated) turns, the rate of turn needle indicates current bank angle.

The indicator utilizes rate gyros. It is powered with 27 VDC via the "УКАЗАТЕЛЬ ПОВОРОТА" (TURN IND) circuit breaker on the right circuit breaker panel.

5.4.3. NAVIGATION SYSTEMS AND INDICATORS

ГМК-1А (GMK-1A) GYROMAGNETIC COMPASS SET

The GMK-1A gyromagnetic compass set is a direction sensing system which provides a visual indication of the helicopter heading, required turn angle, and magnetic or true navigation bearing. The system consists of a number of interconnected magnetic and gyroscopic devices. Course information is displayed on the УГР-4УК (UGR-4UK) directional gyros installed in both the pilot and co-pilot instrument panels.

The system is turned on by setting the "ГМК-1" (COMPASS SYSTEM) switch on the right triangular panel to the ON (up) position.

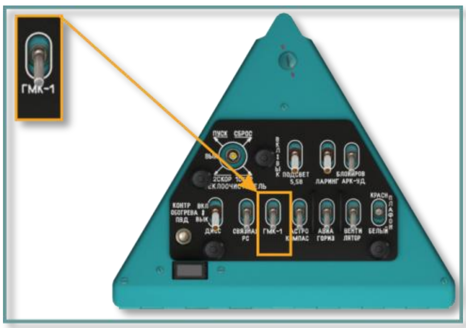


Рис. 9.80. "ГМК-1" (COMPASS SYSTEM) switch, right triangular panel

The ПУ-26 (PU-26) control panel located on the lower right corner of the right overhead console is used to:

- set the compass system operating mode ("МК" (MK, magnetic compass mode) or "ГПК" (GPK, directional gyro mode));
- input latitude correction using the "ШИРОТА" (LATITUDE) knob to correct for apparent drift due to the Earth's rotation;
- correct for mechanical drift due to friction and imperfect balancing within the gyro;
- set the assigned course on the directional gyro indicator using the "ЗК" (ЗК, assigned course) selector in GPK operating mode;
- perform fast alignment using the ЗК selector in MK operating mode
- monitoring and control of the system.

Рис. 9.81. PU-26 control panel, right overhead console:

1 – "СЕВ-ЮЖН" (NORTH-SOUTH) switch; 2 – "КОНТРОЛЬ" (TEST) selector; 3 – "ЗАВАЛ ГА" (BANK CORR) light; 4 – "МК – ГПК – АМ" (MK-GPK-AK) mode selector; 5 – "ШИРОТА" (LATITUDE) knob; 6 – "ЗК" (assigned course) selector.

The УГР-4УК (UGR-4UK) directional gyro displays the helicopter heading, required turn angles, and bearings. Two directional gyros are installed, one on the pilot's and one on the copilot's instrument panels. The helicopter heading is indicated by a moving compass card relative to a fixed index at the top of the compass. The compass card is graduated to 2° and marked numerically for each 30° (divided by 10).

Magnetic heading error does not exceed ±1.5°.

Рис. 9.82. UGR-4UK directional gyro

In GPK mode, the cumulative error of the system does not exceed ±2,5° per hour.

Time to readiness in MK mode does not exceed 3 min, in GPK mode does not exceed 5 min.

Normal alignment rate in MK mode is no less than 1.5° - 7°/min. Fast alignment rate in MK mode is no less than 6°/sec. Alignment rate using the 3K switch is no less then 2°/sec.

The system utilizes a flux detector provide automatic magnetic heading corrections to the gyro, eliminating the need for frequent manual realignment. The system can operate in one of two modes: MK or GPK.

GPK is the primary mode, utilizing the flux detector and a magnetic deviation compensator to correct gyro drift. When operating in GPK mode, the gyro is the source of heading data.

The gyro gradually accumulates error in azimuth due to the earth's rotation (apparent drift) as well as mechanical friction and imbalances within the device (mechanical drift). The latitude corrector is used to correct these errors.

To select GPK mode, set the mode selector to the "ГПК" (GPK) position on the PU-26 control panel.

MK mode is used to align the gyro to the signal provided by the flux detector and magnetic deviation compensator. To select MK mode, set the mode selector to the MK position on the PU-26 control panel.

The system is initialized in MK mode to allow the unit to establish baseline heading data.

The gyro can be aligned at normal speed (via the 3K switch on the control panel) or fast speed.

Automatic fast alignment occurs whenever the operating mode is switched from GPK to MK.

Heading indication accuracy is checked periodically using the TEST switch. The switch is toggled to the 0° and 300° positions, the resulting indication cannot vary by more than +/- 10°. Testing the system must also illuminate the "ЗАВАЛ ГА" (BANK CORR) warning light.

Preparing the compass set for operation:

- set the "СЕВ-ЮЖН" (NORTH-SOUTH) selector to correspond to current hemisphere;
- set current latitude using the "ШИРОТА" (LATITUDE) knob;
- test the set using the "КОНТРОЛЬ" (TEST) switch;
- align the gyro to the correct magnetic heading by pressing the 3K switch (in MK mode) or by turning the compass card using the 3K switch until the correct heading is set (in GPK mode);
- verify proper alignment and correct magnetic heading prior to takeoff.

КИ-13К (KI-13K) MAGNETIC COMPASS

The magnetic compass is mounted on the center windshield left frame. The magnetic compass is used to indicate the magnetic helicopter heading and acts as an autonomous reserve heading indicator. The compass scale is graduated in 5° increments with number markings every 30°. The cardinal points are marked with Cyrillic characters: "C" - North, "Ю" - South, "B" - East, and "3" - West.

Рис. 9.83. Magnetic compass

Magnetic compass specifications:

- magnetic deviation (with no deviation compensator): ±1°;
- pivot friction: no more than 1°;
- magnetic deviation on courses of 0°, 90°, 180°, 270°: no more than ±2.5°;

The compass period (time required to settle oscillations) in temperatures of -60°C to +50°C is no greater than 17 seconds.

The compass is designed to function properly at roll angles of up to 17°.

Because the magnetic compass displays a compass heading, local magnetic variation as well compass deviation must be corrected to determine required true heading.

АЧС-1 (ACHS-1) CLOCK

The mechanical clock is installed on the copilot's instrument panel. The clock displays the current time of day in hours, minutes, and seconds. It can also be used to measure mission time in hours and minutes, and as a chronometer to measure short time periods (up to an hour) in minutes and seconds.

Рис. 9.84. Clock

The clock is equipped with electrical heating elements for cold weather operation. The clock heater is controlled b the "ОБОГРЕВ ЧАСОВ" (CLOCK HEAT) switch on the right side console. The heater allows clock operation at temperatures below +5°C.

Operating in normal temperatures, the clock is accurate to ±20 sec/24 hrs.

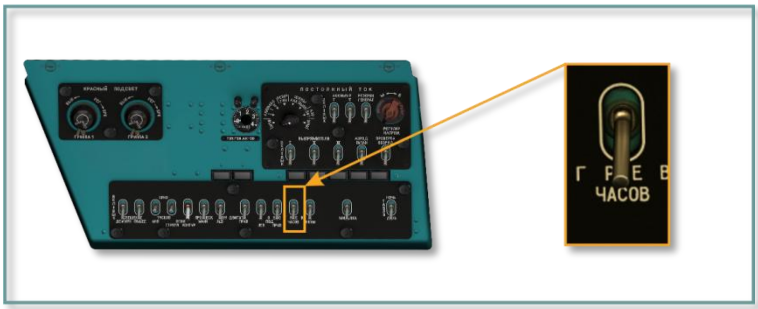


Рис. 9.85. "ОБОГРЕВ ЧАСОВ" (CLOCK HEAT) switch, right side consode

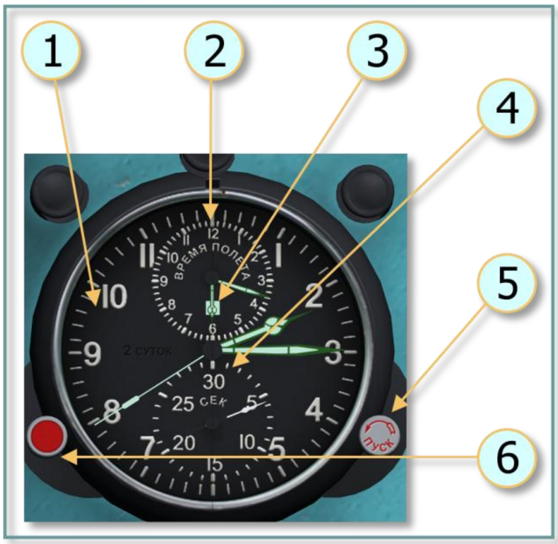


Рис. 9.86. Clock functional elements:

1 – time of day clock dial; 2 – mission (flight) time dial; 3 – mission time indicator; 4 – stop-watch clock dial 5 – right knob; 6 – left knob.

The time of day display operates continuously. Mission time can be activated as desired by pressing the left knob [RALT + RCTRL + RSHIFT + C]. The stop-watch can be activated as desired by pressing the right knob [RALT + RSHIFT + C].

To set the time, rotate the right button crown clockwise [RCTRL + RSHIFT + .] when the second hand points to 12: this will stop the clock. Then pull the left button crown [RSHIFT + M] while holding down the right mouse button and rotate it counter-clockwise [LALT + ,] or clockwise [LALT + .] to set the desired time. Rotating the right button crown counter-clockwise again resumes clock operation with the new time setting [RCTRL + RSHIFT + ,].

Mission time is indicated on the small scale at the top of the clock face. Press the left red button to start the timer [RALT + RCTRL + RSHIFT + C]. A red light will glow, and the timer will start ticking. To stop the timer, press the red button again [RALT + RCTRL + RSHIFT + C]. A red-and-white dot will appear on the timer scale. To reset this timer, press the red button once again [RALT + RCTRL + RSHIFT + C] or [RSHIFT + M].

The stop-watch is the small scale at the bottom of the clock face and is used to accurately measure short time spans (up to 1 hour). It is controlled with the white button on the right, in a similar fashion as the mission time clock.

The clock spring is wound manually by rotating the left button crown to its mechanical stop. The spring contains enough energy for two days of operation.

ВК-53РШ (VK-53RSH) GYRO CORRECTION CUTOUT SWITCH

The VK-53RSh gyro correction cutout switch is designed to automatically disable lateral gyro correction for the attitude indicator and gyro compass set gyroscopes to reduce accumulated error during prolonged unilateral acceleration (increasing speed, braking, and banked turns). Correction cutout occurs whenever angular velocity is greater than 0.3°/sec. Correction cutout does not occur from abrupt and unsustained changes in flight conditions.

The gyro correction cutout switch is turned on via the "ВК-53" (VK-53) switch on the left triangular panel.

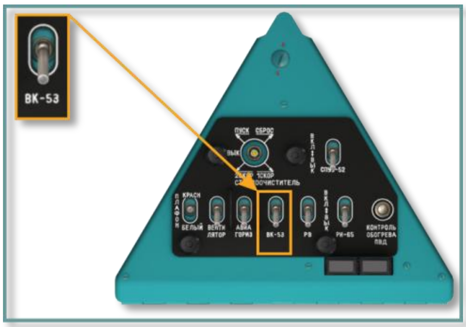


Рис. 9.87. "ВК-53" (VK-53) gyro correction cutout switch, left triangular panel

VK-53RSh specifications:

Power voltage:

36 VAC ±5% 3-phase power; 400 Hz;

27 VDC ±10%.

Correction cutout angular velocity: 0.3°/sec.

Duration of correction cutout: 3 - 15 sec.

Time to readiness: no more than 1 min.

Mass: 2.7 kg.

АП-34Б (AP-34B) AUTOPILOT SYSTEM

The AP-34B four channel autopilot system is designed to stabilize control of the helicopter in roll, pitch, heading, altitude, and airspeed. The four autopilot channels (roll, pitch, yaw, altitude) provide:

- stabilization of helicopter attitude in three axes (longitudinal, lateral, vertical);
- stabilization of altitude in forward flight and hover;
- stabilization of indicated airspeed;

When the altitude channel is engaged, the pitch channel receives correction signals from the КЗСП (KZSP) airspeed correction unit to stabilize the airspeed.

The pilot may intervene at any time while the autopilot is engaged to make manual corrections by operating the flight controls.

The hydraulic flight control servos apply autopilot corrections to the flight controls surfaces and provide feedback signals to the autopilot channels. Autopilot roll, pitch, and altitude correction signals are limited to a maximum of 20% of control travel for flight safety in the event of false signals or system failure.

The autopilot system is supplied with roll and pitch data by the copilot's (right) attitude indicator. Heading data is supplied by the GMK-1A gyro compass system.

The autopilot control panel and zero indicator unit are located on the center console and provide the following functions:

- zeroing of autopilot control input prior to engaging the autopilot;
- individual engaging/disengaging of autopilot channels;
- input of small corrections (±10%) using the centering knobs for pitch, roll, and yaw channels;
- testing of the altitude channel using the "КОНТРОЛЬ" (TEST) switch.

The ИН-4 (IN-4) zero indicator unit shows the relative displacement of the flight control servo spindle for each autopilot channel.

Рис. 9.88. Autopilot system control panels, center console

AUTOPILOT SYSTEM SPECIFICATIONS:

Power voltage, DC	+28.5 V
Power voltage, AC	~36 V, 400 Hz
Time to readiness	under 2 min
Autopilot stability in calm atmosphere conditions:	
yaw	±1°
roll	±0,5°
pitch	±0,5°
altitude	±10 m
airspeed	±10 kph
Max altitude	10000 m
Mass	under 25 kg

The autopilot system is interfaced with the hydraulic flight control servos such that both the autopilot system and the pilot flight control devices affect the flight control surfaces. The final input on the control surfaces is a sum of the autopilot and pilot input to the extent of autopilot authority. Autopilot input is not translated to the pilot flight controls.

With the HEADING channel on, course adjustments can made by turning the HEADING wheel on the IN-4 zero indicator unit. A full turn from one stop to the other corresponds to 10° of heading change.

The autopilot system can be disengaged by pressing the "ВЫКЛ. АП" (Autopilot OFF) button on either cyclic control stick.

The autopilot system is engaged for all normal flight operations. The pitch, roll, and yaw channels are engaged throughout the flight from takeoff to landing.

The system is turned on by pressing the individual button-lamps of the corresponding autopilot channels prior to takeoff. When performing a vertical takeoff, the pitch, roll, and yaw channels are engaged. When performing a rolling takeoff, only the pitch and roll channels are engaged.

When in hover, the autopilot stabilizes the helicopter in pitch and roll, as well as heading when the pedals are released (feet off the pedals). Autopilot functionality in hovering flight can be verified by checking the zero indicator unit for fluctuations in the "К" (roll channel) "Т" (pitch channel) "Н" (yaw channel) servo displacement indicator needles.

In sustained flight conditions such as level flight, climb or descent and the flight controls released by the pilots, the autopilot will stabilize the helicopter attitude while slowly decreasing airspeed, because the system is maintaining pitch angle and not airspeed (up to 150 kph).

The altitude channel can be engaged after establishing level flight at an altitude of no less than 50 m. Altitude channel operation can be verified by fluctuations of the "В" (altitude channel) servo displacement indicator needle on the zero indicator unit, changing of the main rotor collective pitch angle, and vertical displacement of the helicopter as the autopilot system maintains altitude in turbulent air.

Landing approach, braking, and landing is performed with the autopilot channels engaged. After landing, the autopilot system is disengaged with the "ВЫКЛ. АП" (Autopilot OFF) button.

5.5 RADIO COMMUNICATION AND NAVIGATION SYSTEMS

Radio communication and navigation systems of the Mi-8MTV2 include:

- voice communication systems
- radio navigation systems
- transponder and warning systems
- special purpose radio systems

Radio communication and navigation systems provide:

- communication between crew members
- communication with ground stations
- communication between aircraft
- transmission of audio warnings to crew members and ground control stations
- transmission of identification responses and emergency signals
- radio homing on navigation beacons

Electrical power to the radio systems is provided via:

- 28.5 VDC from three ВУ-6А (VU-6A) rectifiers, each rated at 6 kW
- 115 VAC 400 Hz single-phase ТС/1-2 (TS/1-2) power transformer
- 36 VAC 400 Hz three-phase ТС 330С04Б (TS 330S04B) power transformer

Emergency power sources:

- two 12САМ-28 (12SAM-28) batteries and the СТГ-3 STG-3 AC generator
- ПО-500А (PO-500A) 115 VAC and ПТ-200Ц (PTs-200Ts) 36 VAC 400 Hz inverters

All radio equipment is housed in the tail cone, radio compartment, and cockpit.

5.5.1. RADIO COMMUNICATION SYSTEMS

Radio communication systems installed on the Mi-8MTV2 include:

- СПУ-7 (SPU-7) intercommunications set (ICS)
- Р-863 (R-863) VHF/UHF command radio set (AM/FM 2-way air-to-ground and air-to-air communication)
- Ядро-1А (YaDRO-1A) HF radio set
- Р-828 (R-828) LVHF radio set
- П-503Б (P-503B) recording equipment (not implemented)
- commutation and volume leveling system

РИ-65 (RI-65) AUDIO WARNING SYSTEM

The RI-65 audio warning system is designed to alert the crew of in-flight emergency situations over the intercom system. The audio warning system consists of a control unit which receives input from the onboard sensors and plays back the appropriate advisories and a control panel which allows for testing, repeating an advisory, and shutting off an advisory message. The audio warning unit is installed in the radio compartment on the left side. The control panel is located in the upper center area of the left side console.

The audio warning unit automatically broadcasts the recorded advisory message over the intercom when an activation signal is received from the onboard sensors. The fire warning messages (channels 1 through 4) are also automatically broadcast over the VHF (R-860 or R-863) radio. If multiple alerts occur simultaneously, audio warnings are broadcast in order of priority.

The following advisories are recorded:

- Aircraft (tail #)... fire in left engine compartment
- Aircraft (tail #)... fire in right engine compartment
- Aircraft (tail #)... fire in transmission compartment
- Aircraft (tail #)... fire in heater compartment
- Dangerous vibration, left engine
- Dangerous vibration, right engine

- Main hydraulic system failure
- Low fuel emergency
- Service cell fuel pump failure, check remaining fuel
- Saddle tank fuel pump failure
- Ice formation warning
- Generator 1 failure
- Generator 2 failure
- Audio warning system operational

RI-65 components:

- message broadcasting equipment
- control panel

The audio warning system includes a "ВКЛЮЧИ РИ-65" (TURN ON RI-65) annunciator on the left triangular panel. The warning is removed when the system is turned on with the "РИ-65" (AUDIO WARN) switch.

The audio warning system receives 27 VDC from the battery bus. The system is engaged using the "РИ-65" (AUDIO WARN) switch located on the left triangular panel.

СПУ-7 (SPU-7) INTERCOMMUNICATIONS SET (ICS)

The SPU-7 intercommunications set (ISC) is a signal distribution system designed to provide internal crew communication, airwave transmission via the R-863, R-828, YaDRO-1A radio sets, monitoring of ADF code ID signals, as well as transmission of signals from the audio warning system and radar altimeter.

SPU-7 components:

- amplifier
- distribution unit
- control boxes for pilot and copilot located to the left and right of the circuit breaker consoles, respectively
- control box in the troop commander station in the cargo cabin, as we as the "ЛАРИНГ ВКЛ. - ВЫКЛ." (MIC) switch
- thee additional ICS tie-in points
  1. crew chief station;
  2. winch operator station;
  3. tail gunner station;
- переключатель "ПРОСЛУШИВАНИЕ АРК СВ – СПУ – АРК УКВ" установлен на правой этажерке;
- кнопка "СПУ" на кронштейне правой этажерки;
- "ЛАРИНГ ВКЛ.- ВЫКЛ." (MIC) switch on the right triangular panel
- "СПУ – РАДИО" (ICS RADIO PTT) buttons on the pilot and copilot cyclic control stick

– "СПУ-7" (SPU-7) circuit breaker on the right circuit breaker panel

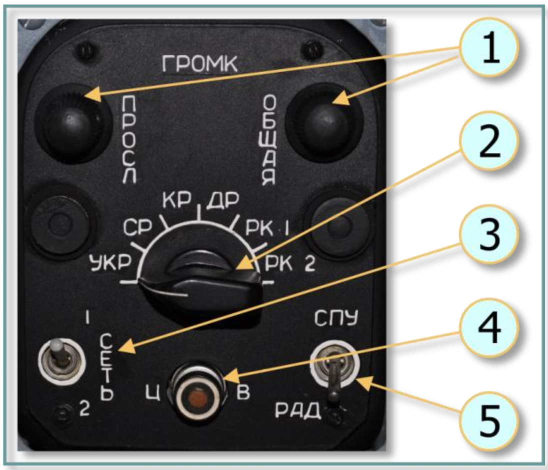


Рис. 9.89. SPU-7 control panel:

1 – "ОБЩАЯ" (MASTER) and "ПРОСЛ" (MONITOR) volume control knobs to set volume of internal and external comms.; 2 – rotary selector to select source to monitor:

"УКР" (UHF) – R-863 UHF/VHF radio set

"СР" (HF) – YaDRO-1A radio set

"КР" (VHF) – R-828 UHF radio set

"ДР" (SW) – not utilized

"РК 1" (ADF) – ARK-9 ADF set

"РК 2" (SAR) – ARK-UD VHF homing set

СЕТЬ 1-2 (NET 1-2) - not utilized

4 –"ЦВ" (ALL CALL) button for transmission of emergency messages. When pressed, interphone signal is transmitted to all ICS station at doubled volume level, audio warning messages are transmitted with maximum volume level; 5 - "СПУ-РАД" (ICS-RADIO) selects communication via ICS or the selected radio.

P-863 (R-863) VHF/UHF COMMAND RADIO SET

The R-863 radio set provides two-way voice communications in the VHF range of 100 to 149.975 MHz and UHF range of 220 to 399.975 MHz in AM or FM modes. Minimum frequency separation between adjacent channels is 25 kHz. Frequency stabilization is achieved by means of a digital synthesizer which provides instant selection of 20 fixed frequencies that are preset on the ground (R-863 channel selector panel) or manual frequency control (R-863 frequency control unit). An emergency receiver built into the radio set provides standby reception of one preset emergency frequency (121.5 MHz or 243 MHz).

Рис. 9.90. Left overhead console: R-863 "КОМАНД. РС АМ-ЧМ" (AM-FM) switch (FM up position, AM down position); R-863 "КАНАЛ" (CHANNEL) selector panel with 20 available channels.

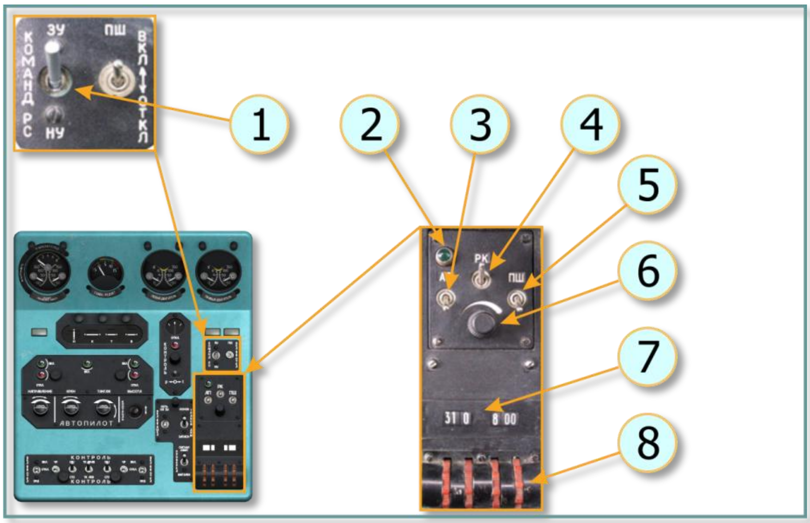


Рис. 9.91. R-863 frequency selector unit:

1 – "ЗУ-НУ" (PRESETS-MANUAL) switch selects between preset channels and manual frequency control; 2 – "АП" (EMERG) green lamp indicates presence of an active signal on the emergency receiver (regardless of the position of the "АП" (EMERG RCVR) switch;3 – "АП" (EMERG RCVR) switch allows the pilot to monitor signals from the emerency receiver when set to the ON (up) position; 4 – "РК" (RK) switch enables monitoring of radio transmission regardless of the position of the rotary selector on the SPU-7 control panel устанавливается в верхнее положение для парал-лельного прослушивания команд по радиостанции независимо от положения переключа-теля рода работ на абонентском аппарате СПУ-7; 5 – "ПШ" (SQUELCH) switch to active the noise suppression circuit; 6 – "РГ" (VOLUME) control knob.

R-863 specifications:

Frequency range:	
VHF	100-149.975 MHz
UHF	220-399.975 MHz
Frequency separation	25 kHz
Number of discrete frequencies:	
VHF	2000
UHF	7200
Power output:	
VHF	10 W
UHF	8 W
Receiver sensitivity	3 µV
Emergency receiver frequency:	
VHF	121, 5 MHz
UHF	243 MHz
Frequency tuning time, no more than	1.5 sec
Time to readiness	5 min
Power voltage	28.5 V

R-863 operation:

Turn ON the "КОМАНД. РС" (CMND RADIO) and "СПУ" (ICS) circuit breakers on the right circuit breaker panel. Set radio selector on the ICS control box to the "УКР" (VHF1) position and the "СПУ-РАДИО" (ICS-RADIO) selector to the RADIO (down) position. On the R-863 control panels:

– SQUELCH (AS) switch to the OFF (down) position
– AM-FM switch to the appropriate position for the desired channel
– CHANNEL selector to the desired channel
– volume control to maximum

In case of poor reception, turn off the squelch. To switch off the radio set, set the "КОМАНД. РС" (CMND RADIO) circuit breaker on the right circuit breaker panel to OFF (down).

Configuring the R-863 channel preset frequencies in DCS:

The frequencies stored in the R-863 20 preset channels are scriped in an external file, which can be opened and edited outside the simulation prior to mission launch. File location:

<game directory> \Mods\aircraft\Mi-8MTV2\Cockpit\Scripts\Devices_specs\Radio\R_863.lua.

The following code lines describe each channel frequency in Hz:

```
presets = {}
presets[1] = 356540000.0
presets[2] = 256750000.0
presets[3] = 485435000.0
presets[4] = 356575000.0
```

The number in brackets corresponds to the channel number. Up to 20 channel frequencies can be stored.

For example to set 124.0 MHz for channel 1, change the default frequency number to 124000000.0

NOTE: *A dedicated code-editor is recommended when editing game configuration files.*

ЯДРО-1А (YADRO-1A) HF RADIO SET

The YaDRO-1A HF radio set is designed to provide simplex, fixed-tuned, air-to-ground and air-to- air voice communications. The radio set offers tuning in flight to any communication frequency within a range of 2 to 17.999 MHz in 100 Hz increments in AM or SSB (single sideband) modes. The radio set operates via a wire antenna. The radio set is supplied with 27 VDC from the rectifier bus via the "СВЯЗН РС" (COMM RADIO) circuit breaker on the right circuit breaker panel, and with 115 VAC from the 115 VAC primary bus via a fuse located in the main fuse box.

YaDRO-1A components:

- transceiver and automatic tuning control unit
- wire antenna (steel cable strung along the upper left and right sides of the tail boom to the outboard leading edges of the horizontal stabilizers)

Рис. 9.92. Wire antenna

- control panel located on the right auxiliary panel
- "СВЯЗН РС" (COMM RADIO) circuit breaker on the right circuit breaker panel

YaDRO-1A specifications:

Frequency range	2-17.999 MHz
Frequency separation	100 Hz
Effective range	no less than 900 km
Time to readiness	2 min
Continuous operation time	6 hrs
Receiver sensitivity:	
AM mode	5 μV
SSB mode	3 μV
Transmitter output power:	
below 12.000 MHz	100 W
in range 12.000 – 17.999 MHz	50 W
Frequency tuning time	5 sec
Power voltage	28.5 V

YaDRO-1A control panel:

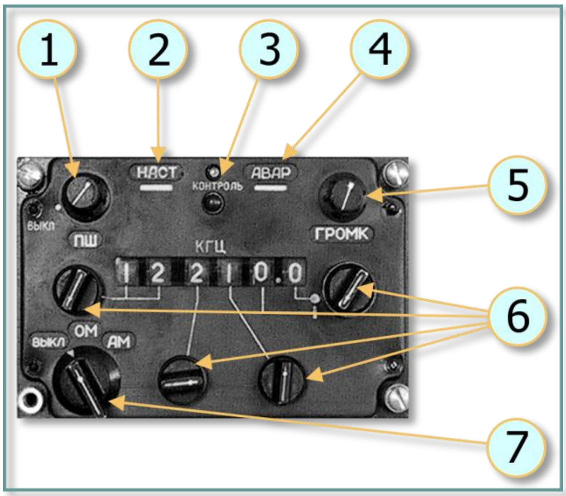


Рис. 9.93. YaDRO-1A control panel:

1 – "ПШ" (SQUELCH) knob for incremental control of the noise reduction circuit; 2 – "НАСТ" (TUNING) light to indicate that the radio set is tuning; 3 – "КОНТРОЛЬ" (TEST) button and light to activate and indicate progress of the radio set self-test; 4 – "АВАР" (EMERG) light to indicate the radio set is in emergency status; 5 –"ГРОМК" (VOLUME) control knob; 6 – four knobs for frequency setting; 7 – three position selector: "ВЫКЛ" (OFF) - radio set of switched off, "ОМ" (SSD), "АМ" (AM) - selection of operating mode.

YaDRO-1A operation:

Turn ON the "СВЯЗН РС" (COMM RADIO) and "СПУ" (ICS) circuit breakers on the right circuit breaker panel. Set radio selector on the ICS control box to the "СР" (HF) position and the "СПУ-РАДИО" (ICS-RADIO) selector to the RADIO (down) position. On the YaDRO-1A control panel:

- power up the radio set by setting the "ВЫКЛ. – ОМ - АМ" (OFF - SSB - AM) selector on to the position corresponding to the desired mode of operation
- set the "ПШ" (SQUELCH) knob to the OFF position to disable the noise reduction circuit
- set volume control to maximum
- set the desired frequency using the frequency selection knobs. The "НАСТ" (TUNING) light will illuminate. Tuning should be complete within 5 seconds and the light should go off.

A built-in test facility is provided to check the serviceability of the receive, transmit, and tuning functions. The self-test is initiated by pressing the "КОНТР" (TEST) button. If the radio set is operational, the "КОНТР" (TEST) light will be on and noise heard in the headset when the radio is in receiving mode or a signal when it is in transmission mode.

To disable the radio set, set the "СВЯЗН РС" (COMM RADIO) circuit breaker on the right circuit breaker panel to OFF (down).

P-828 (R-828) LVHF FM TRANSCEIVER SET

The R-828 LVHF FM transceiver set provides VHF homing in conjunction with the "АРК-УД" (ARK-UD) VHF homing set and standby 2-way voice communications. The radio provides instant tuning to one of ten frequencies preset on the ground. The frequency range is 20 - 59.975 MHz in 25 kHz increments.

The radio set operates in one of two modes: VOICE (voice communication) and HOMING (VHF homing using the ARK-UD system).

R-828 components:

- transceiver
- control panel located on the right auxiliary panel;
- "Р-828 ВКЛ - ВЫКЛ" (R-828 RADIO) power switch and "Р-828 КОМПАС-СВЯЗЬ" (R-828 VOICE-HOMING) mode switch located on the right auxiliary panel
- the NIPV-type antenna mounted at the bottom of the fuselage. The antenna-feeder system includes a phase sensor, an antenna matching device, and an automatic tuning control unit

Рис. 9.94. NIPV-type antenna of the R-828 radio set

R-828 specifications:

Frequency range	20-59.975 MHz
Frequency separation	25 kHz
Time to readiness, no more than	3 min
Number of discrete frequencies	1600
Number of preset channels	10
Receiver sensitivity, at least	2 µV
Transmitter output power	10 W
Effective range at altitude of 1000 m	120 km
Frequency tuning time, no more than	5 sec
Power voltage	28.5 V

Рис. 9.95. R-828 radio set control panel

1 –"ГРОМК" (VOLUME) control knob; 2 – "АСУ" (AGC, automatic gain control) button to enable automatic gain control с целью согласования выхода передатчика с антенной; 3 – "КАНАЛ" (CHANNEL) selector to set one of 10 preset frequencies; 4 – "НАСТР" (TUNING) light; 5 – "ПШ" (SQUELCH) switch.

Рис. 9.96. R-828 power and mode switches:

1 – "Р-828 ВКЛ – ВЫКЛ" (R-828 RADIO) power switch; 2 – "Р-828 СВЯЗЬ – КОМПАС" (R-828 VOICE-HOMING) mode switch.

R-828 operation:

Turn ON the "СПУ" (ICS) circuit breaker on the right circuit breaker panel. Set radio selector on the ICS control box to the "КР" (KR) position and the "СПУ-РАДИО" (ICS-RADIO) selector to the RADIO (down) position.

On the right auxiliary panel:

- turn on (set forward) the "Р-828 ВКЛ – ВЫКЛ" (R-828 RADIO) switch
- set the "Р-828 СВЯЗЬ-КОМПАС" (R-828 VOICE-HOMING) switch to "СВЯЗЬ" (VOICE) (set back)

On the R-828 radio set control panel:

- "ПШ" (SQUELCH) switch OFF
- "ГРОМК" (VOLUME) control to maximum
- "КАНАЛ" (CHANNEL) selector to the desired channel. "НАСТР" (TUNING) light should turn on for 1-5 sec.

To disable the radio set, set the "Р-828 ВКЛ – ВЫКЛ" (R-828 RADIO) switch to the "ВЫКЛ" (OFF) position (back).

To use the R-828 radio in conjunction with the ARK-UD homing set to home on to a ground station, first establish voice contact with the station and request a tone modulated signal from the ground station operator for the desired frequency. Once the tone signal is confirmed in the headset, set the Р-828 СВЯЗЬ-КОМПАС" (R-828 VOICE-HOMING) mode switch to "КОМПАС" (HOMING). Observe the needle on the UGR-4UK directional gyro for signal bearing.

Configuring the R-828 channel preset frequencies in DCS:

The frequencies stored in the R-828 10 preset channels are scriped in an external file, which can be opened and edited outside the simulation prior to mission launch. File location:

<game directory> |Mods|aircraft|Mi-8MTV2|Cockpit|Scripts|Devices_specs|Radio|R_828.lua.

The following code lines describe each channel frequency in Hz:

```
presets = {}
presets[1] = 21500000.0 -- frequency in Hz (21.5MHz)
presets[2] = 25675000.0 -- radio Mayak
presets[3] = 27000000.0
presets[4] = 28000000.0
presets[5] = 30000000.0
presets[6] = 32000000.0
presets[7] = 40000000.0
presets[8] = 50000000.0
presets[9] = 55525000.0
presets[10] = 59975000.0
```

The number in brackets corresponds to the channel number. Up to 10 channel frequencies can be stored.

For example to set 37.75 MHz for channel 1, change the default frequency number to 37750000.0

NOTE: *A dedicated code-editor is recommended when editing game configuration files.*

5.5.2. RADIO NAVIGATION SYSTEMS

Radio communication systems installed on the Mi-8MTV2 include:

- АРК-9 (ARK-9) automatic direction finding (ADF) set
- АРК-УД (ARK-UD) VHF homing set
- ДИСС-15 (DISS-15) Doppler navigation set
- РВ-5 (RV-5) radar altimeter set

АРК-9 (ARK-9) AUTOMATIC DIRECTION FINDING (ADF) SET

The ARK-9 ADF set is designed to use non-directional radio beacons (NDB), broadcasting radio stations or compass locators for in-flight navigation. Frequency range of the set is 150 to 1300 kHz. The relative bearing is displayed by needle No. 1 (narrow) on the UGR-4UK directional gyro on the pilot and copilot instrument panels.

The LF-ADF is used for the following situations:

- Flying to or from a radio station or NDB with visual display of the relative bearing.
- Station identification by monitoring the audio call signs.
- Determination and continuous display of the relative bearings to a radio beacon or broadcasting radio station.
- Performing non-precision instrument landing approaches or navigating to the inner and outer ILS marker beacons.

The ADF can be used as a reserve voice communication receiver. Three operating modes are provided: "АНТ." (ANT, antenna), "КОМП." (COMP, compass), "РАМК." (LOOP).

ARK-9 components:

- receiver unit
- power supply
- antenna assembly in a common housing along the bottom of the fuselage

Рис. 9.97. Рамочная и ненаправленная антенны

- remote tuner switching unit
- control panel on the right overhead console
- "АРК СВ – АРК УКВ" (ADF-MW - ADF USW) switch on the left instrument panel under the UGK-4UK directional gyro to select between ARK-9 and ARK-UD to drive the bearing needle.
- "КОМПАС СВ" (COMPASS MW) circuit breaker on the right circuit breaker panel

Heading/bearing information is displayed on the UGR-4UK directional gyros on the left and right instrument panels.

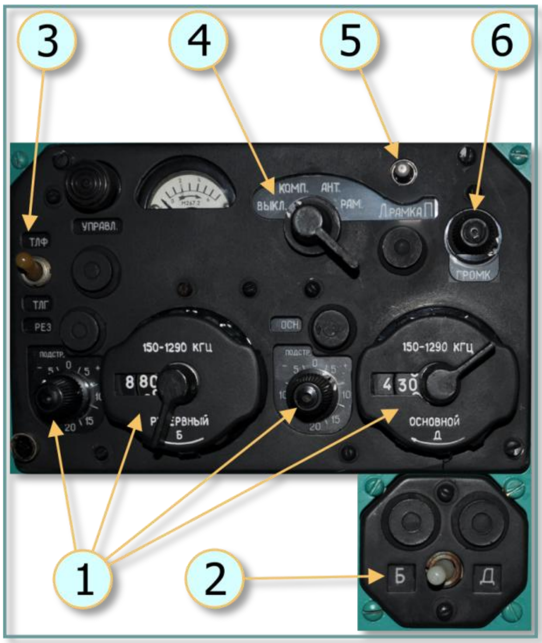


Рис. 9.98. ARK-9 control panel:

1 – Frequency setting dials. The 10 kHz and 100 kHz discrete frequency dials (switch and drum) set the main (right dial) and reserve (left dial) frequency in the range of 150 kHz - 1290 kHz in 10 kHz steps. The "НАСТР." (TUNE) knobs adjust the set frequency from -10 kHz to +20 kHz;

2 – "Б – Д" (B - D CHANNEL) switch to select main ("Д" (D), right) or reserve ("Б" (B), left) channel frequency;

3 – "ТЛФ-ТЛГ" (VOICE - CW) switch. Set to "ТЛФ" (VOICE) to monitor a broadcasting station or demodulate a carrier signal to identify locator beacon call letters. Set to "ТЛГ" (CW) to home on a continuous wave signal. SPU-7 source selector must be set to "РК 1" (ADF) for signal to be heard in headset;

4 – "АРК ВЫКЛ., КОМП., АНТ., РАМ." (OFF - COMP - ANT - LOOP) mode selector:

"ВЫКЛ." (OFF): powers down the ADF set;

"КОМП." (COMP, compass): powers up and prepares the set for operation in ADF mode, audio monitoring of the selected frequency and automatic direction finding are functional. Primary operating mode;

"АНТ." (ANT, antenna): allows audio monitoring of the selected frequency for tuning or for listening to call letters of signal tones, no direction finding occurs in this mode;

"РАМ." (LOOP): allows audio monitoring of the loop antenna output for direction finding by ear, based on signal fade in and out if the COMPASS mode fails;

5 – "Л рамка П" (LOOP) button. Initiates manual rotation of the search coil;

6 – "ГРОМК." (GAIN) volume control knob;

7 - "УПР." (CONTROL) button. Not utilized.

ARK-9 specifications:

Frequency range	150-1300 kHz
Frequency tuning precision	±10 kHz
Frequency separation	10 kHz
Effective homing range to ПАР-10 (PAR-10) type NDB at an altitude of 1000 m	no less than 160 km
Channel switching time	2-4 sec
Signal bearing error	no more than 2°
Time to readiness	1-2 min
Receiver sensitivity in ANT mode	5-8 μV

ARK-9 operation:

Turn on the ARK-9 LF-ADF set (27V, 115V 400Hz) and the ICS with the "КОМПАС СВ" (COMPASS MW) and "СПУ" (SPU) circuit breakers on the right circuit breaker panel. Set the source selector on the ICS control box to the "РК 1" (ADF1) position and the "СПУ-РАДИО" (ICS-RADIO) selector to the RADIO (down) position.

Set the selector knob for the UGR-4UK needle No.1 to the "АРК-СВ" (ADF-MW) position for visual bearing needle control by the ARK-9 LF-ADF system.

On the ARK-9 control panel:

- mode selector to "ANT" (ANT)
- "ТЛФ - ТЛГ" (VOICE - CW) switch to "ТЛГ" (CW). A signal should be heard in the headset and disappear when the switch is set to "ТЛФ" (VOICE)
- "ГРОМК." (GAIN) volume control to maximum
- "Б - Д" (B - D CHANNEL) switch to "Б" (B, reserve channel)
- dial the frequency of the desired beacon using the left frequency setting dial and confirm the beacon call letters (Morse ID)
- mode selector to "КОМП." (COMP). The No.1 bearing indicator on the UGR-4UK directional gyro should display the bearing to the selected beacon transmitter
- press the "РАМКА" (LOOP) button to turn the No.1 arrow on the directional gyro 150° - 170° off the beacon bearing. Upon releasing the button, confirm the No.1 arrow returns to the correct beacon bearing.

Set the "Б - Д" (B - D CHANNEL) switch to "Д" (D, main channel) and tune the main channel following the same process as the reserve channel.

In case radio interference hampers operation of the ADF, use the "РАМКА" (LOOP) mode to determine bearing to the transmitter based on fading signal volume.

АРК-УД (ARK-UD) VHF HOMING SET

The ARK-UD VHF homing set is designed primarily for search and rescue of downed aircraft and aircrews. The system will home on radio stations (beacons), such as Р-855УМ (R-855UM) portable emergency radio, emitting CW or pulse signals over one of six VHF or one UHF preset frequencies. The secondary purpose of the system is to direct aircraft to airfields using VHF ground stations and assist in joining aircraft in flight.

The ARK-UD provides:

- homing on VHF and UHF beacons for search and rescue helicopters
- Indication of the moment a homing beacon is flown over by a reversal of the bearing indicator on the directional gyro.
- audio identification of a homing beacon by the pilot

ARK-UD components:

- loop antenna installed on the bottom of the center fuselage

Рис. 9.99. ARK-UD loop antenna housing

- antenna amplifier
- control panel located on the right overhead console
- приемо-пеленгаторное устройство;
- АШС-УД (AShS-UD) blade antenna on the tail boom

Рис. 9.100. AShS-UD blade antenna

- "БЛОКИРОВКА АРК-УД" (VHF-ADF INTERLOCK) switch on the right triangular panel used to prevent interference with the R-863 radio
- "РАДИОКОМПАС УКВ" (ARK-UD) circuit breaker on the right circuit breaker console
- "АРК СВ - АРК УКВ" (ARK-MW - ARK-USW) switch on the left instrument panel to select between ARK-9 and ARK-UD bearing source for the directional gyro indicator

Operation in VHF and UHF bands is less accurate than MW due to:

1. VHF and UHF wavelengths affected by fuselage elements of equal size causing directional error in the bearings displayed by the directional gyro. In this case the ARK-UD provides only a general direction to the beacon.

2. VHF wavelengths being reflected by fuselage elements causing the bearing indicator to oscillate as the helicopter approaches the homing beacon.

ARK-UD specifications:

VHF frequency range	114.166-124.1 MHz
VHF preset frequencies	114.166 МГц; 121.5 MHz 114.333 МГц; 123.1 MHz 114.583 МГц; 124.1 MHz
UHF frequency range	243-248 MHz
UHF preset frequency	243 MHz
Effective range to R-855UM type beacon at altitudes:	
3000 m	55 km
1000 m	35 km
500 m	25 km
300 m	15 km
Bearing error	no more than ±3
Beacon location error at altitude of 1000 m	no more than ±200 m

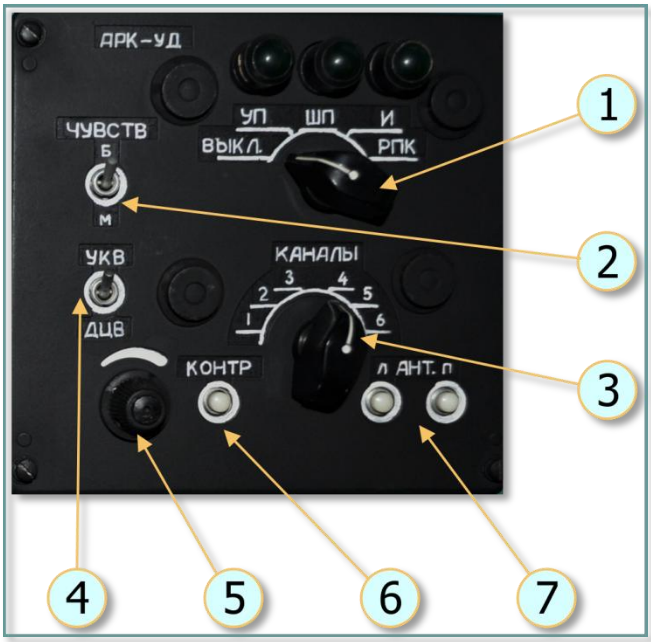


Рис. 9.101. ARK-UD control panel:

1 – "ВЫКЛ., УП., ШП, И, РПК." (OFF - NARROW BAND - WIDE BAND - PULSE - RPK) MODE selector:

"ВЫКЛ." (OFF): ARK-UD system is switched off

"УП" (NARROW BAND): CW narrow band reception, illuminates corresponding lamp

"ШП" (WIDE BAND): CW wide band reception, illuminates corresponding lamp

"И" (PULSE): the homing channel transduces 40 μs pulse signals sent at 300 Hz while the audio output channel operates over the wideband component of the receiver. Operation in PULSE mode illuminates the corresponding

"РПК" (RPK): not utilized

2 – "ЧУВСТВ. Б-М" (SENSITIVITY HIGH - LOW) switch: sets antenna sensitivity for the homing channel

3 – "УКВ-ДЦВ" (FQ BAND) switch: sets VHF (up) or UHF (down) operating band. When set to VHF, use channel selector to tune receiver to the desired frequency channel. When set to UHF, receiver tunes to 243.000 MHz

4 – "КАНАЛЫ" (CHANNEL) selector: sets preset VHF frequency

5 – volume control knob

6 – "КОНТР." (TEST) button: self-test mode operation

7 – "АНТ. Л. - П." (ANTENNA L/R) buttons: pressed to manualy rotate loop antenna left or right

The ARK-UD operates on the following preset frequencies:

Band	Frequency, MHz	Channel #
VHF	114.166	1
VHF	114.333	2
VHF	114.583	3
VHF	121.5	4
VHF	123.1	5
VHF	124.1	6
UHF	243.0	UHF

In TEST mode, the bearing needle of the UGR-4UK directional gyro points to 180°±10° and the currently set operating mode lamp illuminates.

ARK-UD operation:

Turn on the ARK-UD ADF set (27V, 115V 400Hz) and the ICS with the "РАДИОКОМПАС УКВ" (ARK-UD) and "СПУ" (SPU) circuit breakers on the right circuit breaker panel. Set the source selector on the ICS control box to the "PK 2" (SAR) position (only required for audio signal monitoring; not required for radio compass operation) and the "СПУ-РАДИО" (ICS-RADIO) selector to the RADIO (down) position.

Set the selector knob for the UGR-4UK needle No.1 to the "АРК-УД" (ADF-USW) position for bearing needle control by the ARK-UD system.

On the ARK-9 control panel:

- MODE selector set to "УП" (NARROW BAND). When the "ШП" (WIDE BAND) lamp illuminates as the helicopter nears the beacon, switch to WIDE BAND mode
- FQ BAND switch and CHANNEL selector set to correspond to required band and channel for reception of desired signal. *If operating in UHF mode, channel setting is irrelevant.*

In PUSLE mode, a tone signal with a reduced frequency is heard in the headset (not currently implemented in DCS).

The ARK-UD set can be utilized in conjunction with the R-828 radio set allowing for homing on frequencies outside the normal ARK-UD presets. Selection of R-828 antenna is made by setting the "Р-828 СВЯЗЬ – КОМПАС" (R-828 VOICE-HOMING) mode switch on the right auxiliary panel to "КОМПАС" (COMASS). For more information, see the R-828 section of the manual.

> ***ARK-UD operation in DCS:***
>
> *Utilizing the ARK-UD set in DCS requires that a transmitter is created and added to the world by placement on the map or attached to an airborne or ground unit. The transmitter must be configured to transmit over the correct frequency and modulation setting compatible with the ARK-UD set. See the DCS User Manual for more information on unit placement and configuration in DCS World.*

ДИСС-15 (DISS-15) DOPPLER NAVIGATION SET

The DISS-15 Doppler system, operating in conjunction with the AGB-3K gyro-horizon and the GMK-1A gyro-compass system, is designed for continuous automatic measurement and display of the ground speed components in the low speed (hover) mode; ground speed and drift angle in the navigation mode; computation and indication of the helicopter positional coordinates; and for delivery of these data to other onboard systems.

The Doppler system, in conjunction with other onboard instruments (i.e., autopilot, radar altimeter, etc.) assists the pilot in solving the following navigational and flight problems:

- navigation to waypoint coordinates
- precision approaches
- hovering and landing when current wind information is not available
- hovering and controlling helicopter movement in poor visibility or IMC

DISS-15 components:

- low frequency unit;
- coordinate computer
- high frequency unit (underside of the tail boom)

Рис. 9.102. DISS-15 high frequency unit

- stationary flight indicator located on the pilot's (left) instrument panel
- ground speed and drift angle indicator on the copilot (right) instrument panel
- digital display unit located on the copilot instrument panel
- "ДИСС ОТКАЗАЛ" (DISS FAILURE) light on the copilot instrument panel (illuminates when the system is in MEMORY mode or in case of failure)
- control panel on the right rack in the cockpit (behind the copilot)
- "ДИСС" (DOPPLER) circuit breaker on the right circuit breaker console

The Doppler transceiver/antenna unit is located at the bottom of the tail boom. It generates, transmits, and receives microwave energy. It sends the energy it receives to the low frequency signal converter unit for conversion into DC signals that are proportional to the lateral, longitudinal, and vertical components of ground speed. The unit is equipped with a fan for air cooling.

Ground speed data is supplied to the following indicators:

- low speed (hover) indicator
- ground speed and drift angle indicator
- digital display unit

When flying over water with a sea state of greater than 1 - 2, the Doppler system switches to MEMORY mode. Previously measured readings are displayed on the indicators. The system also switches to MEMORY mode at roll angles of greater than 30° and pitch angles of greater than 7°.

DISS-15 specifications:

Emission type	continuous
Emission frequency	13325 + 20 - 30 MHz
Emission power output	no less than 2 W
Altitude limits	10-3000 m
Altitude limits in hover mode:	
over land surface	2-1000 m
over water surface (sea state greater than 1)	2-500 m
Measured ground speed range	0-400 kph
Measured drift angle range	±45°
Measurement error:	
ground speed	0.5% ± 1, 5 kph

drift angle	25 minutes
coordinates	1% ± 1 km/h
Longitudinal and lateral components calculation error	± 1.5 kph
Vertical component calculation error	± 0.4 m/s

DISS-15 DOPPLER SYSTEM CONTROLS AND INDICATORS:

DOPPLER CONTROL PANEL: used to select the operating mode of the system and to introduce three test functions. Additionally, the following failures are continually monitored and reported by the system:

- the ground speed and drift angle indicator "П" (P) warning light illuminates whenever the radio signal ground return is too weak or absent
- the Doppler control panel "М" (M) warning light illuminates in case of Doppler system magnetron failure
- the Doppler control panel "В" (V) warning light illuminates in case of Doppler computer failure

The "ДИСС ОТКАЗАЛ" (DISS FAILURE) annunciator on the copilot instrument panel illuminates whenever either the "М" (M) or "В" (V) light illuminates on the Doppler control panel.

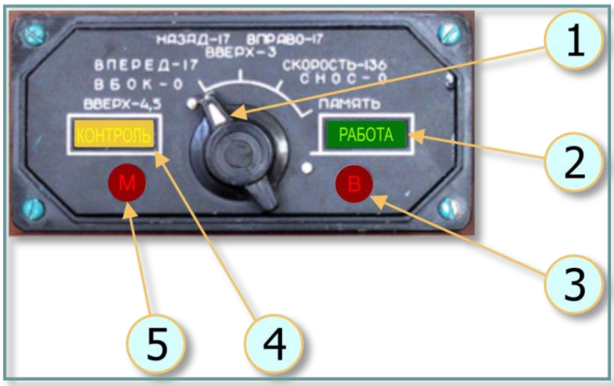


Рис. 9.103. Doppler control panel:

1 – MODE selector: positions 1-4 perform test functions and do not initiate radio emissions. Position 5, "РАБОТА" (OPERATE) is the normal functional mode and initiates radio emissions and measurement of ground speed and drift angle components;

2 – "РАБОТА" (OPERATE) light: indicates the system is operating normally;

3 – "В" (V) light: illuminates if the Doppler computer fails;

4 – "КОНТРОЛЬ" (TEST) light: indicates the system is in test mode;

5 – "М" (M) light: illuminates in the event of magnetron failure.

STATIONARY FLIGHT INDICATOR: continuously displays the vertical, lateral, and longitudinal components of helicopter ground speed during hover and low speed flight.

Рис. 9.104. Stationary flight indicator:

1 – Vertical pointer: displays vertical speed within a range of ±10 m/s on a scale graduated to 1 m/s;

2 – Lateral and longitudinal indexes: display the lateral speed within a range of 25 kph, forward speed up to 50 kph and rearward speed up to 25 kph. Scales graduated to 5 kph;

3 – "ВЫК." (OFF) light: illuminates whenever:

forward speed passes 50 kph (stationary flight indicator disengages, ground speed and drift angle indicator engages);

the Doppler system is in MEMORY mode;

GROUND SPEED AND DRIFT ANGLE INDICATOR: displays the ground speed and drift angles when the helicopter is traveling at speeds in excess of 50 KPH.

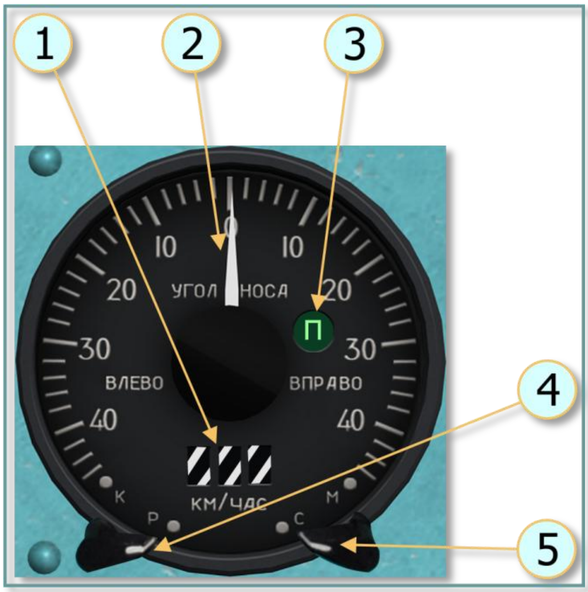


Рис. 9.105. Ground speed and drift indicator:

1 – ground speed window: displays ground speed in kilometers per hour (KPH) within a range of 50 - 400 KPH. At speed below 50 KPH, the window is blanked out;

2 – drift indicator needle: indicates the drift angle, to the right or left, in degrees within a range of ±45° on a scale graduated to 2°;

3 – "П" (P) light: illuminates when the Doppler system is operating in MEMORY mode;

4 – "Р-К" (TEST - OPERATE) knob: selects either test or normal indicator operation mode. In TEST mode, the indicator shows 306 ±3.5 KPH and 15± 1° of drift;

5 – "С-М" (LAND - SEA) knob: used to select the characteristics of the surface the helicopter is traveling over;

Digital display unit: displays the distance the helicopter has flown from the starting point and the lateral distance to the left or right of the course that the pilot enters on the "УГОЛ КАРТЫ" (COURSE ANGLE) counter. The readout information is provided by the Doppler computer.

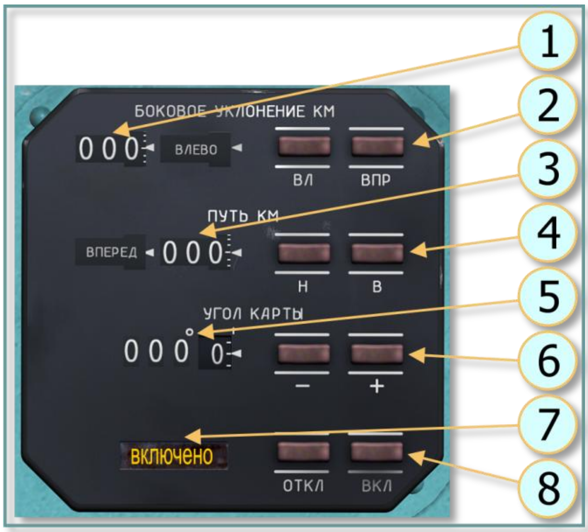


Рис. 9.106. Digital display unit:

1 – "БОКОВОЕ УКЛОНЕНИЕ КМ" (LATERAL DEVIATION) counter: drum-type counter with four wheels, right window displays direction of deviation from course ("ВЛЕВО" (LEFT) or "ВПРАВО" (RIGHT)); numerical counter displays the amount of lateral deviation in kilometers in 200 m steps;

2 – "ВЛ" (LEFT), "ВПР" (RIGHT) buttons: used to reset the LATERAL DEVIATION counter;

3 – "ПУТЬ КМ" (DISTANCE) counter: drum-type counter with four wheels, dislpays the distance the helicopter has flown from the starting point. The left window displays the relative direction, "ВПЕРЕД" (FORWARD) or "НАЗАД" AFT of the starting point; numerical counters dislpay the distance traveled in kilometers in 200 m steps;

4 – "Н" (AFT), "В" (FWD) buttons: used to reset the DISTANCE counter;

5 – "УГОЛ КАРТЫ" (COURSE ANGLE) counter: drum-type counter with four wheels, displays the desired course in degrees (first three digits) and minutes (last two digits) in 6 minute steps;

6 – "-" and "+" buttons: used to set the counters to the desired course; counter does not rollover between 0 and 360 degrees;

7 – "ВКЛЮЧЕНО" (ON) light: indicates operation of the unit;

8 – "ВКЛ" (ON) and "ОТКЛ" (OFF) buttons: engage/disengage digital readout.

PB-5 (RV-5) RADAR ALTIMETER SET

The radar altimeter set continuously indicates absolute altitude. The system is a "look down" device which accurately measures the distance between the aircraft and the highest terrain from 0 to 750 meters. The system accuracy is ±2 m at altitudes up to 20 m and ±0.1 x N (where N equals altitude) at altitudes above 20 m.

RV-5 components:

The RV-5 radar altimeter set includes the following components:

– transceiver
– altimeter indicator on the pilot's (left) instrument panel
– receiving and transmitting antennas installed on the bottom of the tail boom
– "РАДИОВЫСОТОМЕР" (RV-5) circuit breaker on the right circuit breaker console
– "РАДИОВЫСОТОМЕР ВКЛ. - ОТКЛ." (RADAR ALTIMETER) power switch on the left instrument panel

Рис. 9.107. Radar altimeter indicator:

1 – altimeter pointer; 2 – altimeter fail flag; 3 – SET ALTITUDE knob used to adjust ground-proximity warning setting. The SET ALTITUDE knob incorporates a yellow LOW ALT caution light which illuminates when the helicopter descends below preset altitude; 4 – low altitude pointer shows low altitude setting; 5 – "ТЕСТ" (TEST) button to test the altimeter; 6 – "РАДИОВЫСОТОМЕР ВКЛ. - ОТКЛ." (RADAR ALTIMETER) power switch.

The radar altimeter does not require additional adjustment or tuning for in-flight use (except setting of ground proximity warning altitude).

Reliance on the radar altimeter is not recommended whenever:

– flying in mountainous terrain where absolute altitude variations may exceed the altimeter's limitations
– roll or pitch angle exceeds 40°

At roll angles greater than 20° the reading accuracy diminishes due to slant range effects.

If helicopter altitude exceeds the altimeter's limitations or in case of failure, the red fail flag appears along the scale on the right side of the indicator.

При проверке радиовысотомера в режиме "Контроль", которая может производиться на любой высоте нажатием кнопки ТЕСТ на индикаторе высотомера, необходимое время контроля определяется временем прохождения стрелки индикатора из затемненного сектора до высоты 15 м. После отработки контрольной высоты флажок бленкера не должен быть в поле зрения.

The LOW ALT caution light illuminates and an audio warning tone is heard when the helicopter descends to the set ground proximity warning altitude.

The radar altimeter may indicate an erroneous reading if large sized cargo is transported on external sling.

Switching off power to the radar altimeter will raise the power/failure warning flag on the indicator and may leave the pointer indicating along the altitude scale.

The radar altimeter is powered with 27 VDC and 115 VAC 400 Hz.

RV-5 specifications:

Frequency range	4200-4400 MHz
Altitude range	0-750 m
Modulation type	frequency
Audio warning duration	3-9 sec
Accuracy:	
altitude: 0-20 m	±2 m
altitude:20-750 m	± 0.1 x N (N = altitude)

RV-5 operation:

Turn on the "РАДИОВЫСОТОМЕР" (RV-5) circuit breaker on the right cb panel

Set the "РАДИОВЫС. ВКЛ.– ВЫК." (RADAR ALTIMETER) switch on the left instrument panel to the ON (up) position

When turned on, the radar altimeter performs a self-test indicated by the pointer turning to the blanked area at the top of the scale and returning to the double-graduated area at the start of the scale within 1-2 min. When complete, the test should result in the warning flag disappearing.

If the ground proximity warning altitude is set to at least 5 meters, descent past the warning altitude setting will trigger a 3 - 9 second audio warning tone and illuminate the LOW ALT caution light.

Press the "ТЕСТ" (TEST) button to test the indicator. Pressing the "ТЕСТ" (TEST) button should turn the arrow around the scale to the banked out area at the top.

Release the "ТЕСТ" (TEST) button to allow the arrow to return to its starting position.

5.5.3. SPECIAL PURPOSE RADIO SYSTEMS

УВ-26 (UV-26) CONTROL PANEL

The UV-26 countermeasures control panel is located to the right of the overhead panel and it is used to configure the release of infrared (IR) flare countermeasures. These are used as decoys against heat-seeking missiles like the Igla (SA-16), FIM-92 Stinger, AIM-9 Sidewinder, R-60 (AA-8 Aphid), and R-73 (AA-11 Archer), etc.

Рис. 9.108. UV-26 control panel:

*1. **Program display**. The digital read-out indicates the currently selected flare dispensing parameters. When the "**НАЛИЧ-ПРОГР**" (REMAIN-PROGRAM) switch is in the "**НАЛИЧ**" (REMAIN) position, the display shows the remaining quantity of flares (the Mi-8 can carry a maximum of 128). When in the "**ПРОГР**" (PROGRAM) position, the first number indicates the "**СЕРИЯ**" (SEQUENCES) setting, the second number indicates "**ЗАЛП**" (SALVO) setting, and the third number shows the setting for "**ИНТЕРВАЛ**" (INTERVAL).*

*2. **Dispenser side lamp** – Indication that flares will be dispensed from the left dispenser.*

*3. "**БОРТ**" (LFT-RGT, left/right) release select switch. This is a three position switch that can be set to the center position for release of flares from both sides; to the left for release of flares from the left side or to the right for release of flares just from the right side. Depending on the selection, the appropriate lamp(s) will be visible in the display field above. [] + RALT].*

*4. "**СЕРИЯ**" (SEQUENCUES) button [INSERT + RSHIFT]. Pressing this button cycles through the number of flare sequences options. The number of sequences is equal to the number of times the program will be run (except for 5 when the number of sequences is 12 and for 7 when the number of sequences is 15). When the value is set to 0, flares will be dispensed continuously.*

*5. "**ЗАЛП**" (SALVO) button [INSERT + RCTRL]. Press this button to cycle between the number of flares to be released in a single program sequence. Values range 1 through*

*6. "**СТОП**" (STOP) button [DELETE]. Stops the currently running program.*

*7. **Dispenser side lamp** – Indication that flares will be dispensed from the right dispenser.*

*8. "**НАЛИЧИЕ – ПРОГР**" (REMAIN - PROGRAM) switch [] + RCTRL]. When set to "**НАЛИЧИЕ**" (REMAIN), the display indicates the number of flares remaining; when set to "**ПРОГР**" (PROGRAM), it shows the current flare program numeric code.*

*9. "**ИНТЕРВАЛ**" (INTERVAL) button [INSERT + RALT]. Pressing this button cycles between the time-delay between flare release settings. The delay is in seconds and is equal to the displayed number except for the cases of 7, 9 and 0, for which the intervals are 0.25, 0.5 and 0.125 seconds respectively.*

*10. "**СБРОС ПРОГР**" (RESET) button [DELETE + RCTRL]. This button resets the programmed parameters to the default, "110".*

*11. "**ПУСК**" (DISPENSE) button [INSERT]. Pressing this button executes the configured flare dispersion program.*

Example programs:

110: 1 sequence, dispense 1 flare, delay of 0.125s. Pressing "ПУСК" releases a single flare from the selected side container (depending on the position of the "БОРТ" (SIDE) switch). This is the default program.

622: 6 sequences, 2 flares in a sequence, 2 second interval. Flares will be dispensed in pairs, one from each side or from one side only, again depending on the "БОРТ" (SIDE) switch position.

529: 12 sequences, 2 flares in a sequence, interval of 0.5 s between releases.

6 NORMAL PROCEDURES

6. NORMAL PROCEDURES

6.1 OPERATING LIMITS AND RESTRICTIONS

6.1.1. CALCULATING MAXIMUM TAKEOFF WEIGHT

Maximum takeoff weight for out of ground effect vertical takeoff (landing) (OGE maximum hover weight) is displayed by FРис. 9.109. Maximum takeoff weight for in ground effect vertical takeoff (landing) (IGE maximum hover weight) is displayed by Рис. 9.110.

The maximum hover weight charts display maximum takeoff weight in relation to the pressure altitude of the landing field and free air temperature (FAT) assuming calm winds, 93% main rotor RPM, disengaged PZU air inlet particle separator system, disengaged anti-icing systems.

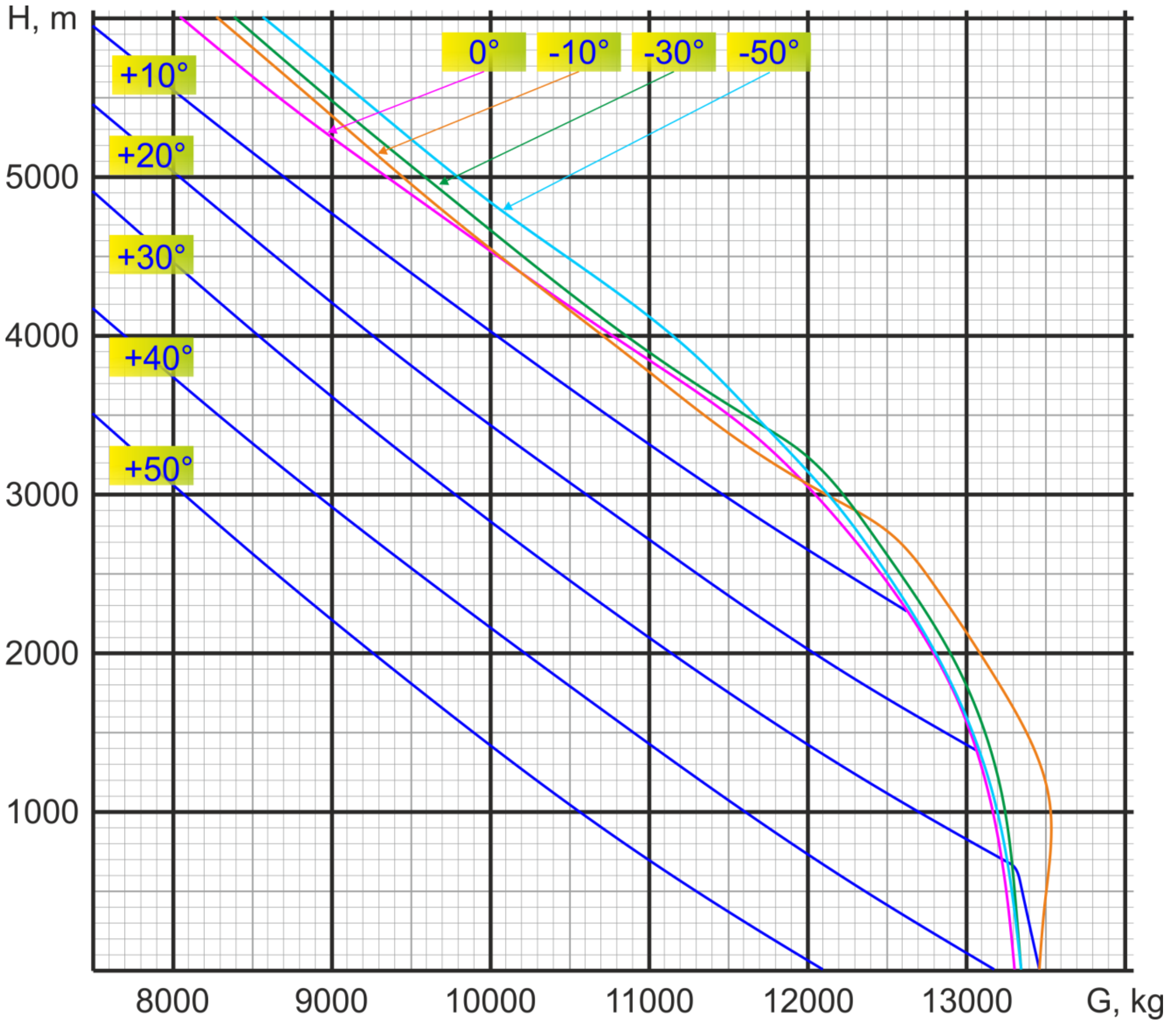


Рис. 9.109. OGE maximum hover weight chart (hover altitude 20 m). PZU and anti-icing disabled.

N O T E . *If EGS installed, reduce maximum weight indicated in chart by 300 kg.*

With PZU system turned on, reduce maximum weight indicated in chart by 200 kg. With engine and rotor anti-ice systems turned on, reduce maximum weight indicated in chart by 1000 kg.

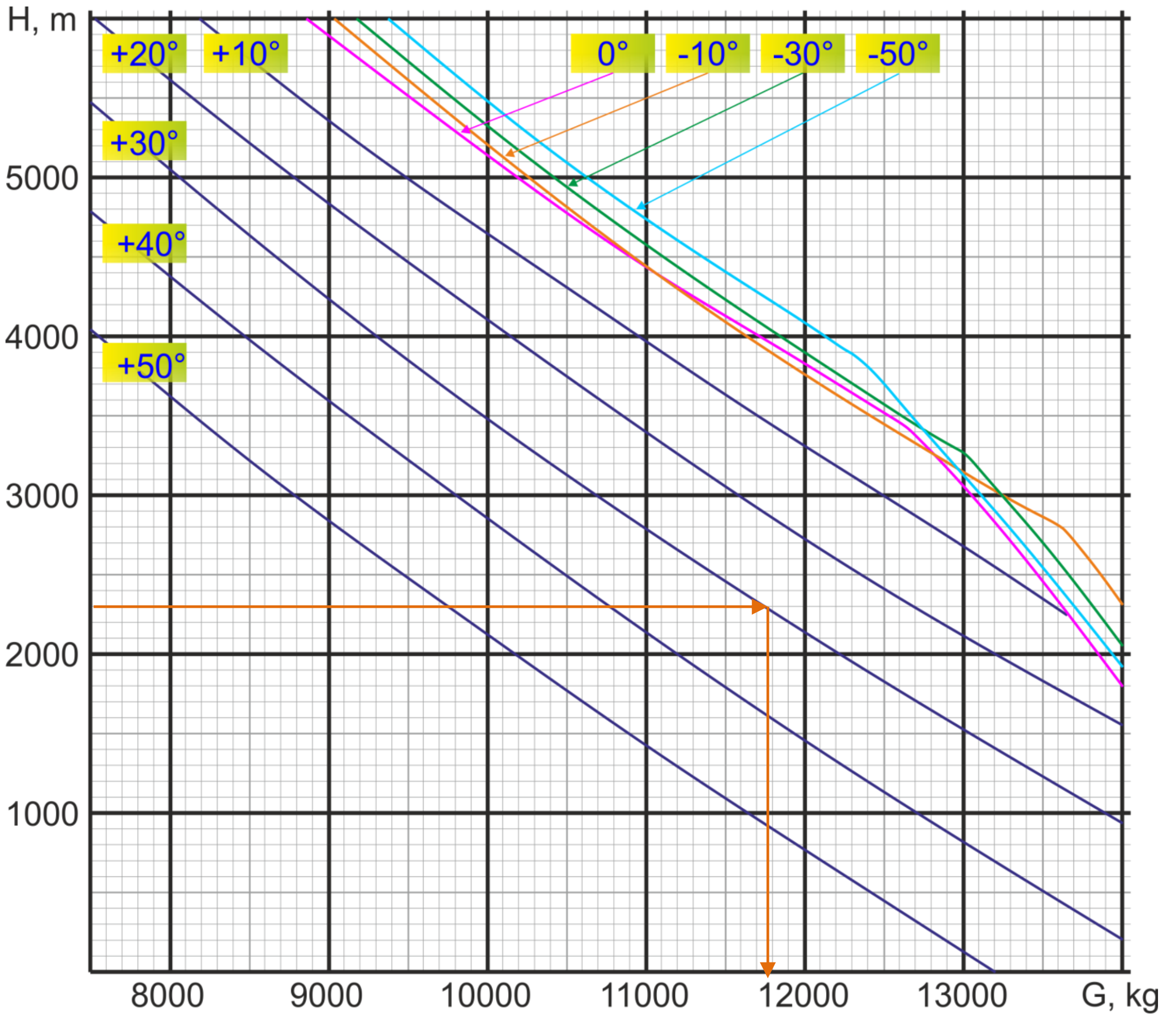


Рис. 9.110. IGE maximum hover weight chart (hover altitude 3 m). PZU and anti-icing disabled.

Any headwind increases maximum takeoff weight: +200 kg at 5 m/sec; +1200 kg at 10 m/sec.

Crosswind up to 5 m/sec reduces performance by affecting the tail rotor and increasing engine power requirements. Reduce maximum takeoff weight by 200 kg in the presence of a crosswind of up to 5 m/sec. At greater crosswind speeds, translational lift effects become more dominant.

Performance reduction in tailwind conditions (blowback of hot exhaust gases into the exhaust system) is not modeled in the simulation.

When calculating wind corrections for maximum hover weight, consider that wind speed and direction may vary during takeoff/landing. Assume the lowest maximum hover weight corresponding with possible wind variance.

If wind conditions cannot be determined, assume poor hover conditions of 4-6 m/sec tailwind.

Example:

Рис. 9.110 includes a solution (orange arrows) to the following example problem: determine the maximum hover weight for vertical takeoff in ground effect from an airfield located at an altitude of 2,300 m and +30°C FAT.

Solution:

Using the IGE maximum hover weight chart Рис. 9.110, enter the graph from the left at the point of the desired pressure altitude of 2,300 m. Draw a line *horizontally to intersect the desired temperature of +30°C. From the intersection point, draw a vertical line down to find the maximum hover weight value, in this case 11,780 kg.*

To determine the maximum takeoff weight for a vertical takeoff out of ground effect, perform the same process using the OGE maximum hover weight chart Рис. 9.109.

MAXIMUM TAKEOFF WEIGHT FOR A RUNNING TAKEOFF:

To determine the maximum takeoff weight for a running takeoff, utilize the IGE maximum hover weight chart Рис. 9.110, but add an additional 500 kg to the solution. Prior to performing a running takeoff, execute a test hover to an altitude of no less than 1 m to verify correct maximum weight calculation.

MAXIMUM TAKEOFF WEIGHT FOR A NOSE WHEEL RUNNING TAKEOFF:

Use nose wheel running takeoff maximum takeoff weight chart Рис. 9.111 to determine the maximum takeoff weight for a nose wheel running takeoff.

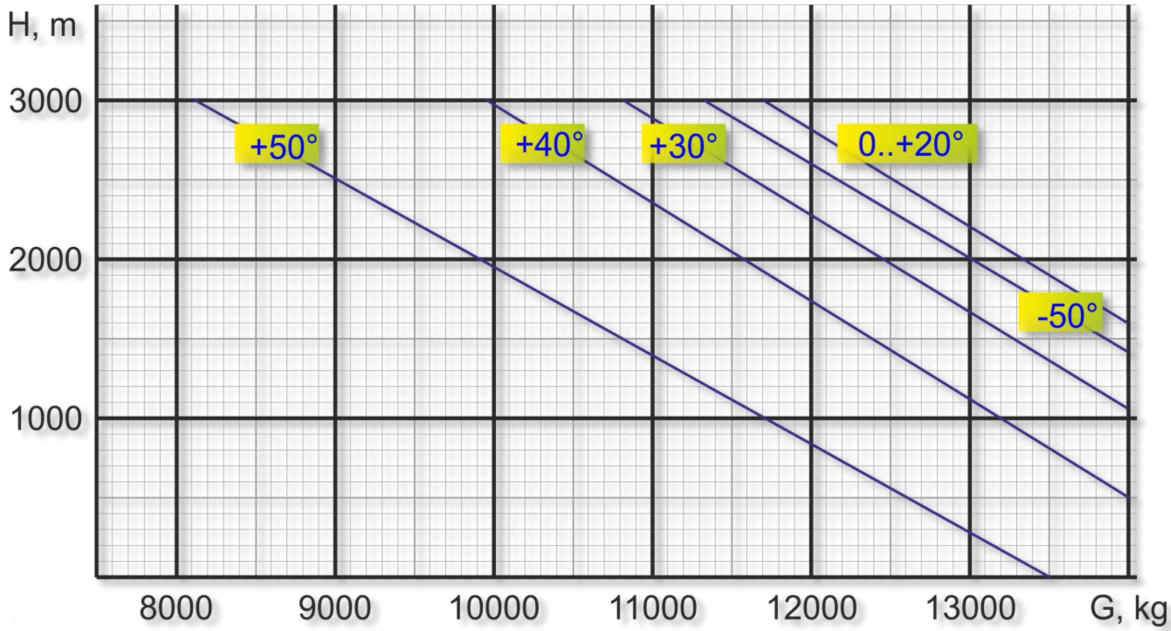


Рис. 9.111. Nose wheel running takeoff maximum takeoff weight chart

Execute a test hover to verify correct maximum weight calculation prior to performing a nose wheel running takeoff. The takeoff can be performed if the helicopter is able to lift off the ground during the test hover.

In all cases, the maximum takeoff weight should never exceed the helicopter maximum gross weight of 13,000 kg.

The calculate fuel and cargo weight limitations, individual helicopter component weights are provided in the following table:

Table. 9.1

No	Mi-8MTV2	May be	Included in simulation model
1	Empty helicopter weight	7200	
2	Crew of three	270	270
3	Cabin ladder	7.3	7.3
4	Safe	4.5	
5	Auxiliary fuel tank	70	0
7	Troop seats (30)	58.7	58.7
8	Cargo ramps	31.6	
9	ЛПГ-150м (LPG-150M) hoist	33.5	33.5
10	Hoist pintle mount	19.8	19.8
11	First aid equipment	93.6	
12	Assault ropes	6	
13	Lubrication oil	71.7	71.7
14	Unusable fuel	20	20
	fuel 0.775 kg/L		
	- service tank	322	
	- main tanks	1608	
	- auxiliary tanks	1388	
15	Armor plating	419	419
	- cockpit	332	
	- cargo cabin	33	
	- hydraulics compartment	54	
16	Weapons stations racks	401	401
17	Nose PKT machine gun w/ ammo	38.8	0
18	Tail PKT machine gun w/ammo	26.9	0
19	UV-26 w/t ammo	32.6	32.6
	flares	16.5	16.5
20	B8-V20A launchers w/t ammo	100	
21	rockets	242	
22	GUV (machine gun)	452	
23	GUV (grenades)	274	
24	UPK-250	230	
25	Minelaying container (empty)	70	
26	стропы внешней подвески	40.9	
27	внешняя подвеска (без строп)	21.3	
28	Crew O2 equipment	19.3	
29	Rope ladder	19.7	19.7
30	PKV sight	2.5	2.5
31	OPB-1r sight	8.2	
32	РК вооружения с пультом	1.9	15.9
33	Rescue eqiupment:	216	
	-LPG-900 hoist	60	
	-hoist installation	95.5	
	-ферма с рк	15.6	
	-spot light	20.5	
	-люлька	30	
	-багор	0.9	
	-hand spot light (2)	2	
	-rescue belt (2)	4	
	-crew cheif belt	1.8	
	-rubber mat	6.6	
	-подъёмное сиденье	9д	
	-other	5.4	
34	External sling system:	65.5	

	-fixed components	46.9	
	Releasable components	46.9	
	-sling cable type 1м	1.8	
	-sling cable type юм	9	
	-sling cable type 5м (2)	9.9	
	-lower strap (4 шт.)	14.6	
	-minor components	5.6	
35	Rotor blade mooring equipment	43.3	
36	ограждение по штанге 13	9.3	
37	L 166-v1a	25	25
	Total equipment weight, kg		1413.2
	Total helicopter weight (oil, crew) WITHOUT fuel or armament, kg		8613.2

6.1.2. CALCULATING FLIGHT RANGE, RADIUS, AND TIME

This section provides the required data for calculating flight navigation planning.

Flight range (radius) and flight time depend on fuel quantity and consumption rate, which in turn depends on helicopter weight, payload (which affects aerodynamic performance (in particular drag)), flight altitude and airspeed.

The effects of these factors on flight distance and time are examined below.

ALTITUDE. Helicopters are generally flown at low altitudes. However if long range operations are required, flight at altitudes of 2000 - 3000 m result in approximately 15% greater range than low altitudes.

AIRSPEED. Greatest flight range is achieved at or near optimum cruise speed (±20 kph)

CRUISE SPEED – optimum speed that provides greatest flight range (minimum fuel consumption rate) is provided in Table. 9.2.

Table. 9.2

Altitude, m	Helicopter weight 11 100 kg or less		Helicopter weight greater than 11 100 kg	
	Airspeed (kph)			
	indicated	true	indicated	true
100	230	233	215	219
500	225	233	210	218
1000	220	233	205	218
2000	210	234	195	218
3000	195	230	160	190
4000	170	213	120	154
5000	120	163		
6000	100	145		

AERODYNAMIC FACTORS

When exhaust gas suppressor (EGS) devices are fitted, fuel consumption rates per kilometer and per hour provided in Табл. 9.4 increase by 6%.

With armament fitted, fuel consumption rates are as indicated in Табл. 9.4.

ENGINE AIR BLEED FACTORS

With anti-icing and particle separator system engaged, fuel consumption rates indicated in the tables below increase as follows:

- engine anti-icing: 3%
- main and tail rotor anti-icing: 2%

With the PZU particle separator system engaged, fuel consumption rates per hour provided in Табл. 9.4 increase by 3%.

MINIMUM FUEL QUANTITY

To ensure flight safety, a minimum fuel quantity is provided, which equals 260 L for the Mi-8MTV2.

GROUND RUNUP FUEL CONSUMPTION (G_{T3}) includes:

- fuel required for engine start, warm-up, and taxi: 30 kgf/5 min (6 kgf/min)
- fuel required by the APU while powering the electrical systems prior to engine start: 1.25 kgf/min)

GROUND TARGET ATTACK RUNS consume 12 kgf of fuel/min on the first run. With 4-minute repeat attack runs, each is estimated to consume 50 kgf, which is equivalent to a reduction of flight radius by approximately 10 km.

Fuel consumption rates required from takeoff to altitude are provided below in Table 6.3 (nominal engine power setting)

FUEL CONSUMPTION, DISTANCE, AND TIME REQUIRED FROM TAKEOFF TO ALTITUDE:

Table. 9.3

Altitude, m	Indicated airspeed, kph	Helicopter weight, kg								
		11000			12000			13000		
		Fuel con-sumption, kgf	Distance, km	Time, min	Fuel con-sumption, kgf	Distance, km	Time, min	Fuel con-sumption, kgf	Distance, km	Time, min
Takeoff and climb	-	15	-	1	15	-	1	15	-	1
100	120	20	-	1.5	20	-	1.5	20	-	1.5
500	120	25	-	2	30	-	2	30	-	2
1000	120	35	4	2.5	40	5	3	40	5	3
2000	120	55	7	4	60	9	4.5	70	10	5.5
3000	110	75	10	6	85	13	7	100	15	8
4000	110	95	15	7.5	115	19	9	140	30	11.5
4800	100	-	-	-	-	-	-	215	40	18
5000	100	115	20	9.5	155	27	13	.	.	.
6000	90	170	30	15	*	*	-	-	-	-

Per kilometer and per hour fuel consumption rates at various altitudes and airspeeds for maximum rage depending on helicopter weight

Main rotor RPM 95%

Табл. 9.4

H, m	Fuel consumption rate vs helicopter weight														
	9000			10 000			11 000			12 000			13 000		
	q, kgf/km	Q, kgf/hr	Qmin кgf/hr/ at Vind, kph	q, kgf/km	Q, kgf/hr	Qmin кgf/hr/ at Vind, kph	q, kgf/km	Q, kgf/hr	Qmin кgf/hr/ at Vind, kph	q, kgf/km	Q, kgf/hr	Qmin кgf/hr/ at Vind, kph	q, kgf/km	Q, kgf/hr	Qmin кgf/hr/ at Vind, kph
Transport configuration															
100	2.66	620	445 / 120	2.69	627	470 / 120	2.75	641	495 / 120	2.84	621	520 / 110	2.93	640	550/ 120
500	2.55	593	445 / 120	2.6	605	455 / 110	2.67	621	485 / 110	2.76	601	515 / 110	2.84	623	545 / 110
1000	2.44	569	425 / 120	2.49	580	450 / 120	2.57	599	475 / 120	2.66	587	505 / 120	2.77	614	540 / 120
2000	2.24	525	400 / 100	2.33	546	425 / 100	2.42	572	455 / 110	2.56	559	490 /130	2.72	592	530 / 120
3000	2.11	485	380 / 100	2.23	510	410 / 110	2.36	540	445 / 120	2.65	500	480 / 120	2.94	554	535 / 120
4000	2	426	370 / 100	2.14	455	400 / 110	2.36	502	445 / 120	3.23	487	495 / 120	3.85	575	580 / 110
5000	2.09	354	360 / 100	2.37	406	400 / 110	2.8	488	470 / 110						
Combat configuration without armament															
100	2.75	643	445 / 100	2.81	660	475 / 100	2.87	676	500 / 115	2.95	651	530 / 120	3.03	673	555 / 120
500	2.67	630	435 / 110	2.73	646	460 / 110	2.79	663	490 / 110	2.85	640	515 / 110	2.94	660	545 / 115
1000	2.55	613	425 / 110	2.6	629	450 / 110	2.66	648	480 / 110	2.75	627	505 / 110	2.9	651	540 / 110
2000	2.34	570	400 / 100	2.42	586	425 / 100	2.53	610	460 / 100	2.63	599	500 / 115	2.81	638	540 / 115
3000	2.21	515	385 / 105	2.29	540	415 / 115	2.44	581	445 / 120	2.7	527	490 / 120	3	579	550 / 120
4000	2.07	447	370 / 120	2.23	477	405 / 110	2.5	523	450 / 115	3.46	522	525 / 100	4.17	596	630 / 100
5000	2.12	375	360 / 100	2.45	431	415 / 100	3.03	507	520 / 100						
Combat configuration with armament															
100	2.83	692	450 / 110	2.91	697	480 / 115	2.99	706	505 / 115	3.07	673	530 / 110	3.15	686	560 / 120
500	2.75	679	440 / 110	2.83	681	460 / 110	2.91	684	490 / 110	2.99	649	520 / 110	3.07	662	550 / 115
1000	2.66	645	430 / 110	2.75	650	455 / 110	2.82	657	480 / 100	2.9	624	510 / 110	2.99	642	545 / 120
2000	2.45	586	405 / 100	2.52	593	433 / 100	2.6	607	465 / 110	2.7	594	505 / 130	2.86	625	550 / 120
3000	2.26	522	385 / 100	2.36	536	415 / 100	2.48	559	450 / 120	2.75	537	495 / 120	3.13	617	560 / 110
4000	2.12	464	375 / 120	2.28	481	405 / 110	2.6	548	455 / 110	3.65	553	545 / 100	4.5	684	695 / 110
5000	2.15	376	365 / 105	2.61	445	425 / 100	3.6	553	595 / 100						

q, kgf/km – fuel consuption in kg for 1 km; Q, kgf/hr – fuel consumption in kg per hour

FUEL CONSUMPTION, DISTANCE, AND TIME REQUIRED IN LANDING APPROACH

Table. 9.5

Starting altitude, m	Indicated airspeed, kph	Descent rate, m/sec	Fuel consump-tion, kgf	Distance, km
Deceleration, hover, and landing	—		15	1
100	120—130	2-4	20	—
500	140—150	5-6	25	5
1000	140—150	5-6	30	10
2000	140—150	5—6	45	20
3000	140—150	5-6	60	30
4000	120	3—4	90	40
5000	120	3-4	130	55

FUEL CONSUMPTION PER HOUR IN HOVER (KGF/HR) OUT OF GROUND EFFECT

Table. 9.6

Helicopter weight	Fuel consumption per hour (kgf/hr) vs airfield altitude, m				
	0	500	1000	2000	3000
9000	700	660	640	630	610
10000	730	710	700	690	690
11000	790	770	770	760	—
12000	850	840	840	—	—
13000	920	920	—	—	—

To calculate the required fuel for a given mission range, calculate the fuel required for non-navigation phases of the mission (start, taxi, target attack run(s)), add the minimum fuel quantity, then subtract this sum from the total fuel quantity on board. Multiply the remainder by 0.95 to add 5% navigational error factor and another 0.95 to add 5% for formation keeping.

6.2 PREFLIGHT COCKPIT CHECK

Perform the following cockpit checks prior to flight:

- Make sure that the braking system is leak-free and operates normally (after depression of the brake handle and attainment of a pressure of 31 to 34 kg/cm^2 in the brake line there should be no noise created by outgoing air and, after releasing the brakes, there should be no residual pressure in the brake system) [Key com.]
- Set the pressure altimeter pointers to zero and check the barometric pressure display for compliance with the actual aerodrome pressure with an accuracy of ±1.5 mm Hg [Key com.]
- energize the helicopter electrical systems [Key com.]
- check crew intercommunication over the SPU-7 ICS [Key com.]
- check windshield wiper operation [Key com.]

- check and set the clock [Key com.];
- check fuel quantity on the fuel gauge and set the fuel gauge selector to "РАСХ" (SVC CELL) [Key com.].

For night time operations:

- turn on red lighting of the instrument and control panels [Key com.]
- turn on the navigation lights and МСЛ-3 (MSL-3) anti-collision light (beacon) [Key com.]
- turn on the taxi and landing lights [Key com.]

6.3 ENERGIZING AND TESTING ELECTRICAL POWER SOURCES

A. Turning on the batteries:

- "АККУМУЛ. I" и "II" (BATT I, II) to "ВКЛ." (ON (up)) [Key com.];
- check the voltage of the battery bus by setting the DC selector knob to "ШИНЫ АКК." (BATT BUS). The voltage should be no less than 24 V.
- check the condition of the batteries as follows:
  a) "АЭРОДР. ПИТАН." (EXT PWR (external power)) selector to "ВЫКЛ." (OFF) [Key com.];
  b) DC selector knob to "АККУМУЛ. I" (BATT I) [Key com.]
  c) "АККУМУЛ. II" (BATT II) to "ВЫКЛ" (OFF (down)) [Key com.]
  d) any fuel boost pump to ON and check Volts (no less than 24 V) [Key com.]
  e) DC selector knob to "АККУМУЛ. II" (BATT II) [Key com.]
  f) АККУМУЛ. II" (BATT II) to "ВКЛ" (ON (up)) [Key com.] and "АККУМУЛ. I" (BATT I) to "ВЫКЛ" (OFF (down)) [Key com.] Check voltage (no less than 24 V).
  g) fuel boost pump to OFF [Key com.];
  h) "АККУМУЛ. I" и "II" (BATT I, II) to "ВКЛ." (ON (up)) [Key com.];
  i) DC selector knob to "ШИНЫ АКК." (BATT BUS) [Key com.].

B. Connecting to external electrical power:

To connect to an external power source on the ground:

- once the "АЭР. ПИТ. ВКЛЮЧЕНО" (EXT PWR ON) light illuminates (after successful connection to an external power source), check the ground power source voltage by setting the DC selector knob to "АЭРОДРОМ. ПИТАН." (EXT PWR). The voltage should be within the limits of 200 - 205 V. Set the "АЭРОДРОМ. ПИТАН." (EXT PWR) switch to "ВКЛ." (ON). Se the "ПО-500А ~ 115" (Inverter 1) and "ПТ-200 ~ 36" (Inverter 2) switches to the "АВТОМАТ" (AUTO) (down) postion. Set the "ВЫПРЯМИТЕЛИ I, II, III" (RECTIFIERS 1, 2, 3) to the "ВКЛ." (ON) (up) position. Check the rectifier bus voltage by setting the DC selector knob to "ШИНЫ ВЫПР." (RECT BUSES). The voltage should be within the limits of 27 - 29 V.

- set the AC selector knob to the "~115" position. The voltage should be 115 V.
- once the "АЭР. ПИТ. ВКЛЮЧЕНО" (EXT PWR ON) light illuminates check the AC ground power source voltage by setting the AC selector knob to "АЭРОДРОМ. ПИТАН." (EXT PWR). The voltage should be within the limits of 27 - 29 V.

Set the "АЭРОДР. ПИТАН." (EXT PWR) switch to "ВКЛ." (ON) and the Inverter 1 switch to "РУЧНОЕ" (MAN).

Check the inverter output voltage by setting the AC selector knob to "~115". The voltage should be 115 V.

6.4 STARTING THE APU AND MAIN ENGINES

Preparing for APU and main engines start:

- release the rotor brake [Key com.]
- make sure the collective pitch control lever is at the lower stop [Key com.] and the throttle control twist grip is turned fully to the left [Key com.], the engines throttle levers are set in the neutral detent [Key com.], the control stick is in a position close to neutral and the fuel shutoff levers are in the aft (closed) position [Key com.]
- switch on all the circuit-breakers and switches required for starting the APU and main engines (the starting system, ignition systems for the APU and main engines, fire protection system, hydraulic systems, trim actuators, fuel tank pumps, fuel quantity gauge, engine anti-icing system, friction clutch, electric clutch, gyro correction cutout switch, attitude indicator, directional gyro, autopilot, voice warning system, tail rotor pitch limit system, cockpit voice recorder, anti-collision light [Key com.]
- make sure the AC generator switches are set to "ВЫКЛЮЧЕНО" (OFF) (down) [Key com.]
- set the "КОНТРОЛЬ ДАТЧИКОВ – ОГНЕТУШЕНИЕ" (FIRE EXT/TEST) switch to "ОГНЕТУШЕНИЕ" (EXT) (up, light out) [Key com.]
- make sure the "ВЗЛЕТНЫЙ РЕЖИМ" (CONTING. PWR) circuit breaker is onбедиться [Key com.]
- установить РРУД в среднее положение на защелку [Key com.];
- switch on the command radio and request clearance for engine start [Key com.]
- включить подкачивающие насосы расходного бака [Key com.] и перекачивающие насосы основных баков [Key com.];
- switch on the fuel boost pumps of the service tank and the fuel transfer pumps of the main tanks [Key com.]
- open the fuel fire (shutoff) valves [Key com.]

STARTING THE AI-9V APU

Start the APU prior to starting the main engines:

- "ЗАПУСК– ПРОКРУТ.– ЛОЖНЫЙ ЗАПУСК" (START-CRANK-FALSE START selector on the APU start control panel to "ЗАПУСК" (START) (up) [Key com.]
- press the "ЗАПУСК" (START) button for 2 to 3 seconds [Key com.]. The "АВТОМАТ. ВКЛЮЧЕН" (AUTO IGNITION) light should illuminate. The APU automatically accelerates to idle speed, indicated by illumination of the "ДАВ. МАСЛ. НОРМА" (OIL PRESS NORM) and "ОБОРОТЫ НОРМА" (NORMAL SPEED) lights. The time to reach idle speed should not exceed 20 seconds.

Once the APU reaches idle speed, check its operational parameters and make sure:

- continuous idle EGT does not exceed 720°C;
- "ДАВ. МАСЛА НОРМА" (OIL PRESS NORM) and "ОБОРОТЫ НОРМА" (NORMAL SPEED) lights illuminate;
- air pressure reading in the APU main air bleed line (APU pressure gauge) is within normal parameters;
- "РЕЗЕРВН. ГЕНЕРАТ." (STBY GEN) switch is set to "ВЫКЛ." (OFF) (down) [Key com.].

The APU must run for a minimum of 1 minute before attempting to start the main engines.

In case of an inadvertent shutdown of the APU, press the "ВЫКЛЮЧЕНИЕ АИ-9В" (APU OFF) button for 2 to 3 seconds in order to cut off fuel supply to the APU [Key com.].

The APU start can be aborted at any time by pressing the "ВЫКЛЮЧЕНИЕ АИ-9В" (APU OFF) button for 2 to 3 seconds [Key com.].

In case of an unsuccessful APU start, crank the APU as follows:

- set the "ЗАПУСК – ПРОКРУТ. – ЛОЖНЫЙ ЗАПУСК" (START-CRANK-FALSE START) selector switch to (CRANK) [Key com.];
- press the "ЗАПУСК" (START) button and check that the "АВТОМАТ. ВКЛЮЧЕН" (AUTO IGNITION) and "ДАВ. МАСЛА НОРМА" (OIL PRESS NORM) lights illuminate.

Restart attempts must be 3 minutes apart. Three attempts can be made. If the unit does not start after three attempts, a 15 minute shut-down/cooling period must follow before another start is attempted.

Continuous APU operation is limited to 30 minutes. In "РЕЗЕРВН. ГЕНЕРАТ" (STANDBY/GEN) mode, the APU cannot be operated beyond 30 minutes, after which a 15 minute shut down/cooling period is required. Cool down the APU 15 minutes between shutdown and restart. Run the APU a minimum of 1 minute before shutdown.

Three consecutive attempts to start the main engines via APU bleed air are allowed. The duration of each air bleed cycle should not exceed 45 seconds with intervals between the air bleed cycles no less than 1 minute, during which the

APU is run at idle speed. The continuous running time of the APU in this condition should not exceed 13 minutes, followed by a 15 minute shut down/cooling period.

Do NOT start the main engines with the APU in DC generator mode (STBY GEN switch on the right side console ON (up)).

В процессе запуска двигателя АИ-9В включать отбор воздуха на запуск двигателей ТВ3-117ВМ и подключать СТАРТЕР–ГЕНЕРАТОР на генераторный режим запрещается.

STARTING THE TV3-117VM MAIN ENGINES

The engines starting order depends on the wind direction. The engine on the downwind side is started first.

Set the start mode selector switch to "ЗАПУСК" (START) [Key com.] and the "ЛЕВ. – ПРАВ." (LEFT - RIGHT) engine selector switch to the desired engine for start (downwind first, upwind second) [Key com.].

Press the "ЗАПУСК" (START) button for 2 to 3 seconds to initiate the start sequence [Key com.]. Open (set forward) the fuel shutoff lever of the engine being started when N1 (compressor) RPM begins to rise [Key com.]. The engine should reach idle speed within 60 seconds. The "АВТОМАТ. ВКЛЮЧЕН" (AUTO IGNITION ON) and "СТАРТЕР РАБОТАЕТ" (STARTER ON) lights should illuminate during the start. After completion of the automatic starting cycle the lights should turn off (AUTO IGNITION ON light in 30 seconds; STARTER ON light upon N1 RPM reaching 60-65%).

Unusual thumps or impact noises during main engine start and rotor spin up indicate the main rotor blades centrifugal droop limiters are hitting their stops. Carefully adjust the cyclic control stick position until the noise is eliminated.

Set the "ЛЕВ. - ПРАВ." (LEFT - RIGHT) engine selector switch to the second starting engine (upwind side) [Key com.] and repeat the starting procedure for the second engine.

With both engines started and running at idle speed, the Nr (main rotor) RPM should stabilize within 55-70%.

Switch on the PZU particle separators for both engines by setting the "ПЗУ ДВИГАТ. ЛЕВ./ПРАВ." (PZU LH/RH) switches to the "ВКЛ" (ON (up)) position [Key com.]. Check the "ЛЕВ. ПЗУ ВКЛЮЧЕН." (LH PZU ON) and "ПРАВ. ПЗУ ВКЛЮЧЕН" (RH PZU ON) lights to illuminate.

After successfully starting the main engines, allow the APU to cool down at idle speed for 0.5 - 1 min and shut the APU down by pressing the "ВЫКЛЮЧЕНИЕ АИ-9В" (APU OFF) button [Key com.].

If engine start is performed on battery power alone, do not shut down the APU until engine run up is complete and Nr exceeds 88%. To provide electrical power at idle engine speeds, switch on the standby generator by setting the "РЕЗЕРВН. ГЕНЕРАТ." (STANDBY GEN) [Key com.] and "ПРОВЕРКА ОБОРУД." (EQUIPM TEST) [Key com.] switches to the ON (up) position.

6.5 ENGINES WARM UP, FLIGHT CONTROLS AND HYDRAULIC SYSTEMS CHECKS

Engine warm up is performed at idle power with collective lowered to minimum [Key com.], throttle turned fully left [Key com.], engine condition levers set in the idle detent (middle) position [Key com.].

Monitor the powerplant instrumentation during engine warm up. Warm up should not exceed 1 minute.

Switch the command radio set on [Key com.].

Test the flight controls and hydraulic systems at idle power as follows:

- alternatively move the cyclic and pedals to make sure the controls move smoothly without jamming
- as the controls are moved, the main hydraulic system pressure should vary within a range of 45±3 to $65\pm^{8}_{2}$ kg/cm^2. Pressure in the reserve hydraulic system should be approximately 5 kg/cm^2.

The throttle can be set from full left to full right to accelerate the engines out of idle power once the engine outlet oil temperature reaches +30°C and the main gearbox oil temperature reaches at least -15°C.

6.6 ENGINE RUN UP, SWITCHING ON GENERATORS AND AVIONICS CHECKS

A. Rotate the throttle full right [Key com.], set the AC generators [Key com.] and rectifiers switches to ON [Key com.]. Request external power to be switched off. When the "АЭР. ПИТ. ВКЛЮЧЕНО" (EXT PWR) light turns off, set the "АЭРОДР. ПИТАН." (EXT PWR) selector switches of OFF [Key com.].

Check the AC generators output voltage to be within 200 to 205 V, the rectifiers output voltage to be within 27 to 29 V, and the transformer output voltage to be 115 V.

Set the ПО-500 ~115 V (Inverter 1) [Key com.] and ПТ-500 ~36 V (Inverter 2) [Key com.] inverters to the АВТОМАТ (AUTO (down)) position.

B. Switch on all the flight, navigation, radio communication and electronic equipment required for the flight, and test for proper functioning. Prior to powering up the АГБ-3К (AGB-3K) attitude indicator [Key com.], cage the device by pressing the "АРРЕТИР" (CAGE) button [Key com.]:

- switch on and test the attitude indicator [Key com.];
- switch on the ADF and tune to the desired channel/frequency (detailed instructions here);
- switch on the "ДИСС-15" (DISS-15) Doppler navigation system [Key com.];
- when he directional gyro heading arrow settles on the starting ground course, set the ГМК-1А (GMK-1A) gyromagnetic compass set to ГПК (directional gyro) mode [Key com.]
- test the autopilot yaw channel by pressing the "НАПРАВЛЕНИЕ" (YAW) [Key com.], "КРЕН" (ROLL) [Key com.], "ТАНГАЖ" (PITCH) [Key com.],

"ВЫСОТА" (ALTITUDE) [Key com.] button-lamps on the autopilot control panel. With feet off the pedals, press the 3K momentary switch on the PU-26 control panel for a short time to the left or right [Key com.]. The YAW channel scale on the autopilot control panel should rotate in response to the manual heading change input.

6.7 ENGINE SHUTDOWN

In preparation for idle power setting, switch off the PZU particle separators [Key com.] and all electrical power consumers apart from powerplant monitoring and control systems. Turn the throttle full left [Key com.] and perform the following steps:

- switch OFF the rectifiers [Key com.], set the "ПО-500А" (Inverter 1) switch to "РУЧНОЕ" (MANUAL (up)) [Key com.], switch OFF the AC generators [Key com.];
- after allowing the engines a 2 minute cool down period in idle power, close (pull aft) the "ОСТАНОВ. ДВИГ. ЛЕВ. ПРАВ." (ENGINE STOP LFT/RGT) fuel shutoff levers [Key com.];
- engage the rotor brake [Key com.]; Nr <20%?
- with engines fully stopped, switch off the fuel fire (shutoff) valves [Key com.];
- switch off the fuel boost [Key com.] and transfer pumps [Key com.];
- switch off all of the circuit breakers and set all other control switches to OFF positions, apart from the reserve hydraulic system;
- switch OFF the batteries [Key com.];
- set the "САРПП-12Д1М "РУЧН – АВТОМ"" (FLIGHT RECORDER) switch to the "АВТОМ" (AUTO) position (down) [Key com.].

6.8 PREPARING FOR TAXI AND TAXIING

A. Prior to taxi, perform a taxi check:

- external power cables are disconnected [Key com.];
- fuel pumps are on (check switch positions and indicator lights) [Key com.];
- APU is shut down;
- all circuit breakers are switched ON.

B. Check the taxiway is clear of obstructions and proceed to:

- set throttle full right [Key com.];
- switch ON PZU particle separators [Key com.];;
- check main rotor RPM to be within 95±2%;
- request clearance to taxi;
- release the wheel brakes [Key com.].

Increase collective to set 1-2° of collective pitch and slightly push forward on the cyclic to begin forward movement.

C. Maintain weight on wheels during taxi.

If the ground surface prevents safe taxiing, perform hover taxi using low speed/low altitude flight.

D. Taxi speed should not exceed 15 - 20 kph. Perform taxi turns using smooth pedal input. Avoid completely unloading weight off the nose wheel shock strut.

E. Wind speed during taxi must not exceed 15 m/sec. In crosswind conditions, the helicopter tends to turn into the wind. Correct any uncommanded turning tendency with slight opposite pedal and any uncommanded roll with slight opposite cyclic.

F. Upon reaching the takeoff position, check the flight and navigation indicators, ensure the attitude indicator is powered up (no warning flag present), the heading indicator shows correct bearing to the selected ADF beacon, and the compass set is slaved and indicating correct takeoff heading.

Start the flight timer on the AChS-1 cockpit clock [Key com.].

6.9 HOVER

A. The following maximum hover altitude limitations apply depending on helicopter gross weight (GW):

- GW ≤ 11,100 kg: 10 m
- GW > 11,100 kg: 5 m

Hover altitudes greater than above limitations are allowed when carrying external sling loads or if dictated by tactical requirements.

B. Yaw rate in hover must not exceed 12°/sec.

C. To perform a hover:

- position the helicopter into the wind if possible
- check throttle set full right
- smoothly increase collective to set collective pitch to 3°
- check main rotor RPM to be 95%. If necessary adjust main rotor RPM using the N_2 TRIM INCR-DECR switch on the collective control handle
- turn on the autopilot "КРЕН–ТАНГАЖ" (ROLL-PITCH) [Key com.] and "НАПРАВЛЕНИЕ" (YAW) [Key com.] channels by pressing the corresponding button-lamps and checking for green light illumination
- continue to smoothly increase collective to lift the helicopter off the ground and climb until reaching desired hover altitude

D. Increase of collective control during liftoff must be smooth and gradual, allowing no less than 5 seconds for the engines to attain Takeoff power, ensuring main rotor RPM is maintained within normal limits of 92 - 94%.

E. During liftoff, the helicopter tends to drift forward and left.

F. The cyclic control stick deflection in hover is approximately:

- 1/4 stick travel aft when helicopter CG is at normal to aft limit position; 1/2 stick travel aft when helicopter CG at the forward limit position
- 1/4 stick travel right regardless of CG position

6.10 HOVER TAXI

A. Hover taxi may be performed for training purposes, special purpose

operations, and in cases where the ground surface conditions do not allow for safe ground taxi.

B. Lateral and reverse hover flight speed may not exceed 10 kph. Use the ground for visual reference and ensure that the flight path is clear of obstacles.

C. Forward hover flight altitude may not exceed 10 m and speed not exceed 20 kph. Use the ground for visual reference and the stationary flight indicator of the Doppler system for precise flight control.

With wind speeds of up to 10 m/sec, hover taxi can be performed into the wind or at 90° to the wind. With wind speeds greater than 10 m/sec, hover taxi should only be performed into the wind.

D. Perform low level flight over uneven terrain (gullies, ditches, drop-offs, etc.) at altitudes of no less than 20 m and speeds no less than 60 kph.

6.11 TAKEOFF

Takeoff is performed using one of the following procedures:

- vertical takeoff with acceleration in ground effect
- vertical takeoff with acceleration out of ground effect
- running takeoff with a ground run to a takeoff speed of 20 - 50 kph
- running nose wheel takeoff

The minimum dimensions of the airfield required for a takeoff or landing at altitudes of up to 1500 m are as follows:

- 50 x 50 m for a vertical takeoff/landing free of obstacles
- 50 x 120 m for a vertical takeoff/landing with an obstacle height of 15 m at the airfield outer edge
- 50 x 160 m for a running takeoff/landing free of obstacles
- 50 x 200 m for a running takeoff/landing with an obstacle height of 15 m at the airfield outer edge

VERTICAL TAKEOFF WITH ACCELERATION IN GROUND EFFECT

A vertical takeoff with acceleration in ground effect may be performed when the helicopter hovers at an altitude of no less than 3 m with the engines set to Takeoff power.

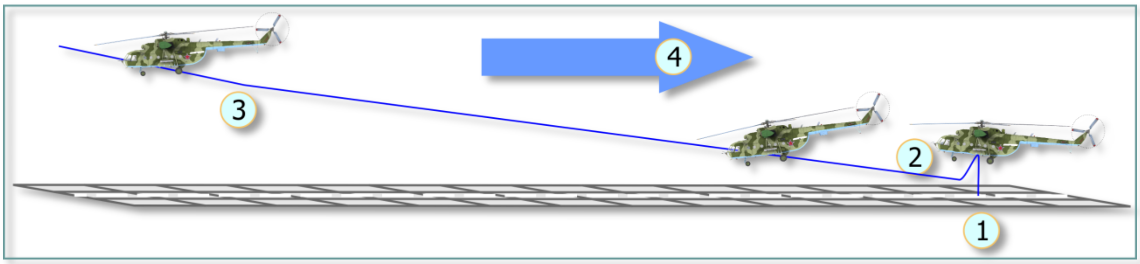


Рис. 9.112. Vertical takeoff with acceleration in ground effect

Position the helicopter into the wind (4) and perform a hover safety check to ensure the helicopter is ready for takeoff (1). Confirm normal indicator readings and a sufficient hover altitude for a vertical takeoff. Reduce altitude to 0.5 - 1 m (2) and begin the takeoff by smoothly pushing the cyclic forward while simultaneously advancing power as required up to Takeoff setting to avoid main rotor RPM drooping below 92%. Accelerate in ground effect in a shallow climb to reach 60 - 70 kph at an altitude of 20 - 30 m (3). Transition to a climbout attitude while accelerating to 120 kph.

VERTICAL TAKEOFF WITH ACCELERATION OUT OF GROUND EFFECT

A vertical takeoff with acceleration out of ground effect must be performed when the takeoff area is confined and surrounded with obstacles, and the helicopter's takeoff weight allows for a hover out of ground effect.

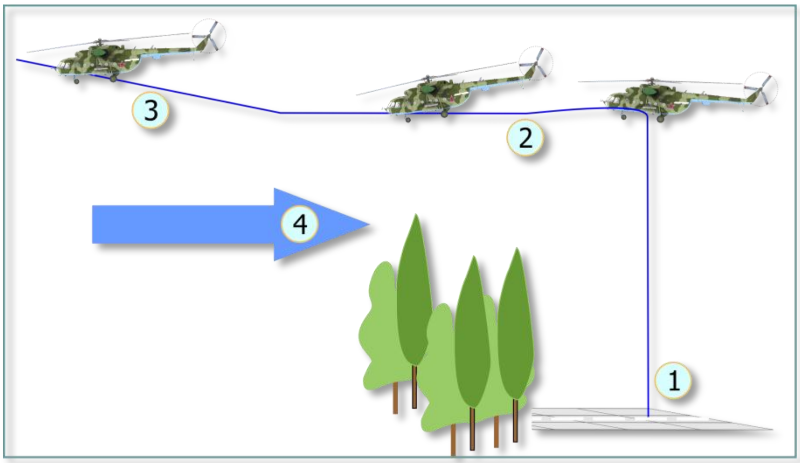


Рис. 9.113. Vertical takeoff with acceleration out of ground effect

Position the helicopter into the wind (4). Perform a vertical takeoff while minimizing drift (1) to an altitude of at least 10 m above obstacle height. In the vertical climb, monitor the main rotor RPM to ensure it does not droop below 92%. Having attained a hover altitude sufficient for a safe transition to forward flight above obstacle height, smoothly push the cyclic forward to accelerate up to 20 - 50 kph (2). Transition to a climbout attitude while accelerating up to 120 kph (3).

RUNNING TAKEOFF

A running takeoff may be performed if the helicopter hovers at an altitude of no less than 1 m with the engines set to Takeoff power. For a running takeoff, only the ROLL-PITCH channel of the autopilot should be engaged.

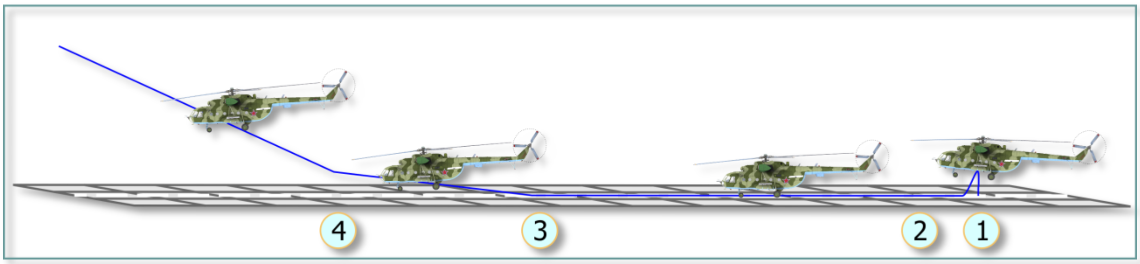


Рис. 9.114. Running takeoff

Perform a hover check then land the helicopter (1). Reduce collective until the helicopter rests on the ground with weight on wheels.

Push the cyclic forward and simultaneously increase collective to establish forward acceleration up to 20 - 50 kph (2). Increase collective further to attain Takeoff power and lift the helicopter off the ground (3).

In the takeoff run, the helicopter tends to lift off the main wheels first, followed by the nose wheel. Compensate for this tendency with slight pull aft of the cyclic at the moment of liftoff.

After liftoff, continue to accelerate up to 120 kph in a shallow climb, followed by a transition to a climbout attitude (4).

The takeoff run requires 250 - 300 m. If the takeoff area is limited or blocked by obstacles, the transition to climbout can be made at 50 - 60 kph .

RUNNING NOSE GEAR TAKEOFF

A running nose wheel takeoff may be performed to increase takeoff performance with a high takeoff weight or to reduce the distance of the takeoff run on airfields that provide for a safe ground run.

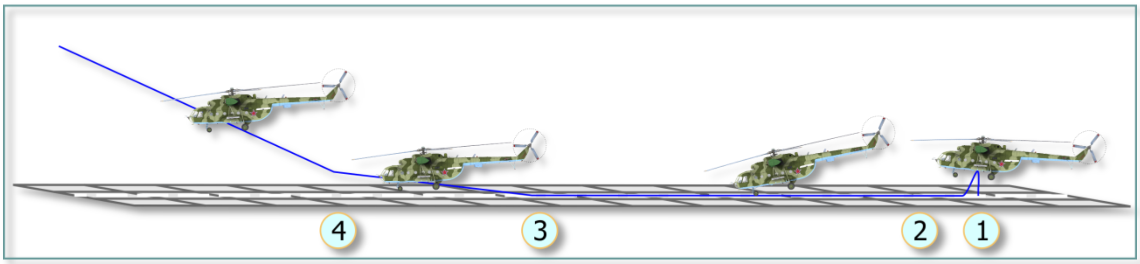


Рис. 9.115. Running nose gear takeoff

Perform a hover safety check then land the helicopter (1).

Disable the autopilot by pressing the AUTOPILOT OFF button on the cyclic control stick. Reduce collective pitch to minimum by lowering the collective control handle to the lower stop (full down). Apply the wheel brakes. Push the cyclic control stick to the forward limit and proceed to turn ON the autopilot ROLL-PITCH channel by pressing the corresponding button-lamp on the autopilot control panel and checking for green light illumination. Pull the cyclic control stick to the aft limit and release the stick force by pressing the TRIM button on cyclic control stick. The forward and aft deflection limits of the cyclic are determined by the absence of thumping noise as the main rotor blades strike against the flapping hinges of the rotor assembly.

Release the wheel brakes. Smoothly increase collective until the main landing gear begins to lift off the ground. Maintain the nose gear on the ground.

Smoothly (3 - 5 sec) push the cyclic forward 1/2 to 2/3 stick travel to begin the ground run and establish a nose-down pitch attitude of -8 to -9° below standing pitch (2). Control the pitch angle during the ground run by maintaining the blade tips of the rotor disc on the horizon line. Smoothly increase engine power to Takeoff setting in the ground run.

At approximately 40 kph the helicopter exhibits a tendency to pitch up and sink onto the main gear, followed by a reversal and an energetic pitch down. These tendencies must be countered with corresponding forward and aft cyclic control adjustments.

Lift off 1 - 2 seconds after the pitch down with a smooth cyclic pull aft as ground speed reaches 60 - 65 kph (3). Continue to accelerate to 70 - 80 kph up to an altitude of 10 m. Proceed with climbout at a speed of 120 kph (4).

With a maximum takeoff weight of 1300 kg, a ground run of 150 m is required for a paved runway or 340 m for a field airstrip. If the helicopter's CG is close to the aft limit, the ground run distance increases by a factor of 1.5.

After leveling off at the desired altitude in stabilized in level flight, switch OFF the autopilot by pressing the AUTOPILOT OFF button on the cyclic control stick, stabilize the controls and switch ON the autopilot ROLL-PITCH and YAW channels by pressing the corresponding button-lamps on the autopilot control panel and checking for green light illumination.

6.12 CLIMB TO ALTITUDE

A. The optimal climb speed is 120 kph in altitudes up to 2000 m; 110 kph in altitudes of 2000 - 4000 m; and 100 kph above 4000 m. Climbs are normally performed in maximum continuous engine power. If required, the climb may be performed in Takeoff power (limited to 6 minutes) as well as power settings below maximum continuous.

After completing the takeoff, establish the desired climb rate and switch OFF the PZU particle separators.

Рис. 9.116. Engine pressure ratio (EPR) indicator

B**.** Current engine power setting is monitored on the engine pressure ratio (EPR) indicator up to an altitude of 2500 m and is determined by the position of the side indices with respect to the "H" and "K" markers:

- Takeoff power: side indices above "H"
- Maximum continuous power: side indices above "K" up to "H"
- Cruise power: side indices aligned with or below "K"

C. At altitudes greater than 2500 m, engine power setting is determined based on corresponding performance charts.

D. In a climb at maximum continuous power with a constant collective pitch angle, the main rotor RPM is automatically maintained at 95±2% up to a limited altitude. Further climb will result in the main rotor RPM drooping as engine power output is reduced due to compressor RPM limits imposed by the engine governor system. Maintain main rotor RPM above 92% by gradually reducing collective pitch as main rotor RPM begins to droop. The maximum continuous power limitations begin to affect main rotor RPM at 1000 - 1500 m.

In a climb at cruise power with a constant collective pitch angle, the main rotor RPM is automatically maintained constant up to an altitude of 2000 - 2500 m.

In a climb at takeoff power with constant collective pitch angle, the main rotor RPM is **not** maintained automatically. Maintain main rotor RPM in the 92-94% range by gradually reducing collective pitch as altitude increases.

6.13 LEVEL FLIGHT

The recommended airspeed for flying an airfield pattern is 160 kph.

Roll angles are limited to 30° at normal takeoff weight and 20° at maximum takeoff weight.

6.14 TRANSITIONAL MANEUVERS

A. To transition from a vertical climb to a hover after reaching the desired altitude, stop the climb by smoothly reducing collective and maintain altitude with slight collective adjustments.

B. To transition from a hover to a vertical descent, reduce collective and ensure the descent rate does not exceed 0.2 m/sec near the ground prior to touchdown.

C. To transition from a hover to level flight, push the cyclic forward to establish an accelerating attitude. Simultaneously adjust (slightly increase) collective to maintain altitude and counter any lateral drift and yaw with opposite cyclic and pedal input. When approaching the desired airspeed, pull the cyclic aft to stabilize in a level flight attitude and maintain airspeed.

D. To transition from level flight to a hover while maintaining altitude, smoothly reduce collective and pull the cyclic aft to reduce airspeed. Upon reaching airspeed of 50 - 60 kph, the helicopter exhibits a tendency to descend. Counter this tendency by increasing collective. At airspeeds below 50 kph, the helicopter develops vibrations, which disappear as airspeed is reduced further. At airspeeds below 40 - 20 kph, the helicopter exhibits a tendency to yaw left. Timely application of cyclic and right pedal input is required to avoid uncommanded roll and left yaw in the transition to hover.

E. To transition from level flight to a power-on glide, reduce collective and apply cyclic to establish a desired glide speed attitude.

F. To transition from a power-on glide to level flight, apply collective to set engine power as required for level flight and apply cyclic to establish a desired airspeed.

G. In transitional maneuvering, the main rotor RPM is automatically maintained at 95± 2% only within a limited rate of collective application:

- when increasing collective, no less than 5 seconds from 1 - 3° collective pitch up to the pitch angle establishing takeoff power.
- when reducing collective, no more than 1°/sec from any starting collective pitch angle

Collective input rates above these limits can lead to main rotor RPM drooping below the minimum allowable limit (88%) when increasing collective or overspeed the main rotor above the maximum allowable limit (103%) when reducing collective.

If main rotor RPM runs outside 95±2%, adjust collective to return RPM to the normal range.

Large deflections of the cyclic can lead to main rotor RPM drooping in accelerations and increasing RPM in decelerations. The range of main rotor RPM divergence is proportional to the rate of cyclic deflection.

When performing transitional maneuvers, unload the forces on the controls with short presses of the TRIM button on the cyclic control handle as the flight controls are adjusted.

6.15 DESCENT

Depending on altitude, power-on descent may be performed either vertically or on a glideslope. Autorotation may only be performed on a glideslope descent.

POWER-ON VERTICAL DESCENT

A power-on vertical descent from am altitude of 10 m down to the ground is permissible in all conditions. From an altitude of 110 m down to 10 m, a vertical descent is only permissible when a glideslope approach cannot be performed due to obstacles or out of tactical considerations. Descent from the helicopter's service ceiling down to 110 m must be performed on a glideslope and within airspeed limitations.

In a vertical descent from an altitude of 110 m down to 10 m, the descent rate may not exceed 3 m/sec. If the descent rate increases beyond 3 m/sec, smoothly increase collective to arrest the descent rate. If engine power is insufficient to arrest the descent and maintain main rotor RPM within limits, transition out of the vertical descent to a glideslope descend or forward flight to gain airspeed.

From an altitude of 10 m down to the ground, continually reduce the rate of descent so it does not exceed 0.2 m/sec at touchdown.

POWER-ON GLIDING DESCENT

In a power-on glideslope descent, maintain main rotor RPM within 95±2% with collective input as required. Gradual reduction of collective pitch down to the minimum setting is permissible to maintain a desired descent rate as altitude decreases as long as main rotor RPM is maintained within limits.

The recommended glide speed at altitudes below 2000 m is 120 - 180 kph. The rate of descent at this speed should be 3 - 5 m/sec.

6.16 AUTOROTATION DESCENT

A. An autorotation descent is used in case of dual engine failure in flight. To perform an autorotation landing:

- establish a desired descent airspeed prior to initiating the descent
- reduce collective down to the lower stop (full down) and check the main rotor RPM to be within normal limits (95±2%)
- counter the any tendency to yaw right and pitch down with opposite pedal and cyclic
- set throttle to full left
- upon transitioning to an autorotation descent, adjust collective as required to maintain main rotor RPM within limits

B. Maintain the following airspeeds in a power-on autorotation descent:

- altitude 2000 m and greater: 100 - 120 kph
- altitude below 2000 m: 120 - 190 kph

The optimum gliding speed for altitudes below 2000 m is 180 kph.

C. Maintain a descent rate of 10 - 12 m/sec. The minimum rate of descent of 10 m/sec corresponds with a gliding speed of 120 kph.

D. Avoid roll angles of greater than 20° during autorotation descents.

E. To recover from a power-on autorotation descent:

- smoothly set throttle to full right while monitoring the engine and main rotor RPM
- at altitudes above 1500 m, counter main rotor overspeeding beyond maximum limits by increasing collective to set a collective pitch angle of 3 - 4°
- at altitudes below 1500 m, increase collective pitch only after setting the throttle to full right. Avoid drooping the main rotor RPM below 92% by raising collective gradually

F. Maintain 100 - 120 kph in a power-off autorotation descent

6.17 LANDING

Landing is performed using one of the following procedures:

- vertical landing from a hover in ground effect
- vertical landing from a hover out of ground effect
- power-on running landing
- single engine landing
- power-off autorotation landing (only in emergency situations)

When performing any landing with forward airspeed, including autorotation landing, disengage the autopilot YAW and ALTITUDE channels.

VERTICAL LANDING FROM A HOVER IN GROUND EFFECT

Perform a glideslope approach at 120 kph. At an altitude of 100 m, smoothly pull the cyclic aft to begin reducing forward airspeed to attain 60 - 50 kph at an altitude of 60 - 50 m.

At an altitude of 5 - 8 m, smoothly pull the cyclic further aft and increase collective as required to establish a hover at a altitude of 2 - 3 m.

While performing the deceleration and transitioning to a hover, release the forces on the controls with frequent presses of the TRIM button on the cyclic control stick.

Upon stabilizing in a hover, smoothly decrease collective to perform a vertical descent while gradually reducing vertical speed such that it does not exceed 0.2 m/sec at touchdown.

Avoid lateral drifting while in the vertical descent. Reduce collective to minimum only when certain that the helicopter is firmly on the ground with weight on wheels.

In a crosswind landing, apply cyclic opposite of the wind direction to maintain position over the landing point until the helicopter is firmly on the ground with weight on wheels.

VERTICAL LANDING FROM A HOVER OUT OF GROUND EFFECT

Perform a vertical landing from a hover out of ground effect only when obstacles make it impossible to perform a landing from a hover in ground effect.

The procedure for a vertical landing from a hover out of ground effect is identical to a vertical landing from a hover in ground effect.

Begin the deceleration at an altitude of 50 m above obstacle height such that a hover position over the landing point is attained at an altitude of no less than 5 m above obstacle height.

POWER-ON RUNNING LANDING

A power-on running landing may be performed in cases where engine power is insufficient to ensure a hover and vertical landing (such as high gross weight, high altitude, high temperatures).

The landing can be performed on a prepared runway or a an unprepared area known to be safe for such an approach (must be sufficiently level and large) provided a clear approach path is available.

Execute the final approach on a glideslope with an airspeed of 120 kph.

Maintain the glideslope such that airspeed is maintained 20 kph faster than current altitude, i.e. 100 kph at 80 m down to an altitude of 40 m.

Perform the remainder of the descent with a continual reduction of airspeed and rate of descent such that at 0.5 - 1 m above the ground, the airspeed is reduced to 50 - 40 kph and the rate of descent is reduced to 0.1 - 0.2 m/sec.

Perform a smooth touchdown on the main gear and reduce collective to minimum. Allow the nose gear to touch down. Set throttle to full left and apply the wheel brakes to brake the helicopter. Anticipate a landing run of 20 - 30 m. The total field distance for safe operations should be no less than 100 m.

If the airfield dimensions do not allow for a landing run of 20 - 30 m, but it is necessary to perform a running landing, execute a running landing with a short landing run.

Begin a smooth reduction of forward airspeed and rate of descent at an altitude of 40 - 50 m above the field by increasing collective and pitching the helicopter up with aft cyclic while maintaining the main rotor RPM within allowed limits. Perform a landing deceleration maneuver so as to attain near takeoff engine power at an altitude of 5 - 10 m with a ground speed of 20 - 40 kph. At an altitude of 5 - 10 m, push the cyclic forward to bring the helicopter to a landing attitude while avoiding a tail boom strike against the ground, but ensuring continued reduction of ground speed down to 10 - 15 kph for touchdown. At an altitude of 5 - 10 m, raise collective at a rate of 2 - 4°/sec to reduce the rate of descent such that it is no greater than 0.2°/sec at touchdown. Upon touchdown, push the cyclic forward 1/3 - 1/4 stick travel, reduce collective down to minimum, set throttle to full left, and apply the wheel brakes to brake the helicopter.

SINGLE ENGINE LANDING

Perform a single engine landing onto a flat landing area that provides for a clear approach or onto a prepared runway. The gross weight of the helicopter for a single engine landing may not exceed 10,000 kg.

Perform a single engine landing into the wind if possible or with a crosswind not exceeding 5 m/sec.

At an altitude of 300 m, before starting the APU, switch OFF the engine anti-icing system and PZU particle separators if these were previously switched on. Start the APU. Confirm successful APU start and illumination of the OIL PRESS NORMAL (ДАВЛ. МАСЛА НОРМА), NORMAL SPEED (ОБОРОТЫ НОРМА) lights.

Execute a single engine landing so that the helicopter touches down at 10 - 20 kph or 50 kph (as decided by the pilot in command) as follows:

- control collective pitch to maintain main rotor RPM within 95±2%
- ensure the operating engine attains emergency power setting
- maintain an airspeed of 20 kph higher than current altitude (in meters) during the approach
- establish a landing attitude at an altitude of 5- 7 m
- from an altitude of 3 - 5 m, reduce the rate of descent by increasing collective. Simultaneously apply smooth right pedal to counter torque-induced yaw from increased collective pitch and use cyclic control to maintain the landing attitude. When increasing collective, ensure that main rotor RPM does not fall under 88%
- upon touchdown immediately decrease collective smoothly and push the cyclic forward 1/3 - 1/4 stick travel to prevent a tail boom strike
- apply wheel brakes after nose gear touchdown to brake the helicopter

Using this procedure the helicopter touches down at a speed of 10 - 20 kph and the landing run is 5 - 20 m. To touch down at a speed of 50 kph, perform the approach such that the airspeed is maintained 20 kph higher than current altitude down to an altitude of 40 m, then maintain 60 km/h down to 5 - 7 m. Perform the touchdown as described above, which results in a landing run of 80 - 100 m due to the higher landing speed.

6.18 SHUTDOWN

In preparation for idle power setting, switch off the PZU particle separators [Key com.] and all electrical power consumers apart from powerplant monitoring and control systems. Turn the throttle full left [Key com.] and perform the following steps:

- switch OFF the rectifiers [Key com.], set the "ПО-500А" (Inverter 1) switch to "РУЧНОЕ" (MANUAL (up)) [Key com.], switch OFF the AC generators [Key com.];
- after allowing the engines a 2 minute cool down period in idle power, close (pull aft) the "ОСТАНОВ. ДВИГ. ЛЕВ. ПРАВ." (ENGINE STOP LFT/RGT) fuel shutoff levers [Key com.];
- engage the rotor brake [Key com.]; Nr <20%?
- with engines fully stopped, switch off the fuel fire (shutoff) valves [Key com.];
- switch off the fuel boost [Key com.] and transfer pumps [Key com.];
- выключить топливные [Key com.] подкачивающие [Key com.] и перекачивающие насосы [Key com.];
- switch off all of the circuit breakers and set all other control switches to OFF positions, apart from the reserve hydraulic system;
- switch OFF the batteries [Key com.];
- set the "САРПП-12Д1М "РУЧН – АВТОМ"" (FLIGHT RECORDER) switch to the "АВТОМ" (AUTO) position (down) [Key com.].

6.19 SEARCH AND RESCUE (SAR) OPERATIONS

A. Prior to departure for a SAR mission:

- turn on the VHF ADF (РАДИОКОМПАС УКВ) circuit breaker on the right circuit breaker panel of the overhead console.
- on the VHF ADF (АРК – УД) control panel, set the mode selector switch to NS (ШП), the frequency selector switch to VHF (УКВ), and the CHANNELS (КАНАЛЫ) selector switch to 4.
- on the intercom control box, set the selector switch to PK2 and the INT - RADIO (СПУ–РАДИО) selector switch to RADIO (РАДИО)
- fly the helicopter to enter the search area bearing in mind that the VHF ADF (АРК – УД) detection and homing ranges increase with altitude (at an altitude of 500 m the coverage is no less than 25 km)

- with the ADF operating in standby reception mode, positive reception of a beacon signal will be indicated by the corresponding indication light.

B. After detection and identification of the beacon signal, determine its location as follows:

- set the mode selector switch to a position corresponding to the indication light: narrow band NB (УП) or broadband BB (ШП) if the NB light is on, set the mode selector switch to NB
- test the pointer arrow by pressing the ANT L (АНТ. Л) or R (АНТ. П) buttons to manually turn the arrow and make sure that it returns to the signal bearing when the buttons are released
- turn the helicopter so that the pointer arrow points to "0" and continue to fly the helicopter to maintain the pointer arrow in this position. At long ranges to the beacon, begin homing in narrow band NB (УП) mode. As signal strength increases (indicated by increasing volume in the headset), select the broadband BB (ШП) mode. The VHF ADF operation is more reliable in broadband mode.

6.20 FLIGHT (HOVER) OVER FEATURELESS TERRAIN USING THE DOPPLER NAVIGATION SYSTEM

A. The stationary flight indicator provides visual indication of the ground speed in the following speed ranges: 0 - 50 kph in forward flight, 0 -25 kph in reverse flight, 0 - 25 kph in lateral flight.

B. The forward and lateral speeds are indicated by corresponding moving indexes against a numerical scale (up and down for forward and reverse flight, left and right for lateral flight). Vertical velocity is indicated by a moving triangular index along the left side of the indicator.

Before takeoff, turn on the Doppler system by setting the DOPPLER (ДИСС) circuit breaker on the overhead console and the DOPPLER (ДИСС) switch on the right switch panel of the overhead console to ON (ВКЛ).

C. When hovering, observe the indicators of the Doppler system. Apply cyclic control opposite of the movement of the line indicators to maintain a hover position by keeping the indicators inside the center ring position. Maintain the vertical velocity indicator at “0” to maintain altitude.

In limited visibility conditions when the natural horizon cannot be seen, control the helicopter’s attitude using the Attitude Indicator and other flight instruments. Control hover altitude using the radar altimeter. The radar altimeter provides accurate altitude indication up to 1000 m above ground level (AGL). If airspeed reaches 50 kph, the stationary flight indicator will turn off and the OFF (ВЫКЛ.) light will illuminate.

6.21 NIGHT OPERATIONS IN VISUAL METEOROLOGICAL CONDITIONS (VMC)

A. The start, ground test, and shutdown procedures for nighttime operations are identical to daytime operations except the following: additionally turn on the LAND LIGHTS (ФАРЫ), NAV LTS (АНО), FORM LIGHTS (СТРОЕВ. ОГНИ) and CHK BLINKER (ПРОВЕРК. ЛАМП-МИГАЛКА) circuit breakers on the overhead console and set the DOME LT RED - WHITE (ПЛАФОН КРАСНЫЙ – БЕЛЫЙ) selector switches to WHITE (БЕЛЫЙ) on the left and right switch panels of the overhead console. Turn down the red lighting rheostats on the left and right side panels of the overhead console and the flight compartment doorway. Turn on ФР-100 taxi light.

B. After starting the engines and disconnecting the external electrical power source, switch off the white dome lights, set the DAY - NIGHT (ДЕНЬ – НОЧЬ) selector switch to NIGHT (НОЧЬ), and turn on the BLINKER (МИГАЛКА), ANTI-COLL LIGHT (ПРОБЛЕСК) and BLADE TIP (КОНТУР. ОГНИ) switches. Set the navigation and formation lights switches to BRIGHT (ЯРКО) or DIM (ТУСКЛО) as desired.

Taxi with the ФР-100 taxi light on. Use the ФПП-7 landing/search lights only when required for improved forward visibility or taxi turns. Limit operation of the ФПП-7 landing/search lights to 5 minutes followed by a 5 minute cooling period.

C. Take off with both the ФР-100 taxi and ФПП-7 landing/search lights turned on. Adjust the direction of the light beams in a hover at an altitude of 3 - 5 m by operating the corresponding switches on the collective control handle.

D. Accelerate and climb out to an altitude of 50 m more gradually than in daytime operations. At an altitude of 30 - 50 m, transition to instrument flight and turn off the taxi and landing/search lights.

E. For night time flying, refer primarily to the flight instruments with occasional checking of the outside airspace.

F. Perform approach and landing maneuvers as during daytime operations. At an altitude of 50 – 70 m, turn on the ФПП-7 landing/search lights. If the landing/search lights make visual perception of the ground more difficult, turn the lights off and use other light sources for ground reference, such as ground-based light projectors if available. Use the radar altimeter to control altitude with visual ground checks using available light source references.

After landing, taxi with the ФР-100 taxi light turned on.

6.22 DAY OR NIGHT OPERATIONS IN INSTRUMENT METEOROLOGICAL CONDITIONS

A. Prior to embarking on any flight in IMC, carefully examine the weather conditions in the area of operations, paying special attention to possible icing conditions, wind speeds and directions. Flight inside clouds is permissible up to an altitude of 3500 m.

B. Before taxiing out, check that all circuit breakers and switches required for flight are turned on and set correctly. Ensure normal operation of the autopilot control channels, attitude indicators, turn indicators, ADFs, compass system, radar altimeter, windshield wipers, and the Doppler system speed and drift indication. Check that the clock is running and set for the correct time. The pressure on the barometric altimeter should correspond to the actual airfield pressure when the altimeter is set to 0 altitude. Check that the compass system is turned on and operating normally, the setting of the latitude correction, selection of magnetic compass (MK) mode, and the Doppler system is operating normally as indicated by the FUNC (РАБОТА) light on the control panel.

C. For ambient temperatures of +5°C or below, turn on the pitot tube heaters before taxiing out of the parking area and turn them off after taxiing to the parking area.

Before taxiing out of the parking area in ambient temperatures of +5°C or below, turn on the engine anti-ice systems to prevent icing in the air intakes and ingestion of ice into the engines by setting the ANTI-ICING SYSTEM. ENG DUST PR-LEFT and ANTI-ICING SYSTEM. ENG DUST PR-RIGHT (ОБОГРЕВ. ДВИГ. ПЗУ ЛЕВ. (ПРАВ)) switches to ON (ВКЛ.).

D. Set the chart angle for the selected route on the coordinate indicator of the Doppler system, set the range and angle error to 0, and turn off the control panel using the OFF (ВЫКЛ.) button.

E. After taxiing to the takeoff position, slave the compass system, set heading pointer of the heading indicator to the takeoff magnetic heading.

F. Request permission for takeoff from the controller. Upon receiving clearance, proceed with takeoff. Maintain visual contact with the ground in hover.

G. After takeoff and before entering the cloud cover, establish a climbing profile at an airspeed of 150 kph and a climb rate of 3 - 4 m/sec. Transition to complete instrument flight 25 - 30 m below cloud cover.

When flying in clouds, the following flight profiles are recommended:

– climb speed of 150 kph at climb rate of 3 - 4 m/sec
– descent speed of 120 - 200 kph at rate of descent of 3 - 4 m/sec
– horizontal flight speed of 160 - 180 kph for a standard approach

Prolonged route flying at altitudes of up to 1000 m at the following airspeed:

– 220 kph at normal takeoff weight
– 200 kph at maximum takeoff weight

6.23 WIDE RECTANGLE PATTERN

The wide rectangle pattern is a convenient landing pattern when the approach to the locator middle marker (LMM) is made within 60° of the magnetic landing course.

Perform an IMC approach and landing by referencing the LMM, which is positioned at a distance of 1300 m from the landing point. The recommended pattern altitude is 300 m, airspeed is 160 kph, roll angle in turns is 10°.

If flying the pattern after takeoff, establish a climbing profile for an airspeed of 150 kph and a climb rate of 3 - 4 m/sec.

Perform the first turn to the crosswind leg at an altitude of no less than 150 m at distance of 3500 m from the reference startling line (runway takeoff position) or when the calculated flight time for the initial leg has expired (1 min 32 sec in calm weather). Upon reaching an altitude of 300 m, establish level flight at 160 kph. In a missed approach or practice approach without landing, perform the first turn to the crosswind leg 2 minutes after passing over the LMM.

Perform the second turn to the downwind leg when the LMM relative bearing (RB (bearing from current heading to marker) equals 240° ± drift angle (DA)

(120° ± DA for a right-hand pattern) or upon reaching the required magnetic radio bearing (MRB, bearing to marker from due North and indicated on the heading indicator compass card by the bearing pointer) 3 min 27 sec after takeoff time.

Perform the third turn to the base leg when RB = 240° ± DA (120° ± DA for a right-hand pattern) or upon reaching the required MRB.

On the base leg, descent at a rate of 2 - 3 m/sec and establish an airspeed of 155 kph. Descend to an altitude of 200 m.

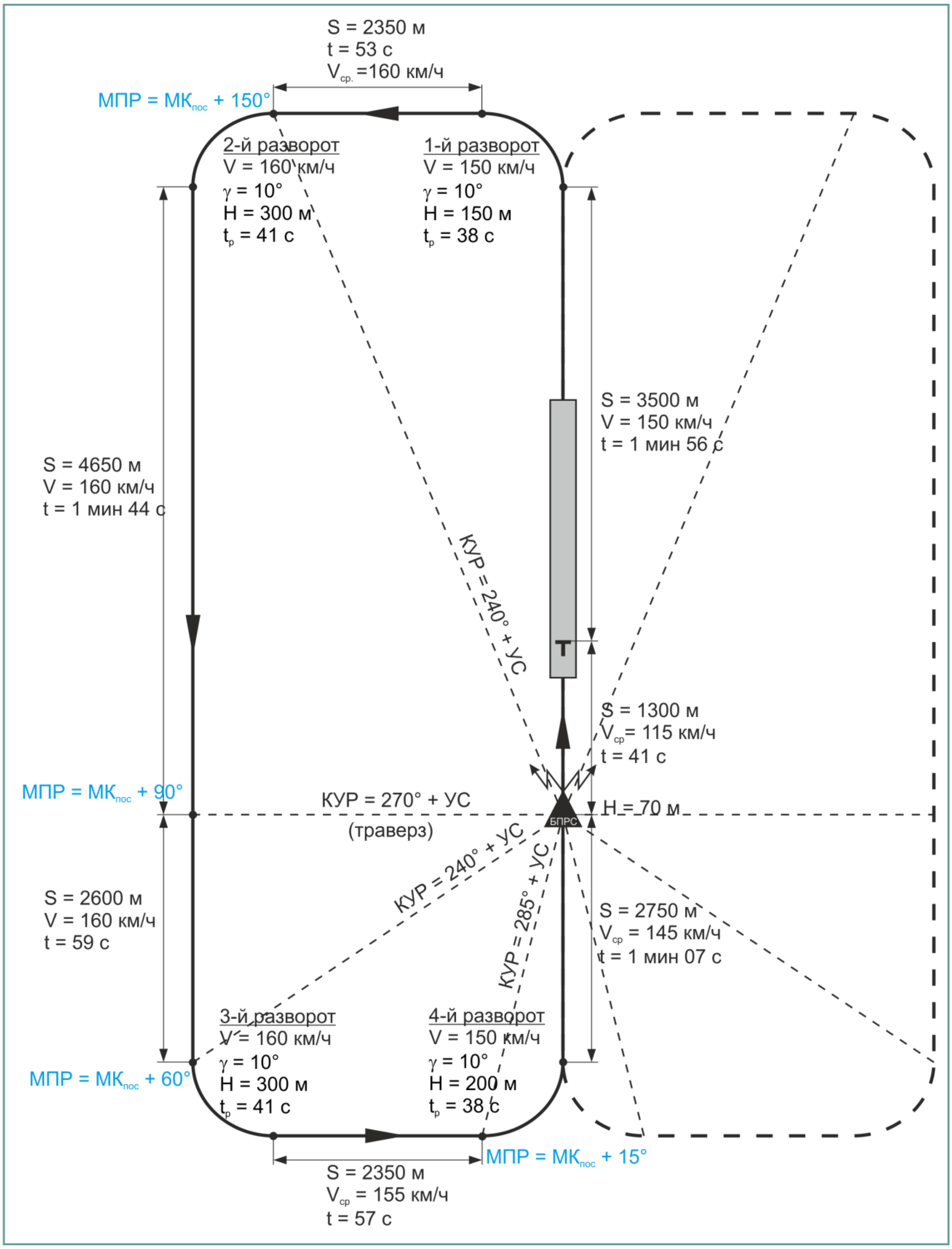


Рис. 9.117. Wide rectangle pattern diagram:

S - Distance

V – Airspeed

H – Altitude

γ - Bank angle

t – Time

tt – Turn time

RB – NDB radio bearing

DA – Drift angle

MRB – Magnetic radio bearing to beacon

MHland – Magnetic landing heading

Perform the final turn in horizontal flight at an altitude of no less than 200 m at 150 kph. Initiate the final turn at RB = 285 ± SA (75° ± SA for right-hand pattern) or upon reaching the required MRB.

Control the turn start and pattern leg flight times based on pattern calculations.

On the base leg nearing the fourth turn to final approach, the bearing needle of the directional gyro will be moving toward the desired course needle (set to magnetic runway heading). At the start of the turn, the angle between the desired course and bearing needles should be 15°. When the turn is executed correctly, the two needles will align approximately 30° prior to reaching final approach course.

Continue the final turn with the desired course and bearing needles aligned.

If during the first half of turn the angle between the bearing needle and the desired course needle is constant or increasing, the angle of roll should be decreased. If after the needles align the bearing needle starts falling behind the desired course needle, the angle of roll should be increased, but by no more than 15°.

After recovering from the final turn, begin to descent at a rate of 2 - 3 m/sec and reduce airspeed to pass over the LMM at 100 - 140 kph at an altitude of 100 m. If an altitude of 100 m is reached prior to passing over the locator middle marker, transition to level flight.

If the final turn is recovered on a heading different from the landing course, perform a course correction while on the descent by checking the course deviation angle when the bearing needle is centered directly ahead to the LMM. If the difference exceeds 5°, correct the heading error by turning toward the bearing needle (away from the desired heading needle) such that the bearing needle is set midway between the heading index on the compass card and the desired heading needle. If the course indicator reads a magnetic heading exceeding the landing course, perform the course correction to the right, otherwise perform the course correction to the left.

After starting the course correction, maintain the corrective heading until the bearing needle aligns with the desired heading needle, then turn the helicopter so as to align the bearing needle and the desired heading needle on the landing course over the compass card (or with an angle-off the landing course to account for drift).

In a right drift scenario, maintain the bearing and the desired heading needles aligned along the landing course, but offset to the right along the compass card to correspond to the drift angle.

Maintain the current landing course after passing over the LMM.

When flying the wide rectangle pattern for landing, maintain the landing course after passing over the LMM and execute the first turn to the crosswind leg when the calculated flight time has expired (2 min in calm weather).

6.24 TIGHT RECTANGLE PATTERN

When the LMM is approached at an angle of greater than 60°, but less than 120° off from the landing course, use the tight rectangle landing pattern.

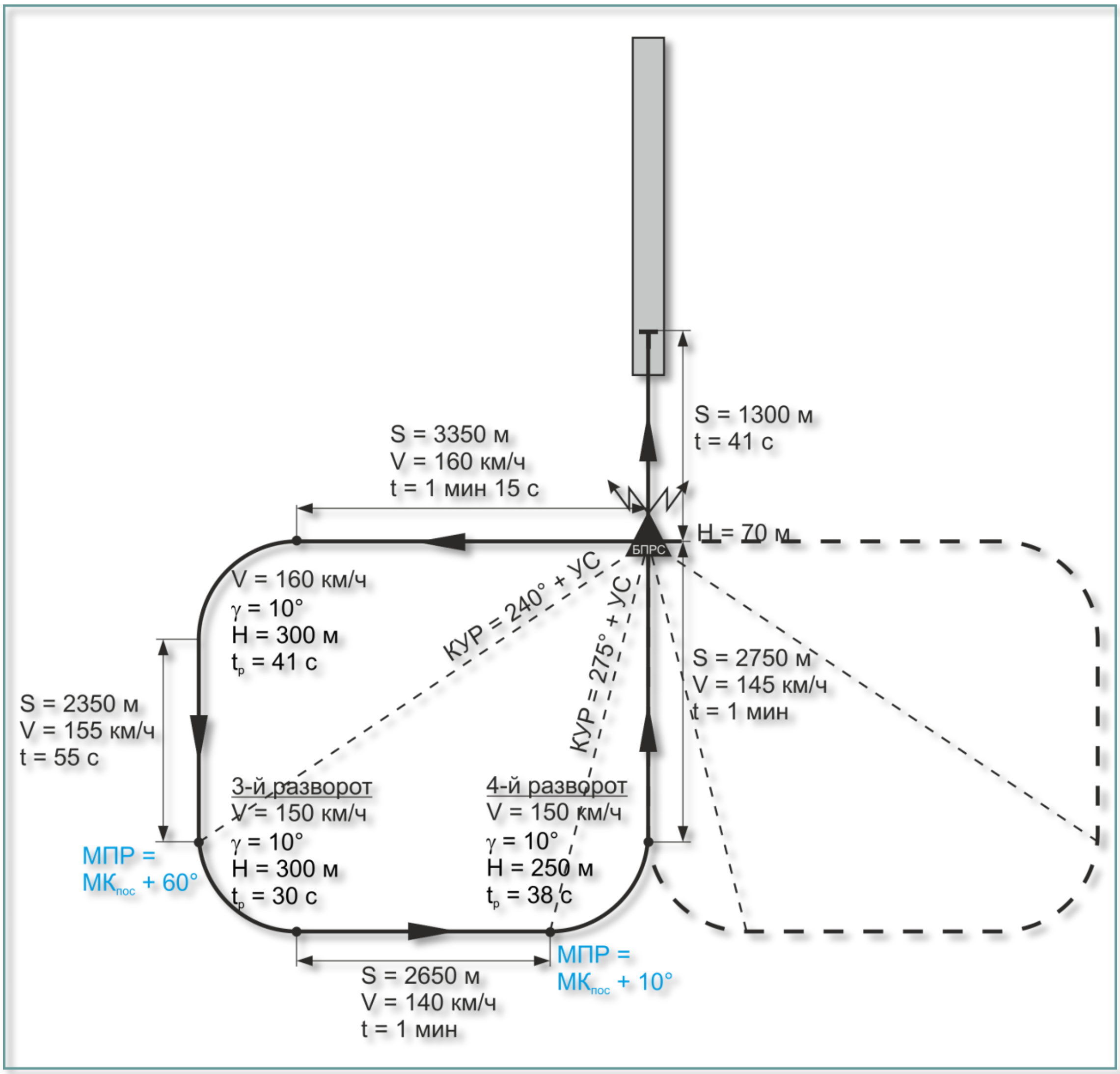


Рис. 9.118. Tight rectangle pattern diagram

After crossing the LMM, turn to a heading perpendicular to the landing (runway) heading (estimating the drift angle). After the estimated time has been reached (1 min 15 sec for calm weather conditions), turn to a heading opposite the landing heading and estimate the drift angle. Afterwards, the pattern is to be completed like the big pattern approach.

6.25 STRAIGHT IN APPROACH WITH TEARDROP PROCEDURE TURN

If the LMM is approached on a magnetic heading opposite to the landing course or if the difference does exceed 60°, perform a straight in approach with a teardrop procedure turn.

The magnetic heading, flight time (HFT), and estimated turn angle (ETA) calculations for performing the teardrop procedure turn are prepared in advance taking into consideration approach altitude and anticipated drift angles based on wind conditions. The resulting values are entered into a reference chart:

Procedure elements	H (altitude), m							
	300	400	500	600	700	800	900	1000
ETA, deg	28	19	14	12	10	8	7	6
HFT, min:sec	1:30	2:15	3:00	3:45	4:30	5:15	6:00	6:45

Note. chart assumes calm weather:

V_{gs} = 160 км/ч; V_s = 2–3 m/s; *AGS* = 150 км/ч; γ = 10°

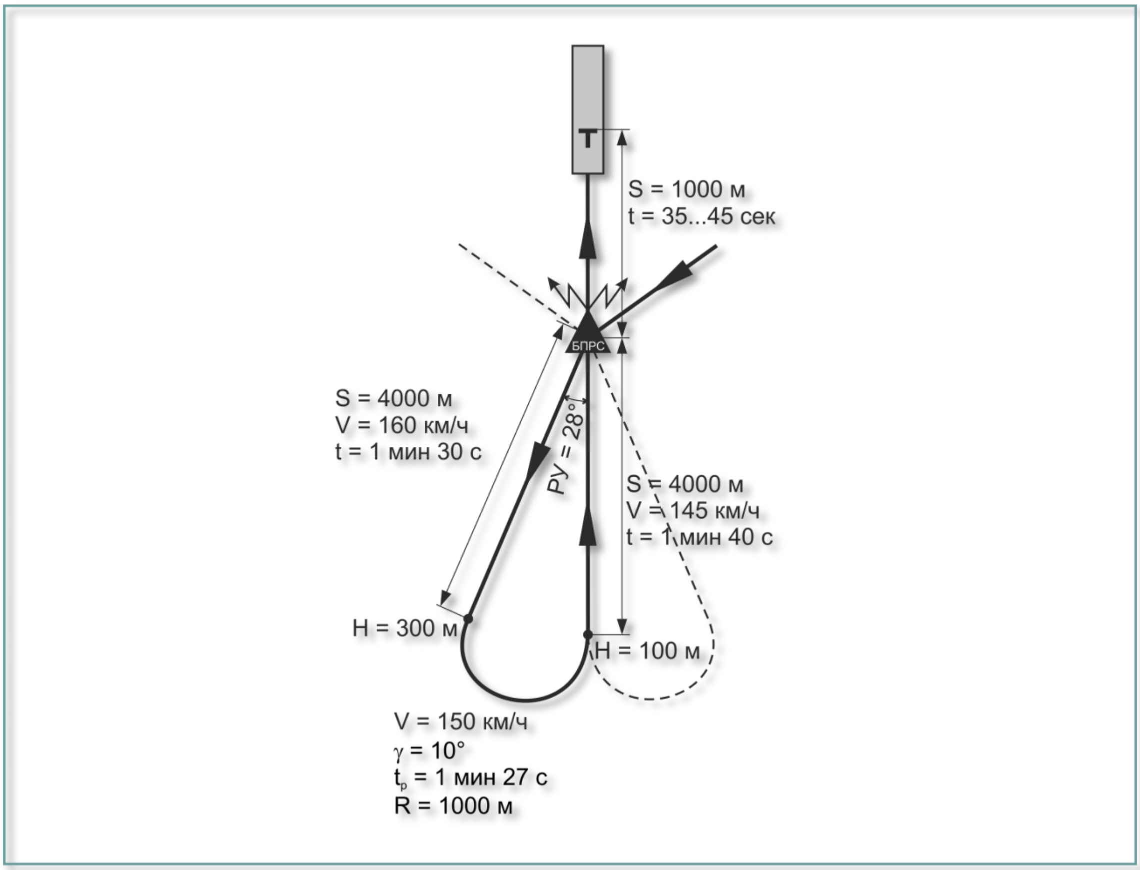


Рис. 9.119. Straight in approach with a teardrop procedure turn diagram

When performing a straight-in teardrop approach, navigate to the LMM at a selected altitude. After passing the LMM, execute a right-hand or left-hand procedure turn corresponding to the calculated turn angle (including drift calculation) and continue flying on this heading until reaching the estimated turn to final approach position. When the calculated horizontal leg flight time expires (HFT), proceed to descend at an airspeed of 150 kph and a vertical speed of 2 - 3 m/sec, turn to the landing course with a roll angle of 10° and a descent of 200 m. In the final approach, compensate for the drift angle, maintain the desired condition of flight and avoid sideslipping and skidding. Having reached an altitude of 100 m, transition to horizontal flight, passing the LMM at 100 m and an airspeed of 100 - 140 kph.

After breaking through the cloud cover, adjust the helicopter's position on the descent as required and proceed to land.

6.26 SPECIAL CONSIDERATIONS FOR TAKEOFF AND LANDING OPERATIONS AT HIGH ALTITUDES

The minimum field dimensions for a vertical takeoff or landing in ground effect with no obstacles are 50 x 50 m. With a 15 m obstacle height, minimum dimensions for the field depend on altitude as follows:

- up to 1500 m: 50 x 120
- 2000 m: 50 x 165
- 3000 m: 50 x 255
- 3500 m: 50 x 300
- 4000 m: 50 x 345

The minimum field dimensions for a running takeoff or landing are:

- up to 1500 m: 50 x 200
- 2000 m: 50 x 225
- 3000 m: 50 x 350
- 3500 m: 50 x 410
- 4000 m: 50 x 475

The minimum dimensions of a field for a single engine running landing at altitudes up to 1500 m are 50 x 190 m if landing speed is 10 - 20 kph and 50 x 360 m if landing speed is 50 kph.

Perform a vertical takeoff with acceleration out of ground effect in cases where the field is of limited dimensions and surrounded with obstacles, and available engine power is insufficient to allow a hover out of ground effect.

Perform a vertical landing with a hover out of ground effect when landing on a field of limited dimensions at helicopter gross weights allowing a hover out of ground effect.

Perform a vertical takeoff with acceleration in ground effect in cases where the available engine power is sufficient to allow a hover at an altitude of no less than 3 m and the field dimensions allow for acceleration in ground effect.

Perform a vertical landing with a hover in ground effect in cases where the field dimensions and approach paths, as well as the available engine power allow for a deceleration and hover in ground effect.

Perform a running takeoff in cases where the available engine power is sufficient for a hover at an altitude of no less than 1 m, and the field surface properties allow a safe takeoff run over a distance of 80 to 100 m and subsequent acceleration in ground effect.

Perform a running landing in cases where the field surface conditions and dimensions allow for a safe execution of this procedure.

In a landing approach for a vertical landing in ground effect, plan the deceleration such that the outer edge of the landing point is reached at an altitude of 2 - 3 m at 5 - 10 kph. Attempt to reach a hover position in the center of the landing point with subsequent assessment of the ground surface and ideal touchdown point. If necessary, approach the desired touchdown point at an airspeed of 5 - 10 kph.

In case of obstacles on the landing approach, plan the approach to allow a minimum altitude of 10 m above obstacle height.

When performing an approach to deliver external sling cargo, plan and begin the deceleration in advance. A high altitude approach with external sling load requires 1.5 - 2 times more distance than a low altitude approach. Aggressive deceleration leads to more difficult flight control and load instability.

6.27 TAKEOFF AND LANDING ON AN INCLINE

Landing fields in mountainous terrain typically consist of inclines of various grades.

Incline grade limits for vertical takeoff and landing operations without engine shutdown are:

- nose up incline: 7°
- nose down incline: 5°
- left side up incline: 7°
- right side up incline: 2°30'

Incline grade limits for vertical takeoff and landing operations with engine shutdown are:

- nose up incline/nose down incline/left side up incline: 3°
- right side up incline: 2°30'

Vertical takeoff and landing on an incline in wind speeds up to 5 m/sec are permissible from any wind heading. In wind conditions above 5 m/sec, vertical takeoff and landing on an incline is permissible only into the wind and within above grade limitation guidelines. Always attempt to perform takeoff and landing from an incline in either a nose or right side up incline position. A nose up incline position is best.

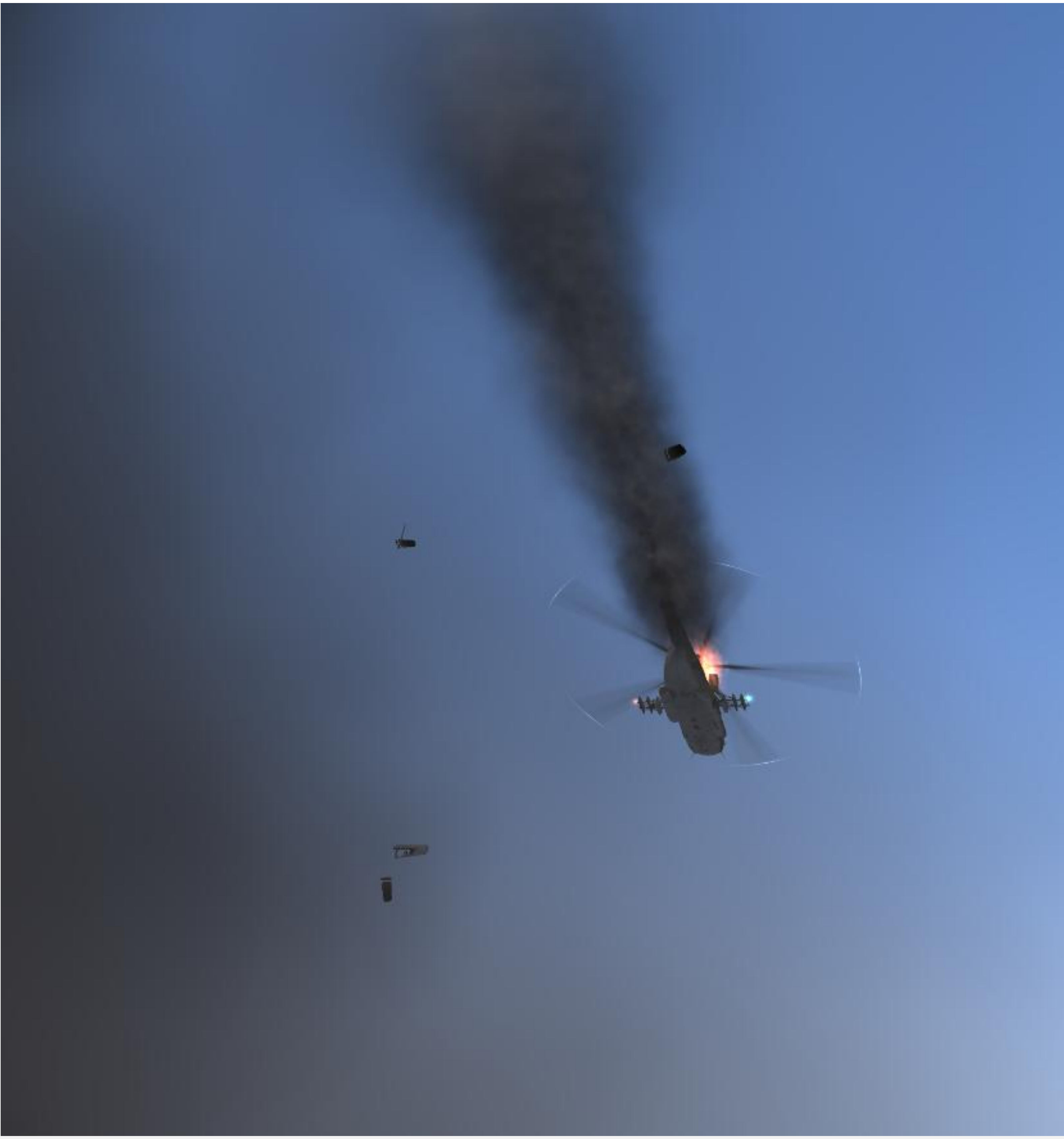
When landing in a down incline position, hover at an altitude of no less than 3 m above ground to avoid striking the tail boom on the ground. Descend to touchdown strictly vertically and avoid any drift, in particular backward.

As the helicopter is hovered 3 m above ground, the height of the tail boom tip from the ground is 0.6 - 0.8 m. At touchdown and liftoff, the height of the tail boom tip is 0.3 m. Aggressive deceleration just prior to achieving a hover position during landing or excessive reduction of collective pitch may lead to the tail boom striking the ground.

When descending to touchdown or taking off from an incline, keep the wheel brakes depressed.

When landing on an incline in a position perpendicular to the slope, adjust cyclic in the up slope direction to avoid drifting down slope. A hover over an incline is maintained with some roll angle.

When lifting off from an incline in a position perpendicular to the slope, climb strictly vertically and avoid any drift or yaw. As the helicopter lifts off, it will exhibit a tendency to roll in the up slope direction, requiring opposite cyclic to compensate and maintain position.



7 EMERGENCY PROCEDURES

7. EMERGENCY PROCEDURES

7.1 SINGLE ENGINE FAILURE

Symptoms:

- Uncommanded right yaw, the severity of which depends on the engine power setting and airspeed at the moment of failure (the higher the engine power setting and the lower the airspeed, the stronger the effect);
- Drop of compressor RPM and EGT of the failed engine;
- Increase of compressor RPM of the operating engine;
- Drooping of main rotor RPM;
- Illumination of the **ЧР. ЛЕВ. (ПРАВ.) ДВ.** (EMER PWR LFT (RGT) ENG) light depending on the helicopter's weight and altitude at the moment of failure.

7.1.1. CREW ACTIONS IN CASE OF A SINGLE ENGINE FAILURE AT AN ALTITUDE ABOVE 100 M:

- Reduce the collective pitch to maintain main rotor RPM no less than 92%;
- Use cyclic and pedal control to correct uncommanded roll and yaw;
- Accelerate or decelerate as required to an airspeed of 120 kph;
- Determine which engine has failed by observing the instrumentation;
- Order the crew chief to close the fuel shutoff lever and the fire valve of the failed engine;

WARNING

When closing the fuel shutoff levers and fire valves, use extreme caution not to shut down the operating engine!

- Having reached an airspeed of 120 kph, operate the collective to set the operating engine to a power setting sufficient to maintain level flight;
- Make sure engine performance is adequate and sufficient to maintain level flight. Navigate to the nearest airfield or find a suitable landing location;
- Prior to landing, check the helicopter weight.

NOTE

1. In case of a single engine failure, the power setting of the remaining engine is automatically increased by the electronic engine governor (EEG) system all the way up to emergency power, depending on helicopter weight.

2. In case of EEG failure in flight, the remaining engine is not automatically set to emergency power.

A. Crew actions if helicopter weight is under 12000 kg

- Performing a gliding descent, maintain airspeed 20 kph higher than current altitude until reaching an altitude of 40 m.
- At an altitude of 40 m, begin to reduce airspeed by pulling the cyclic aft to attain an airspeed of 40 kph at an altitude of 5 m with a vertical descent rate of 2 - 3 m/sec;
- At an altitude of 5 - 7 m, establish a landing attitude;
- From an altitude of 3 - 5 m, reduce vertical speed by increasing collective pitch at a rate of 2 - 4°/sec. When increasing collective pitch, softly press the right pedal to counter induced left yaw. Use the cyclic to maintain the landing pitch angle. While increasing collective pitch, do not allow rotor RPM to droop below 70%;
- Land at a speed of 30 kph;
- After landing, immediately proceed to smoothly lower collective to minimum and simultaneously push the cyclic 1/3 - 1/4 travel forward to prevent the main rotor blades from striking the tail boom.
- After nose wheel touchdown, apply the wheel brakes.

B. Crew actions if helicopter weight is greater than 12000 kg

The following particulars must be taken into account:

- The airspeed on the glideslope must be controlled such that 60 - 70 kph is maintained as the helicopter reaches an altitude of 5 - 10 m;
- Land at a speed of 50 kph;
- Before landing, make sure the rotor RPM is no less than 88%.

NOTE

If at the moment of engine failure the airspeed is less than 120 kph and during acceleration to an altitude of 10 - 20 m the helicopter does not reach sufficient airspeed to allow level flight with a single engine operating in emergency power setting, transition to a rapid vertical and forward deceleration to perform a landing as described above.

7.1.2. CREW ACTIONS IN CASE OF A SINGLE ENGINE FAILURE AT AN ALTITUDE BELOW 100 M

- Reduce collective pitch to maintain rotor RPM no less than 92% and ensure the remaining engine attains increased (emergency) power setting;
- Use cyclic and pedal control to correct uncommanded roll and yaw;
- If airspeed is above 120kph, begin to decelerate and climb by increasing helicopter pitch to 10 - 15°;
- Determine which engine has failed by observing the instrumentation;
- Order the crew chief to close the fuel shutoff lever and fire valves of the failed engine;

- Having reached an airspeed of 120 kph, operate the collective to set the operating engine to a power setting sufficient to maintain level flight;
- Make sure engine performance is adequate and sufficient to maintain level flight;
- When the airspeed is stabilized, navigate to the nearest airfield or find a suitable landing location;

If at the moment of engine failure the airspeed is less than 80 kph, actions are as follows:

- Reduce collective pitch to maintain main rotor RPM no less than 92% and ensure the remaining engine attains increased (emergency) power setting;
- Use cyclic and pedal controls to correct uncommanded roll and yaw;
- Accelerate or decelerate as required to an airspeed of 40 - 60 kph, depending on helicopter weight;
- Begin to descend with a vertical speed not exceeding 3 - 4 m/sec;
- Descend to the chosen airfield;
- Land.

7.2 DUAL ENGINE FAILURE (AUTOROTATION LANDING)

Symptoms:

- Uncommanded right yaw, the severity of which depends on the airspeed at the moment of failure (the higher the engine power setting and the lower the airspeed, the stronger the effect);
- Change in the cockpit sound of the powerplant;
- Rapid drop of the main rotor RPM;
- Drop of RPM and EGT of both engines.

7.2.1. CREW ACTIONS IN CASE OF DUAL ENGINE FAILURE AT AN ALTITUDE ABOVE 100 M:

- Immediately reduce collective pitch to minimum;
- Use cyclic and pedal control to correct uncommanded roll and yaw;
- Close the engine fuel shutoff levers. Order the crew chief to close the fire valves, turn off the boost and transfer pumps;
- Accelerate or decelerate to reach the indicated glide speed of 100 - 120 kph;
- Maintain main rotor RPM at maximum, i.e. 90 - 100% by observing the indicator and adjusting collective control to avoid peaks over 110% and droops under 88%;
- Jettison all external payload in order to reduce weight;

- Trim the helicopter to set a shallow dive, use cyclic control to counter the rolling moment;
- Find a suitable airfield and perform an upwind approach if possible;
- If altitude allows, the approach can be adjusted using collective control while maintaining rotor RPM within permissible limits;
- At an altitude of 70 - 100 m, slightly and smoothly adjust cyclic control to set and maintain a constant airspeed of 100 kph for a running landing or 70 kph for a vertical landing;
- Starting from an altitude of 50 - 70 m, use the ground to visually gauge and control altitude above the landing point. Use cyclic control to maintain helicopter pitch;
- Starting from an altitude of 10 - 15 m for a running landing or 15 - 20 m for a vertical landing, increase collective pitch to 7 - 8° (perform a flare within approximately 1 sec) and maintain it for 0.5 - 1 sec. If this is not sufficient to reduce the vertical speed, increase collective pitch to 12° (within 1 - 1.5 sec) to reduce vertical speed further;
- During the flare and with a collective pitch increase rate of 10°/sec, increase the pitch angle to 5 - 6° in order to reduce forward airspeed for a running landing or to 8 - 10° for a vertical landing. Maintain the pitch angle by slightly pushing the cyclic forward;
- After landing, set collective pitch to 7 - 8° and maintain it until the landing run is complete and the helicopter is stopped;
- Pull back the cyclic to maintain the required pitch angle during landing until nose gear touchdown, then smoothly push the cyclic forward 1/3 - 1/4 travel and apply the wheel brakes.

NOTE

1. If the selected landing field is off course from the flight path or the approach heading must be changed due to wind conditions, perform the required maneuver (provided sufficient altitude is available).

2. For an autorotation landing with a 180° turn (with a roll angle of 15°) altitude must be at least 650 m.

7.2.2. CREW ACTIONS IN CASE OF DUAL ENGINE FAILURE AT AN ALTITUDE OF 100 M AND BELOW

- If the airspeed is close to 70 kph at the moment of dual engine failure, immediately reduce collective pitch to maintain rotor RPM of 90 - 100%. Set a gliding speed of 70 kph for a running landing or as described above for a flare maneuver for a vertical landing in case of a dual engine failure at an altitude above 100 m. After touchdown, during the landing roll, order the crew chief to close the fuel shutoff levers and fire valves, switch off the boost and transfer pumps, and turn off all electrical power;
- If the airspeed is more than 120 kph at the moment of dual engine failure, immediately reduce collective pitch to maintain main rotor RPM of 88% and simultaneously decelerate by setting helicopter pitch up to 20°

depending on airspeed and altitude (the greater the airspeed and the lower the altitude, the higher the pitch angle) above which the engines had failed. Increase collective pitch to keep main rotor RPM under 110%.

Close the fuel shutoff levers of both engines. Use cyclic and pedal control to correct any uncommanded roll and yaw.

If altitude allows for a quick deceleration to 70 kph, balance the helicopter at this speed, then follow the above recommendations. If altitude is insufficient, maintain helicopter pitch until ready to flare (fast pitch-up) at an altitude of 15 - 20 m.

If both engines fail in a hover, crew actions are the same as in the case of a single engine failure, but keep in mind that in a hover, yaw instability, drop of main rotor RPM, and transition to an uncontrolled descent are more abrupt due to the high engine power settings required for hover.

CAUTION
In case of dual engine failure, a safe landing can be performed only on a firm and level surface. Landing in any other conditions may cause damage to the helicopter.

7.3 ONBOARD FIRE

Symptoms:

- Illumination and flashing of red fire lights **ПОЖАР ЛЕВ. ДВ.** (FIRE LFT ENG) or **ПОЖАР ПРАВ. ДВ.** (FIRE RGT ENGINE), **ПОЖАР К0-50** (FIRE K0-50) or **ПОЖАР РЕД. ВСУ** (FIRE XMSN/APU), depending on where the fire has been detected;
- Presence of smoke, fire or odor of gas (not implemented in simulation);
- Illumination of the amber light **I ОЧЕРЕДЬ** (1ST DISCH) corresponding to the compartment where a fire has been detected, upon automatic initiation of discharge of the first extinguisher.

7.3.1. CREW ACTIONS IN CASE OF ONBOARD FIRE:

a) In case of fire in the left (right) engine:

- Close the fuel shutoff lever of the affected engine;
- Order the crew chief to close the fire valve of the left (right) engine and confirm that the first fire extinguisher has been automatically discharged;
- Abort the mission and find an airfield to land.

WARNING
After the fire has been extinguished, attempting to restart the affected engine is prohibited.

b) In case of a gearbox or APU fire:

- If the APU is operating, shut it down;
- Confirm that the first fire extinguisher has been automatically discharged.

c) If the automatic system fails (the **I ОЧЕРЕДЬ** (1ST DISCH) light is not illuminated), engage it manually by pressing the **РУЧНОЕ ВКЛЮЧЕНИЕ I ОЧЕРЕДЬ** (MANUAL 1ST DISCH) button for the corresponding compartment.

If the fire has been eliminated, then within 10 seconds from the moment of the first discharge the **ПОЖАР ЛЕВ.ДВ** (FIRE LFT ENG) (or **ПОЖАР ПРАВ.ДВ.** (FIRE RGT ENG), **ПОЖАР КО-50** (FIRE KO-50), **ПОЖАР РЕД. ВСУ** (FIRE XMSN/APU) – depending on where the fire has occurred) lights will go off while the **I ОЧЕРЕДЬ** (1ST DISCH) light will remain on confirming that the first extinguisher has been discharged.

If the fire has not been eliminated by the first discharge (the **ПОЖАР ЛЕВ ДВ.** (FIRE LFT ENG) or **ПОЖАР ПРАВ. ДВ.** (FIRE RGT ENG), etc. light remains on), manually initiate the second discharge by pressing the **РУЧНОЕ ВКЛЮЧЕНИЕ II ОЧЕРЕДЬ** (MANUAL 2ND DISCH) button for the corresponding compartment.

If the first discharge eliminated the fire, but left signs of fire in another compartment, press the **РУЧНОЕ ВКЛЮЧЕНИЕ II ОЧЕРЕДЬ** (MANUAL 2ND DISCH) for the corresponding compartment.

NOTE

To turn off all electrical power:
- *Set the **ГЕНЕРАТОРЫ 1, 2** (GENERATOR 1, 2) switches to neutral (center position);*
- *Turn the switches **АККУМУЛЯТОРЫ 1.2** (BATTERY 1, 2) to **ОТКЛ.** (OFF);*
- *If the **СТГ-3** starter generator is ON, set the **РЕЗЕРВ ГЕНЕР** (STBY GEN) switch to **ОТКЛ.** (OFF).*

CAUTION

After eliminating of fire, abort the mission. If the fire persists, start immediate landing with a parachute (depending on the situation).

7.4 FAILURE OF ENGINE COMPRESSOR CONTROL (SAR) SYSTEM

In case of an in-flight failure of the engine compressor control system ("САР" (SAR)), crew actions vary based on the particular failure and its indications.

Symptoms:

- Compressor RPM fluctuation of more than 1%;
- One of the engines does not respond to collective control input.

Along with these indications, main rotor RPM is automatically maintained at 95±2%.

Crew actions:

- Should you notice any of these symptoms, abort the mission and land at the nearest airfield.

Symptoms:

More than 2% divergence of compressor RPM between the two engines; un-commanded increase of main rotor RPM (one of these indications or both).

A) Crew actions in hover, takeoff, or approach

With any one symptom occurring, land as soon as possible. If main rotor RPM increases to 101% or more, smoothly turn the throttle to the left and simultaneously increase collective to set main rotor RPM to 95±2% and maintain it manually at this level (as collective increases, throttle turns left).

B) Crew actions in other flight conditions:

- Pull the collective up to set main rotor RPM at 92-93%;
- Determine the type of the SAR system failure by smoothly decreasing collective control, avoiding increasing main rotor RPM to more than 98%, then increase collective back up. The following responses of compressor and main rotor RPM are possible:

Variant 1. As collective is adjusted, compressor RPM of both engines fluctuates, but main rotor RPM is automatically maintained at 95±2%. In this case, establish level flight at an airspeed of 100 - 150 kph. Abort the mission and return to base or land on the nearest airfield.

Variant 2. When collective is decreased and increased, compressor RPM of one engine fluctuates accordingly (decreases and increases, respectively). Main rotor RPM is automatically maintained at 95±2%. The other engine continues to operate in takeoff power setting and its compressor RPM does not fluctuate. In this case, smoothly decrease collective to set main rotor RPM to 95%.

Smoothly lower the Engine Condition Lever (ECL) of the affected engine to reduce compressor RPM by 3%. This will result in increasing compressor RPM of the normal engine. Flight control in this case remains as normal, except for increasingly smoother control requirements due to only a single functioning SAR operating to maintain main rotor RPM. Throttle is kept full right. Abort the mission, establish a level flight airspeed of 100 - 150 kph and proceed to execute a running or vertical landing at the nearest airfield or airport.

Variant 3. Decreasing collective does not change compressor RPM of the engine operating in takeoff power setting, but slowly decreases the compressor RPM of the other engine while main rotor RPM is not automatically maintained at 95±2%. In this case, when main rotor RPM reaches 96%, stop decreasing collective. Turn the throttle left (decrease) to set main rotor RPM to 95%. When maneuvering or transitioning out of level flight, set the required engine power to maintain main rotor RPM by smoothly adjusting throttle and collective (as collective increases, throttle turns right, as collective decreases, throttle turns left).

Abort the mission, establish a level flight airspeed of 100 - 150 kph and proceed to execute a running or vertical landing at the nearest airfield or airport.

7.4.1. FAILURE OF ELECTRONIC ENGINE GOVERNOR (EEG) POWER TURBINE CHANNELS

Symptoms:

- Illumination of the yellow **ПРЕВ.nст ЛЕВ ДВ.** (HIGH N2 LFT ENG) or **ПРЕВ. nст ПРАВ ДВ** (HIGH N2 RGT ENG) light on the left instrument panel;
- the engine does not shut down.

Crew actions:

- Temporarily switch off the EEG of the affected engine;
- Check the **ПРЕВ.nст ЛЕВ. (ПРАВ.) ДВ.** (HIGH N2 LFT (RGT) ENG) light to extinguish;
- Switch on the EEG;
- If the EEG light does not illuminate after resetting the EEG, check engine operation indicators for normal readings and if no further faults are found, continue the mission paying particular attention to the engine performance parameters;
- If the EEG light illuminates once again and remains on, abort the mission and land at the nearest airfield, paying particular attention to the engine performance parameters.

7.4.2. FAILURE OF ELECTRONIC ENGINE GOVERNOR (EEG)

Symptoms:

- Illumination of the **ОТКЛ.ЭРД ЛЕВ ДВ.** (GOV OFF LEFT ENG) or **ОТКЛ.ЭРД ПРАВ.ДВ.** (GOV OFF RGT ENG).

Crew actions:

- Switch OFF the failed EEG;
- Continue the mission paying particular attention to engine performance parameters.
- With a failed (switched off) EEG, the compressor RPM must not exceed 102.5%.

7.5 YAW CONTOL FAILURE

Symptoms:

If the tail rotor or its transmission are damaged in flight, the helicopter exhibits an abrupt left yaw, right roll, and negative pitch.

Crew actions:

1. Immediately reduce collective pitch and, if altitude is sufficient, order the crew to eject from the helicopter.
2. If altitude is not sufficient for the crew to eject, crew actions are:

   – Begin an autorotation descent; maintain heading by setting a roll angle to the side opposite of the turning tendency;
   – Balance the helicopter with sideslip as required; compensate the yaw moment with lateral cyclic control;
   – Find an airfield to land;
   – Shut down the engines by closing the fuel shutoff levers;
   – Close the fire valves, close the boost and transfer pumps (if possible);
   – Perform an autorotation landing. Before landing, set a zero roll attitude for touchdown.

3. If the actuator of the tail rotor is operative, but the cockpit controls are damaged (the helicopter does not respond to pedal inputs), establish an air-speed of 120 - 130 kph, adjust collective as required to establish level flight or a shallow descent and proceed to an airfield that can be used for a safe landing. Balance the helicopter with sideslip as required. Execute a running landing. It is PROHIBITED to increase collective pitch before touchdown to avoid unbalancing the helicopter.
4. If yaw control fails in hover or while moving at low altitude, crew actions are:

   – Immediately smoothly reduce collective pitch and descend to touch-down;
   – During the descent, press the right pedal and deflect the cyclic to the right to counter left turn and left drift; pull the cyclic aft to counter the negative pitch;
   – At the moment of touchdown by the main wheels, immediately and rap-idly minimize collective pitch and shut down the engines.

7.6 HYDRAULIC SYSTEM FAILURE

7.6.1. FAILURE OF MAIN HYDRAULIC SYSTEM

Symptoms:

The red **ДУБЛИР.ВКЛЮЧЕНА** (B/U SYS ON) light on the center overhead console illuminates and starts flashing while the **ОСНОВН. ВКЛЮЧЕНА** (MAIN SYS ON) extinguishes;

The pressure in the main hydraulic system drops down below 42 .48 kgf/cm2, while the pressure in the backup hydraulic system grows up to 63 - 73 kgf/cm2.

Crew actions:

- Set the **ОСНОВН ГИДРОСИСТЕМА** (MAIN HYD) switch to to **ВЫК** (OFF).

> *NOTE*
>
> *Switching to the backup system disengages the AP-34B autopilot and the collective clutch release system. In this case, collective handle friction force can be adjusted manually using the friction hand wheel (not implemented in simulation).*

- Disengage the autopilot by pressing the autopilot disconnect button on the cyclic control stick;
- Abort the mission. With a particular attention to the hydraulic system, perform landing in the nearest airport or onto a chosen airfield.

7.6.2. IN CASE OF FAILURE OF BOTH MAIN AND BACKUP HYDRAULIC SYSTEMS

- Eject from the helicopter.

7.7 UNCOMMANDED LEFT YAW DURING TAKEOFF OR LANDING

7.7.1. DURING A HOVER CHECK BEFORE TAKEOFF

Symptoms:

- The helicopter does not respond to right pedal input up to full deflection and continues to yaw left;
- Main rotor RPM droops below the lower limit due to a sharp increase of collective pitch angle.

Crew actions:

- Immediately decrease collective pitch by 1 - 2° to counter uncommanded roll and pitch;
- Disengage the SPUU-52 tail rotor pitch limit system;
- Descend to touchdown;
- At the moment of touchdown rapidly lower collective to minimum and order the crew chief to shut down the engines, close the fire valves, and turn off all electrical power.

7.7.2. DURING A HOVER BEFORE LANDING

Symptoms:

- The helicopter does not respond to right pedal input up to full deflection during final deceleration to hover prior to landing and continues to yaw left;
- Main rotor RPM droops below the lower limit due to a sharp increase of the collective pitch angle during final deceleration to hover prior to landing;
- While turning, the helicopter loses altitude with uncontrollable evolutions in roll and pitch.

Crew actions:

In a hover at an altitude below 10 m

- Immediately decrease collective pitch by 1 - 2° to counter uncommanded roll and pitch;
- Disengage the SPUU-52 tail rotor pitch limit system;
- Descend to touchdown;
- At the moment of touchdown rapidly lower collective to minimum and order the crew chief to shut down the engines, close the fire valves, and turn off all electrical power.

In hover at an altitude above 10 m

- While applying full right pedal, quickly decrease collective pitch by 1 - 2° and simultaneously push the cyclic forward and left to correct uncommanded roll and pitch angles; transition to forward flight;
- Disengage the SPUU-52 tail rotor pitch limit system;
- Execute a go-around;
- Repeat the landing approach and perform a running landing.

7.8 VORTEX RING STATE (VRS)

The helicopter is susceptible to VRS in a vertical descent of greater than 3 m/sec or in a powered glide with a forward airspeed of less than 40 kph and a vertical speed of more than 4 m/sec.

Symptoms:

- Uncommanded rapid increase of vertical speed;
- Abrupt attitude changes and severe vibrations;
- Loss of flight control effectiveness;
- Unstable readings of airspeed and vertical speed indicators.

Crew actions:

- Push the cyclic forward to establish a nose-down pitch of -10 to -20°, increase collective to set engine power up to takeoff setting and begin to transition into forward flight while avoiding drooping main rotor RPM below 92%;
- Having reached an airspeed of 60 - 80 kph, transition to level flight.

NOTE

1. A transition out of a vortex ring state to level flight may require 50-200 m of altitude loss, depending on:

- *initial forward speed at the moment of entry into VRS;*
- *the vertical descent rate at the moment of exiting VRS;*
- *forward acceleration rate (pitch angle for dive) and increase of engine power;*
- *helicopter weight;*
- *free air temperature and pressure.*

2. If the helicopter does not exit VRS quickly, vertical speed may reach 20 m/sec.

3. The pitch angle used in the acceleration out of VRS depends on the altitude of VRS exit.

8 ARMAMENT SYSTEMS

8. ARMAMENT SYSTEMS

The armament systems of the Mi-8MTV2 helicopter include unguided rockets, cannon and machine guns, free-falling bombs, and airborne minelaying systems (not implemented in simulation) in various payload configurations.

The weapons control system is designed to provide weapon firing/release stations, control of weapon fire modes, and weapons employment. The weapons control system includes the following components (Рис. 9.120 и Рис. 9.121):

- 6 BDZ-57KrV (БДЗ-57КрВ) external weapon stations equipped with "ПУС" (PUS) fire control devices (FCD)
- Circuit breakers and switches operating weapons indication and control systems
- Pilot’s upper and lower armament control panels
- Copilot’s bombs control panel
- ESBR-3P/A (ЭСБР-3П/А) electrical release control box
- Mine release control panel (not implemented in simulation)
- Fire control panel for the PKT (ПКТ) nose-mounted machine gun (not implemented in simulation)
- PKV (ПКВ) collimating sight (pilot)
- OPB-1r (ОПБ-1р) optical bombing sight (copilot) (not implemented in simulation)
- Weapons fire switches on each cyclic control handle, bomb release triggers on the OPB-1r (ОПБ-1р) optical bombing sight and two KSB-49 (КСБ-49) remote bomb release triggers
- S-13 gun camera
- The following weapon sub-systems:
  a) unguided rocket system: B8V20-A (Б8В20-А) rocket launchers (pods) firing 80 mm unguided rockets with various warhead types;

  b) cannon pod system: UPK-23-250 (УПК-23-250) gun pods equipped with GSh-23L (ГШ-23Л) twin-barrel 23 mm cannon;

  c) machine gun pod systems: GUV-8700 (ГУВ-8700) gun pod (index 9-A-669) equipped with either YakB-12.7 (ЯкБ-12,7) (index 9-A-624) and GShG-7.62 (ГШГ-7,62) (index 9-A-622) machine guns or with the AGS-17 (АГС-17) (index 9-A-800) grenade launcher;

  d) free-falling bomb systems: 100, 250 и 500 kg bombs and incendiary containers (not currently implemented);

  e) minelaying system: K-29 mine containers with 29 mine canisters of various types (currently not implemented).

1.Master arm switch (above left blister)
2. Upper armament control panel
3. Lower armament control panel
4. PKV gunsight
5. Left KSB-49 remote bomb release trigger
6. Left cyclic weapons fire switch
7. Electrical release control box
8. Right cyclic weapons fire switch
9. OPB-1r optical bomb sight (not currently implemented)
10. Right KSB-49 remote bomb release trigger
11. Bombs control panel
12. Circuit breaker panel of the weapons control system

8.1 WEAPON STATIONS

The Mi-8MTV2 is equipped with an external hardpoint rack consisting of 6 БДЗ-57КрВ (BDZ-57KrV) weapon stations and integrated ПУС (PUS) fire control devices (FCD). The stations are designed to carry and provide electrical commands to loaded weapon systems. The hardpoints are numbered 1 – 6 left to right (facing forward in the cockpit). Stations 1, 3, 4, 6 are equipped with PUS-36-71 (ПУС-36-71) type FCDs, which are used to control the firing of S-8 unguided rockets at an interval of 0.05 sec for each rocket launcher. ПУС 1 FCD controls rocket fire from stations 1 and 2 (Рис. 9.121); ПУС 6 FCD from stations 5 and 6, ПУС 3 FCD from station 3, and ПУС 4 FCD from station 4. Readiness of the corresponding FCD to support rocket fire is indicated in the cockpit by the ПУС FCD lights on the pilot's upper weapons control panel.

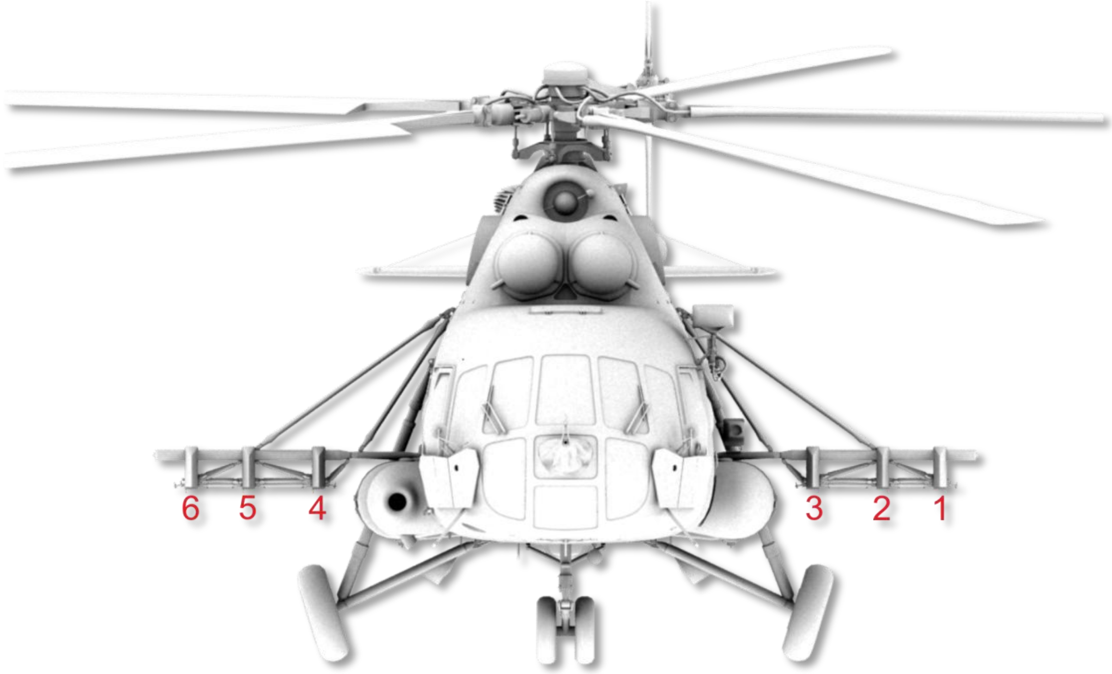


Рис. 9.121. External weapon stations

8.2 WEAPONS CONTROL SYSTEM CONTROLS AND INDICATORS

The weapons system circuit-breakers, located at the top left of the Circuit-Breaker Panel, are designed to protect the weapon system circuits from a short-circuit. (Рис. 9.122)

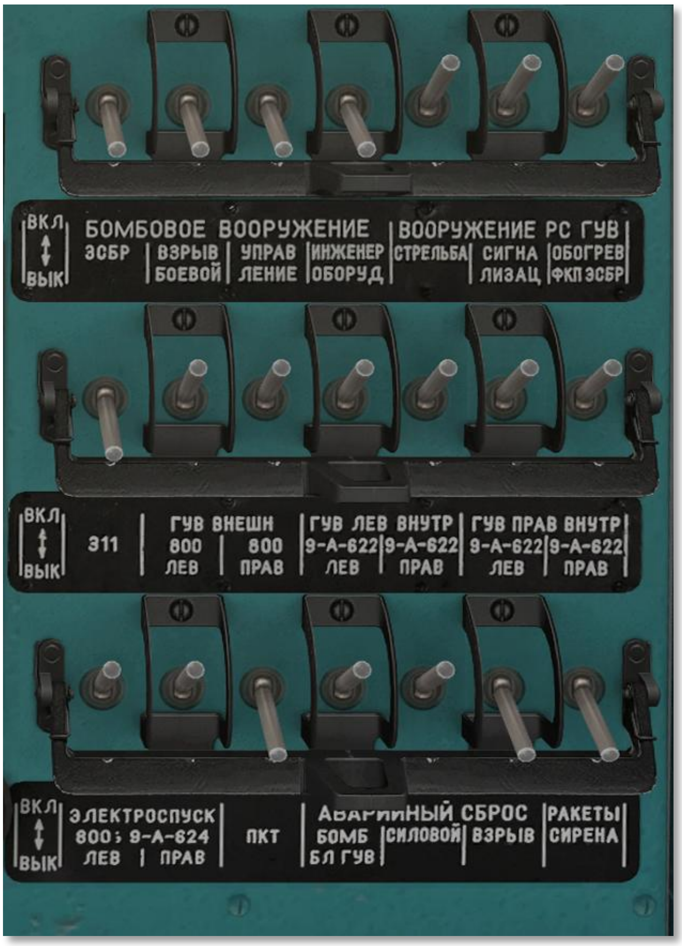


Рис. 9.122. Weapons Systems circuit-breakers.

MASTER ARM. The master arm switch connects weapon systems circuits to the weapons fire (release) switches on the pilot controls (not to be confused with the main power switches of weapon sub-systems, which connect specific weapon system components to the electrical power system). With the Master Arm switch off, it will not be possible to fire (release) weapons. This is a safety precaution required for safe ground operations with the ground crew and weapons preparation.

Рис. 9.123. The Master Arm switch and its associated red caution lamp.

8.3 PILOT'S UPPER AND LOWER ARMAMENT CONTROL PANELS

8.3.1. UPPER ARMAMENT CONTROL PANEL

The pilot's upper armament control panel (Fig. 1.5) provides indication of weapon readiness status, control of the MAIN WEAPONS and MINELAYING SYSTEM (not currently implemented) power switches, payload jettison, energizing of the fire control devices (FCD), PKV (ПКВ) collimating sight brightness, and amount remaining of 12.7 mm, 7.62 mm, 23 mm rounds or 30 mm grenades.

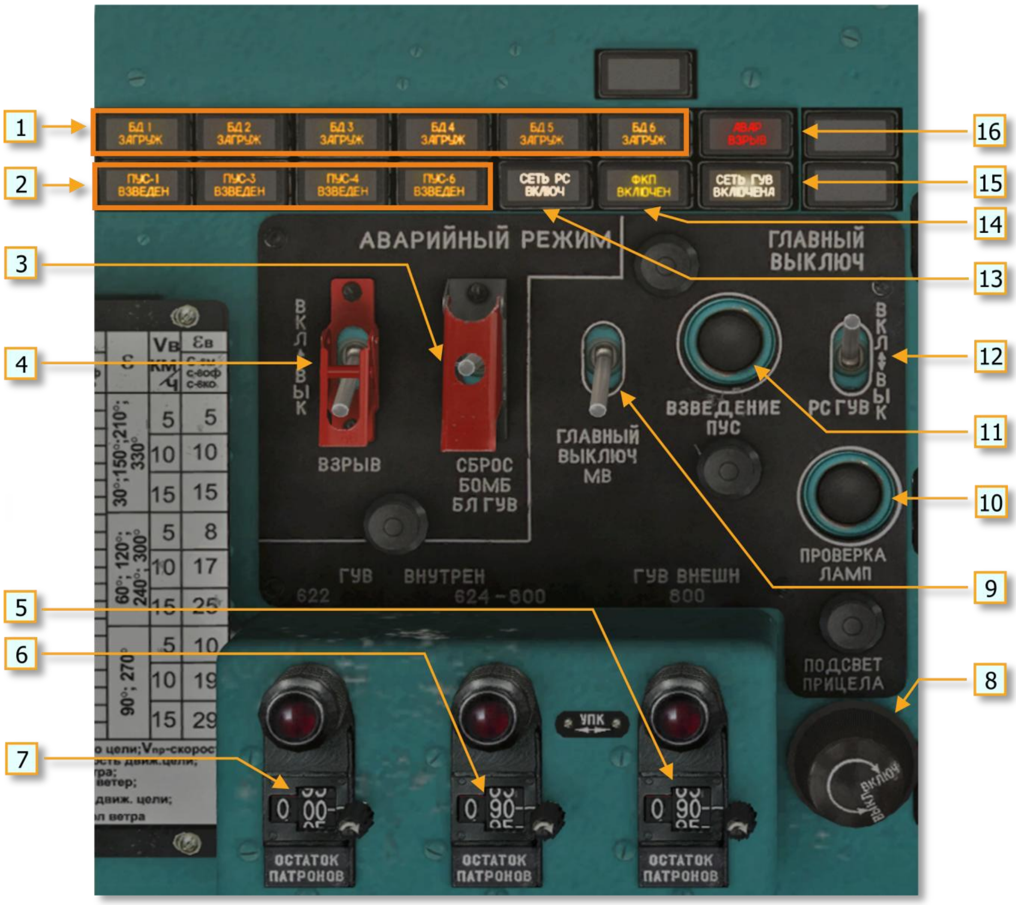


Рис. 9.124. Pilot's upper weapons control panel

1. Stations loaded indication lights
2. PUS (ПУС) Fire Control Devices energized indication lights
3. Aircraft Commander's Emergency Jettison switch (releases all stores)
4. Jettison ARMED/UNARMED switch
5. Right-side UPK (УПК) rounds remain counter if UPK is loaded (or grenades if mixed load)
6.Left-side UPK (УПК) rounds remain counter if UPK is loaded (or 12.7 mm GUV (ГУВ) rounds if mixed load)
7.7.62 mm GUV (ГУВ) rounds remain counter
8. Gun sight brightness control
9.MAIN MINE CANNISTER Power switch
10. Aircraft Commander's Weapons Control Panel Lamp Test
11. PUS (ПУС) Fire Control Devices Energize button
12.MAIN WEAPONS Power switch
13. Unguided Rockets electrical circuit ON light
14. Gun camera ON light (not implemented)
15. GUV (ГУВ) gun pod electrical circuit ON light.
16. Jettison Armed light

1. **Stations loaded indication lights.** Indicate presence of weapons on corresponding stations.
2. **FCD energized indication lights.** FCD are installed on stations 1, 3, 4, 6. The lights indicate readiness to launch from corresponding rocket launchers (FCD 1 for stations 1, 2; FCD 3 for station 3, FCD 4 for station 4, FCD 6 for stations 5, 6).

   ТАБЛО СИГНАЛИЗАЦИИ ВЗВЕДЕНИЯ ПУС. ПУС установлены непосредственно в БДЗ-57КрВ №1, 3, 4, 6. Сигнализируют о положении подвижного контакта прибора управления стрельбой в положении готовности к пуску НАР из ствола №1. ПУС-1 – для блоков на БД №1 и 2, ПУС-3 – для БД № 3, ПУС-4 – для БД № 4, ПУС-6 для блоков на БД №5 и 6.
3. **Pilot's Emergency Jettison switch.** Used to quickly lighten the helicopter's gross weight in special circumstances, such as emergency landing or in case the standard bomb release mechanisms fail.

N o t e . *The pilot's emergency jettison switch released stores loaded on ALL the weapon stations, unlike the copilot's emergency jettison switch, which releases stores according to the selected payload profile set on the copilot's weapons configuration panel. For example, if profile I is set on the weapons configuration panel, an emergency jettison attempt by the copilot will not release any stores, because profile I corresponds to a rocket pod configuration on all weapon stations. To release any stores by the copilot's emergy jettison switch, the payload profile selector must be set to profile II.*

4. **Jettison ARM/UNARM switch.** Set to "ВКЛ" (ARM) to jettison bombs armed. If a mixed payload is loaded (such as bombs and rockets), both bombs and rocket pods will jettison, but the bombs will detonate upon impact.
5. **Right Rounds Remain Counter.** Displays number of 23 mm UPK rounds remaining in the right UPK container or total number of grenades depending on loaded weapon system.
6. **Center Rounds Remain Counter.** Displays the number of 23 mm UPK rounds remaining in the left UPK container or total number of 12.7 mm GUV rounds depending on loaded weapon system.
7. **Left Rounds Remain Counter.** Displays number of 7.62 mm rounds remaining.

N O T E

The rounds remaining counters display the actual number of remaining rounds as follows:

- UPK: actual number divided by 2 (for example counter display of 100 means 200 rounds remain)

- 9-A-624: actual number divided by 5 (for example counter display of 10 means 50 remain)

- 9-A-622: actual number divided by 4

- grenade launcher: displays to actual number of grenades remaining

8. **Gunsight Brightness Control.** Controls PKV reticle brightness. Set to 50% by default.
9. **Minelaying system arming switch.** NOT IMPLEMENTED.

10. **Lamp Test Button.** Tests the lights installed on the pilot's upper weapons control panel.

11. **FCD Energize Button.** Energizes the FCDs in preparation for rocket fire. FCDs are energized if the WEAPONS MAIN power switch is set to ON (up), the corresponding circuit breakers are turned on, the UPK-PKT-RKT switch is set to RKT, and the rocket station selector switch is set to AUTO or stations currently loaded with rockets.

12. **WEAPONS MAIN power switch.** Primarily intended to prevent unintended weapons fire. Set to ON (up) during the target attack run. The switch powers rockets fire circuits, FCD energized indication (lights), and stations loaded indication (lights).

13. **RKT CIRCUIT light.** Illuminates if the WEAPONS MAIN (12) switch and MASTER ARM switches are ON (Рис. 9.123).

14. **GUN CAM light.** Illuminates if the gun camera system is turned on (gun camera system is not implemented).

15. **GUV CIRCUIT light.** Illuminates if GUV payload profile is set on the copilot's weapons configuration panel and the MASTER ARM switch is ON (Рис. 9.123).

16. **JETT ARM light.** Illuminates if the JETTISON ARM/UNARM switch is set to ARM.

8.3.2. LOWER ARMAMENT CONTROL PANEL

The pilot's lower armament control panel (Рис. 9.125) is used to control fire settings for rockets and GUV containers, set the active weapon system (rockets, 23 mm UPK containers, 12.7 mm PKT nose mounted machine gun, and to power up the gun camera system.

NOTE

To set GUV containers as the active weapon, the GUV payload profile must be set on the copilot's bombs control panel.

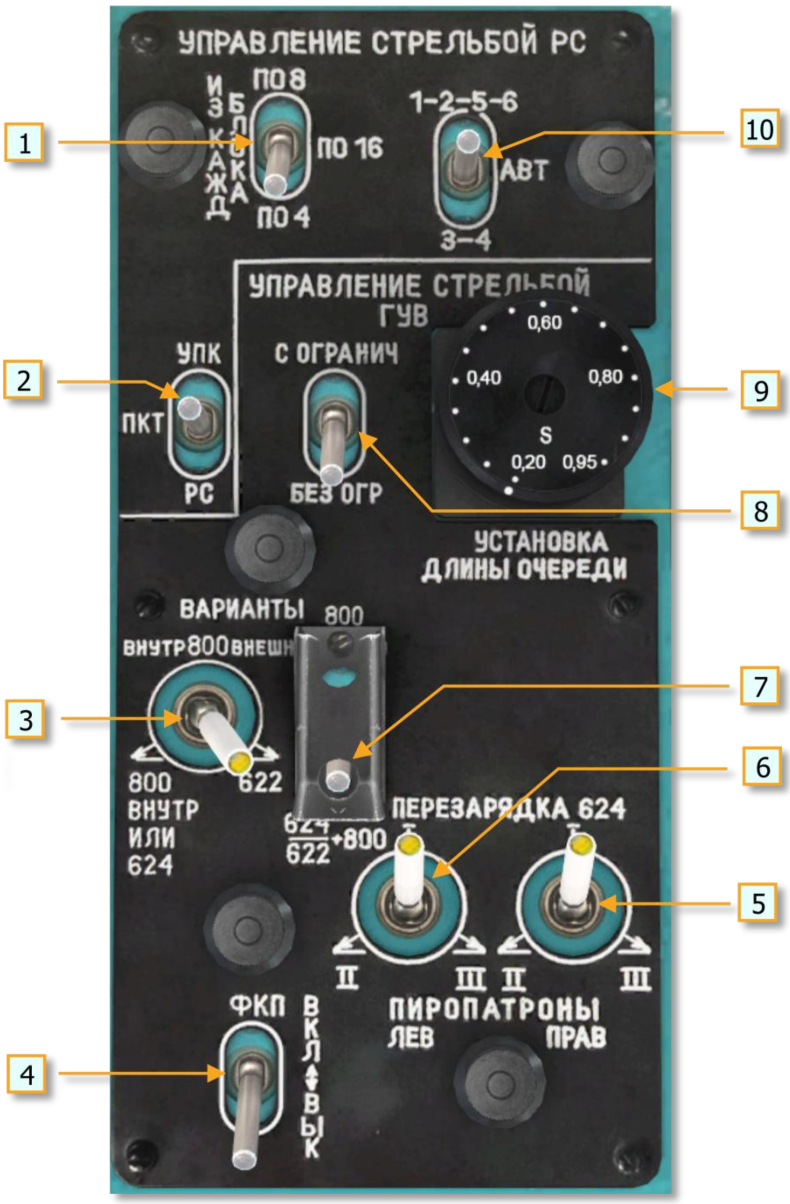


Рис. 9.125. Pilot's lower weapons control panel.

1. Rockets Quantity switch to control selection of 4, 8, or 16 rockets to be fired per pod
2. Weapon Selector switch: UPK (УПК) – PKT (ПКТ) – RKT (PC).
3.GUV (ГУВ) fire selector switch
4. Gun camera switch (not implemented)
5. Charging switch for reloading the right-side YakB-12.7 guns (three cartridges for guns I, II, III)
6. Charging switch for reloading the left-side YakB-12.7 guns (three cartridges for guns I, II, III)
7. GUV (ГУВ) payload selector switch
8. GUV (ГУВ) fire burst cutoff switch
9. GUV (ГУВ) burst length switch
10. Rocket Station Selector switch

1. **Rockets Quantity switch: ПО8 – ПО16 – ПО4 (8 - 16 - 4).** Controls the number of rockets fired from each rocket launcher while the Weapons Fire switch is held down. For example if two pods are loaded, set the switch to "ПО4" to fire up to 8 rockets (4 per launcher).
2. **Weapon Selector switch: УПК – ПКТ – РС (UPK - PKT - RKT).** Used to select the weapon for fire when the Weapons Fire switch is pressed (except for GUV, which has a separate selector on the copilot's weapons configuration panel). УПК (UPK) – firing of UPK-23-250 gun pods. ПКТ (PKT) –

firing of the nose-mounted PKT machine gun when in stow mode (not implemented). PC (RKT) – firing of unguided rockets from the B8V20-A launchers (pods).

3. **GUV (ГУВ) Fire Selector switch: ВНУТР 800 ВНЕШ – 800 ВНУТР ИЛИ 624 – 622.** The ВНУТР 800 ВНЕШ position is used to select grenades for fire from stations 1 and 6. The 800 ВНУТР ИЛИ 624 position is used to select grenades or the YakB-12.7 machines gun for fire on stations 2 and 5. The 622 position is used to select the GShG-7.62 machines guns for fire on stations 2 and 5.

   This switch is used in conjunction with the GUV Payload Selector switch. All possible switch combinations are reviewed below.

4. **Gun Camera switch.** Enables the gun sight gun camera, which records whenever the Weapons Fire switch is pressed on the Aircraft Commander's Cyclic control handle. (not implemented).

5. **YakB-12.7 Charging switch (right).** Used to reload the YakB-12.7 gun pod machine guns in case of a jam. Must be placed to the "I" position prior to firing.

6. **YakB-12.7 Charging switch (left).** Used to reload the YakB-12.7 gun pod machine guns in case of a jam. Must be placed to the "I" position prior to firing.

7. **GUV Payload Selector switch: 800 – 624/622+800.** Set to 800 when only grenade launchers are loaded (stations 1, 2, 3, 4, 5, 6). Set to 624/622+800 when mixed payload is carried for correct fire selection: stations 1, 6 grenade launchers, 2, 5 machine gun pods.

   This switch is operated in conjunction with the GUV Fire Selector switch. All possible switch combinations are reviewed below.

8. **GUV Cuttoff switch.** When set to OFF (down), the GUV containers will fire as long as the trigger switch is held down. When set to ON (up), the GUV containers will fire in burst lengths as set by the BURST knob.

9. **GUV BURST knob.** Sets the burst length for GUV containers in seconds:

   – short and medium burst length is set by setting the knob to 0.25 and 0.6 seconds, respectively.

   – when employing the grenade launcher, setting the knob between 0.25 and 1.00 approximately equals the number of round expanded multiplied by a factor of 10.

   – when employing the YakB 12.7 mm gun, setting the knob to 0.25 corresponds to approximately 15 - 18 rounds per burst; 0.6 to 40 - 42 rounds per burst

   – when employing the 7.62 mm gun, setting the knob to 0.25 corresponds to approximately 20 - 25 rounds per burst; 0.6 to 50 - 60 rounds.

10. **Rocket Station Select switch: 1-2-5-6 – AUTO – 3-4.** Used to select rocket stations for fire.

    When set to "1-2-5-6" rockets are fired in a sequence of:

a. rocket 1 from launchers 1 and 6

b. 0.025 interval

c. rocket 1 from launcher 2 and 5

Rockets are fired from each launcher with an interval of 0.05 seconds.

When set to AUTO, rockets are first fired from launchers on stations 1, 2, 5, 6. Once these stations are expended, the system automatically switches to launchers on stations 3, 4.

8.4 BOMBS CONTROL PANEL

The bombs control panel is designed to indicate weapon stations loaded status, control tactical and emergency release of weapons, and arm the GUV firing circuits. The panel is installed on the canopy frame on the right side of the cockpit for use by the copilot (Рис. 9.126).

Рис. 9.126. Copilot's payload configuration panel

1.Jettison ARMED switch
2.Jettison ARMED light
3.Jettison switch
4.Bombs cuircuit ON light
5. Stations loaded lights (6)
6. Bombs main power switch
7. Lamp test button
8.Payload profile selector
9.Paload profile guide
10.ESBR heating switch (not implemented)

1. **Jettison ARMED switch.** When set to ARMED (up), jettisoned bombs are armed for detonation upon impact.
2. **Jettison ARMED light.** Indicates bombs are armed to detonate upon impact if jettisoned. Illuminates if jettison ARMED switch is set to ARMED (up).
3. **Jettison switch.** Used to jettison bombs.
4. **BOMBS CIRCUIT ON light.** Indicates bomb release circuits are switched on. Illuminates if BOMBS MAIN power switch is set to ON (up).

5. **Stations loaded lights.** Illuminate to indicate stations loaded with bombs when the BOMBS MAIN power switch is to ON (up).
6. **BOMBS MAIN power switch.** Energizes the bombs release circuits when set to ON (up).
7. **Lamp test button.** Tests the lights installed on the payload configuration panel.
8. **Payload profile selector.** Five-position selector is set to correspond to current payload and used to control the release/jettison of stores only from stations loaded with bombs (primarily intended to prevent accidental release/jettison of stores other than bombs).

   I. *All rockets:* all bomb release circuits are energized, however no bombs (or any other stores) will actually release when any of the three bomb release triggers are pressed (two KSB-49 remote triggers or the OPB-1R optical bombing sight trigger).

N O T E

The release system does not actually "know" what types are stores are loaded on the stations, it is only supplied the position of the payload profile selector switch (8).

   II. *All bombs:* pressing any bomb release trigger will sequentially release all stores from all stations starting with station 6 with the first press of the release trigger.

   III. *4 bombs + 2 rocket launchers:* pressing any bomb release trigger will sequentially release any stores from stations 6-1-5-2 starting with the first press of the release trigger.

   IV. *2 heavy bombs + 2 rocket launchers:* pressing any bomb release trigger sequentially release any stores from stations 5-2 starting with the first press of the release trigger.

   V. *2 heavy bombs + 2 standard bombs:* pressing any bomb release trigger will sequentially release any stores from stations 5-2-4-3 starting with the first press of the release trigger.

N O T E

The "-" (dash) mark on positions IV and V indicates that no release signal will be supplied to the corresponding station.

The "heavy bomb" symbol indicates a heavy or incindeary bomb, however this does not affect the jettison as any store type (including rocket launcher, UPK or GUV pod) will be successfully released from stations 5 and 2 in these payload profile selector positions.

   ГУВ (GUV). Energizes the GUV firing circuits. In this position all other fire/release circuits are blocked and no other weapon system can be fired or released with the exception of an emergency release by the pilot's emergency jettison switch.

9. **Payload profile guide.** Payload profile index guide for profile setting.

10. ESBR heating switch. Set the electrical release control system heating on/off for operations in cold (negative) temperatures (not implemented).

8.5 ЭСБР-3П/А (ESBR-3P/A) ELECTRICAL RELEASE CONTROL BOX

The ESBR electrical release control box is located below the copilot's instrument panel. The ESBR controls sequential single or paired release of bombs and provides for station selection for release of any store.

Рис. 9.127. ESBR control box

1. Signal setting knob
2. Signal setting index plate
3. ESBR power swtich

1. **Signal setting knob.** Used to set single or pairs release mode or select the release number in the release sequence.
2. **Signal setting index plate.** The index plate consists of a series of numerical indexes that indicate either single ("I") or pairs ("II") release mode setting as well as Arabic numerals that indicate the current release number in the release sequence.
3. **ESBR power switch.** Connects the electrical release control system to the bomb release circuits.

When releasing bombs, all of the required circuit breakers must be switched ON, the BOMBS MAIN power switch set ON (up), the desired payload profile set, the ESBR signal setting knob (1) set to the desired position for release and the ESBR power switch (3) set to "ВКЛ" (ON) (right).

When the signal setting knob is set to "\" or "0", no stores will be released. These positions are used to system ground tests.

POSITION I: In position "I", the ESBR commands the weapons control system for single bomb release in sequence from stations 6-1-5-2-4-3 (if payload profile "II" is set on the bombs control panel). However if desired, the ESBR can be used to manually select the desired station for release. For example, to select station 3 for release:

- turn off the ESBR by setting the ESBR power switch to "ВЫКЛ" (OFF) (left).
- set profile "II" on the bombs control panel (profile "V" will work as well, however this will alter the subsequent procedure)
- set the signal setting knob on the ESBR control box to "5"

When the ESBR is turned on with the signal setting knob set to "5", the next press of the bomb release trigger will release the store from the sixth station in the release sequence, i.e. station 3 given that it is preceded by stations 6, 1, 5, 2, 4 in the release sequence.

When the ESBR is turned on and profile "II" is set on the bombs control panel, rotating the signal setting knob past the "I" position will result in automatic release (without pressing the bomb release trigger) from the consecutive station(s) in the release sequence with each progressive setting of the knob.

POSITION II: In position "II", the ESBR commands the weapons control system for paired bombs release in sequence from stations 6+1, 5+2, 4+3 (if payload profile "II" is set on the bombs control panel). As with single release, the ESBR allows for manual station selection for paired release.

If profiles "IV" and "V" are set on the bombs control panel (and all relevant components required for stores release are enabled), a first press of the bombs release trigger will release stores from station 5 (or 5+2 if the ESBR is set to position "II"). I.e. in these payload profiles, release commands are not supplied to stations 6 and 1.

8.6 PKV COLLIMATING SIGHT

The PKV collimating sight (Рис. 9.128) is used to aid with visual target ranging and weapons aiming using target size methodology when employing the nose mounted PKT machine gun, external gun and cannon systems, rockets, and bombs.

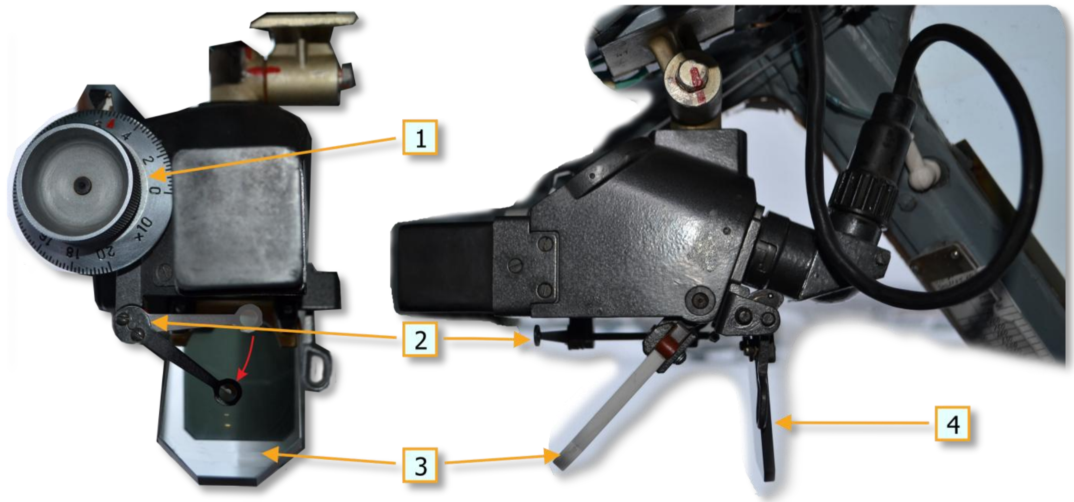


Рис. 9.128. PKV collimating sight (front and side view)

1- sight elevation knob
2- mechanical ring sight (stowable)
3- reflector glass
4- sun filter glass (stowable)

The sight reticle Рис. 9.129 is turned on by the "СИГНАЛИЗАЦИЯ" (INDICATION) circuit breaker.

Target range is determined using the PKV reticle according to the following formula:

$$D_t = \frac{\mathrm{b_t}}{2\mathrm{tg}(0.5\psi_t)}$$

where:

D_t = target range

$\mathrm{b_t}$ = apparent target size (in meters)

ψ_t = target current angular size (in mils as viewed in the reticle)

For example, an object 100 meters in width will be 100 mils across in the reticle at a range of 1000 meters.

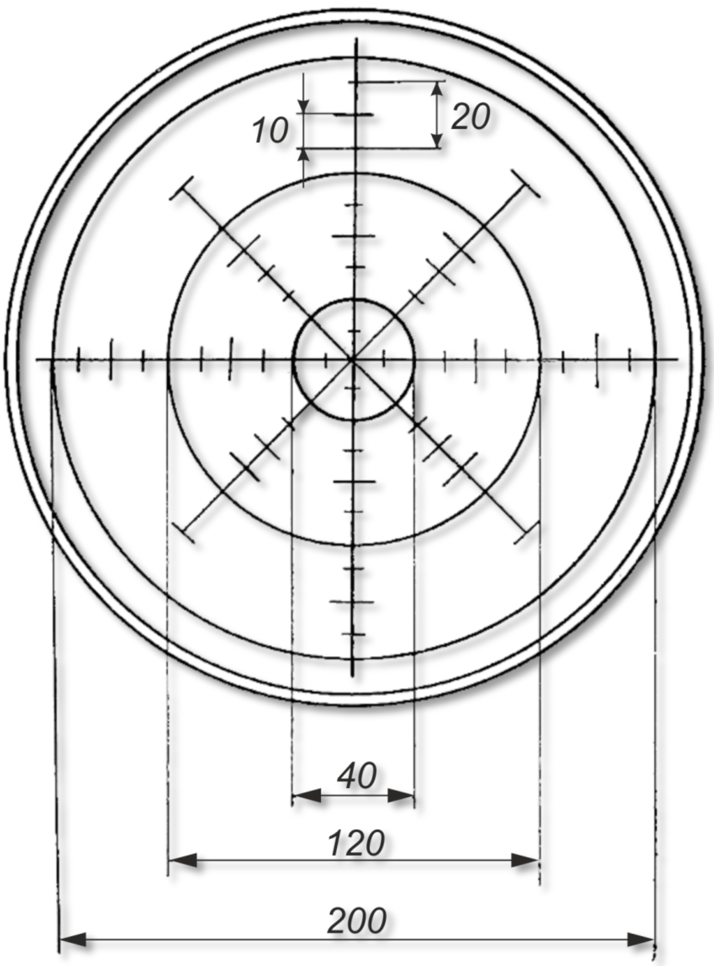


Рис. 9.129. PKV reticle pattern with element sizes in mils

The sight is installed on a bracket assembly on the left side of the cockpit ahead of the pilot's head position. To use the sight, the pilot must raise the seat by 15 – 20 cm.

PKV technical specifications: Table 9.1

Table 9.1

Reticle ring size:	Size (mils)
inner	20
middle	60
outer	100
Reticle graduation	10
Elevation knob numerical marking	each 20
Elevation knob graduation	2
Elevation knob large hash graduation	4
Elevation angle range	0 - 200 (0 - 11.5°)
PKV line of sight relative to helicopter water line (sight elevation set to 0)	57.5 (up)
Elevation knob red index corresponding to (mils)	52.4
Overall weight	1.8 kg

The elevation angle of the sight is set by manipulating the reflector glass using the elevation knob. Aim is accomplished by placing the sight reticle over the target.

The hash marks of the reticle allow for simple range estimation for targets of known (approximated) apparent size.

The sight is equipped with a stowable reserve mechanical ring sight in case the optical system is inoperable.

The "ПОДСВЕТ ПРИЦЕЛА" (SIGHT DIMMER) rheostat on the pilot's upper weapons control panel control reticle brightness. A stowable brightness filter glass is available for use in case of bright background (such as near direct sunlight).

The sight elevation angle is determined by projectile gravity fall, helicopter pitch angle, and particular weapon system's installed elevation angle relative to the helicopter water line (WL). As such, the sight elevation angle is the angle between the projectile throw elevation and the line of sight to the target (Рис. 9.130).

Sight elevation angles are recalculated for a variety of standard target ranges, helicopter airspeeds, flight profiles (level flight or dive) for each available weapon system. Sight elevation charts are provided in the Combat Employment chapter.

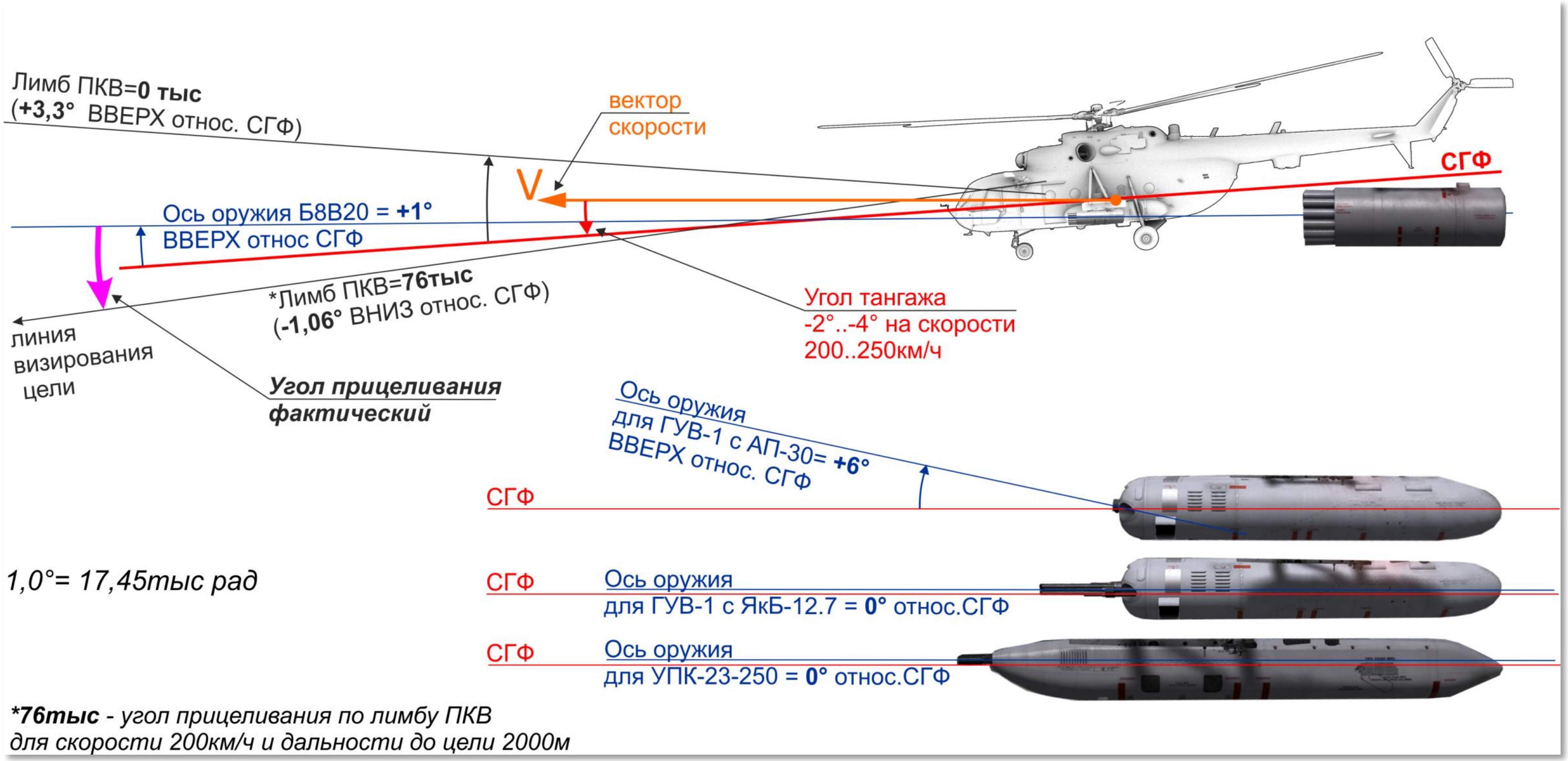


Рис. 9.130. Elevation angles relevant to weapons employment using the PKV collimating sight.

8.7 WEAPONS FIRE AND BOMB RELEASE SWITCHES

The WEAPONS FIRE switches installed on both cyclic control sticks are used to employ all weapon systems, except release of bombs. Bomb (or any other external store) release switches are available on the OPB-1r optical bombing sight and two KSB-49 remote bomb release triggers (one for the pilot and copilot located to the left and right of the respective instrument panels).

8.8 WEAPON SYSTEMS

The Mi-8MTV2 weapons control system includes a number of sub-systems which make it possible to employ a variety of weapon systems in mixed payload configurations.

Mi-8MTV2 Payload configurations (profiles)

Available stores for each external weapon station are listed in Table. 9.7.

Table. 9.7.

Available loads for weapons stations #1 - 6 for combat employment						In service with RF military
1	2	3	4	5	6	
–	B8	B8	B8	B8	–	yes
B8	B8	B8	B8	B8	B8	no [1]
–	UPK	B8	B8	UPK	–	yes
B8	UPK	B8	B8	UPK	B8	no
–	AB-250,100	B8	B8	AB-250,100	–	yes
AB-250,100	AB-250,100	B8	B8	AB-250,100	AB-250,100	no
AB-250,100	AB-250,100	AB-250,100	AB-250,100	AB-250,100	AB-250,100	yes
–	AB-500	AB-250,100	AB-250,100	A-500	–	yes
GUV (GD)	GUV (MG)	Б8	Б8	GUV (MG)	GUV (GD)	no
GUV (GD)	GUV (MG)	–	–	GUV (MG)	GUV (GD)	yes
GUV (GD)	GUV (GD)	–	–	GUV (GD)	GUV (GD)	yes
–	VSM	VSM	VSM	VSM	–	yes
–	UPK	VSM	VSM	UPK	–	yes
GUV (GD)	GUV (GD)	VSM	VSM	GUV (GD)	GUV (GD)	yes
GUV (GD)	GUV (MG)	VSM	VSM	GUV (MG)	GUV (GD)	no

NOTE

Chart legend:

B8: B8V20-A rocket launcher with 20 80 mm S-8 unguided rockets;

UPK: UPK-23-250 cannon pod system;

AB-250, 100: 250 kg, 100 kg free-fall bomb;

GUV (MG): GUV-8700 pod with 1 x 12.7 mm, 2 x 7.62 mm machine guns;

GUV (GD): GUV-8700 pod with AG-17A automatic grenade launcher;

VSM: mine container, part of the VSM-1 minelayin system (not implemented in simulation).

[1] Not in service for administrative reasons, but technically supported by the Mi-8MTV2 weapons control system.

8.8.1. UNGUIDED ROCKET SYSTEM

Purpose

The unguided rocket system is designed to be employed against column or area (group) targets consisting of unarmored or lightly armored ground units. The Mi-8MTV2 is armed with B8V20-A rocket launchers equipped with 20 S-8 80 mm rockets. Previous generation UB-32A-24 launchers equipped with S-5 57 mm rockets are no longer in service.

Components

Used with the B8V20-A launchers, the unguided rocket system includes:

- four 20-tube B8V20-A rocket launchers (Рис.9.131) (the weapons control system support up to 6 launchers)
- 80 S-8 unguided rockets of various modifications (S-8M, S-8AS, S-8B, S-8KO, S-8OF) (the weapons control system supports up to 120 S-8 type rockets)
- four ПУС-36-71 (PUS-36-71) fire control devices (FCD) integrated into the external weapon stations #1, 3, 4, 6
- control interfaces

Рис.9.131. Loading of a B8V20-A rocket launcher on an Mi-8MTV5 helicopter.

Description

The B8V20-A rocket launcher serves as a container/casing with 20 integrated launch tubes used to house and launch S-8 unguided rockets (Рис.9.132).

Рис.9.132.B8V20-A launcher tubes as seen from the rear.

The rocket launchers are attached to the weapon stations via suspension locks. The weight of an unloaded launcher is 100 kg. The weight of a loaded launcher is 332 – 405 kg depending on rocket modification.

The technical specifications of S-8 rocket modifications available in DCS: Mi-8MTV2 Magnificent Eight are provided below in Табл. 9.8.

Табл. 9.8

Rocket modification	S-8KOM Рис. 9.133	S-8OM	S-8TsM Рис. 9.134	S-8OFP2 Рис. 9.135
Purpose	Destruction of lightly/medium armored units and troops	Illumination	Target designation	Destruction of troops (explosive and fragmentation effects) and lightly armored units
Diameter, mm	80	80	80	80
Length, mm	1570	1632	1632	1570
Launch mass, kg	11.3	12.1	11.1	16.7
Warhead/combat section mass, kg	3.6	4.1	4.1	9.5
HE mass , kg	0.9	***	***	2.9
Warhead type	Dual-purpose (shaped charge/ fragmentation)	Illumination flares, ignition 17 sec after launch, duration 40 sec	smoke	Explosive fragmentation, penetrating (delayed HE detonation), 1000 - 2000 fragments of 3 - 6 g

Peak velocity, m/sec	Up to 650	Up to 545	670	Up to 450
Muzzle velocity, m/sec	37 - 52	37 - 52	37 - 52	37 - 52
Targeting elevation angle (mils) at 2000 m, level flight, V=200 kph	76	***	76	98

Рис. 9.133. S-8KOM rocket

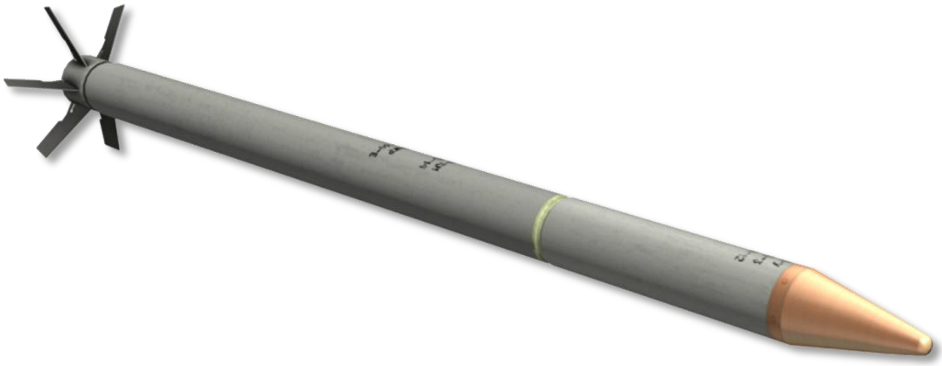


Рис. 9.134. S-8TsM rocket

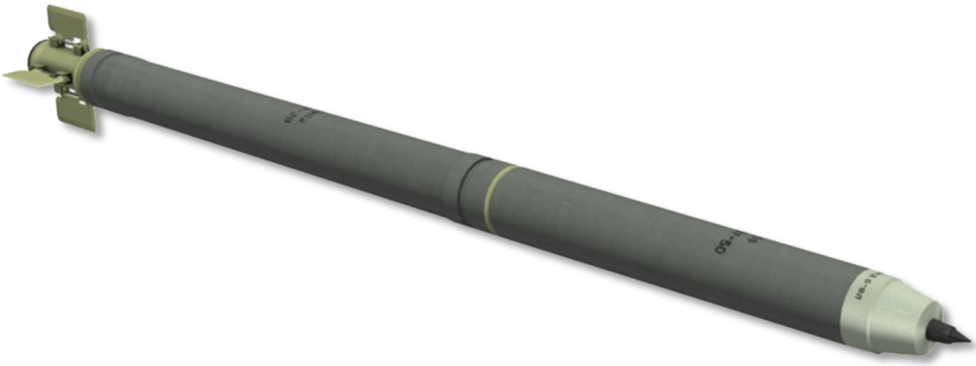


Рис. 9.135. S-8OFP2 rocket

Ripple and salvo firing of rockets from multiple stations in various payload profiles is accomplished by use of ПУС-36-71 (PUS-36-71) fire control devices (FCD), which are integrated into the weapons stations. FCDs process and supply electric signals to the launch tubes of the B8V20-A launchers to command rocket launch. FCD-1 controls the launchers on stations #1-2; FCD-3 controls the launcher on station #3; FCD-4 controls the launcher on station #4; FCD-6 controls the launchers on stations #5-6.

Attached to the weapons stations, the launchers are elevated 1° up from the helicopter water line.

Rocket employment procedures are described in the Weapons Employment chapter.

8.8.2. UPK CANNON SYSTEM

Purpose

The UPK podded cannon system is designed to be employed against individual and group unarmored or lightly armored ground targets within visual contact in day and night time conditions.

Components

The УКП-23-250 (UPK-23-250) cannon pods are equipped with GSh-23L 23 mm twin barrel cannon.

The podded cannon system includes the following components:

- two UPK-23-250 cannon pods equipped with the GSh-23L cannon (Рис. 9.136)
- two weapons stations (#2, 5) supporting UPK-23-250 cannon pod load-ing
- control interfaces

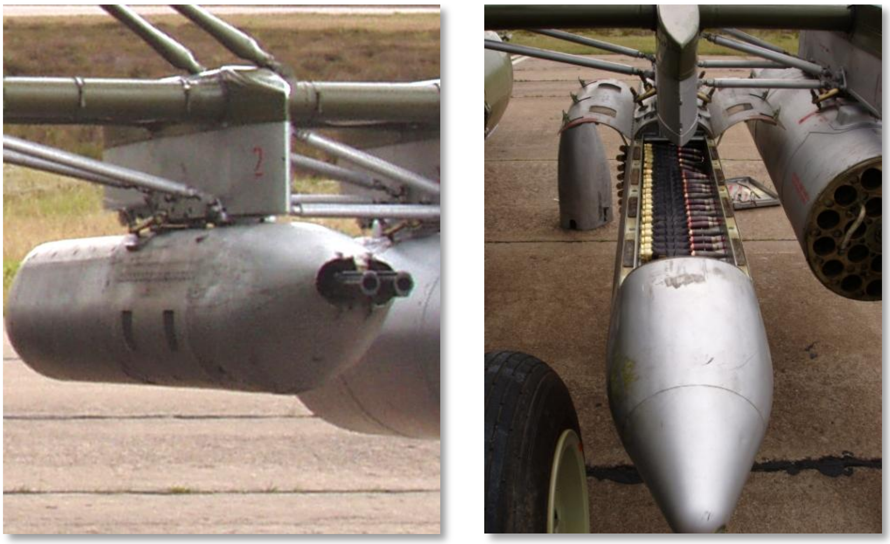


Рис. 9.136. UPK-23-250

Description

Each UPK pod is loaded with 250 rounds of 23 mm ammunition. The weight of a loaded UPK pod is 230 kg. The system includes an automatic burst cutoff of 0.16 seconds, during which 8-10 rounds are fired. The burst length cannot be adjusted.

The technical specifications of the GSh-23L cannon employed in the UPK-23-250 cannon system are provided below in Table. 9.9.

Table. 9.9

Specification	Value
Caliber, m	23
Dimensions, mm:	

length	1537
width	165
height	168
Mass, kg	50±1.5
Rate of fire, rounds/min	3000-3400
Muzzle velocity, м/sec	715±15
Recoil impulse, kgf	<2900
Ammunition capacity	250
Max burst length, rounds	10
Thermal capacity, rounds	250

Aim is accomplished using the PKV collimating sight.

Attached to the weapons stations, the UPK pods are parallel to the helicopter water line.

Cannon employment procedures are described in the Weapons Employment chapter.

8.8.3. GUV UNIVERSAL GUN OR GRENADE LAUNCHER CONTAINER SYSTEMS

Purpose

GUV machine gun and grenade launcher podded systems are designed to be employed against individual and group unarmored or lightly armored ground targets within visual contact in day and night time conditions.

Components

The GUV gun pod systems include the following components:

- GUV-1 (GUV-8700) pod equipped with AG-17A (AP-30) 30 mm "Plamya-A" automatic grenade launcher (service index 9-A-800) (Рис. 9.137) or single YakB-12,7 (service index 9-A-624) 12.7 mm machine gun and twin GShG-7,62 (service index 9-A-622) 7.62 mm machine guns (Рис. 9.138)
- four weapons stations (#1, 2, 5, 6) supporting GUV pod loading
- control interfaces

Рис. 9.137. GUV-1 equipped with automatic greande launcher

Рис. 9.138. GUV-1 equipped with machine guns

Description

The grenade launcher variant of the GUV pod system is equipped with the AG-17A 30 mm automatic grenade launcher ("Plamya-A", AP-30, 9-A-800) (Рис. 9.139).

Рис. 9.139. AG-17A ("Plamya-A") grenade launcher and VOG-17 grenade munition

The grenade launcher pod is loaded with 300 grenades.

The technical specifications for the AG-17A (AP-30) automatic grenade launcher and its munition are provided below in Table. 9.10

Table. 9.10

Specifications	Value
Caliber, m	30
Munition	VOG-17 (VOG-17M)
Mass of grenade launcher, kg	21 - 22
Muzzle velocity, m/sec	185
Muzzle energy, J	4791
Firing mode	Continuous (automatic)
Rate of fire	600/min
Practical range	1700
Direct fire range for 2 m target, m	200 - 250
Mass of munition, g	350 / 280 (36 g HE)
Self-destruct time, sec	25 - 27
Kill radius , m	6 - 7

The machine gun variant of the GUV pod system is equipped with a single YakB-12,7 (9-A-624) 12.7 mm machine gun (Рис. 9.140) and two GShG-7,62 (9-A-622) 7.62 mm machine guns (Рис. 9.141).

Рис. 9.140. YakB-12,7 12.7 mm 4-barrel Gatling gun

Рис. 9.141. GShG-7,62 7.62 mm 4-barrel Gatling gun

The gun variant of the GUV pod is loaded with 750 rounds of 12.7 mm ammunition and 3400 rounds of 7.62 mm ammunition.

The technical specifications for the machine guns equipped on the GUV-1 pod system are provided below in Table. 9.11.

Table. 9.11

Specifications	Value	
Caliber, mm	12.7	7.62
Dimensions, mm:		
length	1345	800
width	145	
height	190	
Mass, kg	45	19
Rate of fire, rounds/min	4000-4500	6000
Muzzle velocity, m/sec	810	850
Recoil impulse, kgf	1400	
Ammunition capacity, rounds	750	1800
Max burst length, rounds	400	1000
Operational life, rounds	8000	

The weight of a loaded machine gun variant of the pod does not exceed 452 kg. The weight of a loaded grenade launcher variant does not exceed 274 kg.

In the grenade launcher pod is loaded on weapons stations #1, 2, 5, 6 (1, 6 if only two pods loaded). The machine gun pod is loaded only on stations #2, 5.

The machine gun pods are attached to the weapons station parallel to the helicopter water line. The grenade launcher elevation is +6° from the water line.

The weapons control system supports simultaneous loading of grenade launcher and machine gun pod systems. In this case, grenade launcher pods are loaded on stations #1, 6 while machine gun pods are loaded on stations #2, 5. Employment of the different pod systems in the same payload configuration must be separate (i.e. cannot fire grenade launcher and machine gun pods simultaneously).

Limitations

The YakB-12,7 gun requires cooling time after expanding 400 rounds of ammunition as follows:

- 25 min if OAT is greater than +10°C
- 15 min if OAT is -10°C to +10°C
- 5 min if OAT is below -10°C

The GShG-7,62 gun requires a 25 minute cooling cycle after expanding 1000 rounds of ammunition if OAT is under 20°C. If OAT exceeds 20°C, fire past 1000 rounds is **prohibited**.

8.8.4. BOMB DELIVERY SYSTEM

Purpose

The bomb delivery system is designed to be employed against ground targets using aimed bombing with 100, 250, or 500 kg free-fall bombs released from level flight within visual target contact in day and night time conditions.

Components

The bomb delivery system includes the following components:

– six weapons stations equipped with БДЗ-55ТН (BDZ-55TN) suspension locks

– ОПБ-1Р (OPB-1R) optical bombing sight with "ЛЕВО — ПРАВО" (LEFT-RIGHT) cueing signal lighting

– ЭСБР-3П/А (ESBR-3P/A) electrical release control system

– system controls

Description

At altitudes between 100 – 4000 m, bomb sighting is performed by the copilot using the OPB-1R optical bombing sight. At altitudes below 100 m, bomb sighting is performed by the pilot using the PKV collimating sight.

The right KSB-49 remote bomb release trigger and the BOMB RELEASE switch of the OPB-1R optical bombing sight are used by the copilot for tactical (combat) release of bombs. The release switches are connected to the release circuits via the BOMBS MAIN power switch.

The left KSB-49 remote bomb release trigger is used by the pilot for tactical (combat) release of bombs. The switch is connected to the release circuits via the BOMBS MAIN power switch.

The bomb delivery system provides both the pilot and copilot the ability to release bombs tactically or jettison in case of emergency. Tactical release is always performed for bomb detonation and in a particular release sequence based on the position of the PAYLOAD PROFILE selector on the bombs control panel and the signal setting switch of the ESBR electrical release control box.

Bombs jettison can be performed either for detonation or not depending on the position of the ARM switches on the corresponding weapon control panels.

When jettisoned by the pilot, all bombs, rocket launchers and containers are released from the weapons stations. When jettisoned by the copilot, all bombs are released only when the PAYLAOD PROFILE selector is set to position II or V.

When the PAYLOAD PROFILE selector is set to position III or IV, rocket launchers cannot be released from the weapons stations by the copilot via the bombs control panel. Rocket launchers can be released by the pilot using the EMER JETTISON switch on the pilot's upper weapons control panel. If release by the copilot is required, the PAYLOAD PROFILE selector must be set to position II or V (to "fool" the weapons control system that all weapons stations are loaded with bombs).

Free-falling bombs

The DCS Mi-8MTV2 is armed with 100 kg bombs (FAB-100, SAB-100), 250 kg bombs (FAB-250) (Рис. 9.142), and 500 kg bombs (FAB-500M62). Incendiary bombs are not implemented.

Рис. 9.142. FAB-250 250 kg free-fall bomb

FAB – high explosive warhead. Designed to be employed against personnel, vehicles and other types of ground targets.

SAB – illumination bombs. Designed to illuminate the battle area in low light conditions. Can and have previously (Tajikistan) been used as a preventative[1] countermeasure against MANPAD and other infrared-guided SHORAD systems.

In DCS, bombs are modeled with impact fuses, making their delivery at low altitudes dangerous. Delayed fuse modeling is planned.

[1] When operating in canyons/valleys, a covering flight releases 4 – 6 SAB illumination bombs before the primary flight entered below, forcing any potential air defense assets on the ground to aim in the direction of the illumination flares as they attempted to target the primary flight helicopters.

9 WEAPONS EMPLOYMENT

9. WEAPONS EMPLOYMENT

9.1 CONFIGURING DCS OPTIONS

9.1.1. WEAPON SYSTEMS INDICATOR (HINTS)

A special weapon systems indicator (Рис. 9.2) is available in DCS: Mi-8MTV2 to assist with monitoring of weapons selection and status. The indicator can be toggled on/off by pressing [LShift+LCtrl+H]. To enable the indicator by default at mission start, check the SHOW HINTS AT MISSION START box in the OPTIONS/SPECIAL/Mi-8MTV2 menu (Рис. 9.1).

Рис. 9.1. SHOW HINTS AT MISSION START checkbox

Рис. 9.2.Weapon systems indicator.

The line descriptions of the weapon systems indicator are provided below in Рис. 9.3.

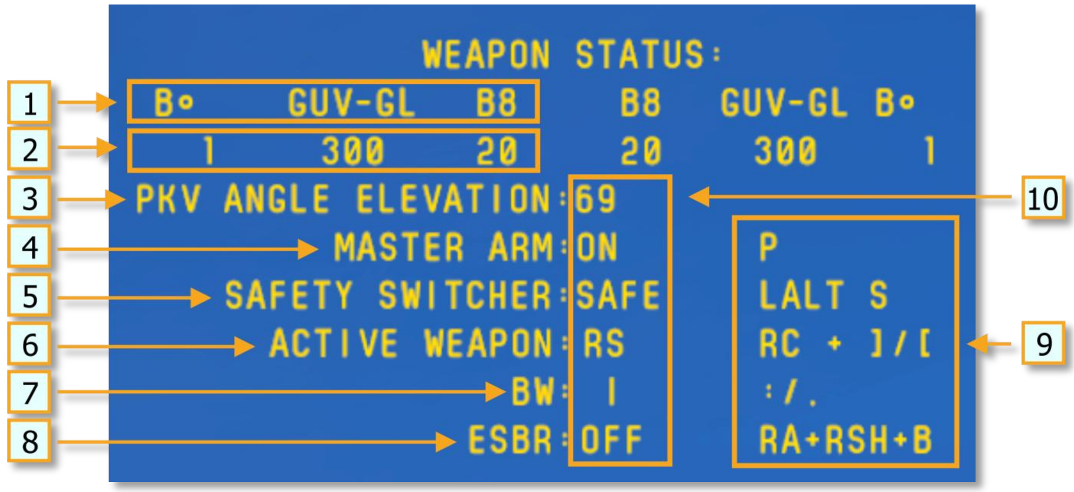


Рис. 9.3. Weapon systems indicator

1. Payload loaded on each weapons station (B – bombs, GUV-GL – grenade launcher pod, GUV-MG – machine gun pod, UPK – cannon pod, B8 – rocket launcher)
2. Remaining ammunition counters for each weapon station
3. PKV (OPB-1R) sight elevation in mils
4. WEAPONS MAIN power switch position (ON/OFF)
5. MASTER ARM switch position (SAFE/ARMED)
6. Active weapon selection (RS – rocket system, UPK – cannon pod system, GUV – gun pod systems)
7. PAYLOAD PROFILE selector position on the bombs control panel (I, II, III, IV, V, GUV)
8. ESBR electrical release control box power switch position (ON/OFF)
9. Hotekeys for changing corresponding line settings (RC – RCTRL, RA – RALT, RSH – RSHIFT)
10. Switch/device setting display field

9.2 SETTING UP "SNAPVIEWS"

The PKV collimating sight is correctly positioned in DCS as in the real Mi-8MTV2 cockpit, making it 15 – 20 cm higher than the normal pilot's forward line of sight out of the cockpit. This makes it nearly impossible to align the PKV reticle line of sight with a target without shifting the view higher in the cockpit. Doing so however makes it more difficult to read the instruments on the instrument panel.

To allow the view to be quickly switched between a dedicated PKV reticle view and either a normal cockpit view or dedicated instrument panel view, custom snapviews can be created and saved in DCS for the Mi-8MTV2. Snapviews are selected using the keyboard numpad with the "0" key held down as a modifier, so up to 9 snapview positions are available and can be edited.

Prior to creating custom snapviews, it is recommended that the default ones are tested by pressing [Num0 + Num1…9] as they may be sufficient for use.

To create custom snapviews:

Once loaded into the Mi-8MTV2 cockpit, turn on all of the circuit breakers and check for the PKV reticle to be ON. Select any **one** of the default snapviews by pressing [Num0 + Num1…9]

Adjust the cockpit view by using the standard cockpit view control commands:

- [Num*] – optical zoom in
- [Num/] – optical zoom out
- [LShift+LCtrl+Num2] – shift camera down
- [LShift+LCtrl+Num8] – shift camera up
- [LShift+LCtrl+Num4] – shift camera left
- [LShift+LCtrl+ Num6] – shift camera right
- [LShift+LCtrl+ Num*] – shift camera forward
- [LShift+LCtrl+ Num/] – shift camera back
- [Num1..9] – pan camera ([Num5] – center camera)

to set the view as follows:

- shift the view UP to the level of the PKV reticle
  [LShift+LCtrl+Num8];
- shift the view FORWARD so that all three rings of the PKV reticle are visible
  [LShift+LCtrl+Num*];
- adjust as needed until the view is approximately as displayed below in Рис. 9.4

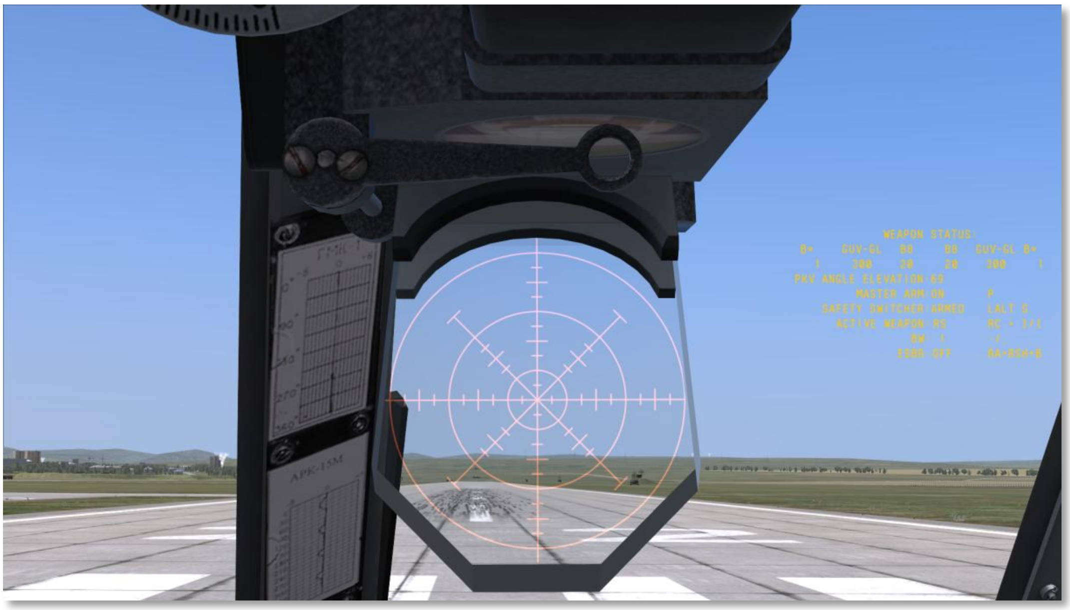


Рис. 9.4.PKV reticle with three rings visible

- save the custom snapview by pressing [RAlt + Num0+Num1…9] (whichever numpad kay desired)

Snapview settings are saved in:

"C:\Users\USER-1\Saved Games\DCS\Config\View\SnapViews.lua"

PKV elevation angle chart for rocket fire

9.3 PARTICULARS OF FLIGHT CONTROL WITH EXTERNAL PAYLOAD

With an external payload loaded, the CG shifts forward, requiring adjustments in cyclic control and pitch angles in standard flight profiles. In level flight, a balanced cyclic stick position is 1/5 – 1/6 stick travel more aft with an external payload when compared to a clean configuration.

When firing large rocket salvos (6 - 16 rockets), the exhaust gases exert a significant force on the launchers as the rockets exit the tubes, which in turn results in a slight negative pitch moment.

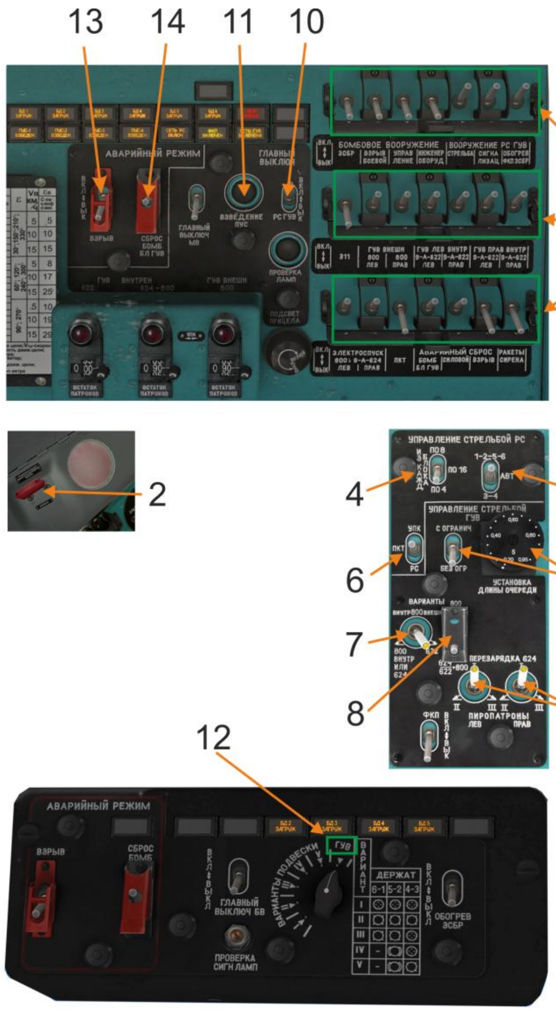
9.4 COMABT EMPLOYMENT PROCEDURES

9.4.1. BEFORE TAXI (TAKEOFF)

Before weapons can be employed, all of the relevant systems myst be switched on. Some systems (components) are switched on prior to takeoff while others are switched on only in the combat area (to avoid unintended weapons fire). Normally, all of the relevant systems are switched on prior to takeoff, apart from the weapon systems main power switches (the Mi-8MTV2 has three of these: WEAPONS MAIN power switch, MINELAYING MAIN[1] power switch, BOMBS MAIN power switch).

1. Depending on the mission payload, the guides provided below display the required steps to prepare weapon systems for fire - Рис. 9.5 for rocket, cannon, and gun systems, and Рис. 9.6 for bomb delivery system.

[1] Minelaying system not currently implemented in DCS.



Use armament system for Mi-8MTV2 (w\o bomb armament)

a quick guide

Use:

for **B8V20-A**: 1, 2, 3 (AUTO or 1-2-5-6 or 3-4), 4, 6 (PC), 10, 11 (press and hold to light up display ready ПУС...ВЗВЕДЕН) - push FireButton

for **UPK-23-250**: 1, 2, 6 (УПК), 10 - push FireButton

for **GUV-MGun [only 2 and 5 pylons]** (12,7mm 9A624):
1(all upper CB - ON), 2, 12, 5 (any position),
7 (800 ВНУТР ИЛИ 624), 8 (624/622+800), 9 (I, or II, or III),
10- push FireButton

for **GUV-MGun [only 2 and 5 pylons]** (7,62mm 9A622):
[same as for 12,7], 7 (622), 8 (624/622+800),
10 - push FireButton

for **GUV-GrL** (AP-30): 1, 2, 12, 5(any position),
7 and 8 (see below), 10 - push FireButton

if var GrL of 1, 2, 5, 6 pylons
and there is need for ***simultaneous shooting*** *of 4 GrL*
- use: 7=ВНУТР 800 ВНЕШНИЕ and 8=800

if var GrL of 1, 2, 5, 6 pylons
and there is need for ***shooting of 1 and 6*** *GrL*
- use: 7=ВНУТР 800 ВНЕШНИЕ and 8=624/622+800

if var GrL of 1, 2, 5, 6 pylons
and there is need for ***shooting of 2 and 5*** *GrL*
- use: 7=800 ВНУТР ИЛИ 624 and 8=800

if var GrL of 1, 6 and MGun of 2, 5 pylons
and there is need for ***shooting of 1 and 6*** *GrL*
- use: 7=ВНУТР 800 ВНЕШНИЕ and 8=624/622+800

Рис. 9.5.Weapon systems setup procedures for employing rocket, cannon, and gun systems

Порядок работы с вооружением Ми-8МТВ2. Бомбовое вооружение

краткое руководство

включить вооружение в следующем порядке:

для сброса **по одной бомбе на одно нажатие**:

1, 2, 3-I (положение римское I, как указывает красный треугольный маркер на этой схеме),
4 (включить - вправо), 6 (II..V выбрать вариант), 10, 5 - нажать кнопку СБРОС

для сброса **по две бомбы на одно нажатие**:

1, 2, 3-II (положение римское II, как указывает синий треугольный маркер),
4 (включить - вправо), 6 (II..V выбрать вариант), 10, 5 - нажать кнопку СБРОС

Рис. 9.6.Weapon systems setup procedures for employing bombs

2. Set the required elevation angle on the PKV collimating sight for the given attack profile (weapon type, flight profile, target range). Use the mouse or keyboard shortcuts to turn the PKV elevation angle knob to set the required elevation angle. If desired, utilize the PKV snapviewas described above. The required PKV elevation angles are provided below for various attack profiles in Table. 9.1 - Table. 9.9.

SIGHT ELEVATION FOR EMPLOYMENT OF B8V20A ROCKET LAUNCHERS FROM LEVEL FLIGHT:

Table. 9.1

Target range at launch, m	Sight elevation setting for **S-8KOM** (and other types with mass of 11 - 12 kg) from **B8V20A** launchers from level flight, in mils, for various airspeeds, in kph			
	100	150	200	250
1000	82	73	57	13
1500	90	80	64	20
2000	100	90	76	32
2500	114	104	90	44
3000	128	118	104	58
3500	146	136	122	76

Table. 9.2

Target range at launch, m	Sight elevation setting for **S-8OFP2** (mass 16.7 kg) from **B8V20A** launchers from level flight, in mils, for various airspeeds, in kph			
	100	150	200	250
1000	100	90	74	34
1500	112	102	86	46
2000	125	114	98	58
2500	139	128	112	72
3000	152	141	125	85
3500	169	157	140	99

return to unguided rocket system description
return to PKV collimating sight description

SIGHT ELEVATION FOR EMPLOYMENT OF B8V20A ROCKET LAUNCHERS FROM A DIVE:

Table. 9.3

Dive angle, deg	Dive entry airspeed, kph	Airspeed at launch, kph	Target range at launch, m	Sight elevation setting for employment of **B8V20A** launchers of various rocket types from a **dive**, mils S-8KOM
10	150	180	1500	68
			2000	74
			2500	82
			3000	92
			3500	104

20	150	200	1500	64
			2000	70
			2500	78
			3000	88
			3500	98
			4000	110
			4500	128

Wind correction (B8V20A):

Table. 9.4

Wind direction on attack course, deg	Wind speed, m/sec	Wind correction, mils S-8KOM
30°; 150°; 210° и 330°	5	5
	10	10
	15	15
60°;120°; 240° и 300°	5	8
	10	17
	15	25
90° и 270°	5	10
	10	19
	15	29

Sight elevation for employment of UPK-23-250 in level flight:

Table. 9.5

Indicated air-speed, kph	Sight elevation settings for employment of **GSh-23L** cannon (**UPK-23-250** pod) against ground targets from level flight at various target ranges, in mils					
	500 m	1000 m	1500 m	2000 m	2500 m	3000 m
0	48	56	72	90	—	—
100-250	44	54	66	84	102	123

Sight elevation for employing GUV-8700 YakB 12.7 mm guns:

Table. 9.6

Dive angle, deg	Target range, m	Sight elevation settings for employment of **YakB-12.7** (GUV), in mils, for various airspeeds, in kph				
		0	100	150	200	250
0	500	65	65	65	60	60
	1000	70	70	70	65	65
	1500	80	80	80	75	70
	2000	95	95	90	90	85
10	500	–	–	60	60	55
	1000	–	–	65	65	60
	1500	–	–	75	70	65
	2000	–	–	85	85	80
20	500	–	–	55	50	45
	1000	–	–	60	55	50
	1500	–	–	70	65	60
	2000	–	–	80	75	70

30	500	–	–	45	40	–
	1000	–	–	50	45	–
	1500	–	–	60	55	–
	2000	–	–	70	65	–

SIGHT ELEVATION FOR EMPLOYING GUV-8700 GSHG-7.62 MM GUNS:

Table. 9.7

Dive angle, deg	Target range, m	Sight elevation settings for employment of **GShG-7.62** (GUV), in mils, for various airspeeds, in kph				
		0	100	150	200	250
0	500	65	60	60	60	55
	1000	70	70	70	65	65
	1500	90	90	85	85	80
	2000	120	120	115	110	105
10	500	–	–	60	55	55
	1000	–	–	65	65	60
	1500	–	–	85	80	65
	2000	–	–	110	110	80
20	500	–	–	50	50	45
	1000	–	–	60	55	50
	1500	–	–	75	75	60
	2000	–	–	100	100	70

SIGHT ELEVATION FOR EMPLOYING GUV-8700 AP-30 AUTOMATIC GRENADE LAUNCHER:

Table. 9.8

Dive angle, deg	Target range, m	Sight elevation settings for employment of **AP-30** (GUV), in mils, for various airspeeds, in kph						
		100	140	160	180	200	220	250
0	800	80	70	65	60	50	45	30
	1000	115	105	100	90	85	75	60
	1500	225	200	190	175	165	155	135
	2000	–	–	–	–	–	245	225
10	800	–	70	65	60	50	40	30
	1000	–	105	100	90	80	70	55
	1500	–	195	185	175	160	150	130
	2000	–	–	–	–	–	237	217
20	800	–	65	60	50	40	30	–
	1000	–	90	85	75	70	60	–
	1500	–	175	165	155	145	130	–
	2000	–	–	–	240	220	215	–

NOTE

Generally multiple bursts are assumed in an attack run, but adjusting the sight elevation setting between bursts is not practical as there is not sufficient time in the attack. Given the attack plan (starting target range, ending target range, weapons planned for employment, etc), a maximum and minimum range is calculated. The sight elevation setting is set to the average range between the calculated maximum and minimum ranges. When planning the attack, the difference between the resultant sight elevation setting and the closest matching setting in the chart *is taken as a basis for calculating high or low correction on the reticle sight during the attack phase. For example see Рис. 9.8. In the simulation, the default sight elevation setting is 69 mils, which can be taken as a basis for calculating the required reticle correction in the attack phase.*

SIGHT ELEVATION FOR BOMBING FROM LOW ALTITUDES USING THE PKV COLLIMATING SIGHT:

Table. 9.9

Altitude, m	Sight elevation setting, in mils, for various ground speeds, in kph Release delay, sec										
	150	160	170	180	190	200	210	220	230	240	250
50	200	200	200	200	183	174	165	157	149	140	123
	1.0	0.5	0.5	—	—	—	—	—	—	—	—
100	200	200	200	200	200	200	200	200	200	200	200
	3.0	2.5	2.0	2.0	1.5	1.0	0.5	0.5	0.5	—	—
Release delay, sec											
150	6.0	5.5	5.0	4.5	4.0	3.5	3.0	2.5	2.0	1.5	1.0
200	8.5	7.5	7.0	6.5	6.0	5.5	5.0	4.5	4.0	3.5	3.0
250	11.5	10.5	10.0	9.5	8.5	8.0	7,.0	6.0	5.5	5.0	4.5
300	15.0	14.0	13.0	11.5	10.0	9.5	9.0	8.5	7.5	6.5	6.0

N O T E

1. The required sight elevation setting must be set by rotating the elevation knob on the PKV collimating sight. For example, for a release from an altitude of 50 m at 200 kph, the elevation setting must be set to 174 mils, as demonstrated in Fig. 9.7.

*2. Release delay - the time delay between the target passing throught the **bottom point of the outer reticle ring** (along the center vertical line or displaced to either side in case of crosswind or sideslip) and bomb release.*

3. When employing bombs from low altitude, a fuze delay setting is used to avoid damaging the helicopter and crew (not currently implemented)

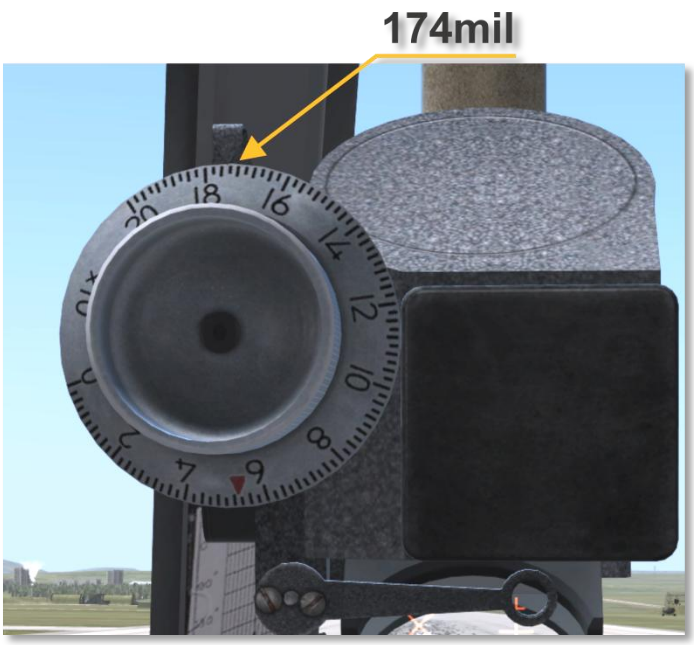


Рис. 9.7. Setting 174 mil elevation on the PKV sight

3. Prior to flight (takeoff), it is recommended to prepare, in particular for the attack phase, by mentally picturing the sequence of events: target search, aiming, aim adjustment based on conditions, exiting the attack, checking for threats or return fire.

As experience with employment of rocket and cannon/gun systems increases, the interval between subsequent salvos of fire tends to close to 3 – 5 seconds. At an airspeed of 180 – 200 kph the helicopter closes approximately 250 – 285 meters or range to the target, requiring a nose down aim adjustment of approximately 3 – 6 mils (1/2 reticle subtension). Additionally, any speed increase also requires an aim adjustment. For example an increase of 20 kph requires a reduction of elevation by 4 – 5 mils (1/2 reticle subtension).

As such when initiating a rocket or cannon/gun attack run at maximum range, raise the reticle cross above the target in accordance with the calculated adjustment. As the target range closes toward minimum range, lower the reticle cross by approximately 1 subtension (10 mils) for each 5 seconds of flight time at 200 kph. If airspeed increases in the attack run to 250 kph, the reticle adjustment during the attack may be as high as 2 – 3 subtensions.

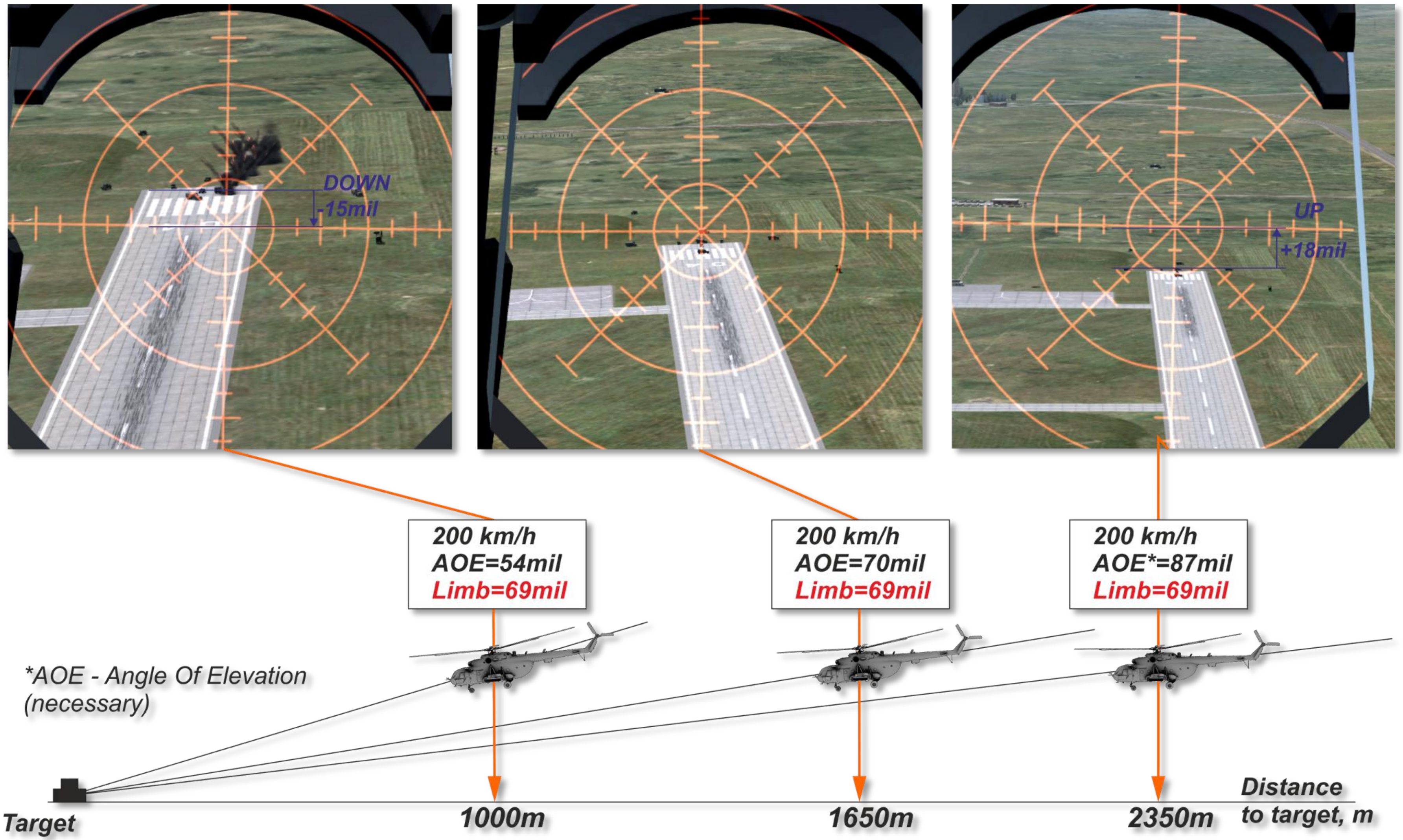


Рис. 9.8. Estimated required target elevation angle in three points of the attack run without adjusting the PKV elevation knob

9.4.2. ATTACK RUN

The approach to the target area must be planned and flown so as to minimize the chances of detection by hostile forces and engagement by hostile air defense assets. Low altitude to nap-of-the-earth (NOE) flight is generally most effective at minimizing exposure to threats.

When employing rockets or cannon/gun systems, generally the most effective flight profile in the attack is level flight with an airspeed of 180 – 200 kph in the initial phase followed by a shallow dive (5 – 10°) in the aiming and firing phase. Once stabilizing at this airspeed, re-trim the autopilot by neutralizing the deviations on the autopilot zero indicator, trim the flight controls, take note of the collective pitch angle (this will be helpful in re-establishing level flight after the attack).

Turn on the WEAPONS MAIN and/or BOMBS MAIN power switches as required depending on employed weapon system.

At a range of 3000 – 2500 m, perform a pop-up maneuver to gain visual contact with the target. This can be done either using the cyclic to increase pitch by +10 – 15° or using the collective to increase collective lift. Once attack altitude is reached, return to level flight by either reducing pitch or collective depending on the method used to perform the pop-up maneuver.

N O T E

Although the second (collective) option for performing the pop-up maneuver is less "pretty", it is nevertheless preferable as it maintains line of sight to the target, avoids increasing own helicopter's area of exposure to air defense fire, and prevents a loss of airspeed in the pop-up maneuver.

At the attack altitude, set the collective pitch as required for level flight (angle noted prior to the pop-up maneuver), search for and identify the target, perform any required heading corrections to line up with the target, and eliminate any climb/descent to maintain level flight.

N O T E

Remember that weapons fire in conditions of vertical speed or side sleep becomes highly inaccurate. Rocket and cannon and machine gun rounds will fall short if fired in a negative vertical velocity condition and fall long if fired in positive vertical velocity condition. If fired with side slip, the rounds will tend to fall toward the side of the slip ball. Rockets are particularly sensitive to poor firing conditions due to their (relatively) low initial velocity of 30 – 50 m/sec.

If the attack heading is taken out of a turn, the leveling of the turn should being when the remaining turn angle approximately equals the turn roll angle, i.e. if the roll angle in the turn is 40°, begin to level out of the turn onto the attack heading approximately 40° short of the attack heading. Remember that turns with large roll angles (exceeding 15°) result in a climbing tendency when the helicopter is leveled out of the turn, requiring a reduction in collective pitch by 1/8 – 1/6 travel.

Next steps:

Employing rockets or cannon/gun systems:

a) After leveling out of the turn establish level flight at 180 – 200 kph, eliminate climb/descent rate, center the slip ball (to minimize dispersion)

b) When employing rockets: at 2500 m perform final course corrections to place the target directly on course, place the sight reticle over the target with smooth cyclic control, adjust reticle position based on range and wind correction and initiate weapons fire at 2000 m by pressing the WEAPONS FIRE switch on the cyclic control handle

c) If multiple salvos are planned, continue to close the range to the target while making aim corrections for the reduced range and, if required, increased airspeed (see pg. 204)

d) Turn off the target prior to reaching minimum range (1000 m)

Rocket and cannon/gun fire produces a slight recoil which tends to pitch the helicopter down due to the payload being positioned below the CG. When firing long salvos, plan for recoil effects by correcting the reticle position 3 – 5 mils higher to allow for recoil drop during the fire sequence.

Bomb delivery by the pilot using the PKV collimating sight:

a) Plan the attack run such that it take 10 – 15 sec between initial point and release points. As experience grows, this time can be reduced.

b) If no crosswind is present, maintain the attack heading such that the helicopter flight path crossed directly over the target. In this case, the PKV reticle cross should cross over the target as well.

c) In a crosswind condition, the PKV sight picture has to be adjusted so that the vertical bar passes to the left (right) of the target at an angle equal to the slip angle in the opposite direction

d) In a head or tailwind condition (as well as no wind), bombs are released when the target passes through the bottom of the outside ring of the reticle (Рис. 9.9);

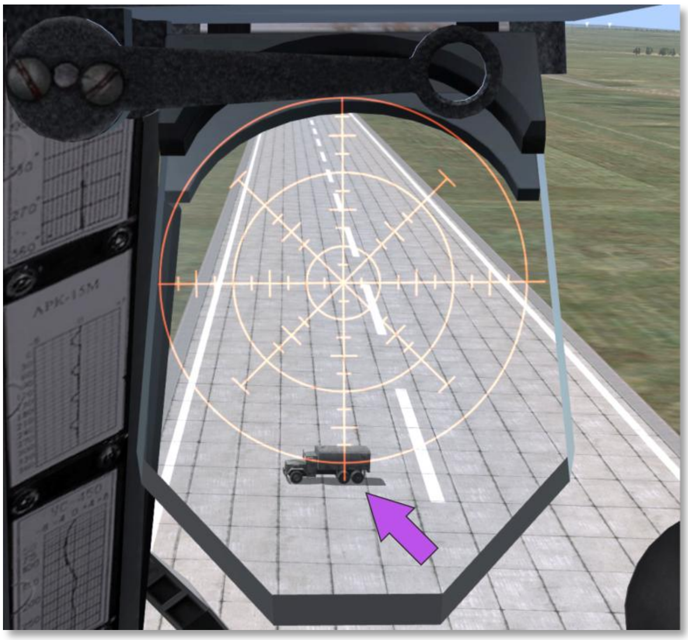


Рис. 9.9. Bomb release point in calm weather or only head/tailwind; altitude 50 m

e) In a crosswind condition, bombs are released when the target passes through an imaginary horizontal line that is tangent to the bottom point of the outside ring of the reticle Рис. 9.10;

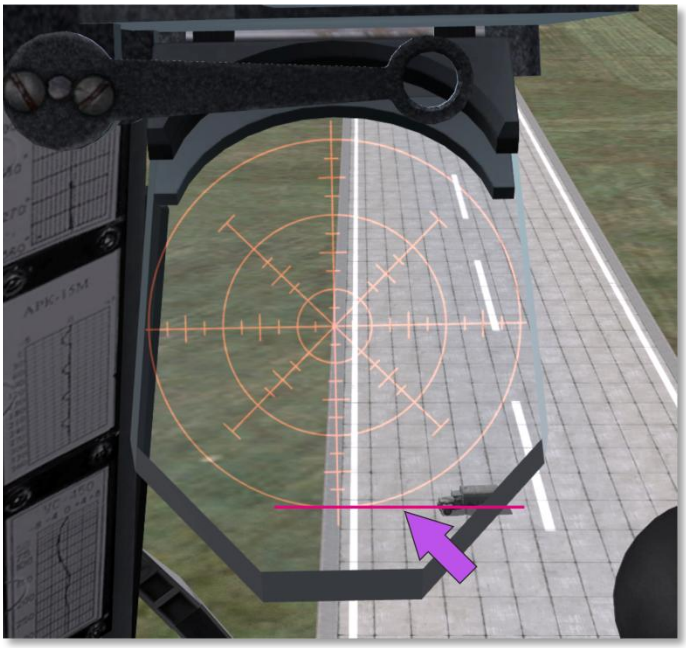


Рис. 9.10. Bomb release point in a LEFT crosswind condition; altitude 100 m

f) If the target line of sight passes under the PKV reticle visible view angles, the bomb release point is estimated using a countdown. In this case the PKV elevation is set to the lowest angle of 200 mils.

g) After the target passes through the intersection of the reticle vertical bar and outside ring, the pilot begins the countdown and releases the bombs upon completing the countdown.

Bombs released from low altitudes and set for delayed detonation may bounce and detonate further afield.

9.4.3. EXITING THE ATTACK

After completing weapons fire, perform an energetic maneuver away from the target while descending to low altitudes and increasing airspeed to maximum of 230 – 250 kph. To minimize exposure to hostile air defenses, perform evasive maneuvering: alternating left and right turns of 30 – 40° bank and 40 – 50° heading (4 – 5 sec) until reaching 1000 – 1500 m of range off the target.

If required, repeat the attack pass(es).

When the attack is complete, switch OFF the WEAPONS MAIN and/or BOMBS MAIN power switches.

Navigate to the landing point.

10. ADDITIONAL (SPECIAL) AIRCRAFT PROPERTIES

The DCS Mission Editor includes a number of special "tuning" options for the Mi-8MTV2 helicopter.

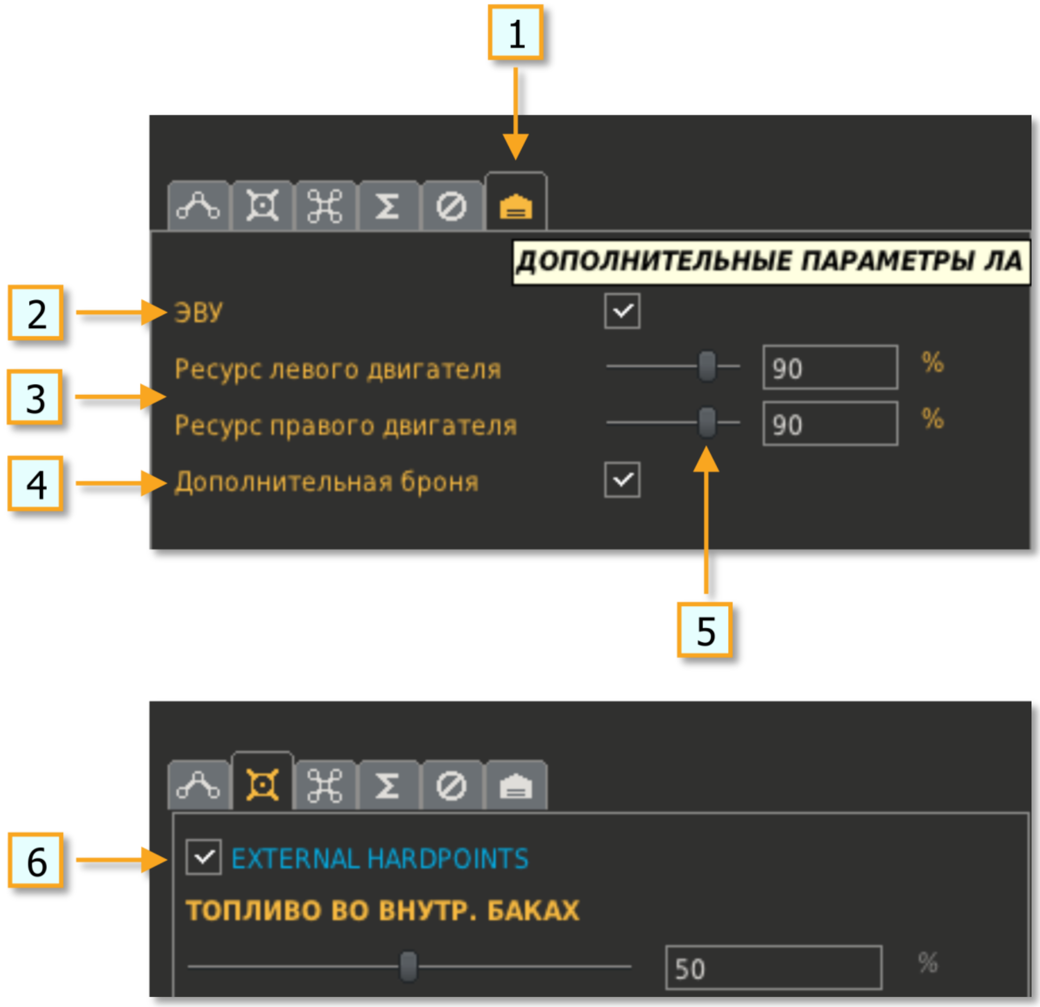
In additional to the standard air group settings of the ME, the following special properties are available for the Mi-8MTV2:

Exhaust Gas Suppressors (EGS) (IR signature suppressors) ON/OFF

Engine health (0 – 100%)

Addon armor plating

External weapon stations



1. Additional properties menu tab
2. EGS checkbox
3. Engine health setting
4. Addon armor checkbox
5. Engine health slidebars
6. External weapons stations checkbox

Рис. 9.11. Additional aircraft properties menu of mission editor

EGS: Installment of EGS approximately halves the helicopter's IR signature, which reduced the effective engagement range of IR air defense missiles and increases the chances of avoiding air defense threats.

N O T E . *The EGS also have a negative effect on flight performance. Maximum takeoff weight must be reduced by 300 kg. When consulting performance charts, this is equivalent of raising the OAT by 3°C. The helicopter's takeoff weight also increases by 160 kg.*

ADDON ARMOR: Increase the helicopter vital systems and crew survivability (in development) against small arms and shrapnel damage. Increases takeoff weight by 419 kg.

ENGINE HEALTH: Can be lowered to simulate reduced engine performance and higher risk of engine failure. Reduced engine performance results in reduced helicopter flight performance.

N O T E

90% is the default value and corresponds to a brand new factory engine.

100% – test bench performance

The coefficient is non-linear, as such:

75% – NR droops at 11.5° collective pitch

50% – NR droops starting at 5° pitch. At this condition the engines are not airworthy.

EXTERNAL WEAPONS STATIONS: Used to carry the full assortment of available weapon systems. Increases takeoff weight by 401 kg.

11. COMMANDS LIST

#	KEYBOARD KEY(S)	SIMULATION COMMAND
		Armament System
1	"O"	800 или 624-622-800
2	"RShift - O"	800 или 624-622-800 крышка
3	"LAlt - R"	Cut Off On/Off
4	"RAlt - B"	ESBR On/Off
5	"RAlt - RShift - B"	ESBR Rotate
6	"H"	Emergency Explode
7	"RAlt - H"	Emergency Explode Cover
8	"J"	Emergency Release
9	"LAlt - J"	Emergency Release Cover
10	"RAlt - RCtrl - ["	GUV Mode Decr
11	"RAlt - RCtrl -]"	GUV Mode Incr
12	"RCtrl - P"	Main Bomb Switcher
13	"P"	Main Switcher
14	"RCtrl - ["	Mode UPK/PKT/RS Down
15	"RCtrl -]"	Mode UPK/PKT/RS Up
16	";"	Pylons setup Down
17	"."	Pylons setup Up
18	"B"	Release Bomb
19	"RAlt - ["	Rocket Pylons 1-2-5-6/Auto/3-4 Down
20	"RAlt -]"	Rocket Pylons 1-2-5-6/Auto/3-4 Up
21	"RShift - ["	Rocket Series 8-16-4 Down
22	"RShift -]"	Rocket Series 8-16-4 Up
23	"RAlt - L"	Second Pilot Check Lamp
24	"I"	Second Pilot Emergency Explode
25	"RAlt - I"	Second Pilot Emergency Explode Cover
26	"U"	Second Pilot Emergency Release
27	"RAlt - U"	Second Pilot Emergency Release Cover
28	"LAlt - S"	Weapon Safe Switcher
29	"LCtrl - R"	ПУС, взведение
30	"L"	Проверка сигнальных ламп
31	","	ЭСБР, обогрев
		Левая панель электропульта
	"LAlt - LShift - G"	Attitude Indicator Left, Power
	"LAlt - LShift - F"	ВК-53, питание
	"LAlt - LShift - T"	СУУ-52, питание
		Панель АЗС
32	"RCtrl - RShift - 1"	Group 1 CB switcher
33	"RCtrl - RShift - 2"	Group 2 CB switcher
34	"RCtrl - RShift - 3"	Group 3 CB switcher
35	"RCtrl - RShift - 4"	Group 4 CB switcher
36	"RCtrl - RShift - 5"	Group 5 CB switcher
37	"RCtrl - RShift - 6"	Group 6 CB switcher
38	"RCtrl - RShift - 7"	Group 7 CB switcher
39	"RCtrl - RShift - 8"	Group 8 CB switcher
40	"RCtrl - RShift - 9"	Group 9 CB switcher
		Правая панель электропульта
41	"RAlt - RShift - T"	Doppler Navigator, Power
42	"RCtrl - RShift - P"	GMC, Astrocompass Mode
43	"RCtrl - RShift - G"	GMC, Control 0
44	"RCtrl - RShift - Y"	GMC, Control 300
45	"RCtrl - RShift - O"	GMC, Gyrocompass Mode
46	"RCtrl - RShift - I"	GMC, Magnetic Compass Mode
47	"RCtrl - RShift - U"	GMC, Nord/Souse Hemisphere
48	"RAlt - RShift - U"	GMC, Power
49	"RCtrl - RShift - K"	GMC, Set Course Left

#	KEYBOARD KEY(S)	SIMULATION COMMAND
50	"RCtrl - RShift - L"	GMC, Set Course Right
51	"RCtrl - RShift - H"	GMC, Set Latitude Decrease
52	"RCtrl - RShift - J"	GMC, Set Latitude Increase
53	"RAlt - RCtrl - Z"	АРК УД, МВ/ДВ
54	"RAlt - RCtrl - F"	АРК УД, антенна левая
55	"RAlt - RCtrl - G"	АРК УД, антенна правая
56	"RAlt - RCtrl - C"	АРК УД, выкл.
57	"RAlt - RCtrl - S"	АРК УД, громкость, увеличить
58	"RAlt - RCtrl - A"	АРК УД, громкость, уменьшить
59	"RAlt - RCtrl - N"	АРК УД, импульсный сигнал
60	"RAlt - RCtrl - 1"	АРК УД, канал 1
61	"RAlt - RCtrl - 2"	АРК УД, канал 2
62	"RAlt - RCtrl - 3"	АРК УД, канал 3
63	"RAlt - RCtrl - 4"	АРК УД, канал 4
64	"RAlt - RCtrl - 5"	АРК УД, канал 5
65	"RAlt - RCtrl - 6"	АРК УД, канал 6
66	"RAlt - RCtrl - M"	АРК УД, радиокомпас
67	"RAlt - RCtrl - V"	АРК УД, узкий диапазон
68	"RAlt - RCtrl - D"	АРК УД, управление
69	"RAlt - RCtrl - X"	АРК УД, чувствительность
70	"RAlt - RCtrl - B"	АРК УД, широкий диапазон
71	"RAlt - RCtrl - P"	Авиагоризонт правый, выключатель
72	"RAlt - RCtrl - RShift - P"	Астрокомпас, питание
73	"RAlt - RShift - L"	Ларингофон
		Виды
74	"LShift - F4"	Аркадный вид на заднюю полусферу
75	"Num8"	Взгляд плавно вверх
76	"Num7"	Взгляд плавно вверх-влево
77	"Num9"	Взгляд плавно вверх-вправо
78	"Num4"	Взгляд плавно влево
79	"Num2"	Взгляд плавно вниз
80	"Num1"	Взгляд плавно вниз-влево
81	"Num3"	Взгляд плавно вниз-вправо
82	"Num6"	Взгляд плавно вправо
83	"F1"	Вид из кабины
84	"F2"	Вид на ЛА
85	"F5"	Вид на ближайший ЛА
86	"LCtrl - F12"	Вид на гражданский трафик
87	"LCtrl - F5"	Вид на дружественные наземные объекты
88	"LCtrl - F4"	Вид на заднюю полусферу
89	"F4"	Вид на заднюю полусферу
90	"F10"	Вид на карту боевых действий
91	"F9"	Вид на корабли
92	"F7"	Вид на наземные объекты
93	"F6"	Вид на оружие
94	"F3"	Вид на пролете
95	"LCtrl - F2"	Вид на свой ЛА
96	"F12"	Вид на статические объекты
97	"F8"	Вид на цель
98	"LCtrl - F6"	Вид оружие-цель
99	"LAlt - F9"	Вид со стороны офицера посадки
100	"LAlt - F1"	Вид только ИЛС
101	"LAlt - Delete"	Исключить объект
102	"LAlt - Insert"	Исключить/включить все объекты
103	"NumEnter"	Нормальный угол зрения
104	"RCtrl - NumEnter"	Нормальный угол зрения - вид снаружи
105	"LShift - F12"	Переключатель вида на поезда/автомобили
106	"LAlt - F2"	Переключение локального управления камерой
107	"LCtrl - F10"	Переключение на вид ТВД над текущей точкой
108	"LCtrl - F3"	Переключение на вид на пролете
109	"LCtrl - PageDown"	Переключение на просмотр объектов вперед

#	KEYBOARD KEY(S)	SIMULATION COMMAND
110	"LCtrl - F11"	Переключение на свободную камеру
111	"RAlt - F2"	Переключение позиции камеры
112	"LAlt - Num*"	Перемещение камеры вперед
113	"LAlt - Num/"	Перемещение камеры назад
114	"Num/"	Поле зрения расширить (вид в кабине) плавно / отдалиться (вид снаружи)
115	"RCtrl - Num/"	Поле зрения расширить (зум -) плавно (вид снаружи)
116	"Num*"	Поле зрения сузить (вид в кабине) плавно / приблизиться (вид снаружи)
117	"RCtrl - Num*"	Поле зрения сузить (зум +) плавно (вид снаружи)
118	"LCtrl - F1"	Реалистичные перемещения головы пилота
119	"F11"	Свободная камера аэродрома
120	"LCtrl - PageUp"	Смена направления переключения объектов
121	"RAlt - F8"	Фильтр цели игрока/все цели
122	"Num5"	Центровка взгляда
		Виды - кабина
123	"2"	Set Copilot Seat
124	"1"	Set Pilot Seat
125	"3"	Set Technician Seat
126	"LWin - Num0"	Быстрый взгляд 0
127	"LWin - Num1"	Быстрый взгляд 1
128	"LWin - Num2"	Быстрый взгляд 2
129	"LWin - Num3"	Быстрый взгляд 3
130	"LWin - Num4"	Быстрый взгляд 4
131	"LWin - Num5"	Быстрый взгляд 5
132	"LWin - Num6"	Быстрый взгляд 6
133	"LWin - Num7"	Быстрый взгляд 7
134	"LWin - Num8"	Быстрый взгляд 8
135	"LWin - Num9"	Быстрый взгляд 9
136	"RShift - Num8"	Взгляд вверх
137	"RShift - Num7"	Взгляд вверх-влево
138	"RShift - Num9"	Взгляд вверх-вправо
139	"RShift - Num4"	Взгляд влево
140	"RShift - Num2"	Взгляд вниз
141	"RShift - Num1"	Взгляд вниз-влево
142	"RShift - Num3"	Взгляд вниз-вправо
143	"RShift - Num6"	Взгляд вправо
144	"Num0"	Взгляд на приборы в кабине
145	"RShift - Num/"	Вид в кабине, поле зрения расширить (зум -)
146	"RShift - Num*"	Вид в кабине, поле зрения сузить (зум +)
147	"RCtrl - Num5"	Возврат камеры
148	"RAlt - Num5"	Возврат камеры в исходную точку
149	"RCtrl - RShift - Num5"	Камера в кабине - перемещение в центр
150	"RCtrl - RShift - Num8"	Камера в кабине - перемещение вверх
151	"RCtrl - RShift - Num4"	Камера в кабине - перемещение влево
152	"RCtrl - RShift - Num2"	Камера в кабине - перемещение вниз
153	"RCtrl - RShift - Num*"	Камера в кабине - перемещение вперед
154	"RCtrl - RShift - Num6"	Камера в кабине - перемещение вправо
155	"RCtrl - RShift - Num/"	Камера в кабине - перемещение назад
156	"RShift - Num5"	Камера в центр обзора
157	"RCtrl - Num8"	Камера вверх
158	"RCtrl - Num7"	Камера вверх-влево
159	"RCtrl - Num9"	Камера вверх-вправо
160	"RCtrl - Num4"	Камера влево
161	"RCtrl - Num2"	Камера вниз
162	"RCtrl - Num1"	Камера вниз-влево
163	"RCtrl - Num3"	Камера вниз-вправо
164	"RCtrl - Num6"	Камера вправо
165	"RAlt - Num8"	Камера плавно вверх
166	"RAlt - Num7"	Камера плавно вверх-влево
167	"RAlt - Num9"	Камера плавно вверх-вправо

#	KEYBOARD KEY(S)	SIMULATION COMMAND
168	"RAlt - Num4"	Камера плавно влево
169	"RAlt - Num2"	Камера плавно вниз
170	"RAlt - Num1"	Камера плавно вниз-влево
171	"RAlt - Num3"	Камера плавно вниз-вправо
172	"RAlt - Num6"	Камера плавно вправо
173	"LShift - ["	Обзор мышью, быстрее
174	"LCtrl - ["	Обзор мышью, медленнее
175	"LAlt - ["	Обзор мышью, нормальная скорость
176	"LShift -]"	Обзор с клавиатуры, быстрее
177	"LCtrl -]"	Обзор с клавиатуры, медленнее
178	"LAlt -]"	Обзор с клавиатуры, нормальная скорость
179	"RCtrl - Num0"	Переключатель взгляда на приборы в кабине
180		Перемещение камеры, вкл./ выкл.
181	"LWin - F1"	Смещения головы Вкл/Выкл
182	"RAlt - Num0"	Сохранить углы обзора
		Виды - расширенное управление
183	"LAlt - K"	Зафиксировать высоту наземной камеры
184	"LShift - J"	Имитация дрожания видеокамеры
185	"RCtrl - Num+"	Переключение на слежение за полетом оружия
186	"RCtrl - RShift - RAlt - A"	Фильтр внешних камер, все объекты
187	"RCtrl - RShift - RAlt - F"	Фильтр внешних камер, дружественные объекты
188	"RCtrl - RShift - RAlt - D"	Фильтр внешних камер, противник
		Левая панель
189	"LCtrl - B"	Altimeter Left, Pressure Decrease
190	"LShift - B"	Altimeter Left, Pressure Increase
191	"LCtrl - LShift - N"	Attitude Indicator Left, Cage
192	"LCtrl - N"	Attitude Indicator Left, Pitch Decrease
193	"LShift - N"	Attitude Indicator Left, Pitch Increase
194	"LAlt - H"	HSI Left, ARC-9/ARC-UD Select
195	"LCtrl - H"	HSI Left, Course Decrease
196	"LShift - H"	HSI Left, Course Increase
197	"LShift - ,"	Radar Altimeter, dangerous ALT set rotary left
198	"LShift - ."	Radar Altimeter, dangerous ALT set rotary right
199	"LAlt - LShift - A"	Static Pressure System Selector, Left
200	"LAlt - LShift - S"	Static Pressure System Selector, Right
201	"LAlt - LShift - R"	Радиовысотомер, кнопка контроля
		Метки
202	"LShift - F2"	Метки ЛА
203	"LShift - F10"	Метки все
204	"LShift - F9"	Метки наземной техники и кораблей
205	"LShift - F6"	Метки ракет
		Наколенный планшет
206	"K"	Наколенный планшет, быстрый взгляд
207	"RShift - K"	Наколенный планшет, вкл./выкл.
208	"["	Наколенный планшет, предыдущая страница
209	"]"	Наколенный планшет, следующая страница
210	"RCtrl - K"	Наколенный планшет, текущее положение
		Общие
211	"LAlt - Z"	Время замедление
212	"LShift - Z"	Время нормальное
213	"LCtrl - Z"	Время ускорение
214	"Esc"	Закончить миссию
215	"RCtrl - Enter"	Индикация положения органов управления
216	"LAlt - C"	Кликабельная кабина Вкл/Выкл
217	"RCtrl - RShift - Tab"	Новый ЛА - восстановление
218	"LAlt - B"	Окно брифинга
219	"RShift - '"	Окно дебрифинга
220	"LAlt - '"	Окно перевооружения и дозаправки
221	"'"	Окно текущего счёта
222	"Pause"	Пауза
223	"LAlt - Y"	Переключение единиц измерения координат информ.

#	KEYBOARD KEY(S)	SIMULATION COMMAND
		строки
224	"LCtrl - Y"	Переключение информационной строки
225	"RAlt - J"	Переключение на другой ЛА
226	"SysRQ"	Скриншот
227	"RCtrl - Pause"	Счетчик кадров в секунду - служебная информация
228	"Tab"	Чат всем
229	"RCtrl - Tab"	Чат своим
		Осевые команды
230		Autopilot Heading Adjustment
231		Autopilot Pitch Adjustment
232		Autopilot Roll Adjustment
233		Corrector
234		Камера в кабине, вертикаль
235		Камера в кабине, вертикаль (абсолют)
236		Камера в кабине, вертикальное смещение (абсолют)
237		Камера в кабине, горизонталь
238		Камера в кабине, горизонталь (абсолют)
239		Камера в кабине, зум
240		Камера в кабине, зум (абсолют)
241		Камера в кабине, крен (абсолют)
242		Камера в кабине, поперечное смещение (абсолют)
243		Камера в кабине, продольное смещение (абсолют)
244		Педали
245		Ручка ППУ, крен
246		Ручка ППУ, тангаж
247		Рычаг общего шага (РОШ)
		Отладка
248	"LWin - R"	Кабина, перезагрузить
249	"LAlt - `"	Консоль, переключить
		Падлок
250	"Num."	Падлок ЛА (циклический перебор)
251	"RShift - Num."	Падлок все ракеты
252	"NumLock"	Падлок сброс (выключить падлок)
253	"RCtrl - Num."	Падлок точки поверхности
254	"RAlt - Num."	Падлок угрожающей ракеты
		Панель управления запуском двигателей
255	"Home"	Запуск двигателя, кнопка
256	"LAlt - E"	Запуск/холодная прокрутка/ложный запуск, переключатель
257	"RAlt - PageUp"	РРУД левый вверх
258	"RAlt - PageDown"	РРУД левый вниз
259	"RShift - PageUp"	РРУД правый вверх
260	"RShift - PageDown"	РРУД правый вниз
261	"E"	Селектор двигателей, переключатель
262	"End"	Стоп ВСУ, кнопка
263	"RAlt - Home"	Стоп запуск, кнопка
264	"RCtrl - PageUp"	Стоп-кран левого двигателя
265	"RCtrl - PageDown"	Стоп-кран правого двигателя
		Педали
266	"Z"	Педали влево
267	"X"	Педали вправо
		Переговорное устройство СПУ-7
268	"LAlt - LShift - Q"	SPU-7, Main Volume Decrease
269	"LAlt - LCtrl - Q"	SPU-7, Main Volume Increase
270	"LAlt - LShift - E"	SPU-7, Radio Source Select Rotary Left
271	"LAlt - LCtrl - E"	SPU-7, Radio Source Select Rotary Right
272	"LAlt - LCtrl - Z"	SPU-7, Radio/ICS
273	"LAlt - LCtrl - W"	СПУ-7, громкость увеличить
274	"LAlt - LShift - W"	СПУ-7, громкость уменьшить
		Пилотажный комплекс ПКВ
275	"RAlt - O"	Sight Intensity Decrease

#	KEYBOARD KEY(S)	SIMULATION COMMAND
276	"RCtrl - O"	Sight Intensity Increase
		Правая панель
277	"RCtrl - B"	Altimeter Right, Pressure Decrease
278	"RShift - B"	Altimeter Right, Pressure Increase
279	"RCtrl - RShift - N"	Attitude Indicator Right, Cage
280	"RCtrl - N"	Attitude Indicator Right, Pitch Decrease
281	"RShift - N"	Attitude Indicator Right, Pitch Increase
282	"RCtrl - RShift - V"	Fuel Meter, Rotary Left
283	"RCtrl - RShift - B"	Fuel Meter, Rotary Right
284	"RCtrl - H"	HSI Right, Course Decrease
285	"RShift - H"	HSI Right, Course Increase
286	"RCtrl - RShift - RAlt - C"	Mech Clock, Left lever Down
287	"RShift - M"	Mech Clock, Left lever Up
288	"RAlt - ,"	Mech Clock, Left lever turning left
289	"RAlt - ."	Mech Clock, Left lever turning right
290	"RShift - RAlt - C"	Mech Clock, Right lever Down
291	"RCtrl - RShift - ,"	Mech Clock, Right lever Rotate left
292	"RCtrl - RShift - ."	Mech Clock, Right lever Rotate right
		Пульт управления УВ-26
293	"RAlt -]"	УВ-26, БОРТ ЛЕВЫЙ-ОБА-ПРАВЫЙ, переключатель
294	"RCtrl - Insert"	УВ-26, ЗАЛП - количество патронов в залпе
295	"RAlt - Insert"	УВ-26, ИНТЕРВАЛ - интервал между залпами
296	"RCtrl -]"	УВ-26, НАЛИЧИЕ-ПРОГР, переключатель
297	"Insert"	УВ-26, ПУСК - отстрел тепловых ловушек
298	"RCtrl - Delete"	УВ-26, СБРОС ПРОГР - сброс текущей программы
299	"RShift - Insert"	УВ-26, СЕРИЯ - количество серий залпов
300	"Delete"	УВ-26, СТОП - останов отстрела тепловых ловушек
		Радиопереговоры
301	"LWin - Q"	Атаковать мою цель
302	"LShift - \"	Диалог, переключить
303	"LWin - G"	Звено - атака наземных целей
304	"LWin - D"	Звено - атаковать системы ПВО
305	"LWin - E"	Звено - выполнить миссию и вернуться на базу
306	"LWin - Y"	Звено - сбор
307	"\"	Меню радиопереговоров
308	"LWin - T"	Перестроение
309	"LWin - W"	Прикрой меня
		Радиостанция Р-828 УКВ-1
310		Р-828, громкость больше
311		Р-828, громкость меньше
312		Р-828, настройка, кнопка
313		Р-828, селектор каналов - предыдущий канал
314		Р-828, селектор каналов - следующий канал
315		Р-828, шумоподавитель
		Ручка продольно-поперечного управления (РППУ)
316	"LWin - LShift - A"	Autopilot Cut Off
317	"RShift - Space"	Radio trigger ICS
318	"RAlt - \"	Radio trigger RADIO
319	"Space"	Пуск оружия
320	"Left"	РППУ крен влево
321	"Right"	РППУ крен вправо
322	"Down"	РППУ тангаж вверх
323	"Up"	РППУ тангаж вниз
324	"W"	Тормоз колес (нажать и удерживать)
325	"LShift - W"	Тормоз колес, стояночный
326	"T"	Триммер
327	"LCtrl - T"	Триммер - сброс
		Рычаг общего шага
328	"PageDown"	Correction decrease
329	"PageUp"	Correction increase
330	"LShift - 7"	Left Head Light - down

#	KEYBOARD KEY(S)	SIMULATION COMMAND
331	"LShift - 9"	Left Head Light - left
332	"LShift - 0"	Left Head Light - right
333	"LShift - 8"	Left Head Light - up
334	"RShift - 7"	Right Head Light - down
335	"RShift - 9"	Right Head Light - left
336	"RShift - 0"	Right Head Light - right
337	"RShift - 8"	Right Head Light - up
338	"RCtrl - End"	Throttle Down
339	"RCtrl - Home"	Throttle Up
340	"RAlt - Num-"	Перенастройка оборотов свободной турбины на низкие
341	"RAlt - Num+"	Перенастройка оборотов свободной турбины на номинал
342	"Num+"	РОШ вверх
343	"Num-"	РОШ вниз
344	"F"	Рычаг общего шага, стопор, гашетка
		Сенсоры
345	"RShift - H"	Очки ночного видения
346	"RShift - RAlt - H"	Очки ночного видения, уменьшить сигнал
347	"RShift - RCtrl - H"	Очки ночного видения, усилить сигнал
348	"LAlt - LCtrl - C"	Open/Close Cargo Doors
349	"LShift - LCtrl - C"	Open/Close Left Door
350	"RCtrl - C"	Дверь кабины открыть/закрыть
351	"LCtrl - E"	Покинуть вертолёт (нажать 3 раза)
		Центральная панель
352	"LWin - LAlt - A"	Autopilot Altitude Channel Off
353	"LAlt - A"	Autopilot Altitude Channel On
354	"LAlt - V"	Autopilot Altitude Control Down
355	"LAlt - F"	Autopilot Altitude Control Up
356	"LWin - LShift - S"	Autopilot Heading Adjustment Left
357	"LWin - LShift - D"	Autopilot Heading Adjustment Right
358	"LWin - LCtrl - A"	Autopilot Heading Channel Off
359	"LCtrl - LShift - S"	Autopilot Pitch Adjustment Left
360	"LCtrl - LShift - D"	Autopilot Pitch Adjustment Right
361	"LWin - LCtrl - S"	Autopilot Roll Adjustment Left
362	"LWin - LCtrl - D"	Autopilot Roll Adjustment Right
363	"LWin - A"	Autopilot Roll/Pitch Channel On
364	"LAlt - LCtrl - N"	SPUU-52, Control Adjustment Left
365	"LAlt - LShift - N"	SPUU-52, Control Adjustment Right
366	"LAlt - LCtrl - G"	SPUU-52, Control Engage
367	"LAlt - LCtrl - H"	SPUU-52, Control P
368	"LAlt - LCtrl - J"	SPUU-52, Control t
369	"LCtrl - A"	Автопилот, Канал направления, вкл.
		Чит
370	"LWin - Home"	Автоматическое выполнение процедуры запуска
371	"LWin - End"	Автоматическое выполнения процедуры останова
372	"LShift - LCtrl - X"	Взрыв
373	"LShift - LWin - Pause"	Пауза Активная

12. СПИСОК ТЕРМИНОВ И СОКРАЩЕНИЙ

АВСК Аппаратура внутренней связи и коммутации

АЗС Автомат защиты сети

АНО Аэронавигационные огни

АРК Автоматический радиокомпас

АРП Автоматический радиопеленгатор

АЦП Аналогово-цифровой преобразователь

АЭР Аэродром

БАНО Бортовые аэронавигационные огни. Красный – левый, зеленый – правый.

БЧ Боевая часть

БПРМ Ближняя приводная радиостанция с маркером

БПРС Ближняя приводная радиостанция (1000 м от торца ВПП)

ВМГ Винтомоторная группа

ВПП Взлетно-посадочная полоса

ВС Воздушное судно

ВСУ Вспомогательная силовая установка

ГВ Главный выключатель

ГПК Гирополукомпас

ГУВ Гондола универсальная вертолетная

ДИСС Доплеровский измеритель составляющих скоростей

ДПРМ Дальняя приводная радиостанция с маркером

ДПРС Дальняя приводная радиостанция (4000 м от торца ВПП)

ЗПУ Заданный путевой угол

ИВС Истинная воздушная скорость

ИПМ Исходный пункт маршрута

КМГУ Контейнер мелких грузов универсальный

КПМ Конечный пункт маршрута

КУР Курсовой угол радиостанции

КУЦ Курсовой угол цели

ЛА Летательный аппарат

ЛБУ Линейное боковое уклонение

ЛУР Линейное упреждение разворота

МВ Минное вооружение

МК Магнитный курс

МПР Магнитный пеленг радиостанции

МСА Международная стандартная атмосфера

НАР Неуправляемая авиационная ракета

НВ Несущий винт

НОП Наземный обслуживающий персонал

НППУ Несъемная подвижная пушечная установка

НВР Неуправляемое ракетное воорежение

ОПРС Отдельная приводная радиостанция (NDB)

ОПС Оптическая прицельная система

ОСП Оборудование системы посадки. Система посадки по дальней и ближней приводным радиостанциям (ICAO 2NDB Approach)

ОТ Оперативная точка

ОШ Общий шаг винтов

ПВД Приемник воздушного давления

ПВО Противовоздушная оборона

ПВР Пульт выбора режимов

ПЗУ Пылезащитное устройство

ПНК Пилотажно-навигационный комплекс

ПНП Планово-навигационный прибор

ПОС Противообледенительная система

ППД Приемник полного давления

ППМ Промежуточный пункт маршрута

ППУ Продольно-поперечное управление (ручка)

ПрПНК Прицельно-пилотажно-навигационный комплекс

ПРС Приводная радиостанция

ПТБ Подвесной топливный бак

ПУ Путевой угол

ПУИ Пульт управления и индикации

ПУР Пульт управления режимами

РОШ Рычаг общего шага

РППУ Ручка продольно-поперечного управления

РРУ (РРУД) Рычаги раздельного управления (двигателями)

РС Реактивные снаряды

РСНВ Режим самовращения несущего винта

РУ Расчетный угол

САР Система автоматического регулирования

СГФ Строительная горизонталь фюзеляжа

СПО Стрелково-пушечное оружие

СПУ Самолетное переговорное устройство

СРО Самолетный радиолокационный ответчик госопознавания

СТ Свободная турбина

СУО Система управления оружием

ТК Турбокомпрессор

ТТХ Тактико-технические характеристики

УВД Управление воздушным движением

ФПУ Фактический путевой угол

ХС Хвостовой сигнал. Белого цвета, установлен на киле

ЦАП Цифро-аналоговый преобразователь

ЦСО Центральный сигнальный огонь

ШБЖ Штурманский бортовой журнал

ЭВУ Экранно-выхлопное устройство

ЭРД Электронный регулятор двигателя

GPS Global Positioning System – среднеорбитальная спутниковая радионавигационная система НАВСТАР, разработанная в США

NDB Nondirectional radio-beacon (отдельная приводная радиостанция ОПРС)

NAVSTAR - NAVigation Satellites for Timing And Ranging (навигационные спутники для определения времени и расстояний) – название системы GPS в англоговорящих странах, отсюда русское НАВСТАР

VOR Very-high-frequency omnidirectional range (всенаправленный курсовой радиомаяк УКВ-диапазона)

13. ЭКИВАЛЕНТЫ И КОЭФФИЦИЕНТЫ КОНВЕРТАЦИИ МЕТРИЧЕСКОЙ СИСТЕМЫ В ИМПЕРСКУЮ

13.1 Эквиваленты метрицеских единиц

Linear Measure

1 centimeter = 10 millimeters = .39 inch
1 decimeter = 10 centimeters = 3.94 inches
1 meter = 10 decimeters = 39.37 inches
1 dekameter = 10 meters = 32.8 feet
1 hectometer = 10 dekameters = 328.08 feet
1 kilometer = 10 hectometers = 3,280.8 feet

Weights

1 centigram = 10 milligrams = .15 grain
1 decigram = 10 centigrams = 1.54 grains
1 gram = 10 decigram = .035 ounce
1 decagram = 10 grams = .35 ounce
1 hectogram = 10 decagrams = 3.52 ounces
1 kilogram = 10 hectograms = 2.2 pounds
1 quintal = 100 kilograms = 220.46 pounds
1 metric ton = 10 quintals = 1.1 short tons

Liquid Measure

1 centiliter = 10 milliters = .34 fl. ounce
1 deciliter = 10 centiliters = 3.38 fl. ounces
1 liter = 10 deciliters = 33.81 fl. ounces
1 dekaliter = 10 liters = 2.64 gallons
1 hectoliter = 10 dekaliters = 26.42 gallons
1 kiloliter = 10 hectoliters = 264.18 gallons

Square Measure

1 sq. centimeter = 100 sq. millimeters = .155 sq. inch
1 sq. decimeter = 100 sq. centimeters = 15.5 sq. inches
1 sq. meter (centare) = 100 sq. decimeters = 10.76 sq. feet
1 sq. dekameter (are) = 100 sq. meters = 1,076.4 sq. feet
1 sq. hectometer (hectare) = 100 sq. dekameters = 2.47 acres
1 sq. kilometer = 100 sq. hectometers = .386 sq. mile

Cubic Measure

1 cu. centimeter = 1000 cu. millimeters = .06 cu. inch
1 cu. decimeter = 1000 cu. centimeters = 61.02 cu. inches
1 cu. meter = 1000 cu. decimeters = 35.31 cu. feet

13.2 Коэффициенты перевода единиц

To change	To	Multiply by
(imperial)	(metric)	
inches	centimeters	2.540
feet	meters	.305
yards	meters	.914
miles	kilometers	1.609
knots	kph	1.852
square inches	square centimeters	6.451
square feet	square meters	.093
square yards	square meters	.836
square miles	square kilometers	2.590
acres	square hectometers	.405
cubic feet	cubic meters	.028
cubic yards	cubic meters	.765
fluid ounces	milliliters	29,573
pints	liters	.473
quarts	liters	.946
gallons	liters	3.785
ounces	grams	28.349
pounds	kilograms	.454
short tons	metric tons	.907
pound-feet	Newton-meters	1.356
pound-inches	Newton-meters	.11296
ounce-inches	Newton-meters	.007062
(metric)	(imperial)	
centimeters	inches	.394
meters	feet	3.280
meters	yards	1.094
kilometers	miles	.621
kph	knots	0.54
square centimeters	square inches	.155
square meters	square feet	10.764
square meters	square yards	1.196
square kilometers	square miles	.386
square hectometers	acres	2.471
cubic meters	cubic feet	35.315
cubic meters	cubic yards	1.308
milliliters	fluid ounces	.034
liters	pints	2.113
liters	quarts	1.057
liters	gallons	.264
grams	ounces	.035
kilograms	pounds	2.205
metric tons	short tons	1.102

14. РАЗРАБОТЧИКИ

BELSIMTEK

14.1 РУКОВОДСТВО

Александр Подвойский	Управление проектом, техническая документация

14.2 ДОКУМЕНТАЦИЯ

Владимир Тимофеев	Руководство пилота. Разделы истории, аэродинамики, описания оборудования, выполнения полетов.

14.3 МОДЕЛИРОВАНИЕ ДИНАМИКИ И СИСТЕМ

Андрей Коваленко, Николай Володин, Владимир Михайлов, Борис Силаков, Александр Мишкович, Евгений Грибович, Максим Зеленский, Дмитрий Москаленко, Виталий Перепелкин

14.4 МУЗЫКА И ОЗВУЧИВАНИЕ ЭФФЕКТОВ

Константин "btd" Кузнецов

14.5 РАЗРАБОТЧИКИ 3Д-МОДЕЛЕЙ-

Павел Сидоров	3D-model of helicopter, cockpit, damage model
Андрей Решетко	Pilots and gunners
Станислав Колесников	Cockpit
Валерий "Palmal" Мягкий	Варианты окраски вертолетов

14.6 ТЕСТЕРЫ

Dmitry "Laivynas" Koshelev

Gene "EvilBivol-1" Bivol

"AlhpaOneSix "

"BillyCrusher"

"Derelor"

"FrogFoot"

"Kairat"

"Rik"

"Shadowowweosa"

"Vibora"

"Wadim"

14.7 МИССИИ И КАМПАНИИ

Олег Dzen Федоренко, Дмитрий Кошелев

14.8 ОЗВУЧИВАНИЕ ИГРОВОЙ КАМПАНИИ

Русская версия:

dr.lex, BTD, Laivynas, Vatel, Dzen, MadShark, wildcat191, Maler, Рустам

Английская версия:

graywo1fg, Weta43, EvilBivol-1, paulrkiii, Joyride, Walter, Curtis, Alex, Jeremy, Headspace, SimFreak, SiThSpAwN

14.9 ТРЕНИРОВОЧНЫЕ И ОБУЧАЮЩИЕ МИССИИ

Евгений "EvilBivol-1" Биволь	Обучающие миссии, перевод на английский, поддержка форума

14.10 ОТДЕЛЬНОЕ СПАСИБО

Кайрату "Кайрат" Джаксбаеву (летчик 1-го класса)	За организацию записи звука, видео, фотоматериалы, помощь в тестировании динамики модели и уточнении работы систем на реальном вертолете
Олегу Василенко (летчик-снайпер, летчик-испытатель)	За фото и видео материалы, помощь в тестировании динамики модели и уточнении работы систем на реальном вертолете

15. СПИСОК ИСТОЧНИКОВ

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Вертолет Ми-8МТВ. Руководство по эксплуатации и техническому обслуживанию. Книга V. Радиоэлектронное оборудование.

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Ковалев В. Устройство вертолета.

РЛЭ Ми-8МТВ5

РТЭ двигателя АИ-9в

РТЭ двигателя ТВ3-117ВМ

РТЭ Ми-8МТВ5

Техническое описание АРК-9.

Техническое описание АРК-УД.

Техническое описание ДИСС-15.

Техническое описание МС-61.

Техническое описание Р-828.

Техническое описание Р-863.

Техническое описание РИ-65Б.

Техническое описание СПУ-7.

Техническое описание ЯДРО-1А.