THE FIGHTER COLLECTION

Eagle Dynamics

DCS SERIES

L -39C

«ALBATROS»

FLIGHT MANUAL (beta)

DIGITAL COMBAT SIMULATOR

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1. L-39C HISTORY

L-39C DEVELOPMENT

Airplanes development and production always were one of the high priority tasks in the countries, leading on the world stage. However, there are several small countries, which developed airplanes, which took honorable place in the aviation history. One of them is Czechoslovakia. January 1st, 1993 the country peacefully divided itself on Czech Republic and Slovakia. One of the directions in the airplane industry became jet trainer airplanes. L-39C “Albatros” became one of the most mass produced jet trainers, taking 4th place in the world after American T-33, Soviet MiG-15UTI and its compatriot L-29 “Dolphin”.

Photo: L-29 “Dolphin”

Developed in 1956 L-29 “Dolphin” won the Warsaw pact countries jet trainer competition. It marked a new era in pilots training, was very easy to pilot, robust and undemanding in service. At the same time this airplane has several disadvantages and enhancement attempts showed that L-29 has limited modernization potential. Besides that fast aviation evolution posed new requirements in young pilots’ training. Thus there was a need for a new jet trainer.

Ministry of National Defense (MND) of Czechoslovakia officially ordered the airplane. MND started developing technical specifications in 1963. Work was going in collaboration with the main customer – Ministry of Defense of Soviet Union. In particular, it was required to keep positive qualities of the L-29, increase thrust-weight ratio and reliability in operations from unpaved runways. It was indicated that the maximum speed should not exceed 700 km/h. Special attention was paid to the trainee and trainer cockpits. They should be similar to the combat airplanes’ cockpits.

This task was delivered to the team, headed by the main constructor Jan Vlcek from the Aeronautical Research Institute in Letňany (LVÚ, now the Aeronautical Research and Test Institute, a.s. – VZLÚ). Karel Dlouhy was the project's chief designer.

July 15th, 1964 final specifications of the new jet trainer were ready and the name for the new airplane L-39C "Albatros" was approved. After 1,5 years of work, all design activities were transferred to the «Aero Vodochody», where Jan Vlcek moved with his team.

From the beginning Jan Vlcek stopped on the classical cantilever low-wing scheme with three points retracted gear and with trainer behind the trainee tandem cockpit. For the L-39C trapezoidal wing was chosen. It was decided to equip L-39C with ruggedized landing gear, which is quite usual for all jet trainers. To protect engine from various objects air intakes was located on both sides of the fuselage over the wing. To teach trainees how to employ weapons two hardpoints could be installed. The ground maintenance of the airplane was well thought out; in particular, size and location of various inspections covers were chosen thoroughly to ease as much as possible ground maintenance.

A lot of attention was put into the power plant choice. From reliability point of view two engines were necessary, but this led to increased weight and fuel consumption. These minuses convinced chief designer that one engine is enough, especially taking into account increased jet engines reliability. Regarding engine, it was planned to install Czech M-270 with thrust up to 2500 kgF, which Prague "Motorlet" factory was working on. Soviet side was insisting on installation of AI-25 with 1450 kgF thrust, which was under the final stage of development in the "Progress" design bureau (located in Zaporozhje), headed by A.G. Ivchenko. In the end AI-25 was chosen, because Pragues engine was slightly big for the light jet trainer. Besides that after stand testing it was obvious that operational development of this engine could not be finished fast.

During 1964-66 models with scales 1:4, 1:5 and 1:25 were verified in the LVÚ's wind tunnels. Based on these results form of the wing, air intake configuration and other various components were finalized. In February 1967 wooden model of the airplane was ready and prototyping committee start working.

In the same year model manufactured in Letnany was tested in "TsAGIs" (Central Aerohydrodynamic Institute) high-velocity and spin wind tunnels nearby Moscow. Similar testing continued in Czechoslovakia. By end of 1968 all aerodynamic testing was finished.

Photo: L-39 model, 1:1 scale

In the meantime at the “Motorlet” plant was preparing to licensed production of soviet engine, which got local name AI-21W (W –“Walter”). In the beginning it was decided to produce a small lot of these engines. Several units from this lot were tested on stand in Prague and on Il-28 flying lab in LVÚ. Due to fact that AI-25 initially could not produce sufficient thrust, Czech engineers started its modernization. Soon decision was taken, that all mass produced airplanes would have improved AI-25TL engine with 1720 kgF thrust, delivered by Zaporozhye Engine Plant (now it is joint-stock company “Motor Sich”).

VS-1 eject seat, developed in LVÚ by Irgi Mateicek, was planned to be installed on the airplane. Apart from ejection mechanism, seat had to be equipped by rocket booster, allowing ejection from airplane on the ground. In 1967 designers manufactured several seat prototypes and started ground testing. Next year they manufactured several prototypes of VS-1B ejection seats. They had no rocket booster, because development of this unit was delayed. At the same time those seats were tested on MiG-15UTI flying lab. Around 50 ejections were performed. They showed that pilot could safely leave airplane on heights not less than 300 m, and it could be used on first L-39C prototypes. Besides that, various L-39C systems were tested as well.

For testing it was decided to build 7 L-39C prototypes at once. Five of them: X-02, X-03, X-05, X-06, X-07 were intended for flight testing, while X-01 and X-04 for static and fatigue testing correspondingly. «Aero Vodochody» was the main factory. Here, the nose and fuselage midsection were produced and the final assembly was done. “Let” plant in Kunovice produced wings, and Prague «Rudy Lelov» was responsible for tail part and empennage.

Photo: X-02 prototype

Spring 1968 airframe for X-02 prototype was ready. By mid-autumn all necessary equipment and systems were mounted on X-02. Due to delay with AI-25TL engine delivery AI-25W was installed. October 25th, 1968 the airplane was rolled out for the first time. Ground testing started at the factory airfield, where special attention was put on engine operation, landing gear, control system and wing mechanization. They were performed by «Aero Vodochody» chief pilot Rudolf Duhon. October 28th, 1968 airplane three times accelerated up to 175 km/h with nose landing gear lifting. The pilot noted good airplane behavior, brakes efficiency and surprisingly good view from the cockpit.

After fixing several small issues L-39C was prepared to the first flight. The airplane had civil mark OK-32 (later changed to OK-180) on the fuselage. November 4th, 1968 Duhon lifted the airplane in the air for the first time. Take off was performed without flaps. Flaps efficiency was evaluated at height of 1000m; pilot estimated that with flaps extended airplane held in the air at speed of just 160 km/h. During the first flight airbrake functionality, landing gear extraction/retraction operation and engine behavior on various modes were tested. Airplane landed with flaps in takeoff position. Duration of the flight was 35 min.

Photo: Test pilot Rudolf Duhon in the X-02 prototype before the first flight, October 28th, 1968.

Literally after 10 minutes after landing Duhon had to take off again. High level authorities arrived on the factory's airfield and it was decided to arrange for them air show with solo and group aerobatics. At first, accompanied by single seat L-29A, X-02 flew at low altitude with extended airbrakes and switched on landing lights. Later high speed passes followed, which were finished by spectacular climb and combat turn. Guests were quite impressed by this improvised air show.

Photo: X-02 prototype is landing after the first test flight

Photo: After the first official X-02 prototype test flight. From the left to the right: Jan Vlcek, Rudolf Duhon, Charles Long.

After these flights X-02 was returned to the workshop, where small operational development of control system was completed. December 2nd, 1968 the airplane was showed to the customer representatives.

In general, testing followed planned program. High angle of attack (AoA) flights, complex aerobatic maneuvers and several experimental flights to test efficiency of anti-spin parachute were performed. It was proven that such parachute had very low efficiency. Take off and landings on unpaved LVÚ runway in Letnany were conducted. During one of the days, good handling of L-39C was proven, airplane landed with cross wind gusts from 10 to 14 m/s. From time to time flights were interrupted for further operational development. For example, cockpit air conditioning system started operating, and by spring 1969 new wing root fairings were installed.

By that time engine operation caused a growing concern. During one of the flights several short time surges happened and March 19th, 1969 during dive after spin exit engine spontaneously turned off. Duhon, using all his skills, managed to successfully land the airplane. Turbine blades were destructed. Despite this incident chief pilot in his report wrote that the overall impression of the plane is very good. First of all, he noted easy landing, great airplane handling and mentioned that when operation development was finished flight performance would be outstanding.

May 4th, 1969 Duhon lifted in the air X-03 prototype, which was equipped with AI-25W engine. This plane had several differences from previous ones. The airplane had different size of wing root fairies, additional "windows" on the side of air intakes and adjustable rudder trimmer. Then X-03 was handed over to LVÚ to continue the test program. Incident happened again. During one of the flights rear cockpit canopy was torn off and it barely missed empennage.

The same X-03 prototype was used for experimental flights in icing conditions and to verify VS-1BRI ejection seat operation.

Figure: X-03 prototype, used for VS-1BRI ejection seat testing.

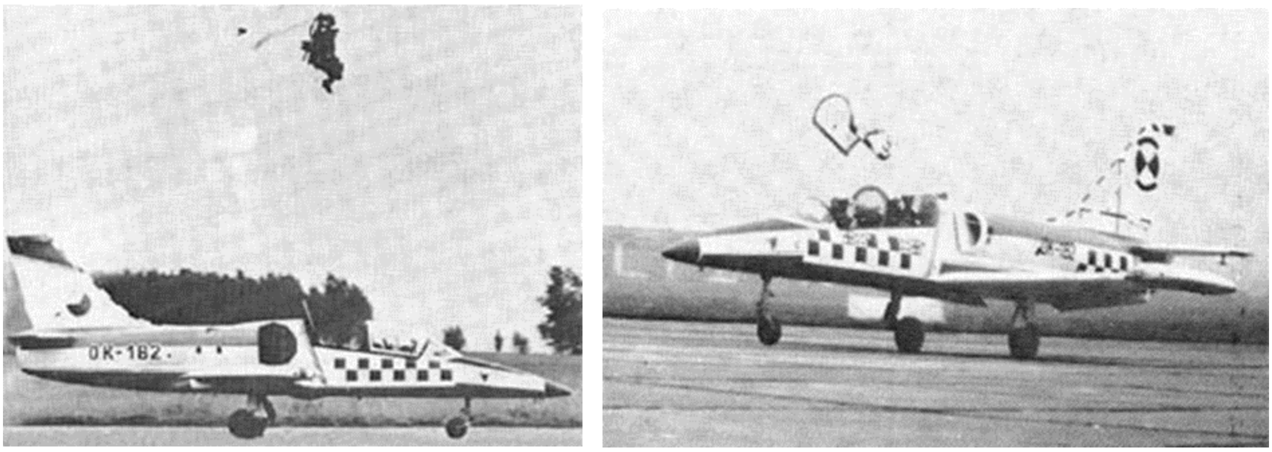

Photo: Ejection seat testing.

Photo: Preparation of X-03 prototype to the test flight.

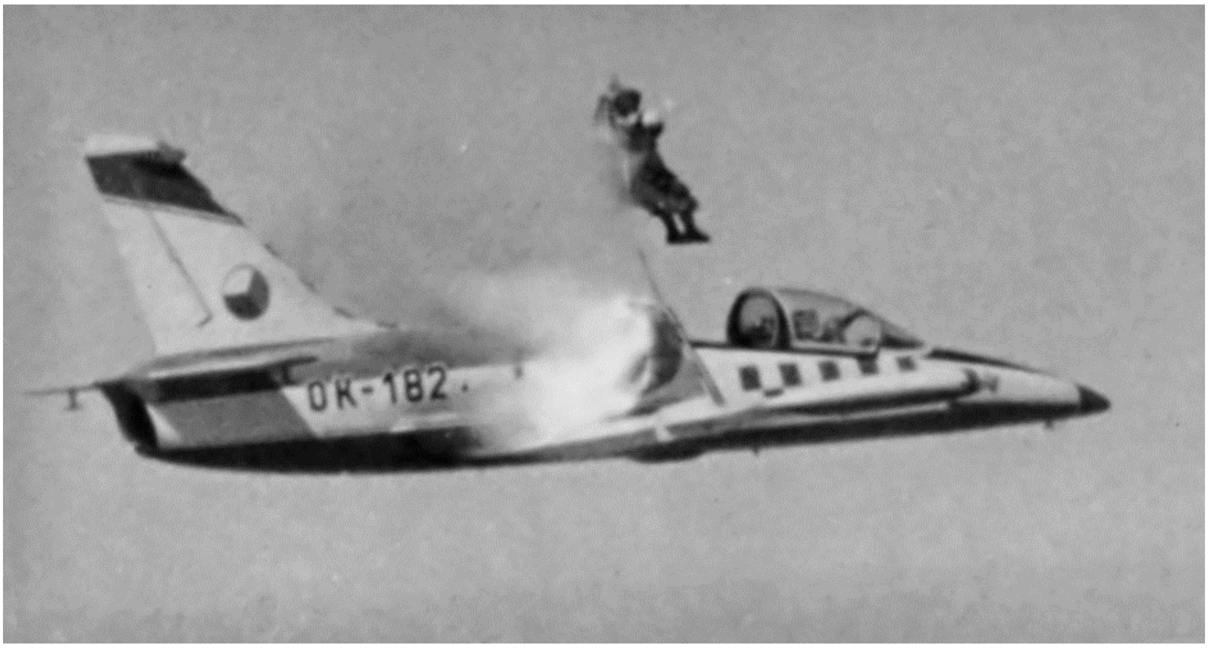

Photo: VS-1BRI ejection seat testing

September 23rd, 1969 X-05 prototype, piloted by Duhon took off. Airplane was equipped with the same engine as predecessors, but had different shape of intakes, wing root fairings and had two hardpoints. During the eight first flights special attention was put to engine operation. Later, in October, airplane was tested at minimum speeds and engineers faced engine surge again.

Figure: X-05 prototype

In April 1970 X-05 was used to test airplane behavior during aerobatic figures. In one of the flight overG was developed, resulting in deformation of the upper wing skin. Wing was send to the manufacturer for fixing, and old engine, operated for 50 hours, was replaced with a new one. In July 1970 flights started again. Once again, the engine was changed in the end of August. In the end of October, beginning of November 16 spin testing flights were conducted. Performed in total 78 spin turns, pilots came to the conclusion, that the airplane exited spin easily and without any delays. During this program engine was changed twice, because it created a lot of troubles. By end of 1970 X-05 performed 159 flights.

April 28th, 1970 X-06 was lifted in the air. Airplane had new air intakes and auxiliary power unit (APU) “Sapfir-5” produced under “Turbomecca” French company license. July 1st, 1970 while performing landing approach the left landing gear did not extend as expected. Vlastimil David several times tried to retract-extend landing gear leg, but did not succeed in this and did emergency belly landing. Incident investigation revealed that a factory defect was the reason.

Photo: X-06 prototype after emergency belly landing.

Photo: Evacuation of X-06 prototype from the crash site.

December 15^{th}, 1970 X-07 prototype took off. “The seventh” was initially built to incorporate AI-25TL engine, but at first time AI-25W was installed. On this airplane once again shape of root wing fairing was changed and fairings between wingtips and wing fuel tanks located there were installed. Some solutions used on other prototypes were not used on X-07, for example adjustable stabilizer. In July 1971 control system was modified. To reduce the effort needed to deflect elevator to more than 28^0 special spring mechanism was installed and to reduce efforts on the pedals rudder servo compensator was lengthened by a quarter. This improved airplane handling during takeoff.

In the end of summer – autumn 1971 X-05 and X-07 passed military tests, having 115 flights together. Engineering staff during that time worked 560 man-days, which was equal to 39 man-hours per flight hour. Indeed, some say “Success in flight is forged on the ground!”

During these tests it was mentioned that due to increased weight of “the seventh”, some characteristics comparing to other prototypes, somewhat deteriorated, but in general remained on acceptable level.

In the end of 1971 the long awaited AI-25TL arrived from Zaporozhye. X-02 was the first prototype who received this engine in the beginning of 1972. Airframe was strengthened and some other improvements were made. By end of March 1972 AI-25TL was installed on X-07 as well. Due to bigger engine weight the center of gravity of the machine was shifted. This led to change in electrical equipment layout, in particular, batteries where moved to the airplane nose. After short testing by factory pilots prototypes were transferred to military testing, which were completed in the beginning of 1973. Experimental flights showed that thrust increase led to significant improvement in flight performance. New engine had better gas-dynamic stability as well. However flight duration decreased slightly, but remained at an acceptable level. On one full tank L-39 could perform 14 seven minutes or 11 nine minutes flight circles or two 40 minutes flights to the aerobatic area. Military pilots tested X-07 on stall behavior. Their results differed very little from those obtained on X-05 prototype. Before stall warning shaking of airplane with the stick twitching occurred, followed by nose stall and smooth slow roll.

Besides that during 1972 X-02 and X-07 was used for special testing. In particular, in the beginning of autumn new air conditioning turbo-cooler operation was tested on “the second”. Extensive program for electronic equipment testing were conducted on “the seventh”.

In the beginning of 1973 X-07 was prepared to be sent to the USSR for government test program in GK NII VVS (Soviet Air Forces Flight Research Institute). By that time the airplane completely corresponded to the production modification L-39C (Cvicna - trainer). It was repainted, got red starts, the plane number № 07 and additional test equipment. Government testing started in May 1973. The Soviet pilots formed a favorable opinion about the airplane. They noted that L-39C met all requirements to the training airplane. Among the positive qualities of the airplane special attention was put: to the similarities with combat airplanes cockpits for both trainee and the trainer, great view from both places, robust emergency system, possibility to start airplane without ground-based services, as well as combat basics learning and MiG-21 landing approach simulation (with retracted flaps).

There were also several disadvantages mentioned, including lower than defined operating range, higher landing speeds and longer landing roll out. Soviet and Czech pilots had significantly different meanings regarding spin behavior. Spin tests, performed according to GK NII VVS test procedure, showed that L-39C’s spin had “unstable and uneven” character and that airplane usually exited spin after 3rd rotation. Despite the shortcomings found in L-39C, it was recommended to put airplane in the USSR air force service and equip with it flight schools.

Figure: X-07 prototype during test flights in the Soviet Union.

After receiving the comments from the customer, the developer started to address them. Special attention was put on L-39C's spin behavior improvement. Work was performed during 1974 on X-02 and X-07 prototypes. Several different design solutions were worked out, including "the second", which got special ridges on the nose sides. Though tests proved that this improved airplane behavior, it was decided to not use this solution. At the end angle of attack restrictions were introduced and more sophisticated spin exit methods were worked out.

It was planned to start manufacturing L-39C in 1971, but implementation of this program faced several serious difficulties. First of all, prototypes were still under testing and the final production configuration was not defined yet. In addition AI-25TL initial delivery dates lagged behind the schedule.

As a result in 1971 it was decided to build initial production lot, consisting of 10 L-39Cs, equipped with AI-25W, which had to be received by MND.

December 7th, 1971 the first airplane from this lot took off and March 28th, 1972 five airplanes were transferred to the flight school in Kosice.

As was planned, after end of AI-25W service life L-39Cs from the first lots were equipped with AI-25TL. It happened in 1974. At the same year L-39C went into mass production, which continued until 1999. In total, there were more than 2,950 airplanes built, without taking into account the first seven prototypes. The L-39C trainer became the most mass produced modification, in the amount of 2,280 units. The USSR air forces received 2,280 airplanes (the latest one was received January 25th, 1991).

In 1970 X-08 L-39V (Viecna - tug) – single seat KT-04 target tug prototyping started. This airplane was requested by MND. In July 1972 X-08 prototype was built. In rear cockpit towing winch was installed, which had up to 1700 meters of 5-mm steel cable wound. It was driven by L-03 ram air turbine, located under the fuselage. This modification of airplane had no air brakes. KT-04 target itself was created on "Rude Letov" factory under the Jan Zranz guidance. It was an all-metal airplane, weighting 110 kg, with length of 4,9 m, wingspan of 5,3 m and intended for cannon fire practicing by both pilots and ground based anti-air artillery crews. Before takeoff KT-04 installed on trolley was attached to the winch cable with a special grip. During takeoff distance between the tug and the target was 100m. After reaching 230 km/h at height of 5m trolley separated from the KT-04. Target operating heights were within 500- 2500m. Standard towing speed was 500km/h, maximum speed was 600 km/h. Distance between airplane and target during shooting was about 1500m. After shooting exercise KT-04 separated itself from the cable, it descended by parachute and landed on inflatable shock absorbers. After replacing the damaged parts target was again ready to use.

Photo: L-39V (Viecna - tug) – single seat KT-04 target tug.

X-08 factory tests started in October 1972 and included 45 flights, including 30 flights with the target. Later “the eight” was used to study behavior of the airplane at lower speeds and to test anti-icing system, equipped with RIO-3 icing radioisotope probe. In July-September 1973 military testing of X-08 and KT-04 were conducted. By that time towing winch was equipped with a hydraulic cable cutter. Small lot of eight L-39Vs was produced in 1976. All of them were put in service in the Czech air forces, but later two of them were transferred to the German Democratic Republic air forces.

There were several experimental airplanes created based on the original L-39C. One of them Czechoslovakia’s Air Forces used during testing as recon airplane. The plane flew with locally developed recon containers on hardpoints, equipped with 4 AFA-39 cameras. This work did not receive further development.

Photo: Experimental L-39C with photo container.

Airframe of another one L-39C was subjected to strength tests, the results of which allowed increasing estimated service life from 3000 to 4500 hours.

In the Soviet Union one L-39C was used in LII (Flight research institute) of M.M. Gromov in 1981-85 as a flying lab for end airfoils testing. Results of this work were used during Il-96 and Tu-204 development.

Photo: L-39C flying labs in LII (flight research institute) of M.M. Gromov.

L-39C FURTHER DEVELOPMENT AND MODERNIZATION

L-39ZO X-09

In 1973 ordered by Libyan air force development of combat trainer L-39ZO (Zagranicny Obchod – armed, export variant) had begun. It was planned to use this airplane for pilot training as well

Photo: Libyan air forces L-39ZO

as light attack airplane. Machine had 4 hardpoints, which could carry a range of weapon systems. Each inner hardpoint was intended for 500 kg payloads, external for 250 kg, but in total airplane could not lift more than 1100kg. New L-39ZO got strengthened wing and landing gear. X-09 test flight started on June 25th, 1975 by Ju. Shouz. First of all attention was paid to the airplane behavior when shooting rockets, impact of rockets' exhausted gases on engine operation and to the landing gear, working under excessive loads. In general, test flight gave very good results, though due to increased takeoff weight of L-39ZO flight performances slightly deteriorated. The most serious problems during X-09 test flight appeared during 150 liters and 350 liters drop tank release. It was found, that after separation they began rotating about transverse axis due to incoming air flow. Speed and direction of rotation depended on aerodynamic forces and moments. There were several very unpleasant situations, when drop tank kind of "glued" to the wings, refusing to fall, and once even left hanging on the pylon until the landing and fell off only during taxiing. The problem was solved by equipping the drop tanks with small horizontal surfaces, which created dive moment. Test flights finished in June 1976. In total, 347 planes of this modification were built.

L-39ZA X-11

In 1974 MND ordered one more L-39 combat training modification, with name "L-39ZA" (meaning of this abbreviation is not mentioned in public sources).

In contrast to its predecessor this airplane was equipped with 23mm twin-barrel cannon GSh-2-23, which was installed in the nose part of the fuselage under the cockpit and covered by fairing. Due to that it was necessary to modify fuselage, move several antennas, cover nose landing gear doors with stainless steel to protect them from hot propellant gases and once again equip gear with broader pneumatics.

May 16th, 1977 test pilot Shouc lifted X-11 in the air. In the same year this machine painted in white-gray camouflage with civil OK-HXA registration was sent to the Paris Air Show in Le-Bourget. It was shown without the cannon, with 2 350-liters drop tanks on inner pylons or with one drop tank and PFK-5 reconnaissance container. The airplane was shown both on the ground and in the air, performing complex aerobatics. Then X-11 passed military tests in Kosice flight school. L-39ZA mass production started in 1980.

Photo: X-11 L-39ZA at Paris Air Show (Salon international de l'aéronautique et de l'espace, **Paris-Le Bourget). June 1977.**

Photo: Slovakian Air Force L-39ZA

Photo: Czech Air Forces L-39ZA.

«Aero Vodochody» company achieved very modest success in sales of new L-39C modifications. Mainly this can be explained by a huge number of L-39s, which are still being in service and have great modernization potential. Moreover, many owners are satisfied with increased airframe service life after traditional maintenance with minimum financial costs. As a result, in many countries several programs, which could extend the L-39C life cycle for many years, were introduced.

At the airplane motherland MND and «Aero Vodochody» in June 1999 singed up an agreement on major overhaul and modernization of eight L-39s from the latest lots for Czech Air Forces. Following this agreement nose and tail parts of airframe, wings and some other items of equipment and systems were replaced. Airframe service life was extended to 4500 hours. Similar works «Aero Vodochody» conducted on eight Hungarian airplanes, which were transferred to customer August 25th, 2005.

Slovakian L-39s were modernized by airplane repair plant in Trencsen. In 1996-97 on six L-39s from 1st and 4th lots, produced during 1973 – 1975, the first stage of service life extension was performed. The airplanes got new noses from unfinished machines. In 1999-2000 similar procedure was conducted on two L-39Vs. At the same year, all L-39s came in Trencsen for the second stage of modernization. This time tails and wings were replaced. After that airplanes got new avionics and various airplane equipment. Among them were TACAN AN/ARN- 153(V) radio navigation system manufactured by Collins ProLine II, ADF-462 radio compass and GPS receiver. The upgraded airplanes were named L-39CM. Head airplane (marked 0111) flew on August 26th, 2003, piloted by J. Kello and R. Rosenberg.

Russia developed a proprietary multi-stage program of modernization of L-39C. It was planned to strengthen airframe and extend its service life to 10000 hours and install four hardpoints, which increase combat load from 250 to 900 kg. The plane had to be equipped with K-93 ejection seat, new radio communication equipment and avionics, including NK-39 navigation complex, SVR-39 video recording system and SOI-39 display. Spare parts had to be manufactured on Russian factories. New airplane got L-39MT name, but this project remained on paper, because Russian Air Forces developed a program to replace L-39C with new Yak-130.

L-39C FLYING SCHOOL DESK

L-39 geography is very broad. It was mainly used for its intended purpose. Usually in the instructor role were Soviet and Czechs pilots. For example, in Libya from April 1978 to June 1981, 10 specialists from Czechoslovakia (pilots and engineers) worked. The intensity of their work can be judged based on total amount of flights hours of pilot-instructor Stefan Zupko. During this time he performed 1302 flights with total duration of 511 h 25 min. L-39, which operated in the harsh conditions of North Africa (high temperatures, sandstorms, etc.) showed unpretentiousness and survivability. Only one serious accident occurred during the mentioned period. July 5th, 1979 airplane with Czech instructor and Libyan cadet did not return from training flight. Airplane was found next day in the water filled ground hole on the sea shore. According to witnesses, airplane suddenly entered into a dive, from which it did not exit. Root causes of the accident and the question, why no one from the crew attempted to eject, stayed unclear.

Photo: Libyan Air Force L-39 ZO

Soviet instructors participated in cadets training in Afghanistan. The first 12 L-39Cs appeared in Afghanistan October 2nd, 1977. From September 23rd to October 2nd 1977 Czech pilots flew the route with total length of 5042 km from Vodochody to Mazar-i-Sharif through Kosice, Lviv (Sknilov), Kiev (Juliani), Donetsk, Krasnodar, Makhachkala, Krasnovodsk, Ashkhabad, Chardjou and Tashkent. Technical experts accompanied the team on An-24. The flight went flawless, without a single incident and took 12 hours and 15 minutes of flight time. According to available information, it was the most distant L-39C group flight.

Flight-technical school in Mazar-e-Sharif was created in 1957, but by the time of L-39Cs arrival, only 22 cadet-pilots studied there. They had to learn how to fly in the 393th UAP (aviation training regiment). One year after the revolution government of Afghanistan transformed the school into the Air Force and Air Defense College. Lack of local trainers was compensated by large number of Soviet specialists. Major V.A. Pehotin became the advisor of the 393th UAP commander. It must be said that Afghan pilots training program was significantly different from one existing at that time in the Soviet Union. After three years of study young pilots were graduated on L-39C. Later they were retrained on MiG-17, which was considered as a transitional machine before MiG-21. For that purpose pilots were sent to the Soviet Union. Soviet officers proposed to learn MiG-21 immediately after the L-39C, according to the accepted in the Soviet Union methodology. Afghans did not agree. Former military adviser to the deputy chief of the school V.I. Ablazov wrote. Once looking at passing caravan of nomads DRA Air Force commander Mir Gausuddin remembered about these offers. «Your children are being born listening TV noise, unable to speak, they already know how to turn on the lights and tape recorder, twitch a car wheel. When they grow up, they do not have problems to release one control knob and take hold of another. Our children break away from the donkey or camel tail, from the mother hem and do you want to put them right into the modern airplane cockpit? Take your time and do not rush». It was hard not to agree with these arguments.

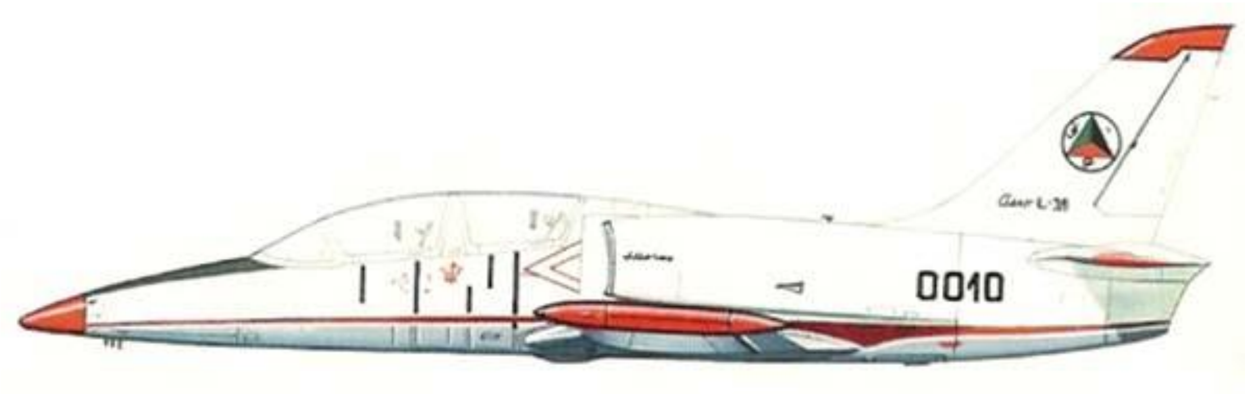

Figure: Afghan Air Force L-39C.

Photo: 393th UAP L-39C, Mazar-i-Sharif. Afghanistan 1979.

In the Soviet Union L-39C became one of the most popular military training airplane. The machine quickly took root, «russified». Latin «L» in its type designation was immediately replaced by Cyrillic «Л». Letter «C», indicating the training intention, disappeared completely, because in the USSR the only one (training) modification was used. And the proper name «Albatros» aviators used less often than the slang nickname «Elka». Airplane arrived in the majority of flight schools: in Chernigov, Kachin and Kharkov, which specialized on preparing pilots for frontline fighter airplanes; in Armavir (air defense fighters); in Yeiskoe and Borisoglebsk (fighter-bombers); in Barnaul (frontline bombers); in Tambov (long-range aviation), in Krasnodar (prepared pilots for the Asian and African countries). The number of planes in training regiments was significantly higher than in combat ones. Some of them had over a hundred of L-39Cs. L-39Cs also were in service in several combat training and pilot re-training centers and in special training, flight testing regiment of Cosmonaut Training Center of the USSR (airfield Chkalovskaya) and in GK NII VVS units. They were also used in several Su-25th regiments, where L-39Cs served as "twin-seaters", before arrival of the Su-25UB trainers. In this role several Soviet L-39Cs were used during the war in Afghanistan. Small amount of L-39Cs was transferred to flying clubs and DOSAAF training centers. Also Flight Research Institute MAP (situated near Moscow Zhukovsky) had some L-39Cs. There L-39Cs were used as flying laboratories and as escort airplane (for example, during VKS Buran-analog flights) and in the test pilot school.

In the Soviet Union a pioneering role in L-39C adoption was given to the 105th UAP of Chernigov Higher Military Aviation School (ChVVAUL), headed by Colonel D.I. Boryakov and located on Konops' airfield.

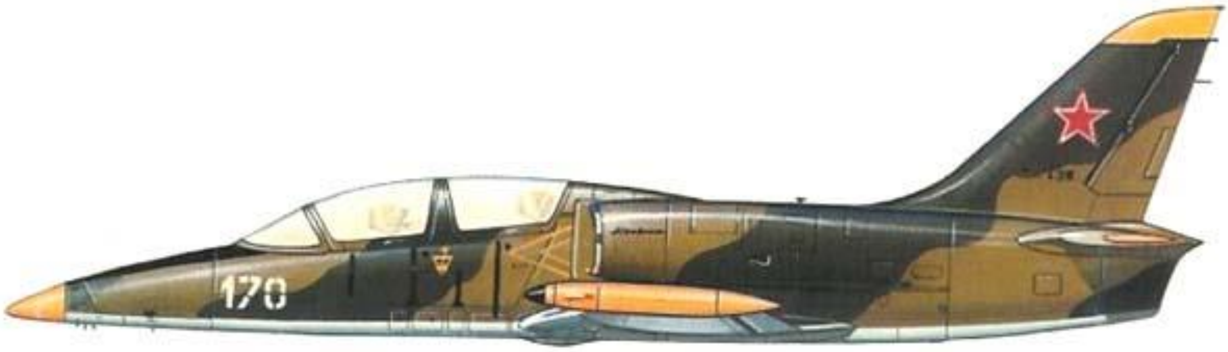

Figure: Soviet Air Force L-39C.

October 20th, 1973 group consisting of 8 officers, headed by regimental commander deputy, Major S.N. Shamsutdinov left to Czechoslovakia to study new machines. Czech pilots flew airplanes to Ivano-Frankovsk and from there these machines flew to the 105th UAP base under regiment pilots' control. The first L-39 was met in Konotop 29th on April 1974.

Among the first flight instructors, which were retrained on L-39C, were P.A. Leontiev, N.S. Saponchik, A.P. Holupov, I.P. Fedorenko, A.T. Filichkin.

Among the first engineers were: V.I. Basco, V.P. Gardens, N.K. Panyuta, A.I. Yakovina. Retraining was completed by the end of the year without accidents.

The airplane in all respects surpassed its predecessor L-29 and quickly won sympathies of the flight and ground personnel. New «Elka» offered excellent view from the cockpit, comfortable chair, excellent air conditioning system, nice liveries and comfortable ergonomics.

L-39C IN LOCAL CONFLICTS

War, started in Afghanistan, brought changes in the life of 393th UAP. Occasionally L-39Cs, piloted by afghan and soviet trainers were involved in combat missions. For example, from August 24th to 30th, 1979, they flew 11 combat missions to attack ground targets using rockets and bombs. Quite often training flights were combined with Mazar-i-Sharif neighborhood reconnaissance. The first graduation of the pilots flying L-39Cs was held in August 1979. 15 pilots were graduated. Average flight time of every pilot was about 77 hours (22 hours without trainer) with 308 landings.

Photo: Afghan air force L-39C

Ethiopia had 2 L-39C wings, including 16th training squadron, which was regularly involved in combat missions. At first they fought in Eritrea and after that took part in the Civil war in Ethiopia. When in May 1991 rebels, fighting against Mengistu Haile Mariam regime, approached Addis Ababa, L-39C pilots defended the capital until it was defeated. After that about 50 airplanes and helicopters flew into neighboring Djibouti. Among them was one L-39C. In 1993 Eritrea became independent state and new Ethiopia's authorities helped his former allies in fight against dictator regime, by training their pilot on L-39C. But soon, in 1998 between neighbors war over territorial disputes began. L-39Cs were not observed in these battles. However during training flights L-39s regularly were under own air defense fire, because ground observers confused them with Italian MB-339, which were in Eritrea's air force. One such incident happened 13th of November 1998 nearby Mekele airfield. L-39C with Ethiopia's captain Endegena Tadesse and russian trainer, whose name was not called in the press release, was shot down.

MODERN TIME

L-39 remains in service in more than 30 countries in the world, including Russian air force. In Krasnodars' Military Aviation School it is used as primary jet trainer for basic flight training. Currently, L-39C is being gradually replaced by Yak-130.

A new phenomenon in the airplane history was a private L-39C ownership. In Czech Republic the first private L-39 lifted in the air on August 13th, 2004. The airplane was bought in Ukraine and previously operated in Chernigov flight school. Hardpoints and various military systems were removed and equipment required to meet international airways requirements was installed. Airplane was painted black and got civil marks OK-JET on the fuselage.

AEROBATIC TEAMS FLYING L-39C

«Rus» is an aerobatic team, created on Viazemsky DOSAAF aviation training center (ДОСААФ) in 1987. Aerobatic team flies L-39C jet trainer.

«Belaya Rus» - is an aerobatic team of the air force and air defense forces of the Republic of Belarus performing aerobatics at the combat training aircraft L-39C "Albatros".

«Baltic Bees» is an aerobatic team from Latvia, based in Tucums city. «Baltic Bees» pilots fly L-39C jet trainer.

«Patriots Jet team» is a private aerobatic team which is sponsored by Fry's Electronics Company. The team was organized by United Airline former pilot Randy Howell.

«Breitling» is a private aerobatic team which is sponsored by Breitling Company, which also produces watches with the same name.

Aerobatic team is a biggest civilian aerobatic team in Europe. The team is based on the military base in Dijon, France. Aerobatic team flies seven L-39C jet trainer.

«Black Diamond Jet Team» is a private aerobatic team with five L-39C and one T-33, all planes are painted in distinctive arctic camouflage. They are piloted by former military fighter pilots from US Navy and Air Force.

MODIFICATIONS

L-39C is a standard modification of the jet trainer for basic and primary flight training. Usually, for standard modifications "C" letter in the name is omitted.

L-39ZO is a modification of the airplane, which can be used as light attack airplane. For this purpose it has 4 hardpoints.

L-39ZA is a further L-39ZO evolution with 23mm twin-barrel automatic cannon installed.

L-39V is a single seat target tug version.

L-39D is a modification with installed BUR "Test-1" instead of SARPP-12. Additionally BUR "Test-1" performs audio information recording for 5 hours and is equipped with operational storage.

L-39MS (L-59 Super Albatros) is a modification with new modular DV-2 jet engine with 2200 kgF thrust, "0-0" type ejection seats and new electronic equipment. It made the first flight in 1986. 80 airplanes were produced.

L-39M1 is a Ukrainian L-39 modernization. AI-25TL engine is replaced with improved AI-25TLSH (thrust increased from 1720 to 1850 kgF and engine response time reduced twice from 8-12 seconds to 5-6 seconds). It has improved engine control system. New onboard emergency and operational flight information recorder with additional sensors and devices was installed.

Aero L-159 «ALCA» is a Czech jet trainer (light attack plane). Airplane is based on L-59 and is further evolution of L-39 "Albatros".

L-39 is in service in more than 30 countries. Years of service proved that very successful airplane was created. Thousands of pilots love L-39, because thanks to this airplane, they mastered the basic flight skills and become pilots. It is rightly called "school desk". Airplane has modernization potential. L-39 systems and engine is being constantly improved and this allows this airplane to stay in many countries air forces service for a long time.

History of the L-39 continues!

SOURCES:

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- http://www.airwar.ru
- http://theworldofmark.com
- http://aerobaticteams.net
- http://letaem-vmeste.livejournal.com
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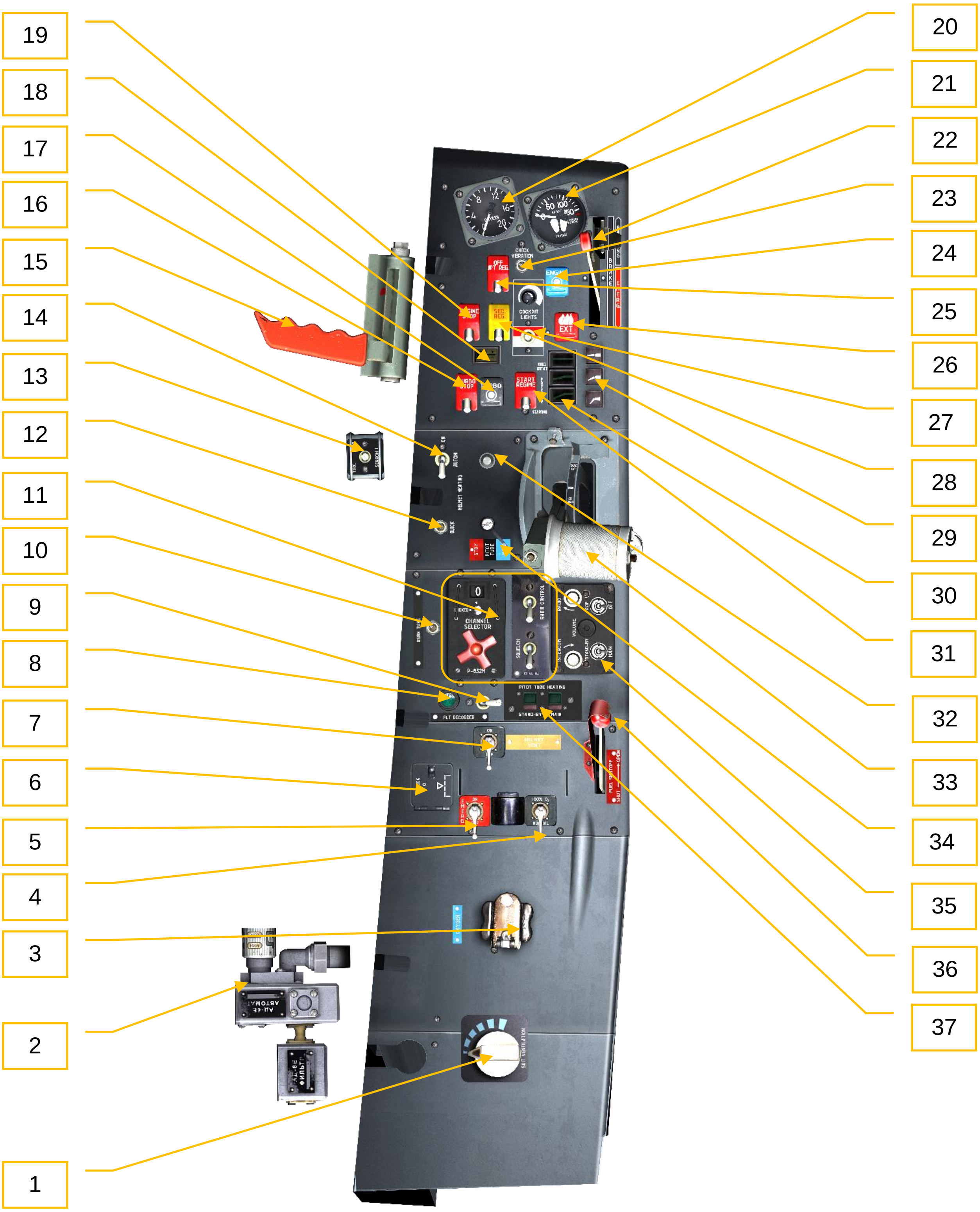
2. GENERAL INFORMATION ABOUT L-39C

EQUIPMENT INSTALLED IN FRONT COCKPIT

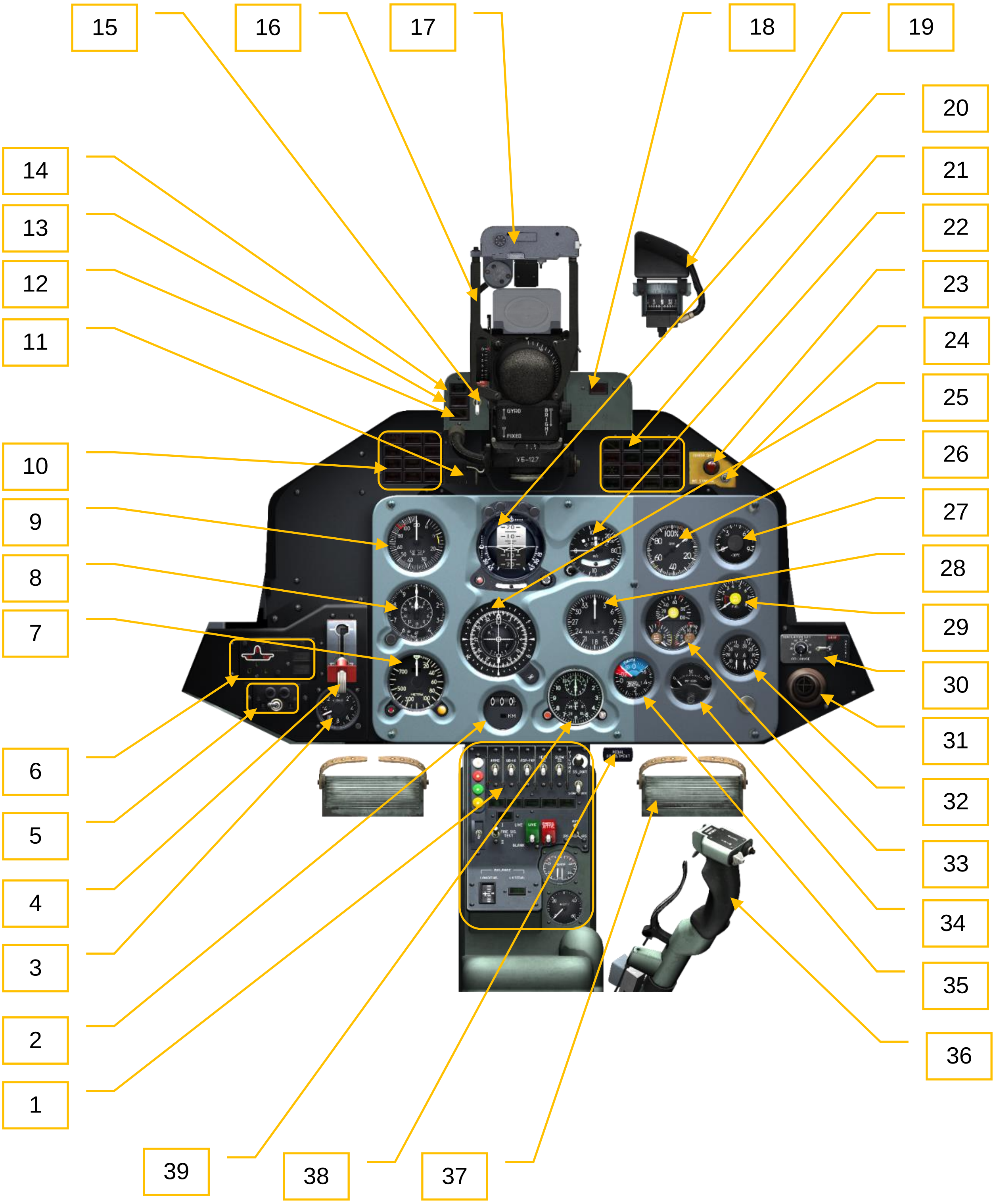
LEFT PANEL



1. Suit ventilation valve (not used).
2. AD-6E pressure regulator which regulates air pressure in anti-G suit's inflatable bladders (not used).
3. Oxygen supply valve.
4. «100% O2- NORM» oxygen supply regulator.
5. Emergency oxygen supply regulator.
6. Check O_2 hatch, oxygen regulator test.
7. Helmet ventilation handle (not used).
8. Flight Data Recorder (FDR) signal lamp.
9. Flight Data Recorder (FDR) switch.
10. RSBN audio button.
11. R-832M radio control panel.
12. Quick helmet heating button (not used).
13. Taxi-Landing lights control switch.
14. «AUTO – ON» helmet visor heating switch (not used).
15. Canopy lock handle.
16. «STOP-TURBO» switch.
17. «TURBO» button.
18. External power indicator light.
19. « ENGINE STOP» switch.
20. Helmet oxygen pressure indicator (not used).
21. IK-52 oxygen pressure indicator and flow annunciator.
22. Emergency/Parking brake handle.
23. «CHECK VIBRATION» IV-300 engine vibration meter control button.
24. «ENGINE» button.
25. «JPT REG- OFF» EGT limiter control switch.
26. «EXT» (Extinguishing) button.
27. Cockpit floodlight control panel with red to white illumination color switch and brightness knob.
28. «SEC. REG» emergency fuel switch.
29. Flaps control buttons.
30. Flaps position indicators.
31. «STARTING – PRESERV. – COLD. ROTAT» switch.
32. Helmet visor heating rheostat knob (not used).
33. Throttle handle.

34. «MAIN – PITOT TUBE – STBY» Pitot-tube receiver selector switch. Switches main and backup Pitot-tube receivers.
35. SPU-9 intercom (ICS) control panel.
36. Fuel shut-off valve handle.
37. Pitot tube heating lamp-buttons.

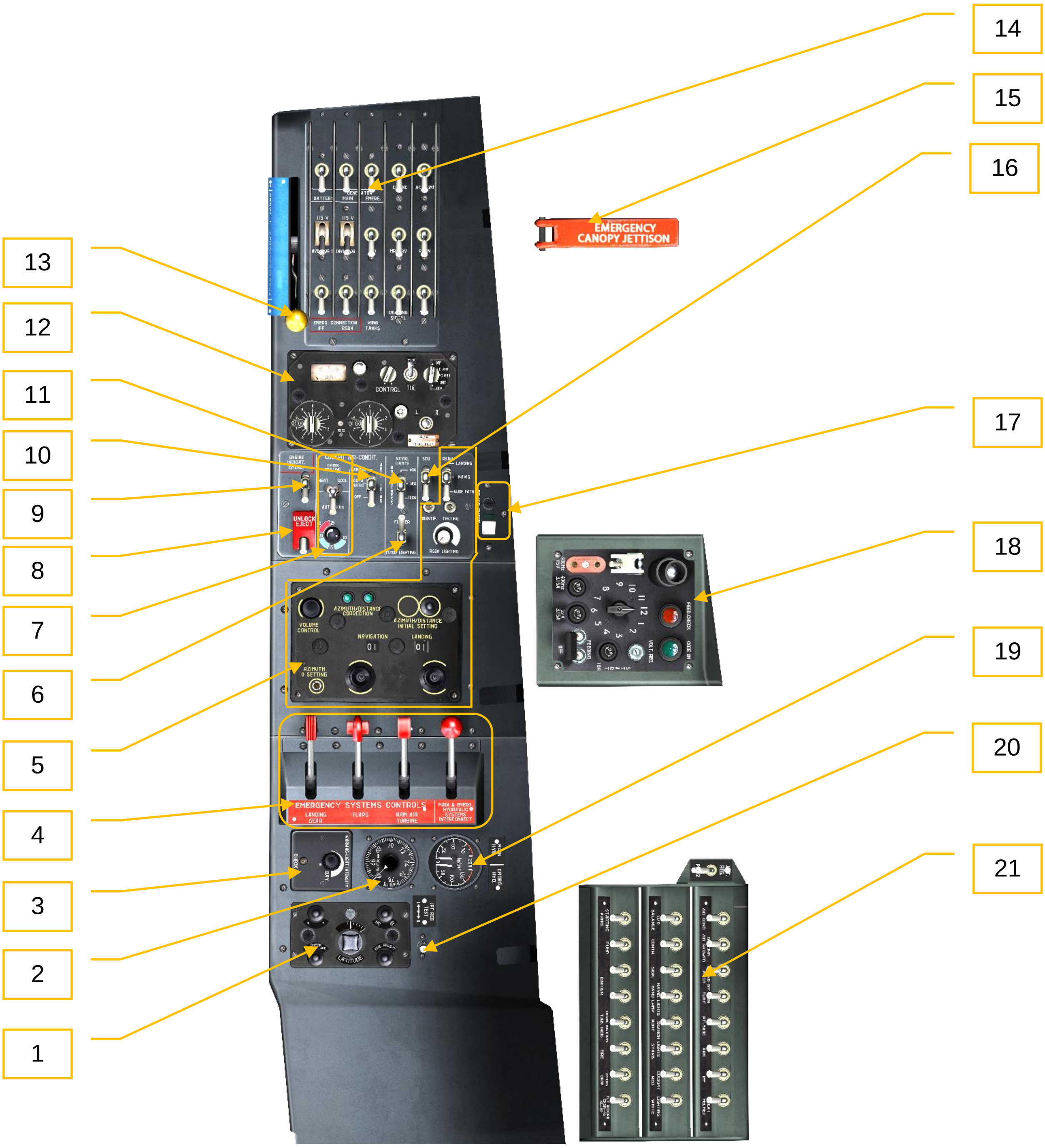
CENTRAL PANEL



1. Signal flares control panel.
2. RSBN range indicator.
3. Accelerometer.
4. L/G control lever.
5. «O-I» (Outer-inner NDB) switch.
6. L/G position indication panel.
7. RV-5M radar altimeter gauge
8. VD-20 barometric altimeter gauge.
9. KUSM-1200 airspeed and Mach number indicator.
10. Warning lights panel.
11. Emergency floodlight lamp
12. Reserved signal (not used).
13. «NO LAUNCH» signal.
14. «STAND ALERT» signal.
15. «EMERG. LIGHT» emergency floodlight switch.
16. ASP-3NMU gunsight.
17. FKP-2-2 gun camera.
18. Master caution panel.
19. KI-13 magnetic standby compass.
20. Attitude Directional Indicator (ADI).
21. Caution & advisory lights panel.
22. Vertical velocity/turn & slip indicator.
23. «ERROR GA» gyroscope error signal lamp.
24. «MC. SYNCHR» magnetic heading alignment button.
25. Radio Magnetic Indicator (RMI).
26. ITE-2 engine RPM gauge.
27. TST-2 exhaust gas temperature (EGT) gauge.
28. RKL-41 automatic direction finder (ADF).
29. Fuel meter gauge.
30. Individual pilot and suit ventilation control panel with «HEAT – COLD – AUTO» switch and desired temperature dial.
31. Individual air shower duct (not used).
32. Voltammeter.
33. Three-pointer oil and fuel pressure and oil temperature indicator.
34. IV-200 engine vibration gauge.
35. UVPD cockpit altitude and pressure difference gauge.

36. Airplane control stick.
37. Rudder pedal.
38. Pedals adjustment (based on pilot's height, not used).
39. AChS-1M cockpit clock.

RIGHT PANEL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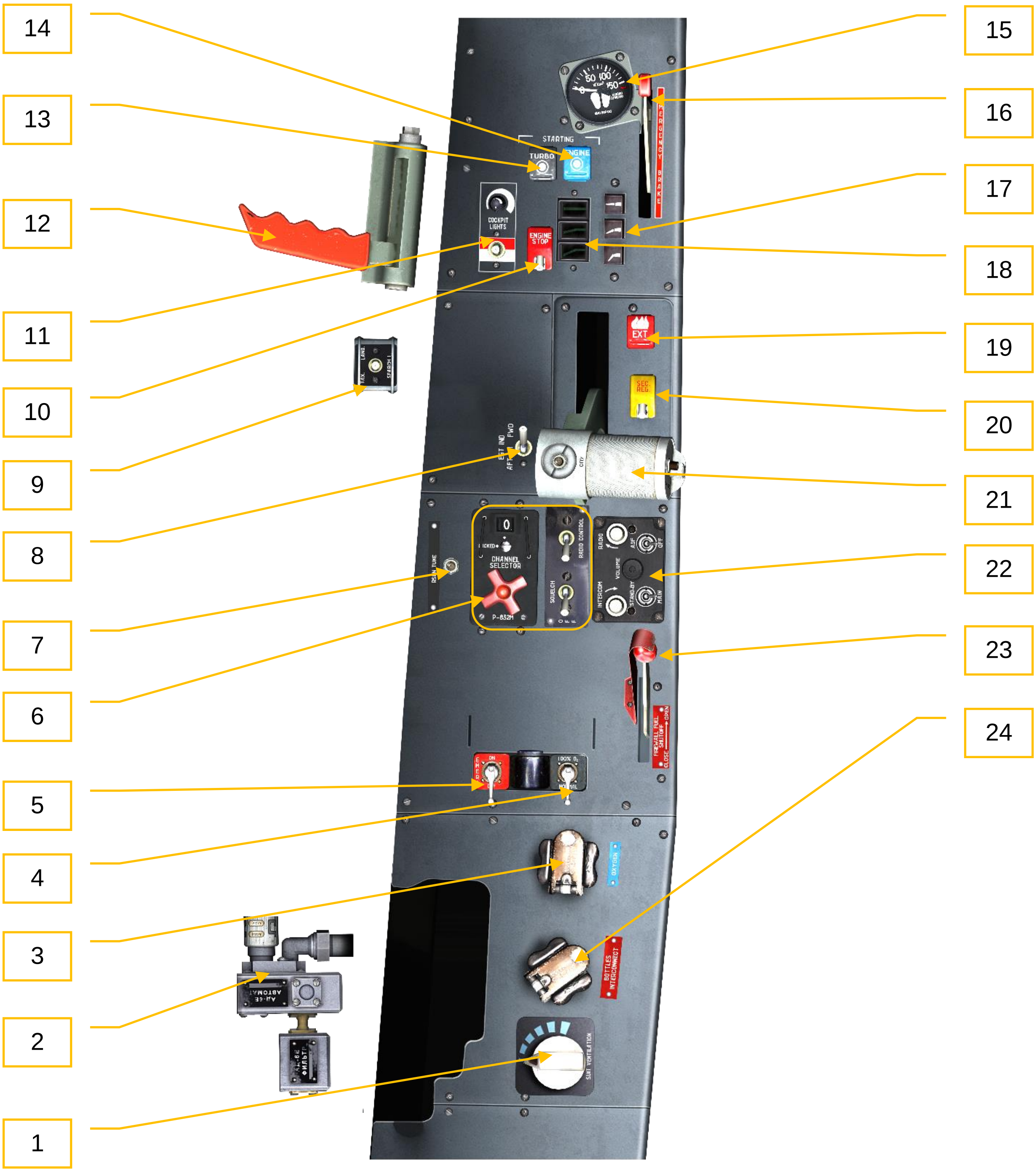
EMERGENCY CANOPY JETTISON
EMERGENCY SYSTEMS CONTROLS
LANDING GEAR
FLAPS
RAM AIR TURBINE

1. GMK-1AE directional gyro control panel.
2. ZDV-30.
3. «CHECK» button with «WARNING LIGHT INTENSITY» rheostat.
4. Emergency hydraulic system valves.
5. RSBN-5S control panel.
6. «FLICKER – OFF – FIXED LIGHTING» navigation lights mode switch.
7. Cockpit temperature control panel with «HEAT-COLD-AUTO» switch and desired temperature dial.
8. «UNCLOCK EJECT» switch (not used).
9. «ENGINE INDICAT. EMERG.» engine gauges emergency supply switch.
10. Anti-icing system switch.
11. «BRIGHTNESS 30% - 60% - 100%» navigation lights brightness switch.
12. RKL-41 automatic direction finder control panel.
13. Cockpit pressurization and ECS handle.
14. Main CB panel.
15. Emergency canopy jettison handle.
16. Remote command landing system (SDU) switch.
17. De-Ice sensor (RIO-3) heating circuit check button (ground check) and corresponding signal lamp.
18. SRO transponder (IFF) control panel (not used).
19. Double-pointer main and emergency hydraulic systems pressure gauge.
20. «JPT. REG. TEST» EGT limiter test switch.
21. Auxiliary CB panel.

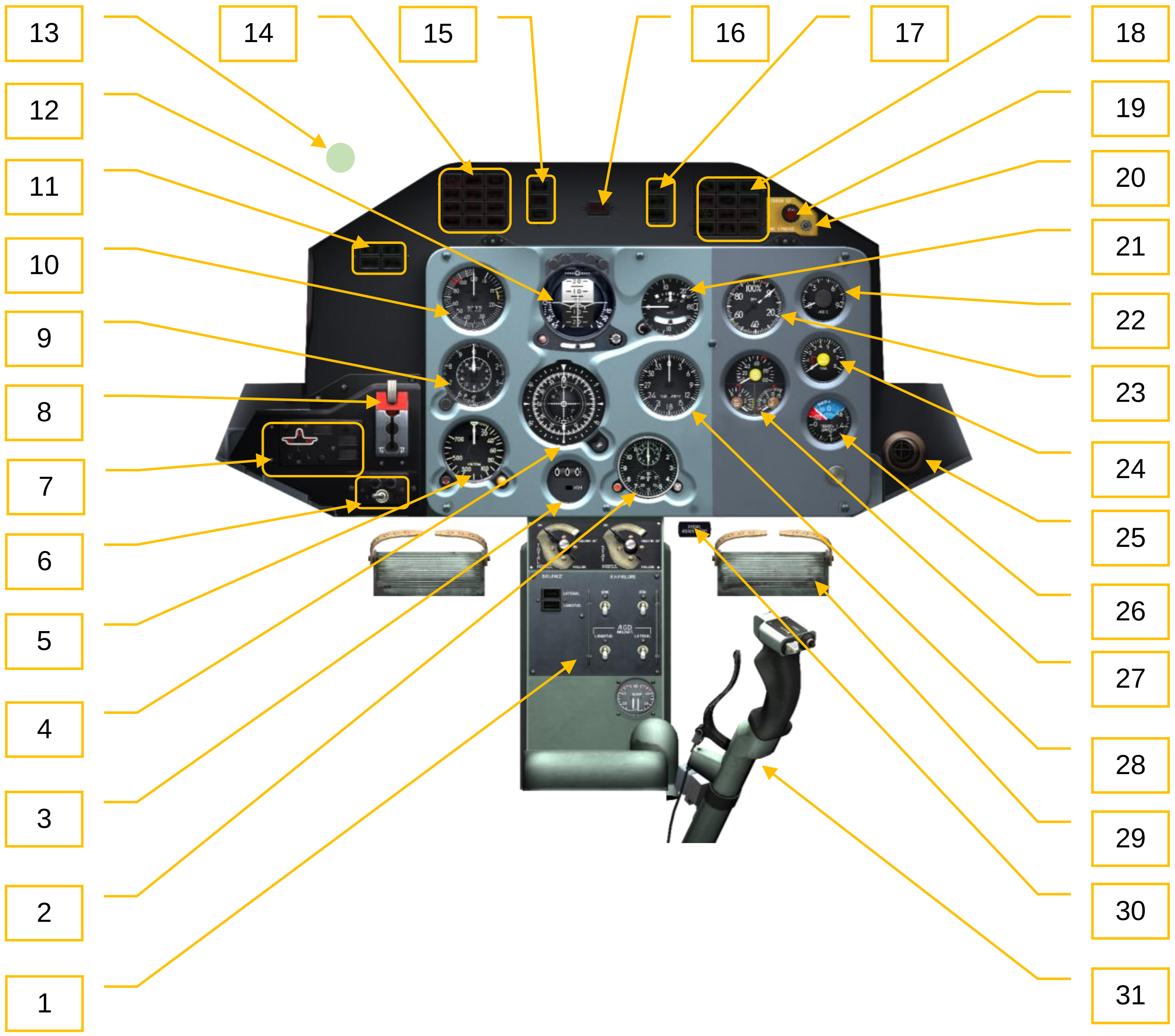
REAR COCKPIT EQUIPMENT

LEFT PANEL



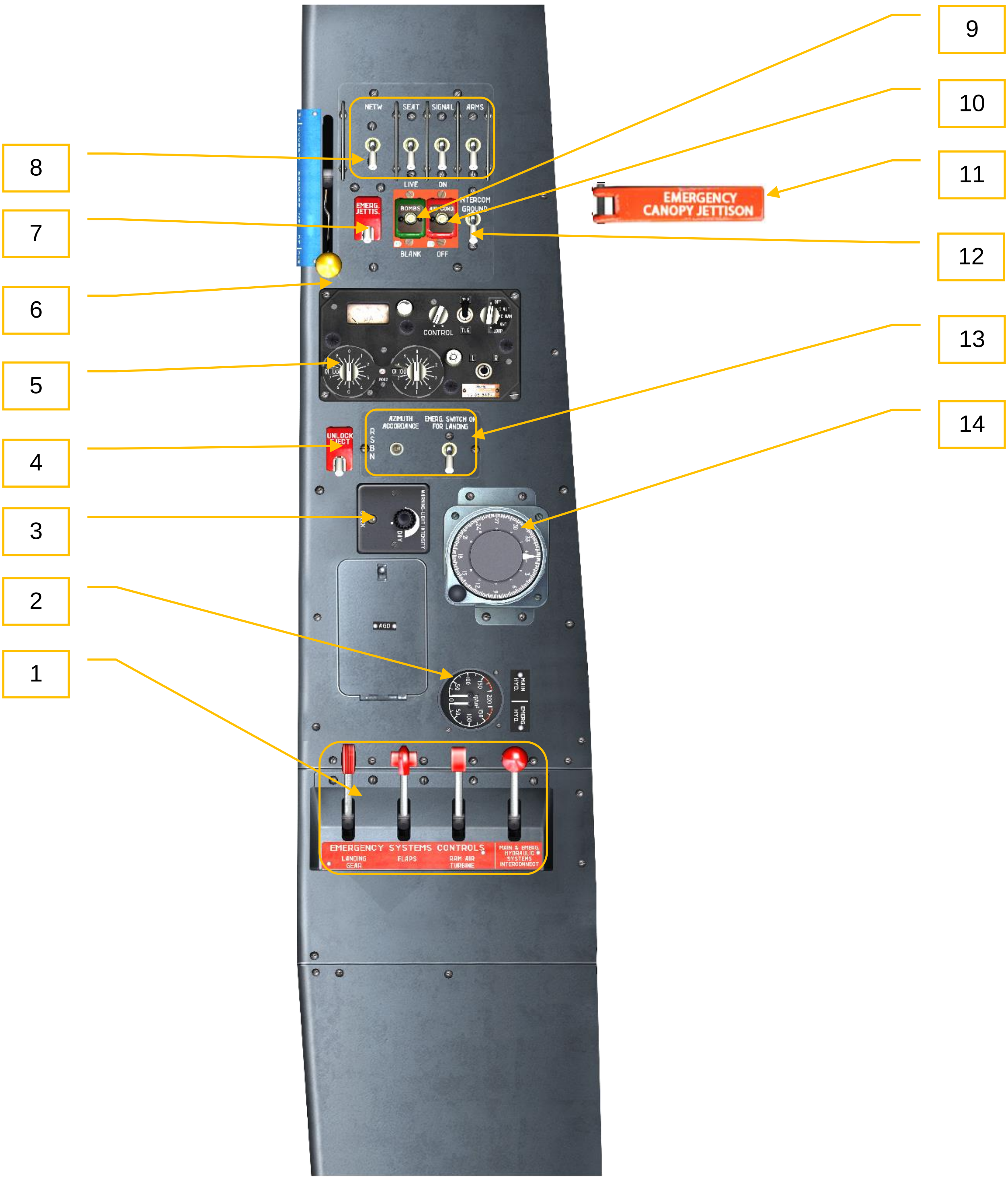
1. Suit ventilation valve (not used).
2. AD-6E pressure regulator (not used).
3. Oxygen supply valve.
4. «100% O_2- NORM» (RPK-52 Mixture -100 %) oxygen supply regulator.
5. Emergency oxygen supply regulator.
6. R-832M radio control panel.
7. RSBN audio button.
8. «EGT IND AFT FWD» switch.
9. Taxi- Landing lights control switch.
10. «ENGINE STOP» switch.
11. Cockpit floodlight control panel with red to white illumination color switch and brightness knob.
12. Canopy lock handle.
13. «TURBO» button.
14. «ENGINE» button.
15. IK-52 oxygen pressure indicator and flow annunciator.
16. Emergency braking handle.
17. Flaps control buttons.
18. Flaps position indicators
19. «EXT» (Extinguishing) button.
20. «SEC. REG.» emergency fuel switch.
21. Throttle handle.
22. SPU-9 intercom (ICS) control panel.
23. Fuel shut-off valve handle.
24. Oxygen tanks interconnect valve.

CENTRAL PANEL



1. Pitch and roll trim indicator panel (on the left), fault simulation panel (on the right).
2. AChS-1M cockpit clock.
3. RSBN range indicator.
4. Radio Magnetic Indicator (RMI).
5. RV-5M radar altimeter gauge.
6. «O-I» Outer-inner NDB switch.
7. L/G position indication panel.
8. L/G control lever.
9. VD-20 barometric altimeter gauge.
10. KUSM -1200 airspeed and Mach number indicator
11. Stores indication panel
12. Attitude Directional Indicator (ADI).
13. Hood control handle.
14. Warning lights panel
15. Left armament indication panel
16. Master caution panel.
17. Right armament indication panel
18. Caution & advisory lights panel.
19. «ERROR GA» gyroscope error signal lamp.
20. «MC. SYNCHR» Magnetic heading alignment button.
21. Vertical velocity/turn & slip indicator.
22. TST-2 exhaust gas temperature (EGT) gauge.
23. ITE-2 engine RPM gauge.
24. Fuel meter gauge
25. Individual air shower duct (not used).
26. UVPD cockpit altitude and pressure difference gauge.
27. Three-pointer oil and fuel pressure and oil temperature gauge.
28. RKL-41 automatic direction finder (ADF) gauge.
29. Rudder pedal.
30. Pedals adjustment (based on pilot’s height, not used).
31. Airplane control stick.

RIGHT PANEL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EMERGENCY CANOPY JETTISON
EMERGENCY SYSTEMS CONTROLS

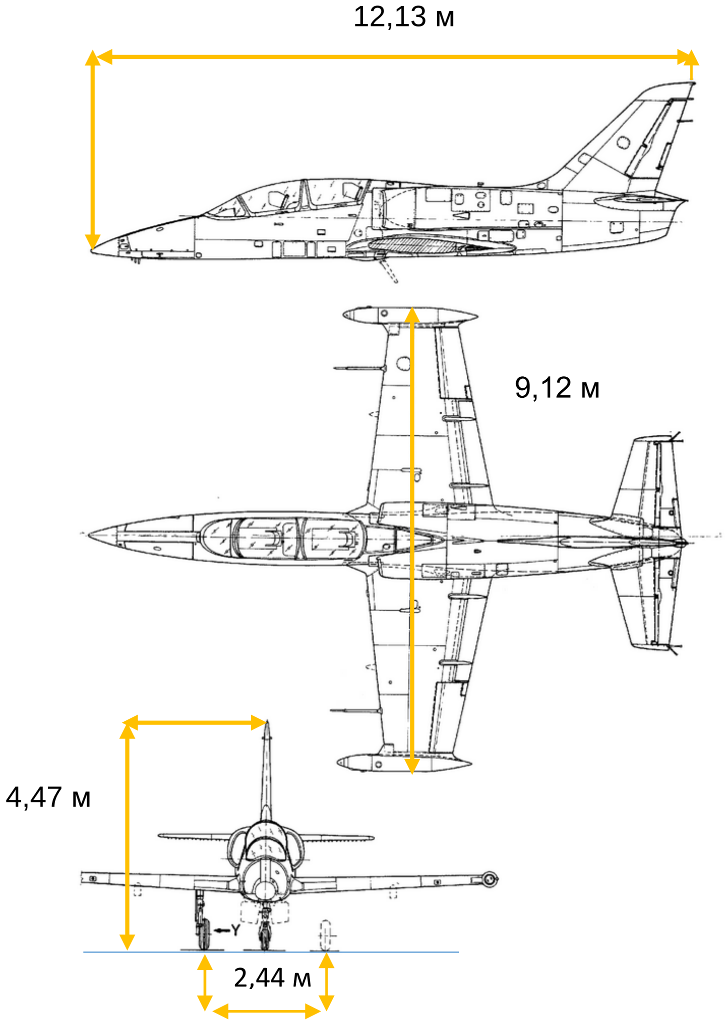
1. Emergency hydraulic system valves.
2. Double-pointer main and emergency hydraulic systems pressure gauge.
3. «CHECK» button with «WARNING LIGHT INTENSITY» rheostat.
4. «UNCLOCK EJECT» (Unblock seat) switch (not used).
5. RKL-41 automatic direction finder (ADF) control panel.
6. Cockpit pressurization and ECS handle.
7. «EMERG. JETTIS.» emergency stores jettison switch.
8. Miscellaneous CB panel
9. «BOMBS» bombs arming switch.
10. «AIR.COND» air conditioning CB.
11. Emergency canopy jettison handle.
12. «INTERCOM GROUND» CB.
13. RSBN-5S control panel.
14. KM-8 correction mechanism.

GENERAL DESCRIPTION OF THE L-39C AIRPLANE

Double seat combat trainer L-39C with AI-25TL turbofan engine is designed for mastering pilot skills, air navigation in simple and adverse meteorological conditions during the night and day, combat employment training, aiming and missile shoots simulations at visually observed aerial targets, photo shooting at aerial targets, dive bombing (photo bombing) with 50-100 kg bombs, S-5 rockets shooting (photo shooting) at ground targets.

In the L-39C module R-3S heat seeker missile shooting at aerial target under clear visual condition is implemented

AIRCRAFT DIMENSIONS



AIRPLANE. GENERAL CONSTRUCTION

The L-39C airplane is a conventional low wing cantilever airplane with trapezoidal wings. Empennage consists of trapezoidal vertical stabilizer with rudder and horizontal stabilizers with elevators. The airplane has three-wheel landing gear with nose gear. Main gear struts are retracted into the wings and the nose one into the fuselage.

The AI-25TL turbofan engine developed under supervision of V.A Lotarev in experimental design bureau produces maximum thrust of 1720 kgF and is mounted in the middle section of the fuselage.

Fuel for engine is allocated in five fuselage fuel tanks, located behind rear cockpit and in tip tanks.

There are two pressurized cockpits in the nose part of the fuselage. The cockpits are equipped with environmental control system, which provides air conditioning and comfortable conditions at higher altitudes. It allows pilots to withstand allowed operational Gs if pilot use special equipment.

The VS1-BRI eject seats are installed in both cockpits; they allow pilots to leave the airplane in case of an emergency.

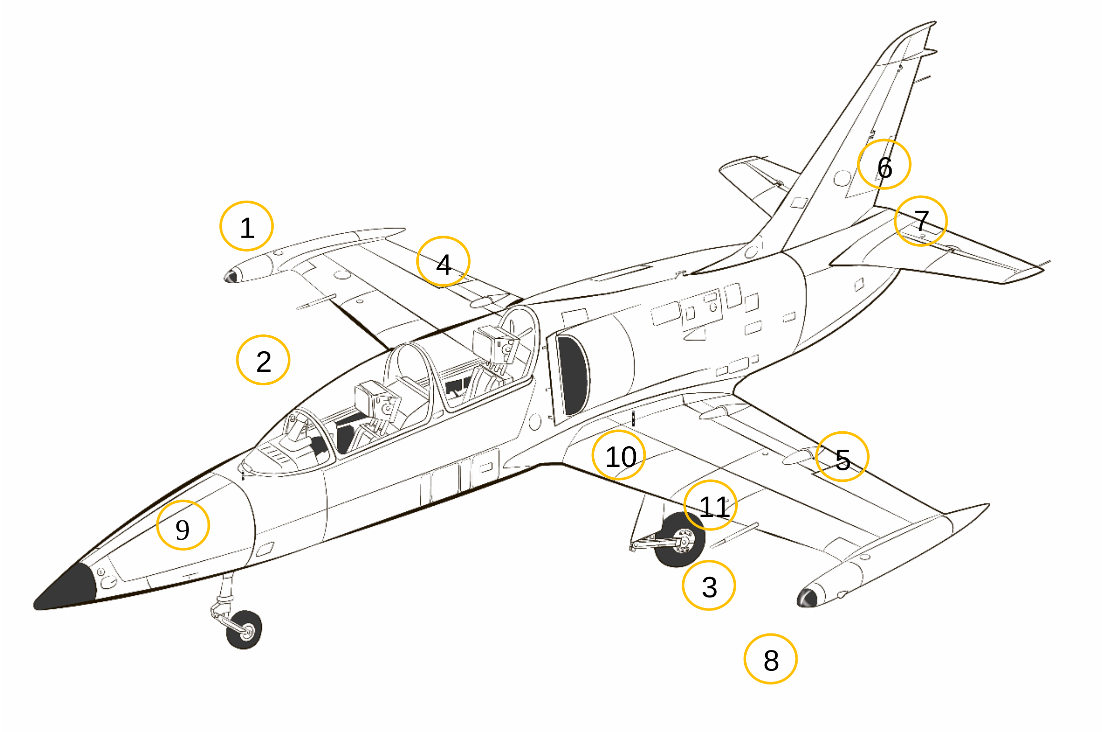
Canopy is sealed, moving parts in case of emergency can be jettisoned by emergency pyrotechnical systems.

Wing is attached to the bottom of the fuselage. Ailerons and extendable double-slotted flaps are installed on the wing.

Various airplane equipment and avionics provide the possibility to fly during day and night in simple and adverse weather conditions.

The airplane can carry missiles, rockets and bombs and is equipped with aiming and photo control equipment.

L-39C airplane



1 Wingtip fuel tanks.
2 Primary Pitot tube.
3 Backup Pitot tube.
4 Aileron servo compensator.
5 Aileron trimmer.
6 Rudder servo compensator.
7 Elevator servo compensator.
8 Landing and taxi lights.
9 Mechanical pointer of nose gear position.
10 Mechanical pointer of main gear position.
11 Mechanical flap position pointer.

AIRFRAME

Airframe consists of fuselage, wing and empennage.

Fuselage is semi-monocoque, framed construction.

To ease operational service fuselage is divided on two parts: the front one and rear one.

The front part consists of three technological sections: fuselage nose, sealed section with cockpits and section where fuel tanks are installed. In the fuselage nose radio electronic and special equipment compartment is placed (RSBN-5S antennas, SRO-2M airplane transponder blocks, R-832M radio, RKL-41 automatic direction finder, RSBN-5S unit, oxygen tanks and 12SAM-28 accumulator). In the bottom of the compartment cut out for the nose landing gear niche is made. On the lower cover of the fuselage nose SRO-2M antenna of IIIrd frequency range and radio isotopic icing sensor (RIO-3) are installed.

In the sealed cockpit-compartment RSBN-5S unit, RV-5 radar altimeter and MRP-56P marker beacon receiver, as well as antennas for RKL-41 automatic direction finder, RV-5 radar altimeter and MRP-56P marker radio beacon receiver are installed.

In the tail part of the airplane the AI-25TL engine is mounted.

Empennage is designed to provide directional and longitudinal stability and controllability to the airplane. It is of classic type, with trapezoidal shapes of vertical and horizontal stabilizers and attached to the top tail section of the fuselage.

It includes horizontal and vertical stabilizing surfaces.

The vertical ones are a fin and a rudder.

The fin provides directional stability and the rudder – directional controllability.

The rudder can be deflected at 30^0 in both directions. It has servo compensator, used to reduce the hinge moment.

The white navigation light is installed on the trailing edge of the fin.

Horizontal stabilizing surfaces consist of a horizontal stabilizer and an elevator, they responsible for longitudinal stability and controllability correspondingly.

The elevator consists of the left and right parts. Elevator can de deflected by 30^0 upwards and 20^0 downwards.

The airplane wing is designed to create lift force, provide lateral stability and control as well as for placing units and various equipment. The wing is non-swept, trapezoidal with non-removable tip tanks. The wing is equipped with ailerons and flaps. Maximum aileron deflection angle is $\pm 16^0$.

1. Flap
2. Aileron
3. Fin
4. Rudder
5. Elevator
6. Horizontal stabilizer

The main landing gear legs are attached to the wing and retract in the wing towards the fuselage.

Airbrakes are located on the lower side of the wing. They can be extended by pilot manually. When reaching Mach=0,78+ 0,02 the airbrakes will be extended automatically. Maximum deflection angle for the airbrakes is 55^0.

Universal hardpoints are located on the bottom side of the wing as well. On the leading wing edge there are tubes of Pitot-static systems, the left one (emergency) and the right one (primary).

Non-removable fuel tanks with 100 liters capacity each are mounted on the wingtips. In the nose parts of the tank landing and taxi lights are installed.

On the left and right wingtips there are navigation lights of green and red color correspondingly.

1. Wing pylon
2. Wingtip fuel tank
3. Landing and taxi light

COCKPIT

The cockpit is designed to accommodate pilots, ejection seats and related emergency equipment, various blocks, components and devices that control airplane, engine and various systems. Cockpits are covered with a canopy.

Both the front one and rear cockpits are pressurized.

Canopy provides pilots with necessary visibility from the cockpits, makes cockpit aerodynamically faired and seal it. Canopy consists of four parts: windshield, openable part of the front cockpit, mid-panel and openable part of rear cockpit.

To prevent icing of the windshield an anti-icing system is installed on the airplane.

Important: if the hood was raised from rear cockpit it can be lowered from rear cockpit only.

For practicing instrumental piloting technique, the front cockpit is equipped with a special hood, attached to the openable part of the front cockpit. The hood can be controlled from both cockpits. Normally, the front L-39 pilot raises and lowers the hood by left hand (in the simulation model with button). In rear cockpit there is a special handle for this purpose on the left side of the cockpit.

Locks of the openable part of the cockpit are opened and closed with help of handle located on the left side of the cockpit. Lock is closing by moving the handle forward and opening by moving handle backward. The "CANOPY UNLOCKED" signal on the warning lights panel indicates if locks are closed or not. When closed, the handles have to be behind the red mark and "CANOPY UNLOCKED" signal is off. In case if canopy is not locked, the "CANOPY UNLOCKED" signal lamp illuminates continuously (not blinking).

The openable parts of the canopy are equipped with emergency pyrotechnical jettison system which provides emergency canopy jettison without ejecting and canopy jettison followed by ejection. To jettison canopy without ejecting is necessary to deflect handle, located on the right side of both cockpits, downward. Locks will be opened and openable parts of the canopy detach from the cockpit. Canopy jettison followed by ejection can be done by pulling double handle on the ejection seat.

VS1-BRI EJECTION SEAT

The VS1-BRI ejection seat is intended to be placed inside the cockpit and eject pilot in emergency cases. To eject pilot has to pull double eject handle located at the front of the seat in the middle, after that all systems trigger automatically up to the deployment of parachute. Pilots can be ejected in any sequence. When it is necessary to leave the airplane after manual canopy jettison, the pilot from rear cockpit ejects first (in order to avoid injuries from exhaust powder gases of the

URM-1 front cockpit ejection seat rocket booster). To exclude the possibility of simultaneous ejection from both cockpits with consequent collision of the ejection seats, there is a blocking system.

If the first crew member was not ejected (because of some reasons), the second crew member can override blocking by the «UNCLOCK EJECT» (44) switch. These switches are located on the right panel of both cockpits. They are not functional in simulation.

HYDRAULIC SYSTEM

Hydraulic system consists of the utility and emergency systems.

The utility hydraulic system is used for:

- landing gear extension and retraction;
- flaps extension and retraction;
- airbrakes extension and retraction;
- main landing gear braking.

The utility hydraulic is controlled by buttons, switches and valves located in both cockpits of the airplane. Utility hydraulic system controls in rear cockpit are the COMMAND ones (it means that they can override controls in front cockpit).

Emergency hydraulic system is used for:

- emergency gear extension;
- emergency flaps extension to "LANDING" position;
- emergency extension of ram air turbine;
- emergency braking;
- emergency gear retraction in case of engine self-stop.

Emergency hydraulic system is controlled by mechanic valves, located on the right panels in both cockpits. There is no priority in operation between them.
Nominal liquid pressure in the utility and emergency hydraulic systems is 150 kg/cm^2.

Pressure in emergency and utility hydraulic systems is monitored with help of double-pointer pressure gauges with 0-200 kg/cm^2 scale, installed on the right panel in each cockpit. The left pointer indicates pressure in the utility hydraulic system and the right one in the emergency system.

UTILITY HYDRAULIC SYSTEM
LANDING GEAR

Landing gear is developed for take-off, landing and maneuvering airplane on the airfield. The front landing gear leg is mounted in the fuselage nose and retracts forward in the corresponding niche. Two main landing gear legs are mounted in the wing and retract completely in the middle section of the wing towards the fuselage. In extended position main landing gear niches are covered with landing gear doors.

The main landing gear wheels during retraction are being automatically decelerated. The nose landing gear wheel is not equipped with brakes and can freely rotate in both sides at an angle of $\pm 60^0$.

There is a lock to prevent possible landing gear retraction on the ground.

The nose landing gear strut has end switch which blocks retraction circuit when nose landing gear is loaded.

Important: If landing gear switch is in the retraction position, the gear will not be retracted while on the ground, but during takeoff after nose wheel lifted the strut become unloaded and nose gear will be retracted.

Landing gear extension and retraction is controlled by electrical switches located on the left side of instrument panels in both cockpits. In front cockpit it is double-position switch. To retract gear set it to the upper position, to extend gear - in the lower.

The same switch in rear cockpit has three positions. In addition to upper (retraction) and lower (extension) it has neutral position.

Important: The L/G control lever in rear cockpit is a command one. Gear can be controlled by the switch in the front cockpit only if the switch in rear cockpit is in neutral position.

Landing gear position and gear doors position indication is the same for both cockpits. For that purpose there is a flight and landing gear indicator, located in the left bottom part of the instrument panel in both cockpits, as well as mechanical pointers. The nose gear mechanical pointer is located on the fuselage nose in front of windshield and main landing gear mechanical pointers are on the wing. When landing gear is extended mechanical pointers are fully elevated, and on contrary when landing gear is retracted the mechanical pointers are fully hidden inside the fuselage and wing.

MAIN LANDING GEAR BRAKING SYSTEM

This system is intended for simultaneous and separate gear braking and to automatically unblock them if they are locked up during braking or skidding.

Landing gears brake simultaneously when the brake levers located on the sticks in both cockpits are pressed.

Separate braking is done by pressing the brake lever and deflecting pedal at an angle of $(18\pm2)^0$ to $(40\pm2)^0$. If pedal is deflected at angle up to $(18\pm2)^0$ separated braking is not performed.

Wheel brakes are released with release of the brake control lever.

Important: Brake lever in rear cockpit are command one. When this lever is pressed in rear cockpit brakes cannot be controlled by the brake lever in front cockpit.

Pressure in brakes is indicated by double pointer pressure gauges installed in both cockpits on the middle control panels. These pressure gauges will normally show the same pressure in the right wheel and left wheel brakes.

Double pointer pressure gauge in front and left cockpits.

Front cockpit

Rear cockpit

There is a parking brake as well, which latches the main landing gear wheels when airplane is parked. Parking brake handle is located on the left panel in front cockpit only. To enable parking brake is necessary to move the handle all the way forward until it stops. To release parking brakes move the handle to the center position. Parking brake operates from emergency hydraulic level.

FLAPS

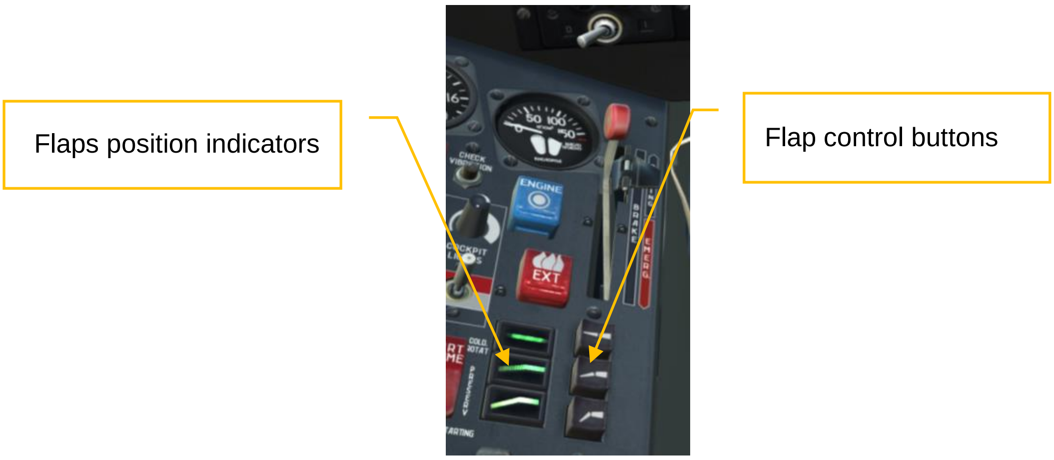
The L-39C has mighty wing mechanization - double-slotted flaps. Their purpose is to improve takeoff and landing characteristic of the airplane by increasing lift force and partly the wing area.

Flaps are controlled with help of three buttons, located on the left panels in both cockpits. The first one is used to set flaps to the «FLIGHT» 0^0 position, the middle one in the «TAKE OFF» 25^0 position and rear one in the «LANDING» 44^0 position.

Flaps position is indicated (the same for both cockpits) by means of three signal panels, located on the left panels near the flap control buttons. When flaps are retracted the front signal panel is on, when flaps are in takeoff position «TAKE OFF» middle signal panel is on and when flaps are in landing position «LANDING» rear signal panel is on. While flaps are retracting or extending corresponding button is hold pressed. When flaps reach required position the button returns to the initial position.

Important: Flaps buttons in rear cockpit are the command ones. Pilot in rear cockpit can override flaps controls in front cockpit.

There are mechanical flaps pointers, located on the wing. When flaps are retracted the mechanical pointers are hidden in the wing, after reaching "TAKE OFF" position they are raised halfway and after reaching "LANDING" position they are fully extended.



Extension time from "FLIGHT" 0^0 to "TAKE OFF" position is (3±1) seconds.

Extension time from "FLIGHT" 0^0 to «LANDING» 44^0 position is (5±1) seconds. Retraction time is the same. If pilot in good time does not retract flaps, they will be retracted automatically at speed of more than 310 km/h.

AIRBRAKES

Airbrakes are used for braking airplane in the air.

Airbrakes extension and retraction is controlled by switches, located on the throttle handles in both cockpits.

In the front cockpit switch has two fixed positions: extension and retraction. From the front cockpit it is possible to extend airbrakes for a short-time by pressing the switch as a button, when released airbrakes retract. To extend airbrakes for a longer time is necessary to toggle the switch in rear position and for retraction in the front position.

In rear cockpit this switch has 3 positions: forward (airbrakes retraction), middle (neutral) and aft (airbrakes extension).

Important: Airbrake control switch in rear cockpit is a command one. Airbrakes can be controlled from the front cockpit only in case if rear cockpit switch is in neutral position.

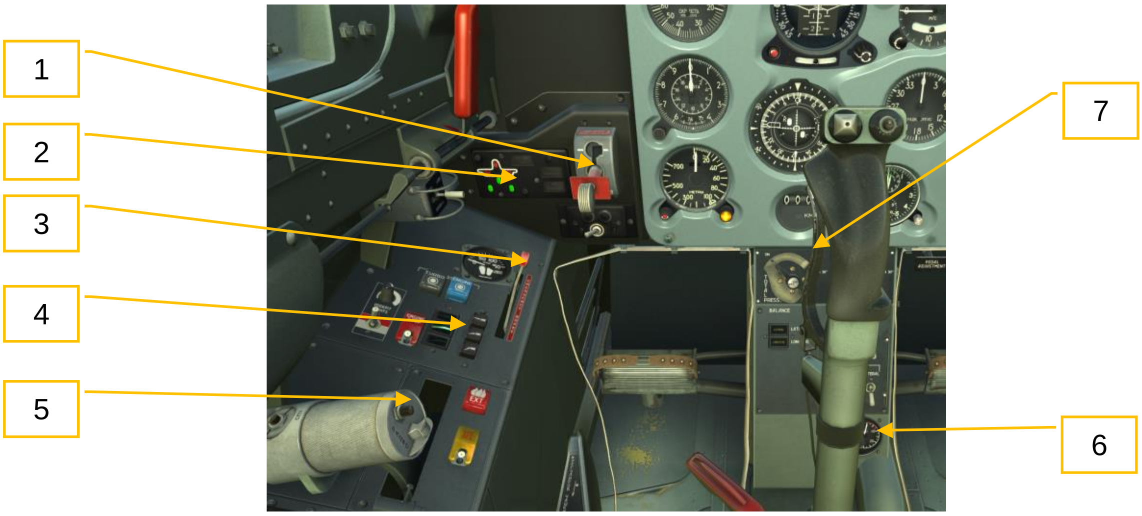
Airbrake position is indicated with the «AIR BRAKE OUT» signal, located on the flight and landing indicators in both cockpits.

When airplane reaches Mach=0, 78+0, 02 airbrakes are extended automatically.

Utility hydraulic system controls and signalization in both cockpits.

Front cockpit

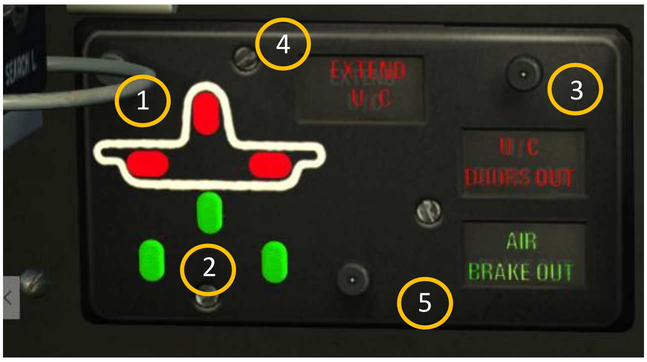
Rear cockpit



1. Landing gear lever.
2. Flight and landing gear indicator.
3. Parking brake handle.
4. Flaps control buttons and flaps position indicators.
5. Airbrakes controls.
6. Double-pointer pressure gauge.
7. Brake lever.

FLIGHT AND LANDING GEAR INDICATOR (41)

1. Three red lamps – gear is retracted.
2. Three green lamps – gear is extended.
3. «UC DOORS OUT» lamp, illuminates during landing gear extension and retraction (in case of emergency gear extension gear doors do not close and the «UC DOORS OUT» lamp continues being on)
4. «EXTEND UC» lamp illuminates if during landing approach flaps are extended in landing position, but gears are retracted (when this lamp is on, electrical siren is heard)
5. «AIR BRAKE OUT», airbrakes are extended signal.



EMERGENCY HYDRAULIC SYSTEM

Emergency hydraulic system is being charged automatically while engine is running and landing gear is extended. In flight with retracted landing gear to charge emergency hydraulic system is necessary to open valve, connecting the main and emergency hydraulic systems, by moving corresponding handle on the right control panel.

During flight it is necessary to control emergency system charging periodically and if needed charge it to 150 kg/cm^2 by moving the valve lever, connecting both systems, back. Landing gear, flaps and ram air turbine can be extended in case of emergency if pressure in the emergency hydraulic system is 105 kg/cm^2. When pressure in the emergency system reaches 100±5 kg/cm^2 the «HYD. SYST. FAIL» lamps blink on the warning lights panel in both cockpits.

To avoid pressure drop in the emergency hydraulic system in case of pressure drop in the utility hydraulic system, systems connection valves have to be closed in both cockpits.

Figure. Emergency hydraulic system valves.

1. Emergency gear extension valve.
2. Emergency flaps extension valve.
3. Emergency ram air turbine (RAT) extension valve.
4. Valve interconnecting main and emergency systems.

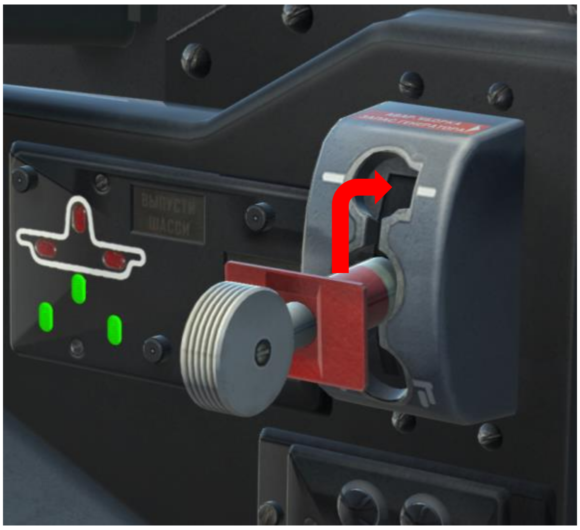
For emergency flap extension is necessary to move the emergency flap extension valve lever, located on the right panel in front or rear cockpits, all the way back. Landing gear extension is monitored by corresponding lights and mechanical pointers. In case of emergency landing gear extension the gear doors are kept opened and the «UC DOORS OUT» (Gear doors are opened) lamp remains on.

With help of emergency hydraulic system flaps extends only to “LANDING” 44^0 position. When flaps are emergency extended the servo compensator on the left elevator does not deflect automatically.

Landing approach with retracted gear and extended to landing position flaps (44^0) is accompanied by lighting on the «EXTEND UC» signal on the flight and landing signal panel and by siren sound.

For emergency ram air turbine extension is necessary to move emergency ram air turbine extension lever backward until it stops in front or rear cockpit.

To retract gear in emergency cases of engine stop is necessary to set landing gear valve in retracted position and to the right for 1-2 seconds in front or rear cockpit.



EMERGENCY MAIN LANDING GEARS BRAKING

To do an emergency braking it is necessary to move emergency brake valve lever, located on the left panel in front or rear cockpit, backward. While performing emergency braking it is impossible to brake wheels separately (make a turn) and wheels are not automatically unblocked when skidding.

Front cockpit

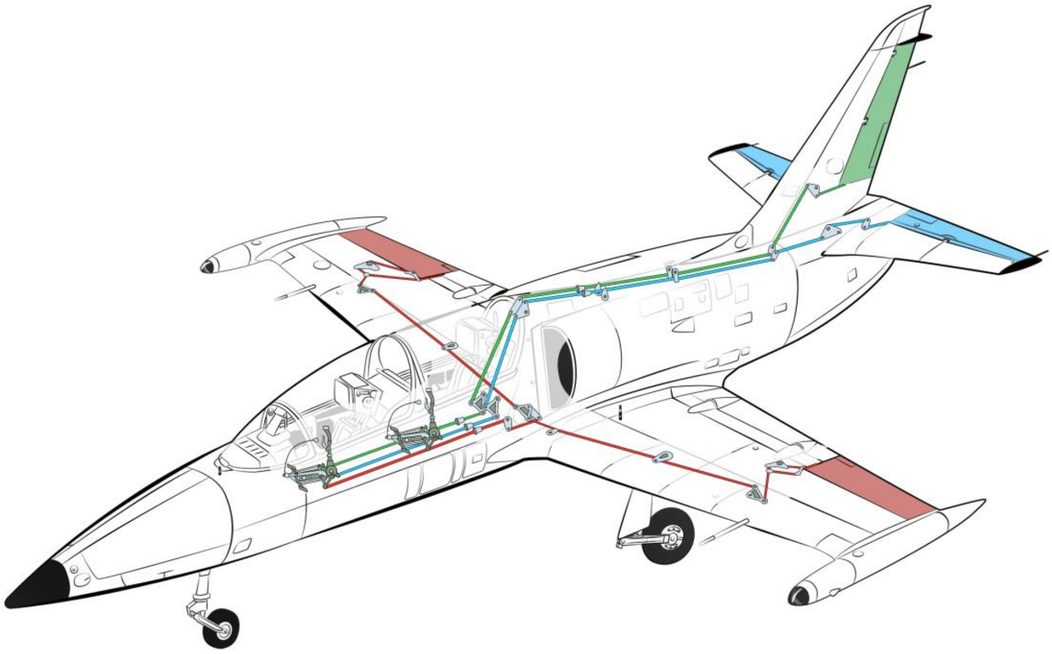
Rear cockpit

Pressure in brakes is indicated by pressure gauge, installed on the middle control panel in front cockpit only.

Emergency braking system pressure gauge

AIRPLANE CONTROLS

Airplane controls include elevators, ailerons, rudder control systems and systems controlling elevators and ailerons trimmers.



Elevator and ailerons are controlled by the sticks installed in both cockpits of the airplane. Control sticks are connected to elevator and ailerons with tube rods, intermediate levers and rockers. Rudder is controlled by pedals, which are connected with rudder with tube rods, intermediate levers and rockers.

All control surfaces of the airplane are equipped with servo compensators to reduce hinge moments on the control surfaces. Servo compensator of the right aileron deflects depending on aileron deflection angle and does not have electrical motor. Servo compensator of the left aileron has electrical motor, which is remotely controlled by push button on the stick. Therefore the servo compensator of the left aileron is an aileron trimmer.

Servo compensator of the rudder does not have electrical motor and deflects depending on rudder deflection angle.

Servo compensators on the right and left sides of the elevator have electrical motors. The one on the right side is remotely controlled by the push button on the stick. This servo compensator is an elevator trimmer.

Servo compensator on the left side of the elevator deflects automatically at 15^0 downward when flaps are extended in landing position.

1. Aileron servo compensator
2. Aileron trimmer.
3. Rudder servo compensator.
4. Elevator trimmer.
5. Elevator servo compensator.

Elevator and ailerons trimmers are controlled remotely with help of electrical motors. Trimmer control buttons are located on the sticks. Neutral aileron and elevator trimmer position indicators are located on the middle panel in both front and rear cockpits. In rear cockpit instead of elevator trimmer position indicator the neutral elevator position signal lamp is installed.

TRIMMER CONTROLS IN FRONT AND REAR COCKPITS.

Front cockpit

Rear cockpit

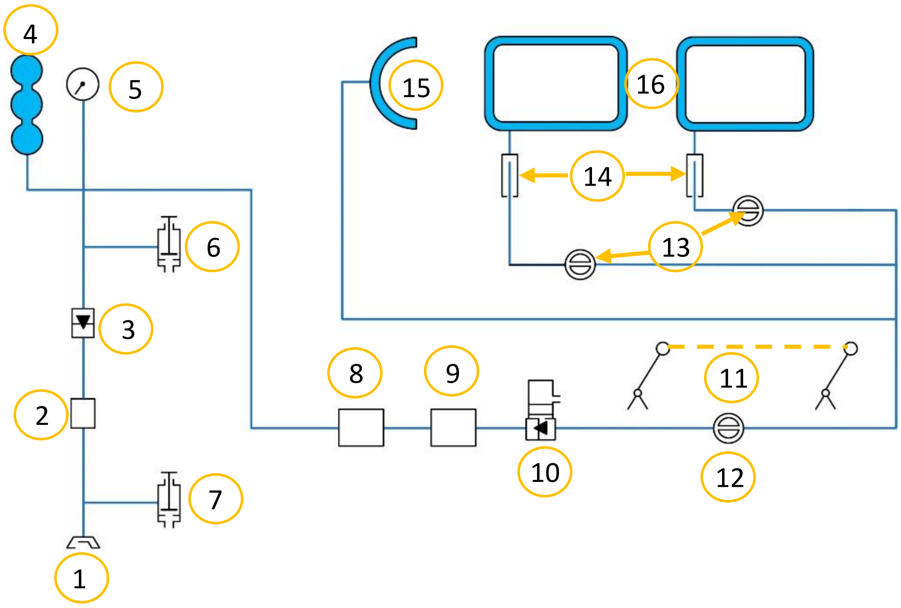
1. Neutral aileron trimmer position.
2. Neutral elevator trimmer position.
3. Trimmer control button.

ENVIRONMENTAL CONTROL SYSTEM

Environmental control system is used for sealing canopy visor and parts of canopy that can be opened.

Cockpit sealing is performed with help of the cockpit pressurization and ECS lever. Cockpit's locks after closing canopy are locked by moving the lever all the way forward in front or rear cockpit. Unsealing is done by moving the lever in opposite direction. Levers are located on the right horizontal panels of both cockpits.

Air system



1. Charge port
2. Filter
3. Non-return valve.
4. Tank
5. Pressure gauge
6. Air bleeding valve, bleeds the air from the system
7. Air bleeding valve, bleeds the air from the charge hose
8. Pressure reducing valve
9. Pressure reducing valve
10. Combined valve
11. cockpit pressurization and ECS lever
12. Sealing valve
13. Sealing valves for parts of canopy that can be opened.
14. Telescopic connections
15. Windshield sealing hose
16. Sealing hoses for parts of canopy that can be opened.

In case of canopy locks opening without preliminary unsealing with help of sealing handle or when ejecting, pressure from the hoses is bled automatically. Canopy opening without depressurization of sealing hoses is not recommended due possibility of canopy detachment from the hinges.

AIR CONDITIONING SYSTEM

Air conditioning system is developed to sustain required temperature and pressure in the cockpit as well as for cockpit ventilation. The air conditioning system together with pressurized cockpit, oxygen equipment, monitoring and control units form airplane altitude equipment.

The airplane cockpit is of ventilation type. Required air pressure in the cockpit is provided by feeding it with compressed air from the engine compressor. Being fed into the cockpit the air ventilates, warms or cools it and the goes out. Cockpit sealing and ventilation occurs after moving the Cockpit pressurization and ECS handle) handle all the way forward in both front and rear cockpits. As a result after 30 seconds the «AIR CONDIT OFF» signal on the right caution & advisory lights panel of both cockpits goes off. The «AIR CONDIT OFF» signal is a blinker. It informs pilot about shut-off air supply valve position. If the signal is blinking – valve is closed, signal is off- valve opened. The shut-off valve is controlled by the Cockpit pressurization and ECS handle) handle. The valve can be controlled only if the «AIR COND» circuit breaker in rear cockpit is in neutral position.

When temperature regulator is in emergency mode, then the «AIRCONDIT EMERG» (Emergency conditioning) signal lights on the caution & advisory lights panel. Temperature regulator emergency functionality is not implemented in simulation and emergency signal lights only if the «CHECK» button is kept pushed.

“Altitude” in the cockpit and air pressure difference is monitored by cockpit altitude and pressure differences gauges (russian: UVPD). UVPD is installed in both cockpits. In case of positive or negative pressure difference in the cockpit, and if the cockpit is unsealed on altitudes higher than 2000 m, the «CABIN PRESSURE» signals on the warning lights panels in both cockpits go on. This signal is a blinker.

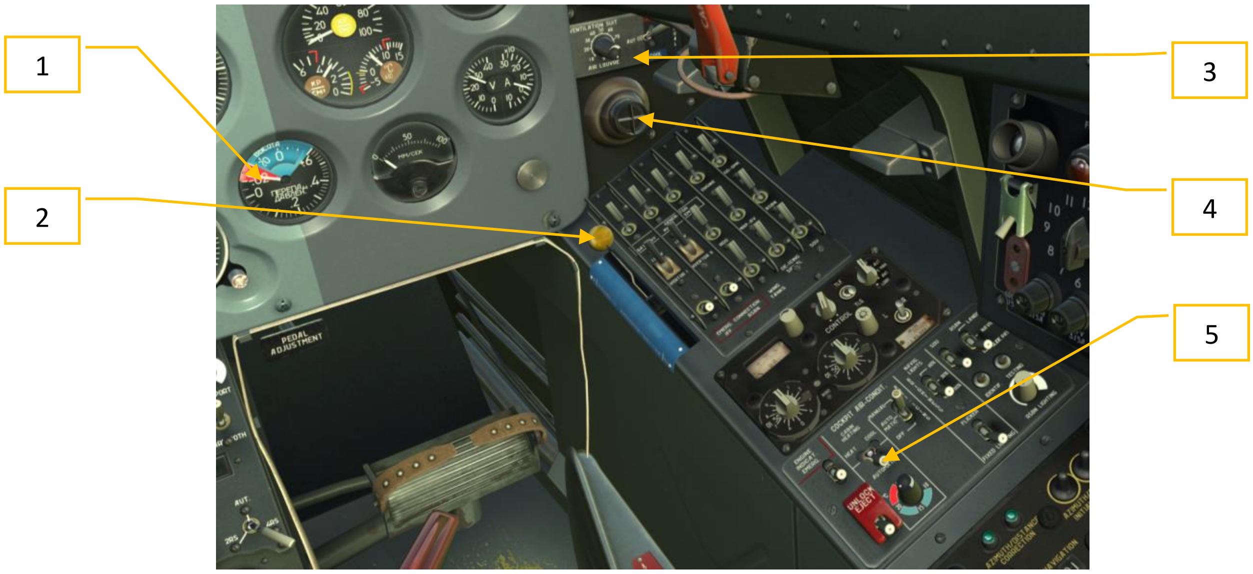
Some functions of the ECS such as automatic cockpit temperature regulation, individual and flying suits line automatic temperature regulation and individual air shower are not implemented.

Cockpit air temperature control panel is installed on the front cockpit right console, behind this panel the «HEAT – COOL – AUTO» switch and temperature dial are located. Suit ventilation valves regulate suit air supply and are located on the left panels in both cockpits.

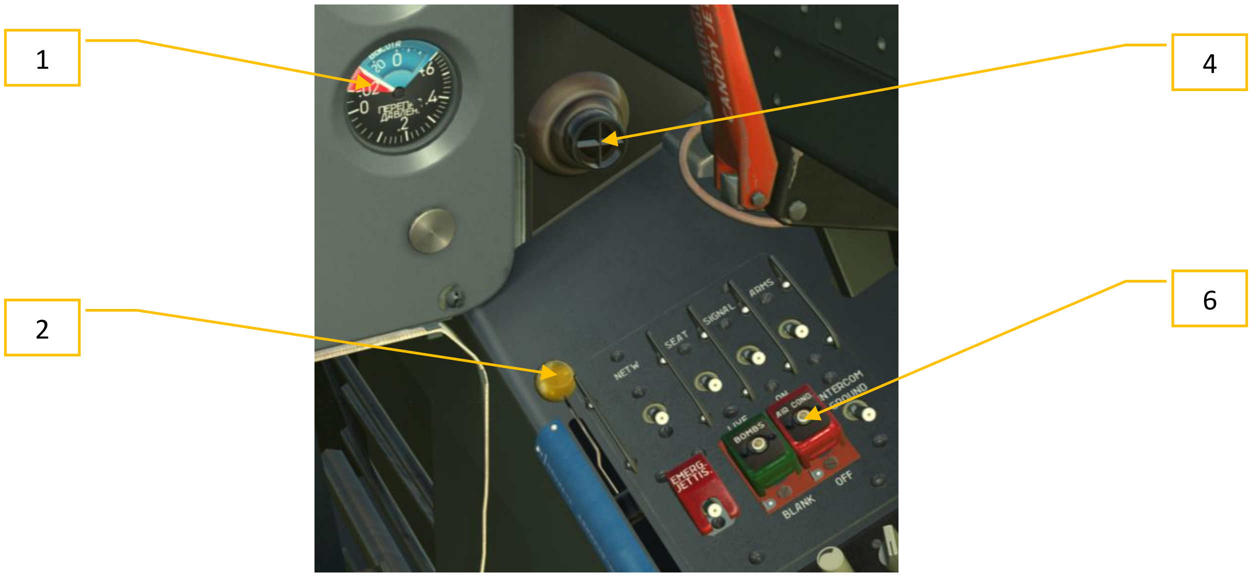
Individual blowing valves are installed in both cockpits on the right from instrument panel.
All controls are animated.

Air system and environmental control systems control and signalization in front and rear cockpits.

Front cockpit



Rear cockpit



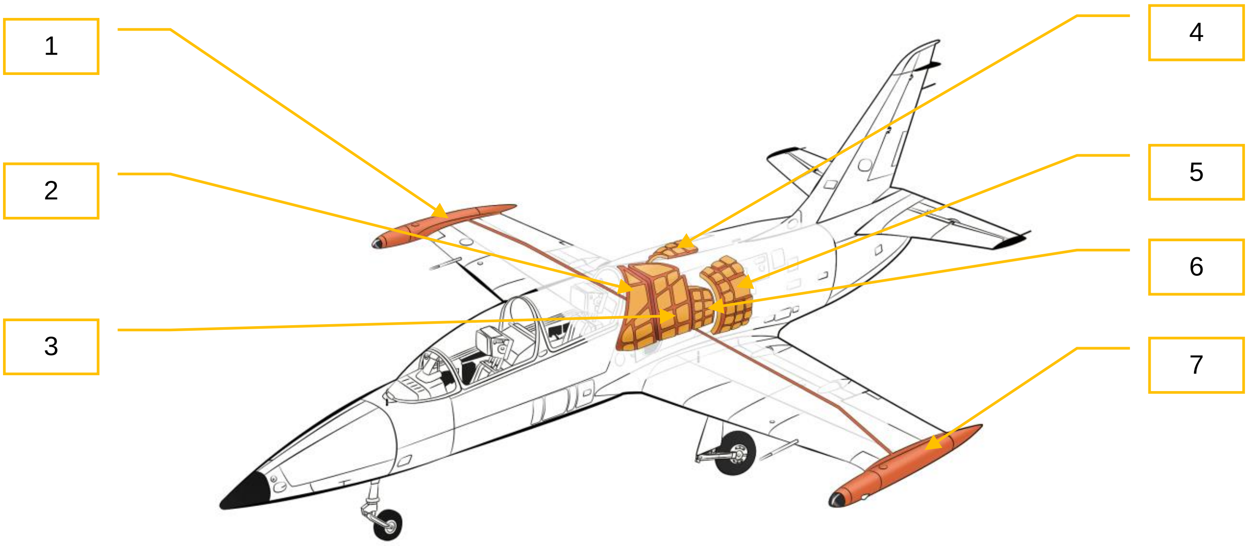
1. UVPD.
2. Cockpit pressurization and ECS lever.
3. Individual ventilation and flying suits temperature control panel
4. Individual air shower duct valve.
5. Cockpit air temperature control panel
6. «AIR COND» circuit breaker.

FUEL SYSTEM

The fuel system of the airplane is used for fuel allocation and providing smooth engine operation throughout the operating range of altitudes and speed.

The fuel system consists of the main fuel system and tip tanks' system.

The main fuel system incorporates five fuselage tanks with a total capacity of 1100 liters (825 kg). To increase the range of flight two tip tanks are present with 100 liters capacity each. Total fuel load is 975 kg.



1	Right tip tank (100 l).	5	Fuselage tank №4 (135l).
2	Fuselage tank №1 (260l).	6	Fuselage tank №5 (205l). Feed tank.
3	Fuselage tank №2 (365l).	7	Left tip tank (100 l).
4	Fuselage tank №3 (135l).		

Fuel accumulator is used to supply engine with fuel while flying with negatives Gs. Its capacity is 10.5 liters. It is allowed to fly with negative Gs for not more than 20 seconds. Accumulator has to be refilled by flying horizontally for at least 20 seconds, before flying again with negative Gs.

To shut off fuel flow from tanks into the fuel pipeline shut-off fire valve has to be used. This valve is controlled with help of levers, located on the left side of both cockpits. Forward position – shut-off fire valve is opened.

Front cockpit

Rear cockpit

FUEL USE ORDER

Order of fuel use has to keep airplane's center of gravity within specified operating limits. When fully refueled (1300 liters) fuel is initially consumed from the fuselage's tanks. When 575-625 kg remains in the fuselage's tanks, this can be monitored on fuel gauge; fuel is consumed from tip tanks. It takes 15 minutes to use all fuel from tip tanks. Fuel gauge shows total remaining fuel in kilograms in fuselage fuel tanks.

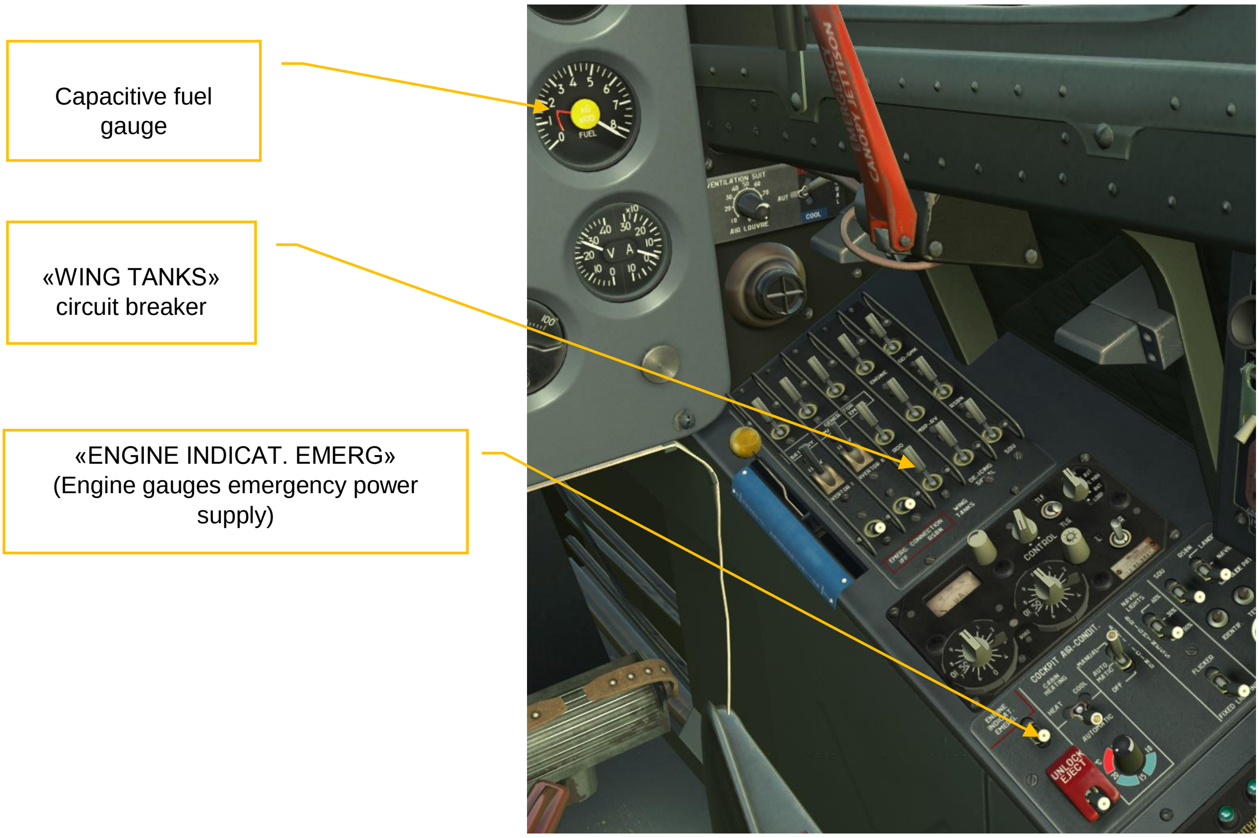
This gauge designed for measuring fuel amount and signalizing reserve amount fuel.

Capacitive fuel gauge (41)

To switch on the device is necessary to enable the «BATTERY» (94) and «ENGINE» (94) switches on front cockpit main CB panel. After 1-2 minutes pointer should show the actual fuel amount in the fuselage fuel tanks. Devices are installed on the instrument panels in both cockpits.

When inverter SPT-40 fails fuel oil pressure gauges do not operate. To enable capacitive fuel gauge operation in this case is necessary to switch «ENGINE INDICAT. EMERG" switch on front cockpit right panel. Zero position on the scale corresponds to 37 kg fuel in the fuselage tanks.

After running out of fuel from tip tanks, fuel from the fuselage fuel tanks is consumed.



SIGNALS

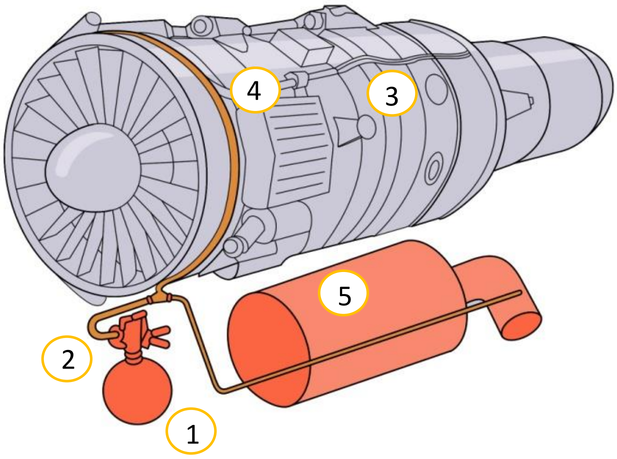
1. «150 KG FUEL» signal on the warning lights panel in both cockpits, indicating reserve amount of fuel in the fuselage tanks; this signal is a blinker.
2. «DON'T START» signal on warning lights panel in both cockpits, indicating fuel pressure drop after fuel pump (blinks); this signal is a blinker.
3. «FUEL FILTER» signal on the caution & advisory lights panel in both cockpits, showing pressure difference on the fuel filter (filter is designed to clean fuel from mechanical impurities); continuous operation mode.
4. «WING TIP TANKS» signal on the caution & advisory lights panel in both cockpits, which lights off when fuel pressure in tip tanks increases and light on when tip tanks are empty. When tip tanks ran out of fuel and signal «WING TIP TANKS» lights on it is necessary to switch off automatic circuit breaker «WING TANKS» on the main CB panel in front cockpit. This signal operates in continuous mode.

FIRE EXTINGUISHING EQUIPMENT

Fire extinguishing equipment is designed to extinguish fire in the fire hazardous engine zone. This zone includes fuel assemblies of the engine, combustion chamber and gas chamber housing.

Fire Extinguishing equipment.

1. Tank.
2. Head gate.
3. AI-25TL engine
4. Collectors.
5. Sapphire-5 APU.



Fire extinguishing equipment consists of fire signalization and fire extinguishing systems.

«FIRE SIG TEST / TEST SSP»
Firefighting system signalization test spring return switch

Fire signalization system is developed to give a light signal when fire occurs. It consists of six thermal sensors (combined in two circuits with three sensors each), «FIRE» signal lamps on emergency panels in front and rear cockpits. To control sensor operation there is a «FIRE SIG TEST / TEST SSP» spring return switch, which is installed on the middle control panel in front cockpit. It has two positions «I» and «II» for the first and second circuits correspondingly. Before flight it is necessary to check if thermal sensors operate correctly, for that one has to press and hold the «FIRE SIG TEST / TEST SSP» switch in position «I», the «FIRE» signal lamp should light on, release the switch, the lamp has to go off, similar procedure should be repeated for position «II» . Red color master caution lights are blinking in case of fire. They are located over the instrument panel in both cockpits. The «FIRE» signal is a blinker.

In case of fire is necessary to press one of the fire extinguishing buttons in the cockpits. When fire is extinguished, signal turns off.

Firefighting system control and signalization in front and rear cockpits.

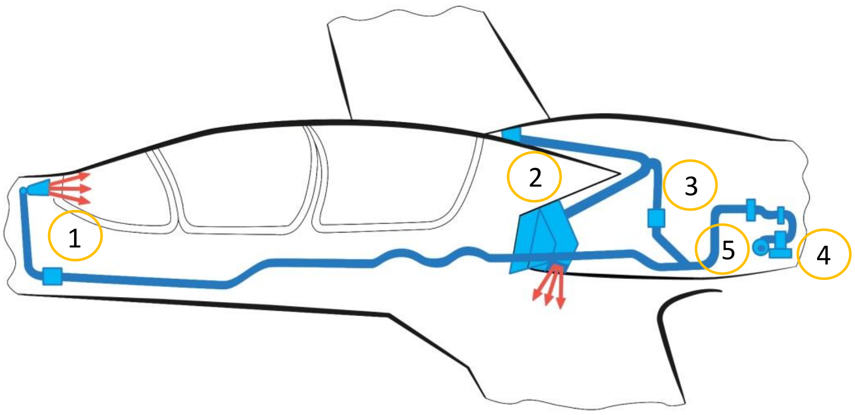
Front cockpit | Rear cockpit

«EXT» Extinguishing button

ANTI-ICING SYSTEM

Anti-icing system is intended to protect the leading edges of engine air intakes and windshield from icing. Hot air is taken from the engine.

Anti-icing system



1. Windshield air duct.
2. Air ducts heating the leading edges of engine air intakes.
3. Air consumption limiter.
4. Shut-off valve.
5. Hot air intake.

System is controlled remotely and can operate in automatic or manual (from the front cockpit only) modes. Modes are selected with help of an «ANTI-ICING» switch located on the right panel in front cockpit. It has three positions «MANUAL – AUTOMATIC - OFF».

In the «AUTOMATIC» position the anti-icing system is enabled by the RIO-3 radioisotope icing sensor signals. When enabled, the «DE-ICING ON» signals on the caution & advisory lights panels in both cockpits are on. The RIO-3 sensor is enabled by the «DE-ICING SIGNAL» CB on the main CB panel in front cockpit. On the right console in front cockpit there is a button checking RIO-3 heating circuit and lamp monitoring heating circuit.

Anti-icing system is activated before the flight when the outdoor temperature is below +5^0 C, as well as before flight in adverse weather conditions and night flights.

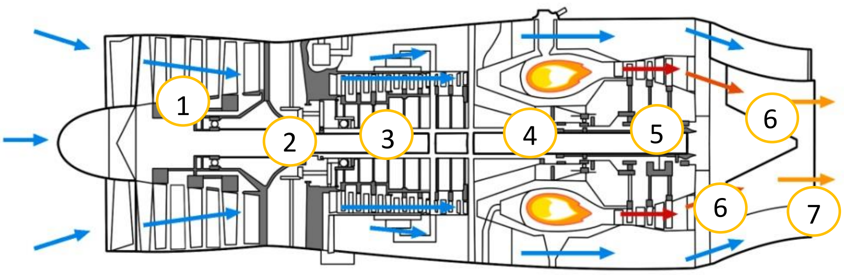
When the switch is in «AUTOMATIC» position and icing condition is detected, first snowflake signal lights on and no later than 30 seconds after that the «DE-ICING ON» signal goes on. After cessation of icing system turns off automatically, first the snowflake symbols lights off and after 30 seconds «DE-ICING ON» goes off as well. Both signals are located on the caution & advisory lights panels in both cockpits. The «DE-ICING ON» signal and snowflake signal operate in continuous mode.

In case of RIO-3 failure and the presence of icing anti-icing system has to be enabled manually. For that the «ANTI-ICING» switch has to set to «MANUAL» position and no later than 30 seconds after that the «DE-ICING ON» goes on. To turn off the anti-icing system return switch to the «OFF» position.

ANTI-ICING SYSTEM CONTROL AND SIGNALIZATION

AI-25TL GENERAL SPECIFICATIONS, OPERATION PRINCIPLE AND MAIN ENGINE DATA

The AI-25TL twin-shaft turbofan engine is installed on the airplane.



AI-25TL engine

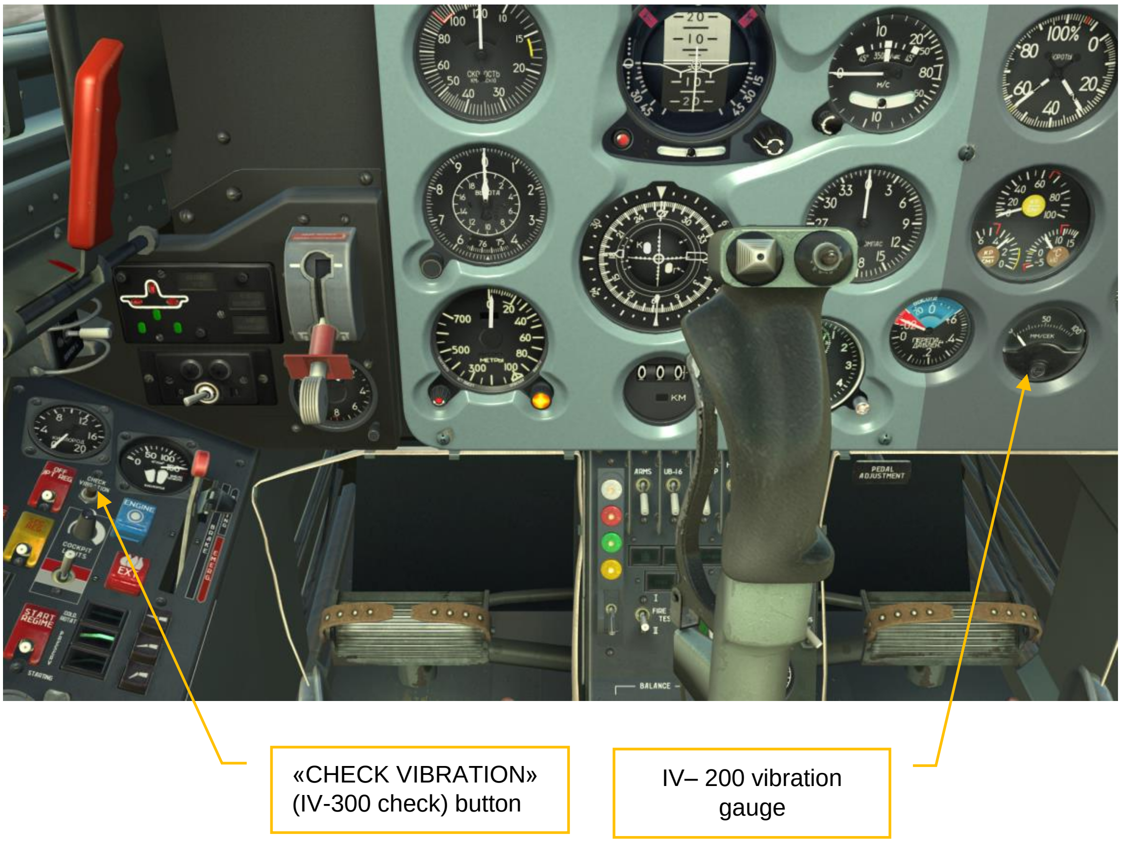
1. Low-pressure compressor.
2. Separation casing.
3. High-pressure compressor.
4. Combustion chamber.
5. Turbine.
6. Mixing chamber.
7. Extension pipe.
8. Jet nozzle.

Air from the atmosphere is supplied through an inlet, which consists of two air intakes, located on the sides of the fuselage.

From the inlet air is fed to low-pressure and high-pressure compressors. Air from the high pressure compressor enters the combustion chamber and moves further through turbine into the mixing chamber and jet nozzle.

Thus the air-gas flow, flowing through the engine gets a significant acceleration and results in engine thrust.

The AI-25TL engine is equipped with the IV-300 engine vibration measuring unit. Vibration is controlled with help of IV-200 gauge, installed on the instrument panel in front cockpit. If vibration exceeds 33 mm/s the «ENGINE VIBRATION» signal blinks on warning light panels in both cockpits. To verify the IV-300 functionality press the «CHECK VIBRATION» button on the left panel in front cockpit, the gauge pointer deflects to 75-100 mm/s and the «ENGINE VIBRATION» signal lights on the warning lights panel. The IV-200 gauge is not installed in the rear cockpit.



Main engine systems:

- engine lubrication system;
- fuel system and engine automatics;
- engine overheating protection system;
- anti-icing system;
- engine start-up system.

ENGINE LUBRICATION SYSTEM

Engine lubrication system – is intended to supply engine with oil under pressure during engine operation to its moving contacting surfaces to reduce friction and partially remove heat. Besides that the oil washes out the smallest metal particles from contacting surfaces and protects parts. The lubrication system defines the reliability of operation and service life of the engine.
Oil pressure and temperature at the engine inlet is measured by the sensors. Oil pressure at 95% of HPC RPM should be not less than 3 kg/cm^2, for other modes not less than 2 kg/cm^2. Oil temperature should be not more than 90^{0}C. In opposite case the «ENG.MIN. OIL PRESS» (Minimum oil pressure) signal lights on the caution & advisory lights panel in front cockpit. This signal operates in blinking mode. There is no such signal lamp in the rear cockpit.

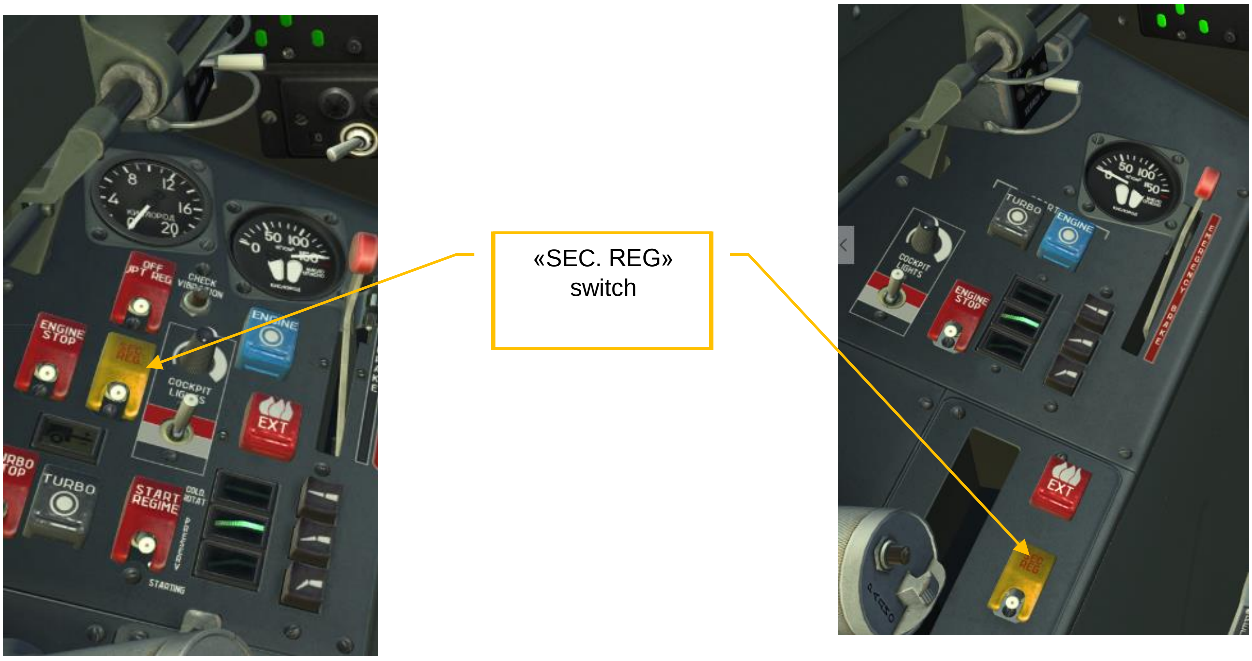
FUEL SYSTEM AND ENGINE AUTOMATICS

Fuel system and engine automatics is intended to supply combustion chamber with require amount of fuel, depending on engine operation mode. It consists of main and emergency fuel supply systems.

Fuel pressure at engine nozzles should be not more than 65 kg/cm^2. In case of partial or complete main fuel supply system failure (combat damage) it is necessary to switch to the emergency fuel supply system by enabling the «SEC. REG» switch, located on the left panels in both cockpits. After that the «SEC. REG» signal lamp will light on caution & advisory lights panels in both cockpits. This lamp operates in continuous mode.

In case of filter clogging or increased pressure difference the «FUEL FILTER» signal illuminates on the caution & advisory lights panels in both cockpits. This lamp operates in continuous mode.

Front cockpit Rear cockpit



Fuel pressure, oil pressure and temperature has to be monitored using three pointer gauge. These gauges are installed on the instrument panels in both cockpits.

Three-pointer gauge.

1. Oil pressure gauge.
2. Fuel pressure gauge.
3. Oil temperature.

To enable device is necessary to enable «BATTERY» (94) and «ENGINE» (94) breakers on the front cockpit main CB panel. Oil and fuel pressure gauge pointers set to zero on corresponding scales after being turned on, and oil temperature pointer shows the actual oil temperature.

In the rear cockpit oil temperature gauge is not operational, because there is no temperature sensor there.

When inverter SPT-40 fails, then fuel and oil pressure gauges do not work, but oil thermometer continues functioning. To enable fuel and oil pressure gauge operation is necessary to enable the «ENGINE INDICAT. EMERG.» switch, located on the front cockpit right panel.

ENGINE OVERHEAT PROTECTION SYSTEM

The RT-12-9 engine overheat protection system is installed on the airplane. All controls for this system are located in front cockpit.
It provides:

a) during ground engine check and during takeoff rolling up to nose wheel lift :

- signalization, when exhaust gas temperature reaches 700±15⁰C with following fuel supply reduction if operating from main fuel supply system to prevent temperature exceeding 700±15⁰C;
- signalization, when exhaust gas temperature reaches 700±15⁰C only if operating from emergency fuel supply system;
- electrical engine stop when exhaust gas temperature reaches 730±15⁰C.

b) during takeoff rolling after nose wheel lift and during flight with extended gear or flaps:

- signalization, when exhaust gas temperature reaches 700±15⁰C and 730±15⁰C. If during the flight the «J.P.T 700⁰C» informational signal is on, then during landing gear or flaps retraction fuel supply will be partially cut and engine thrust reduced while this signal is on.

c) during flight with retracted gear and flaps:

- signalization, when exhaust gas temperature reaches 700±15⁰C with following fuel supply reduction if operating from main fuel supply system to prevent temperature exceeding 700±15⁰C;
- signalization, when exhaust gas temperature reaches 700±15⁰C only if operating from emergency fuel supply system;
- signalization «J.P.T 730⁰C», indicating that temperature reached 730±15⁰C, while operating from main or emergency fuel supply system;
- if during the flight signal «J.P.T 730⁰C» was on, even if exhaust gas temperature was later reduced, it remains on and when during landing nose wheel touches the ground, engine will be stopped electrically.

RT-12-9 system controls and signalization

1. «OFF JPT REG» switch

2. «JPT REG» CB

3. «JPT REG TEST» switch

1. «OFF JPT REG» switch disables engine overheat protection system, installed on the left panel in front cockpit.
2. «JPT REG» circuit breaker provides voltage supply to engine overheat protection circuit and located on auxiliary electric distribution panel in front cockpit.
3. «JPT REG TEST» spring return switch is located on the right panel in front cockpit and intended to check system functionality when engine is not running. It is necessary to press (hold for some time) consequently the switch in positions I and check if the «J.P.T 700^{0}C» signal is on, indicating normal system operation. Repeat the same for position II. After engine start it is not recommended to toggle this switch, because it enables fuel limiting valve.

SIGNALS

1. «J.P.T. 730^{0}C» lights on, when exhaust gas temperature reaches 730^{0}C. This signal is installed on the caution & advisory lights panel in front cockpit and operates in blinking mode.
2. «J.P.T. 700^{0}C» lights on, when exhaust gas temperature reaches 700^{0}C. This signal is installed on the caution & advisory lights panel in front cockpit and operates in continuous mode.

There are no «J.P.T. 730^{0}C» and «J.P.T. 700^{0}C» signals in the rear cockpit.

ENGINE ANTI-ICING SYSTEM

It is used to prevent from icing engine parts, located at the engine inlet (turbine blades, air intakes fairings). System controls and indication is similar to the anti-icing system of the airplane.

ENGINE STARTUP SYSTEM

Startup system is used to spin the engine rotor up from standstill state up to revolutions, corresponding to the idle mode during startup procedure.

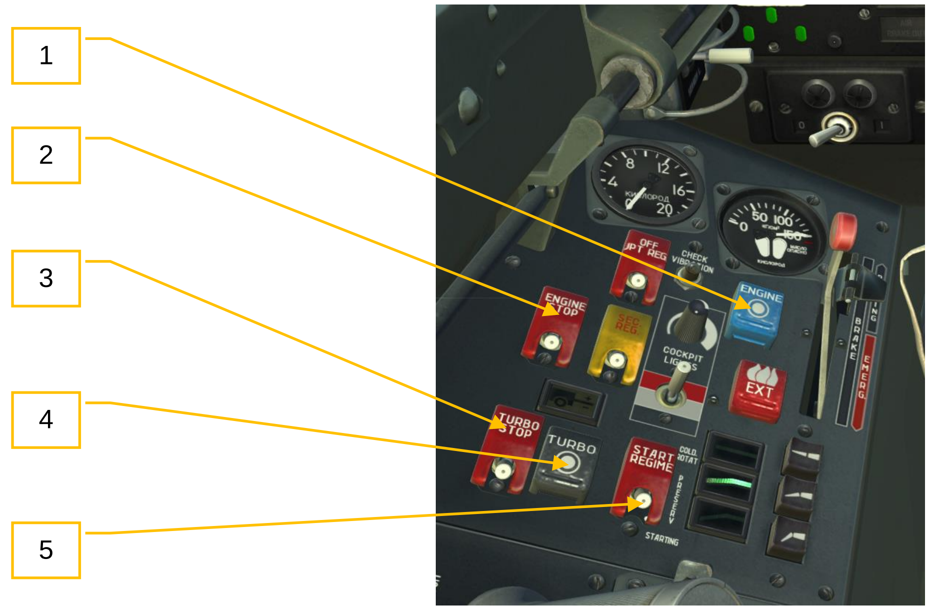
Units involved in startup:

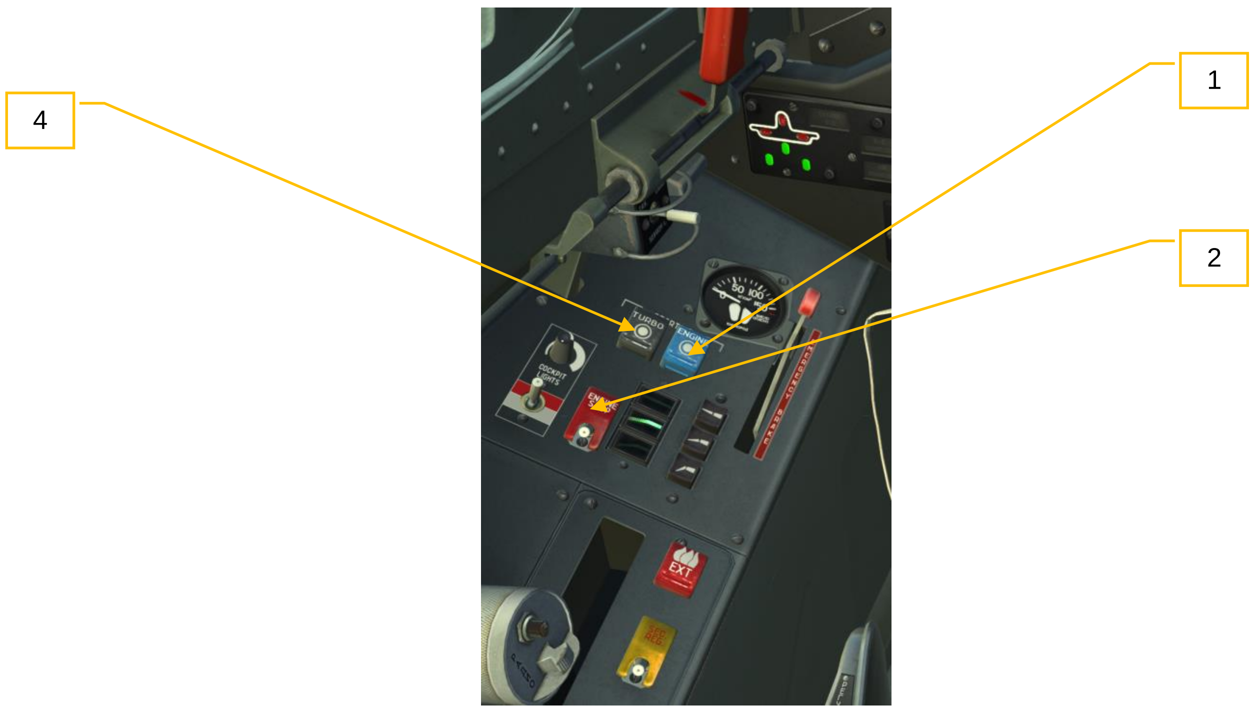
- startup automatics;
- engine fuel automatics;
- compressed air generator(source);
- air starter.

The Sapphire -5 supplementary engine is used as a compressed air source for engine startup. It provides air compression and feeds air starter, which spins up AI-25TL high pressure rotor.

Engine controls in front and rear cockpits.

Front cockpit



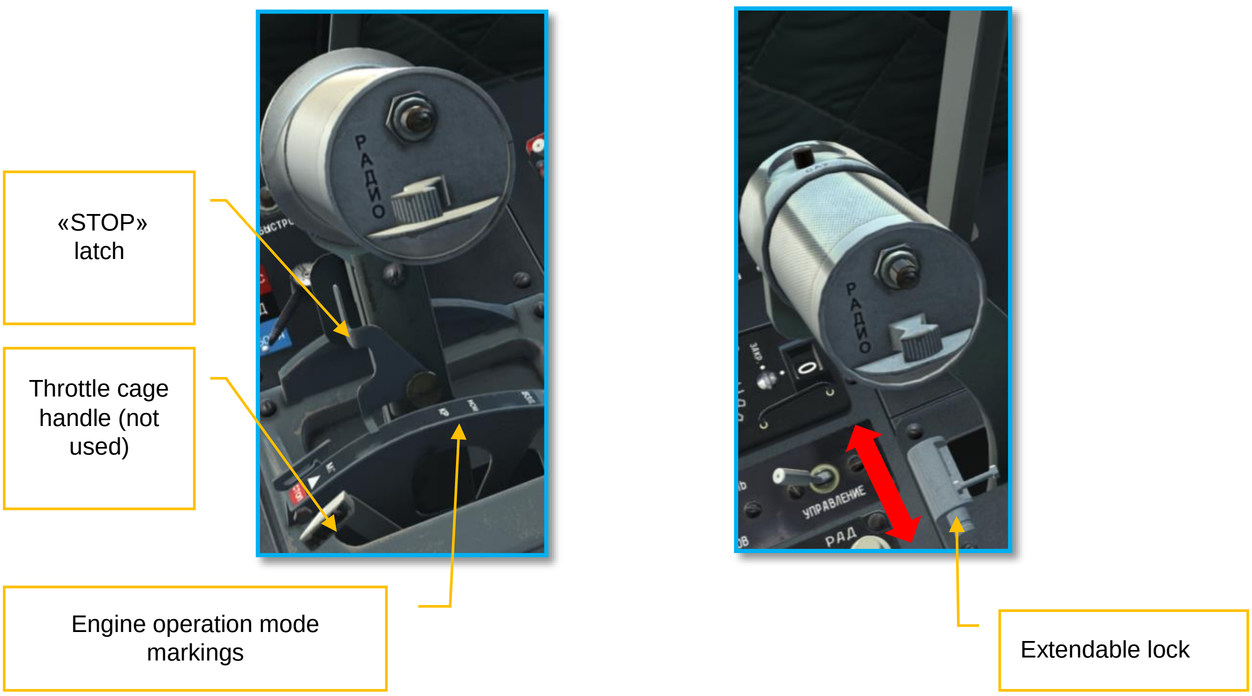


1. «ENGINE» button for AI-25TL engine start.
2. «ENGINE STOP» switch for emergency engine stop by electrical signal, independently on throttle handle position.
3. «STOP-TURBO» switch for disabling the «Sapphire-5» supplementary engine.
4. «TURBO» button for the «Sapphire-5» APU start. When the «Sapphire-5» is running the «TURBINE STARTER» lamp illuminates on the caution & advisory lights panel in front cockpit. This lamp operates in continuous mode.
5. «STARTING – PRESERV. – COLD. ROTAT» switch, must be in the «STARTING» position.

To set required engine operation mode in both cockpits on the left panel the throttle is installed. Throttle in front cockpit has engine operation mode markings: «STOP», triangle mark (used when engine has to be started from emergency fuel system), «IDLE», «CR SPEED», «NOM», «TAKE OFF». This throttle has «STOP» latch, used for shutting off the engine.

Throttle in rear cockpit does not have operation mode markings and does not have the «STOP» (Stop) latch, therefore throttle can be set to «STOP» position from the front cockpit only. This throttle has extendable lock, preventing accidently setting the throttle to «STOP» position in the air. To put the throttle in the front cockpit in «STOP» position, extendable lock in rear cockpit has to be opened (retracted). Engine can be shut off with help of the «ENGINE STOP» switch or by closing shut-off valve.

Throttle in front cockpit Throttle in rear cockpit



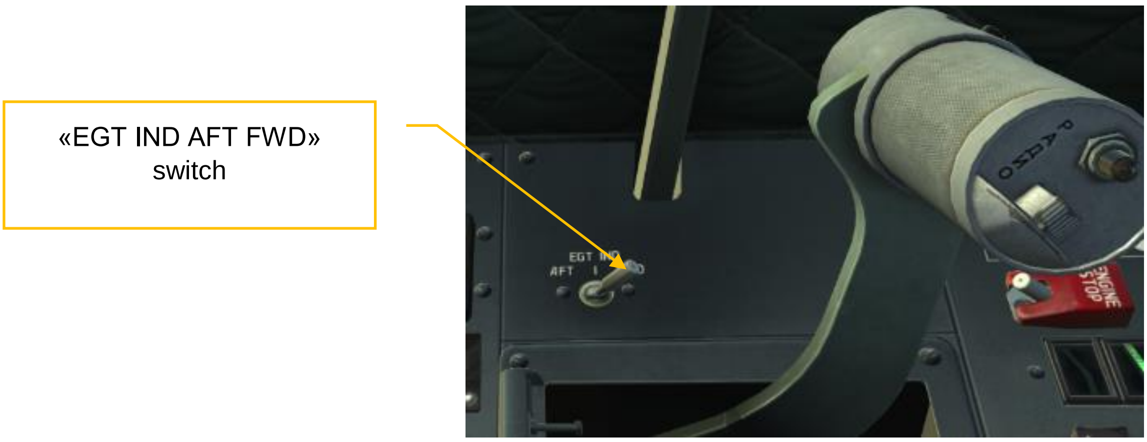
AI-25 TL has the following operating modes:

- **Takeoff mode «TAKE OFF»**. Corresponds to the maximum allowed RPMs of 106.8% (n_1 pointer on the engine RPM gauge) of high pressure compressor and maximum thrust. This mode is used for takeoff, climbing and increasing the flight speed. Exhaust gas temperature should not exceed 660^{0}C.
- **Nominal mode «NOM».** Corresponds to the RPMs of 103,2% (n_1 pointer on the engine RPM gauge) of high pressure compressor and maximum thrust. This mode is used for long-term climbing for flight with near maximum speeds. Exhaust gas temperature should not exceed 625^{0}C.
- **Cruise mode (0.85 of nominal one) «CR SPEED».** Corresponds to the RPMs of 99,6% (n_1 pointer on the engine RPM gauge). This mode is used for flight at maximum range (maximum duration of flight), because the fuel consumption is the lowest. Exhaust gas temperature should not exceed 590^{0}C.
- **Idle mode «IDLE».** Corresponds to minimum allowed RPMs, needed for stable engine operation, and equal to 56± 1,5% (n_1 pointer on the engine RPM gauge). Exhaust gas temperature should not exceed 600^{0}C.

Engine RPM has to be monitored using ITE-2 tachometer and exhaust gas temperature using TST-2 thermometer.

ITE-2 (n1 pointer – HPC RPM, n2 pointer – LPC RPM) and TST-2 are located in both cockpits.

On the left panel in rear cockpit the «EGT IND AFT FWD» is installed, depending on its position the TST-2 gauge in front or rear cockpit is operational.



MAIN SPECIFICATIONS AND RESTRICTIONS OF THE ENGINE

Parameters	Operation mode			
	Takeoff.	Nominal	Cruise.	Idle
Thrust, kgF	1720	1500	1275	Not more 135
RPMs, %	106,8%	103,2%	99,6%	56± 1,5%
Gas temperature, behind the turbine, not more ^{0}C				
on the ground	660	625	590	600
in flight	685 (705* anti-icing is enabled) до H=8000m 715 at H more than 8000m	650 670*	615 635*	600
Fuel pressure, not more than, kgF/cm^2	65	65	65	65
Oil temperature at the engine inlet, ^{0}C	-5÷+90	-5÷+90	-5÷+90	-5÷+90
Maximum operational altitude, m	10 000	12 000	12 000	12 000
The maximum duration of continuous operation, min	not more than 20 min	Not limited	Not limited	Not more than 30 min on the ground. In flight – not limited
Engine response time when throttle handle was moved from the idle to max mode, seconds	9-12			
Engine startup time on the ground and in the flight, c	not more than 50			
Maximum allowed gases temperature behind the turbine during startup, ^{0}C				
on ground	not more than 550			
in flight	not more than 600			

*-when anti-icing system is enabled, exhaust gas temperature increases at 25-30^0

AVIATION EQUIPMENT OF THE L-39C AIRPLANE

Aviation airplane equipment (russian terminology is kept intentionally) is intended to provide consumers with electrical energy in form of direct and alternative currents, control power plant and monitor its operation, determine flight parameters and control various units and systems of the airplane.

Aviation equipment of the L-39C includes:

- electrical equipment;
- instruments (gauges);
- oxygen equipment and special equipment for “high-altitude” flights ;
- onboard monitors and flight data recording devices.

DIRECT CURRENT SUPPLY SYSTEM

- The VG-750Ya primary DC generator;
- The GSR-3000 backup DC generator;
- The 12-SAM-28 onboard battery.

In case of primary generator failure standby generator takes over current supply automatically. When both generators have malfunctioned then emergency current source (battery) takes over power supply.

Nominal operating voltages:

- VG-7500Ya- 28 V;
- GSR-3000- 28 V;
- 12-SAN-28 – 24 V.

The VG-2500Ya is driven by the engine.

The GSR-3000 is extended in the air flow automatically if the VG-7500Ya or engine have malfunctioned during the flight. It is necessary to maintain airspeed of more than 280 km/h for backup generator to start generating electricity for the onboard consumers. Air turbine can be emergency extended with help of emergency extension valve, located on the right panels in both cockpits. In case of forced landing with non-working engine and retracted gears RAT must be retracted before landing. Switch off the «GENERATOR EMERG» (94) switch. If landing gear is emergency retracted, air turbine will be retracted as well.

Battery is an emergency source of energy and provides power supply to important consumers in case of main and backup generators failure.

ALTERNATE CURRENT SUPPLY SYSTEM

- two inverters (1 and 2) SPO-1000 – voltage 115 V;
- inverter SPT-40 – voltage 36 V;
- inverter PT-500C – voltage 36 V.

SPO-1000 provides power supply to:

- RSBN-5S;
- RV-5;
- RKL-41;
- MRP-56P;
- R-832M;
- Air conditioning system;
- IV-300 vibration indicator;
- RIO-3.

SPT-40 supplies:

- backup artificial horizon electrical pointer ;
- capacitive fuel meter;
- fuel and oil pressure gauges.

PT-500C supplies:

- AGD-1 Attitude director indicator (ADI);
- GMK-1AE (gyro magnetic compass);
- RSBN-5S.

ELECTRICAL ENERGY DISTRIBUTION

To distribute electrical energy the front cockpit of the L-39C has two electrical distribution panels: main CB panel and auxiliary CB panel.

There is an electrical distribution panel in the rear cockpit as well. Circuit breakers on this panel are command ones (override that of front cockpit).

MAIN ELECTRICAL CB PANEL IN FRONT COCKPIT

1. «BATTERY» switch to connect accumulator battery or ground supply to the power network.
2. «GENERATOR MAIN» switch to connect main generator to the power network.
3. «GENERATOR EMERG.» switch to connect backup generator to the power network.
4. “ENGINE” automatic circuit breaker, which enables engine startup, operation, engine operation monitoring and enables inverter 3x36V.
5. «AGD-GMK» CB enables the PT-500C inverter and supplies with DC voltage GMK-1AE and AGD-1.
6. «115V INVERTOR I» CB enables the first SPO-1000 inverter.
7. «115V INVERTOR II» CB enables the second SPO-1000 inverter.
8. «RDO» CB enables the R-832M radio and the SPU-9 intercom.
9. «MRP-RV» CB enables marker beacon receiver and radar altimeter.
10. «RSBN» CB enables RSBN-5S.
11. «EMERG. CONNECTION IFF» CB, in flight and on the ground enables transponder powering by battery in case of main and backup generator failure.
12. « EMERG. CONNECTION RSBN» CB enables Iskra-K system powered by backup generator or battery in case of main generator failure.
13. «WING TANKS» CB enables tip tank fuel consumption signalization system.
14. «DE-ICING SIGNAL» CB enables RIO-3 sensor.
15. «SDU» CB enables remote control landing system.

MAIN ELECTRICAL CB PANEL IN FRONT COCKPIT

AUXILIARY ELECTRICAL CB PANEL IN FRONT COCKPIT

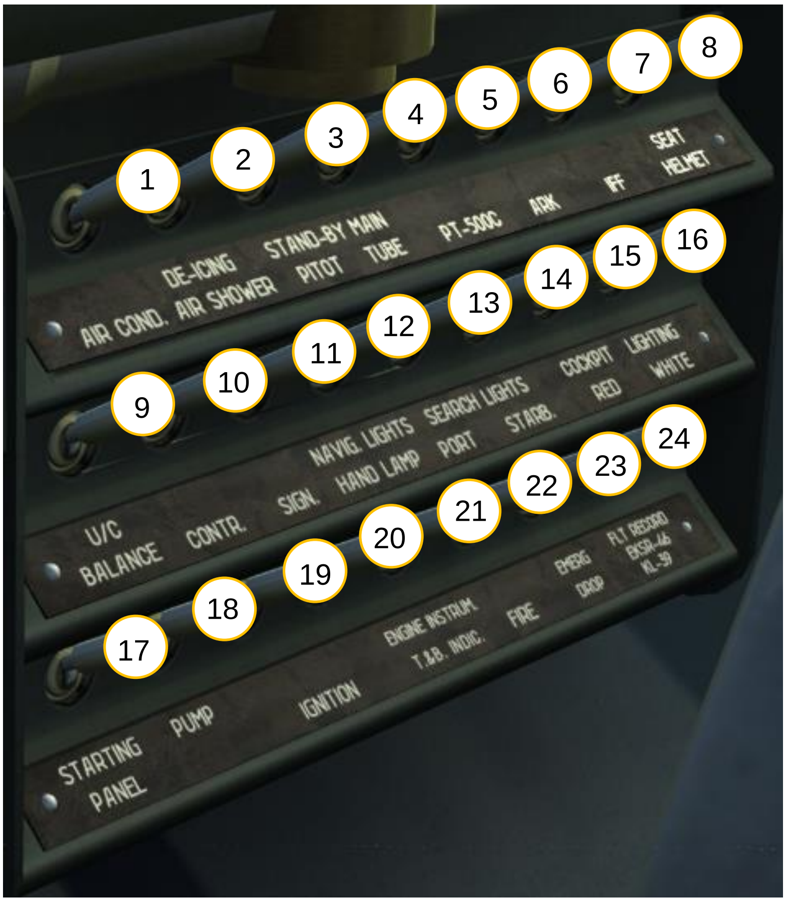
On the auxiliary electrical CB panel there are 24 circuit breakers, enabling various consumers. In practical operation of the airplane all CBs on auxiliary panel are enabled by the ground crew before flight and pilot has to ensure that all of them are enabled.

In the L-39C module all CBs on auxiliary panel are enabled by default.

Auxiliary electrical CB panel contains the following circuit breakers:

1. «AIR COND» – supplies air conditioning system;
2. «DEICING AIR SHOWER»– supplies anti-icing system. It supplies ventilation suit and pilot air shower valves as well, but this function is not implemented in simulation.
3. «STAND-BY PITOT» – supplies backup (left) Pitot receiver;
4. «MAIN TUBE» – supplies primary (right) Pitot receiver;
5. «PT-500C» – enables inverter PT-500C;
6. «ARK» – enables RKL-41 ADF;
7. «IFF» – enables SRO-2M transponder;
8. «SEAT HELMET» - supplies seat adjustment mechanism in front cockpit (height adjustment) and helmet visor heating circuit. Not implemented;
9. «U/C BALANC» – supplies control and indication systems of: aileron and elevator trimmers, landing gear and flaps;
10. «CONTR.» – supplies flaps and airbrakes control system, enables braking system control, signalization of critical Mach number and supplies speed blocking relay, which triggers at speed of 310 km/h and enables the «STAND ALERT» (Ready) signal, indicating armament control system readiness.
11. «SIGN» – supplies signal lamps of all signal panels in front cockpit;
12. «NAVIG. LIGHTS HAND LAMP» – supplies emergency floodlight lamp and exterior lighting system;
13. «SEARCH LIGHTS PORT» – supplies landing-taxi headlight control system;
14. « SEARCH LIGHTS STARB» – supplies landing-taxi headlight control system;
15. «COCKPIT LIGHTING RED» – supplies red cockpit floodlight.
16. «COCKPIT LIGHTING WHITE» – supplies white cockpit floodlight;
17. «STARTING PANEL» – supplies engine starting panel;
18. «PUMP» – supplies engine fuel pump;
19. «IGNITION» (Ignition) – supplies voltage to the CBs on auxiliary panel, responsible for engine start, operation and monitoring.
20. «IGNITION» (Ignition) – supplies voltage to the CBs on auxiliary panel, responsible for engine start, operation and monitoring.
21. «ENGINE INSTRUM. T&S INDIC» – enables the SPT-40 inverter.
22. «FIRE» - supplies onboard fire Extinguishing system;
23. «EMERG. DROP» supplies the «EMERG. JETTIS» switch;
24. «FLT RECOR EKSR - 46 KL-39» supplies flare launcher, ejection system and SARPP-12GM flight data recorder;

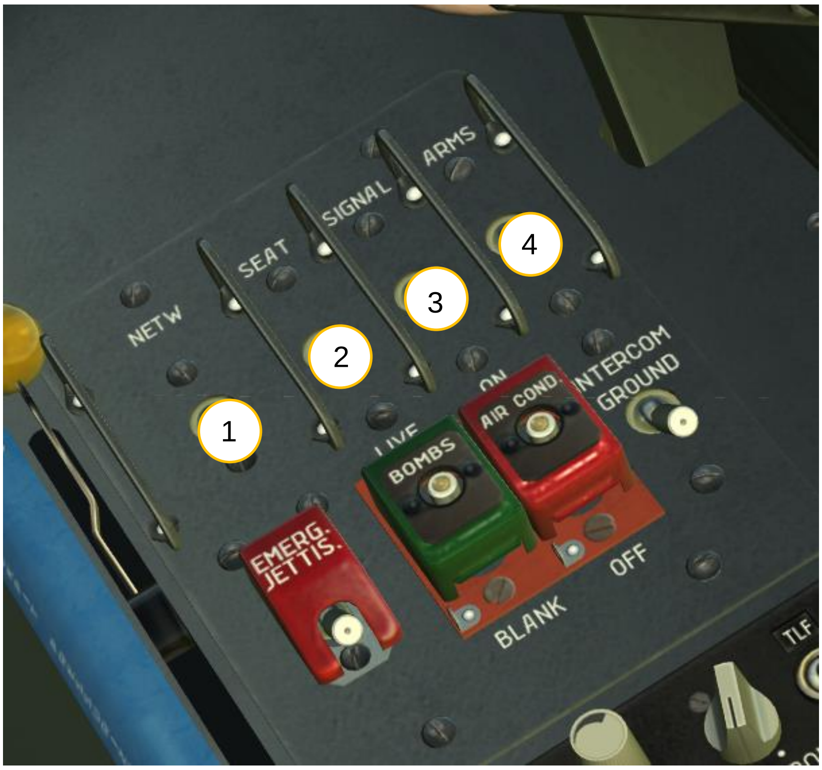
Auxiliary electrical CB panel in front cockpit.



REAR COCKPIT ELECTRICAL CB PANEL

1. «NETW» switch allows inclusion of any current source into the onboard network. Must be always enabled!
2. «SEAT» CB supplies rear cockpit seat adjustment mechanism (seat height adjustment);
3. «SIGNAL» CB supplies signal lamps on all signal panels in rear cockpit;
4. «ARMS» CB supplies weapon control CB in front cockpit. This CB is a command one to that of front cockpit.
5. «INTERCOM GROUND» CB is used for communication with ground crew.

REAR COCKPIT ELECTRICAL CB PANEL



CONNECTING AC AND DC SOURCES TO THE POWER NETWORK AND THEIR MONITORING

1. Connecting ground power into the onboard power network

Ground power connection is indicated to pilot in the cockpit by lighting up signal lamp with ground equipment symbol (38) on the left panel in front cockpit and by voltammeter (41) (voltage within 27-29 V). There is no voltammeter in the rear cockpit.

2. Connecting the 12-SAM-28 battery to the onboard power network:

To connect accumulator battery to the onboard power network is necessary to enable the «BATTERY» (94) switch on the main electrical CB panel. Connection is controlled by voltmeter and by «GENERATOR MAIN» and «GENERATOR EMERG» signals, blinking on the emergency panel. Voltage read on voltmeter is 24V.

3. Connecting the main generator to the onboard power network

To connect main generator is necessary to enable «GENERATOR MAIN» (94) switch on the main electrical CB panel. The main generator will be connected to the power network after engine is started and ground power is disconnected. When the main generator is connected the «GENERATOR MAIN» and «GENERATOR EMERG» signals go off. Voltage on the voltmeter should be within 28-29 V.

4. Enabling the SPO-1000 inverters:

To enable SPO-1000 inverters I and II is necessary to enable the «115V INVERTOR I» and «115V INVERTOR II» (94) CBs on the main electrical CB panel in front cockpit.

Operation testing is based on the normal operation of the consumers, mentioned above, whose are powered by them.

In case of failure of one of the inverters all consumers automatically switch to the working inverter and «INV. 115V FAIL» signal starts blinking on the warning lights panel in both cockpits.

5. Enabling the SPT-40 inverter:

This inverter is enabled by «ENGINE» (94) CB on the main electrical CB panel in front cockpit.

Operation testing is based on the normal operation of the consumers, mentioned above, whose are powered by this inverter.

In case of inverter failure the «INV. 3x36V FAIL» signal of red color lights on the caution & advisory lights panel in both cockpits. This lamp operates in blinking mode.

6. Enabling the PT-500C inverter:

This inverter is enabled by «AGD-GMK» (94) CB on the main electrical CB panel in front cockpit.

Operation testing is based on the normal operation of the consumers, mentioned above, whose are powered by this inverter.

LIGHTING EQUIPMENT

Lighting equipment includes:

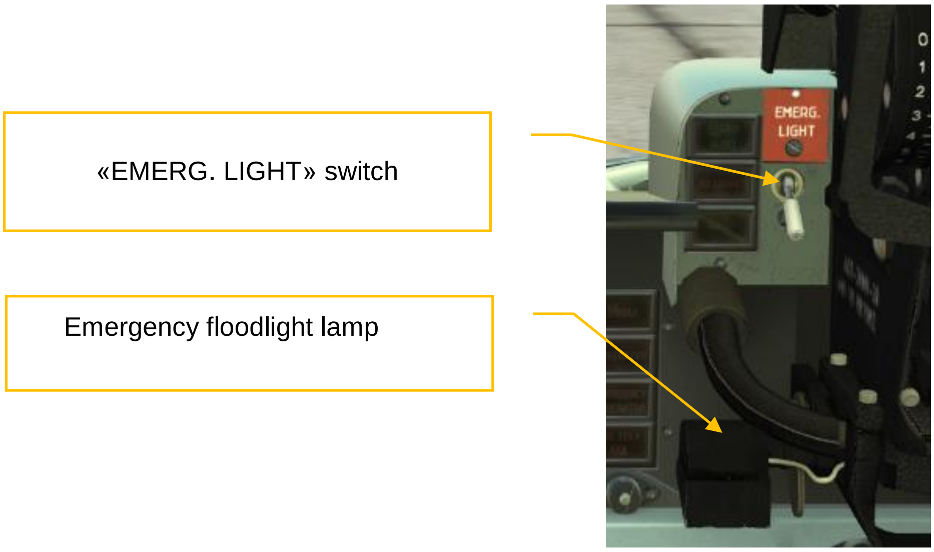
- cockpit white and red color floodlights;
- control of taxi and landing lights;
- exterior lighting signalization;
- interior lighting signalization.

COCKPIT LIGHTING SYSTEM WITH RED AND WHITE COLORS

This system is intended to illuminate gauges, instrument and other panels with red (main) and white (backup) colors.
In case of red lighting system failure, white light is automatically turned on.

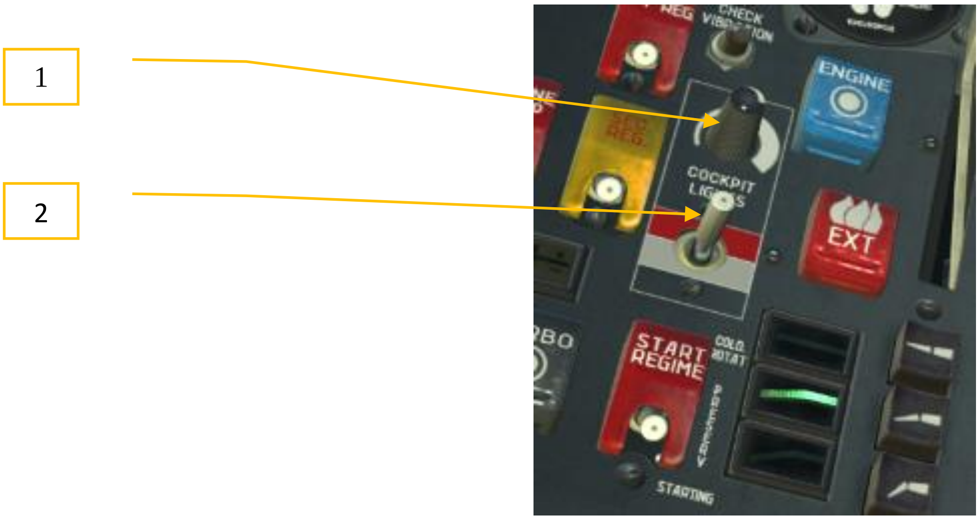
The KI-13 magnetic compass is illuminated by white color, independently of the switch position.

In case of red and white lighting failure emergency lighting must be enabled. Emergency lighting exists in the front cockpit only.



Emergency illumination lamp, located on the left side of the gunsight, designed for emergency illumination of front cockpit instrument panel (there is no emergency lighting in the rear cockpit).

Lighting system controls in front and rear cockpits:



1. Rheostat regulating light intensity, installed on the left panel in both cockpits.
2. «COCKPIT LIGHTS» switch with red and white lines, indicating switch position, located on the left panel in both cockpits.

White color floodlight

Red color floodlight

Emergency floodlight

EXTERIOR LIGHTING

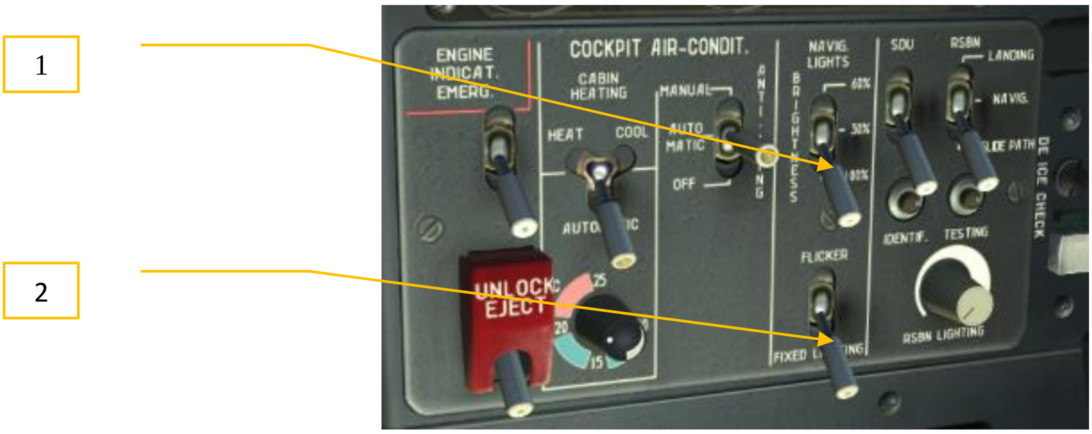
This system is used to mark airplane on the ground and in the air.

The system consists of:

- two navigation lights of green and red colors, located on the right and left tip tanks correspondingly;
- white navigation light, installed on the top of the fin;
- landing gear retracted signalization system (white color lights installed on the gear legs);
- exterior lighting controls (located on the right panel, in the front cockpit only).

Exterior lighting controls.

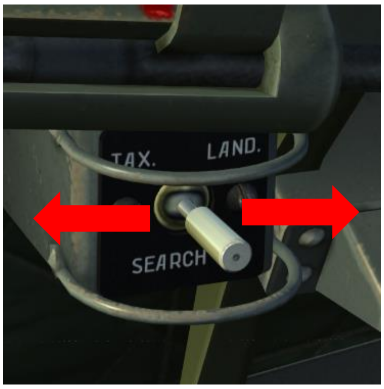
1. «NAVIG. LIGHTS BRIGHTNESS 60% - 30% - 100%» switch.
2. «FLICKER- FIXED LIGHTING» switch.



TAXI AND LANDING LIGHTS CONTROL SYSTEM

It is intended to illuminate taxiways and runway when flying at night.

Taxi and landing lights controls 38



1. «TAX. –SEARCH L. - LAND. » switch for enabling various lights modes and disabling lights.
2. «TAX. » - taxiing position.
3. «LAND. » – landing position.

When performing night flight pilot can ensure if landing gear was extended with help of landing light. To do that is necessary to set the «TAX. –SEARCH L. - LAND.» switch in the «TAX.» position, if lights illuminate – gear is extended, if not – retracted.

INTERIOR COCKPIT SIGNALIZATION SYSTEM

This system is used for informing pilot about normal systems' and engine operation and for indication of emergency or dangerous conditions in engine and various systems' operation.

System consist of:

- information and warning light panels;
- landing gear position indication panel (signals meaning is described in the «Utility hydraulic system» chapter FLIGHT AND LANDING GEAR INDICATOR (**41**));
- flaps position indication panel (signals meaning is described in the «Utility hydraulic system» chapter FLAPS);
- neutral trimmer position indication panel (signals meaning is described in the «Airplane control system» chapter TRIMMER CONTROLS IN FRONT AND REAR COCKPITS.);
- ground power connection indicator;
- armament status panel (signals meaning is described in the «Combat deployment» chapter ARMAMENT CONTROLS AND SIGNALIZATION IN FRONT COCKPIT, ARMAMENT CONTROLS AND SIGNALIZATION IN REAR COCKPIT).

Information and emergency panels are installed on the right and left sides of the instrument panels in both cockpits. In front cockpit the Caution & advisory lights panel contains 16 signals, 15 of which are used, 16-th is the reserved one (not used). In the rear cockpit the caution & advisory lights panel contains 12 signals, 11 of which are used, 12th is the reserved one (not used).

The caution & advisory lights panel in rear cockpit has the following differences:

- instead of «AIRCONDIT. EMERG.» - «INV. 3x36V FAIL»;
- instead of «CONFORM. AZIMUTH» - «AZIMUTH CORRECT»;
- instead of «TURBINE STARTING» - «DISTANCE CORRECT».

Besides that the following signals are absent:

- «ENG. MIN. OIL PRESS»;
- «J.P.T. 730^{0}C»;
- «J.P.T. 700^{0}C».

Warning lights panels consist of 12 signals and are installed in both cockpits.

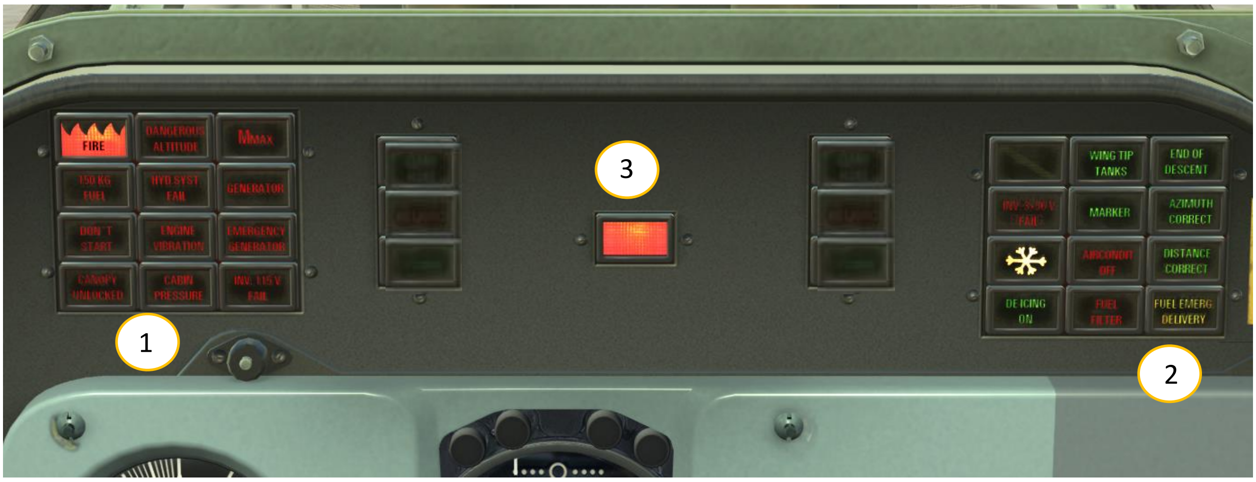
Master caution panel is installed on the right from the ASP-3NMU gunsight and over the instrument panel. It operates in blinking mode together with the following signals:

- «FIRE»,
- «150 KG FUEL»,
- «FUEL FILTER»,
- «DON'T START»,
- "CANOPY UNLOCKED",
- «GENERATOR»,
- «ENGINE VIBRATION»,
- «HYD. SYST. FAIL».

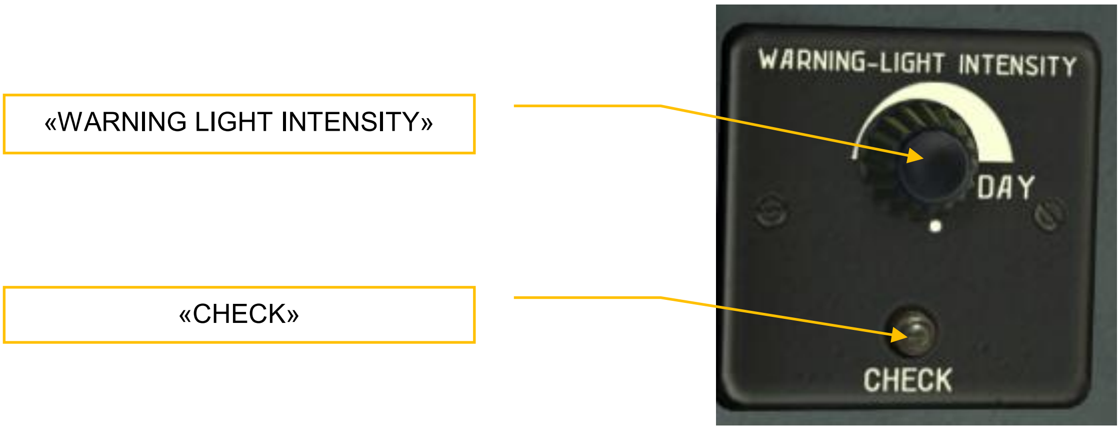
These signals are described in corresponding chapters of this manual.

WARNING LIGHTS AND CAUTION & ADVISORY LIGHTS PANELS IN FRONT COCKPIT

WARNING LIGHTS AND CAUTION & ADVISORY LIGHTS PANEL IN REAR COCKPIT



To check functionality of all signal lamps of all panels pilot has to push «CHECK» button and adjust brightness with the «WARNING LIGHT INTENSITY» (3) potentiometer. The button and potentiometer are located on the right panels in both cockpits.



INSTRUMENTS
FLIGHT AND NAVIGATION INSTRUMENTS

Flight and navigation instruments are developed to provide pilot with information about altitude, speed of flight, angular position of the airplane, presence of angular velocity and skidding, G-value and time of flight.

Altitude and flight speed measurements are performed by aerometric devices, connected to the airplane air pressure system.

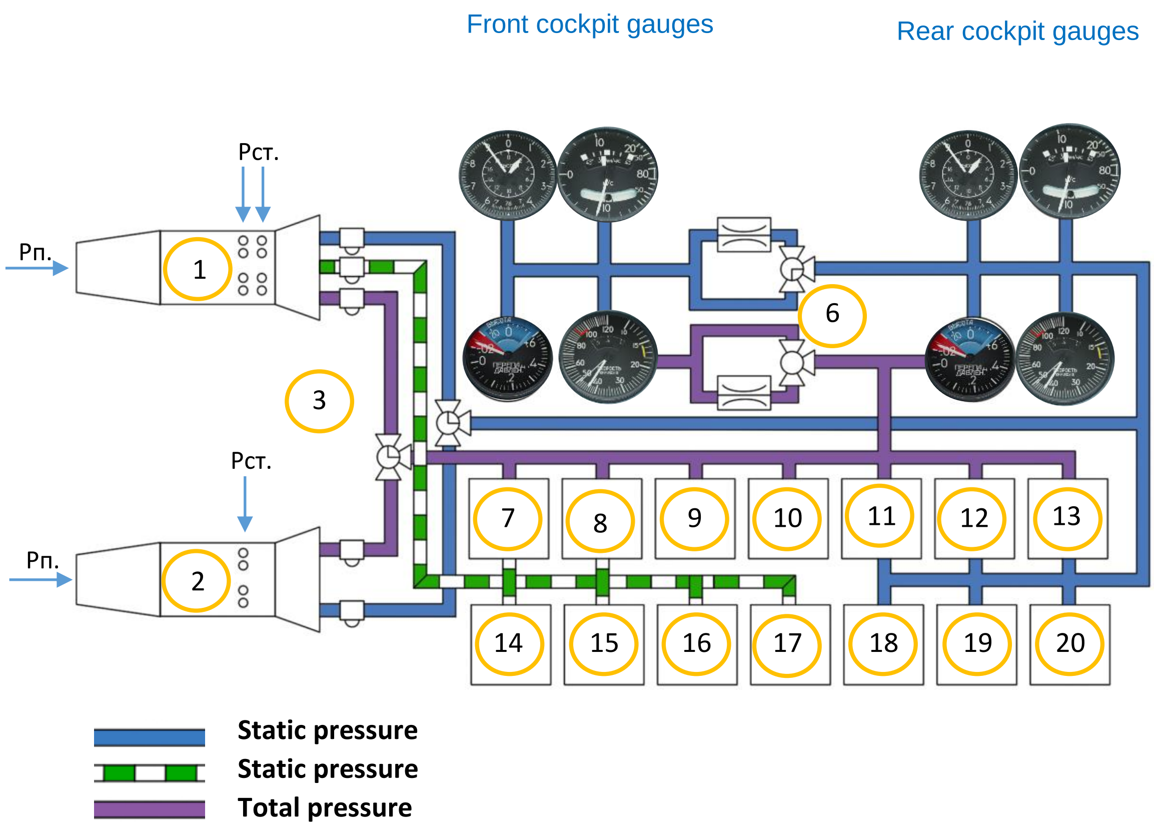
The measurement of the angular position in space and angular velocity is performed by gyroscopic instruments.

G-force is measured by accelerometer and time by cockpit clock.

Pitot-static system for measuring total and static pressure and transferring measured pressure values to the consumers is installed on the airplane.

System consists of primary and backup pitot-static receivers. The primary pitot-static receiver is installed on the right surface and backup one on the left one. Pitot receivers’ controls are located on the left panel in front cockpit.

Pitot-system of the airplane.



1 Primary pitot-static receiver.

2 Backup pitot-static receiver.

3 Valve switching main and backup pitot-static receivers.

4 Front cockpit gauges.

5 Rear cockpit gauges

6 Failure simulation valves.

7 ISKRA-K unit airspeed sensor.

8 ISKRA-K unit airspeed sensor.

9 Front cockpit's ejection seat speed pressure indicators

10 Rear cockpit's ejection seat speed pressure indicators

11 Speed sensor.

12 SARPP-12GM FDR speed and automatic activation sensor

13 Speed signalization in flaps control sensor circuit.

14 Cockpit pressure regulators

15 ASP-3NMU "altitude mechanism"

16 Cockpit pressure regulators

17 ISKRA-K unit pressure sensor

18 Altitude sensor.

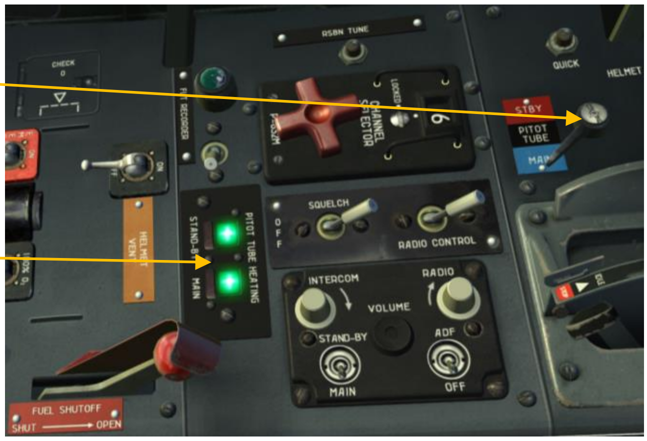
19 Radar altimeter sensor.

20 Dangerous pressure in the cockpit alarm sensor.

PITOT-STATIC SYSTEM CONTROLS

«PITOT TUBE MAIN STBY» switch

«PITOT TUBE HEATING MAIN STAND-BY» lamp-buttons



1. «PITOT TUBE MAIN STBY» valve for switching between primary and backup pitot-static receivers.
2. «PITOT TUBE HEATING MAIN STAND-BY» lamp-buttons for electrical heating of pitot-system receivers.

To simulate failure in front cockpit static and total pressure pitot system lines two «TOTAL PRESS. ON- RED. MIN 30'' -FAILURE» and «STAT. PRESS. ON- RED. MIN 30'' -FAILURE» valves are installed on central pedestal in rear cockpit. When the «TOTAL PRESS. ON- RED. MIN 30'' -FAILURE» valve is set to «FAILURE» position the front cockpit KUSM-1200 (41) failure is simulated. When the «STAT. PRESS. ON- RED. MIN 30'' -FAILURE» is set to «FAILURE» position the front cockpit VD-20 (41), variometer (41) and cockpit pressure difference gauge (41) failure is simulated.

Important: To avoid damaging of pressure gauges in front cockpit, when switching from «FAILURE» to «ON» position pressure guards are installed. For enabling pressure gauges in front cockpit is necessary to set valves from «FAILURE» to « RED. MIN 30''and after 30 seconds to «ON» position.

Front cockpit gauge faults simulation panel.

1. «TOTAL PRESS. ON- RED. MIN 30’’ -FAILURE» valve
2. «STAT. PRESS. ON- RED. MIN 30’’ -FAILURE» valve

Flight and navigation instruments are divided on:

- aerometric instruments;
- gyroscopic instruments.

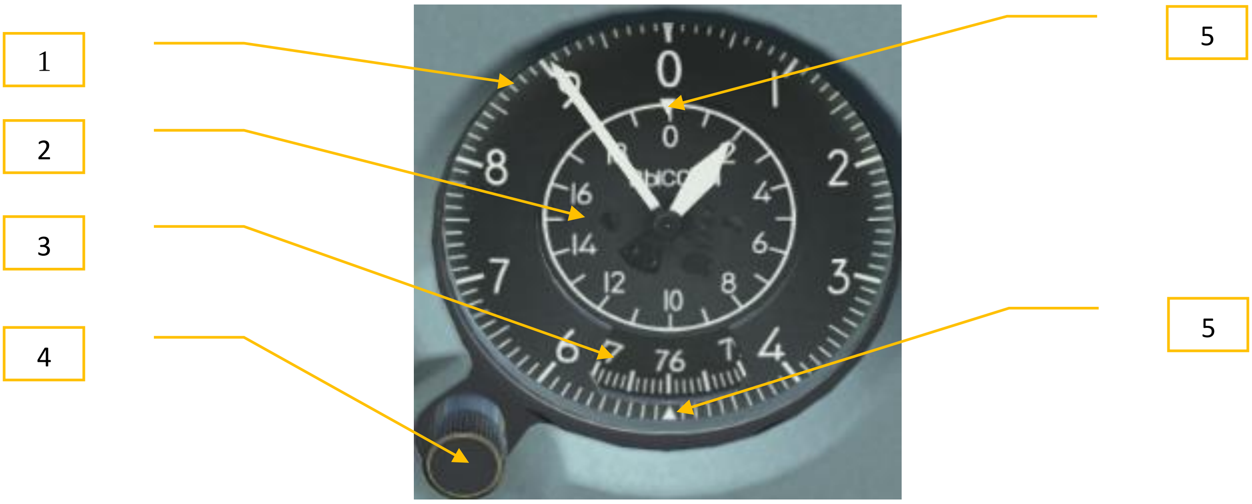
AEROMETRIC INSTRUMENTS

- VD-20 barometric altimeter;
- altitude and pressure difference gauge;
- combined speed and Mach number gauge;
- combined gauge variometer (artificial horizon backup).

VD-20 BAROMETRIC ALTIMETER

It measures relative flight altitude. The altimeter is installed on instrument panels in both front and rear cockpits.

VD-20 (41).

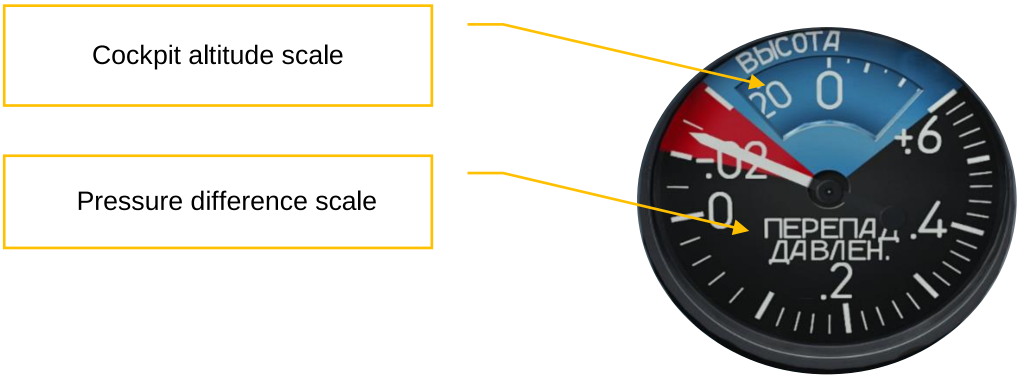


1. External scale shows altitude in meters
2. Internal scale shows altitude in kilometers.
3. Barometric pressure value
4. Knob for setting pointers to «0».
5. Pressure correction indexes for landing at high altitude airfields, where pressure is less than 670 mm Hg. Indexes are moved by the knob.

ALTITUDE AND PRESSURE DIFFERENCE GAUGE

It is used to measure “altitude” in the cockpit as well as pressure difference between cockpit and ambient atmosphere. The gauge combines in one case both altimeter (“cockpit altitude”) and pressure difference pressure gauge. UVPD is installed on instrument panels in front and rear cockpits.

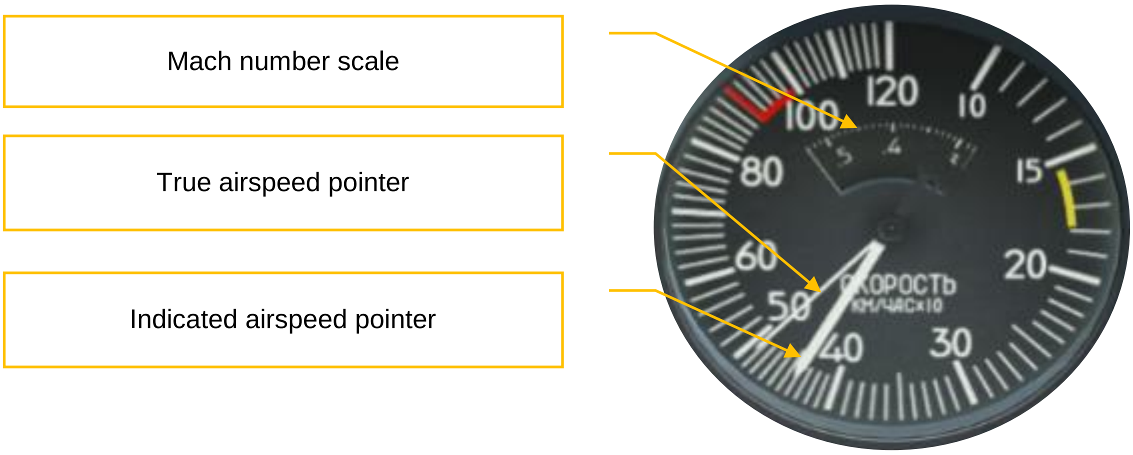
UVPD cockpit altitude and pressure difference gauge (41).



KUSM-1200 SPEED AND MACH NUMBER COMBINED GAUGE

It is used for indicated air speed measurement from 100 to 1200 km/h, true speed from 300 to 1200 km/h, Mach number from 0.5 to 1 and for critical Mach=0.78 signalization. When airplane reaches Mach=0.78 the «M max» lights up on warning lights panels in both cockpits and airbrakes extend automatically. This signal operates in continuous mode. KUSM-1200 is installed on instrument panels in front and rear cockpits.

KUSM-1200 (41).



COMBINED GAUGE VARIOMETER

It is intended to measure vertical speed. Variometers are installed on the instrument panels in front and rear cockpits.

Combined gauge variometer (41).

Climb rate scale

Descent rate scale

Knob for setting variometer's pointer to zero position

GYROSCOPIC INSTRUMENTS

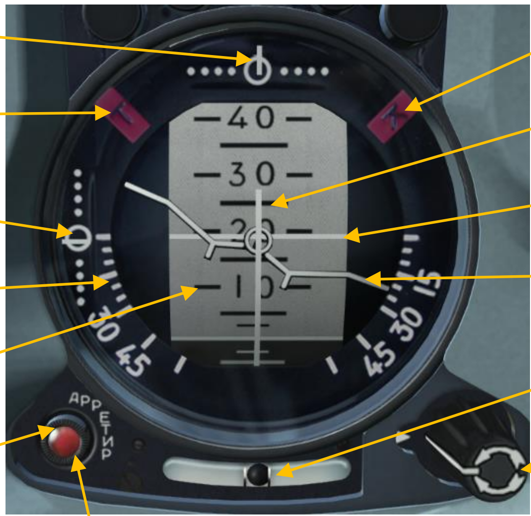
- AGD-1 attitude directional indicator;
- electrical turn and slip indicator (T/S);
- accelerometer.

AGD-1 REMOTE ARTIFICIAL HORIZON

The AGD-1 is developed to give a pilot information about bank and pitch angles relative to the horizon, presence and direction of slip. The KPP-1273K is used as ADI gauge, which is combination of artificial horizon pointer together with command and additional pointer pointers. To use SDU L-39 remote command landing system, ADI has lateral and longitudinal channel pointers, as well as course deviation and altitude deviation pointers. The pointers are controlled by command landing system signals. The SDU-L39 provides a semi-automatic airplane control during landing. This system is enabled by the «SDU» circuit breaker located on the main CB panel and by the «SDU» on the right panel in front cockpit. For enabling ADI is necessary to enable «BATTERY» (94) and «AGD-GMK» (94) CBs on the main electrical CB panel in front cockpit. After enabling the «АРРЕТИР» (Cage) button lamp lights on and after not more than 15 seconds goes off. ADI will show zero angles of bank and pitch. After 1.5 minutes being enabled ADI should show actual bank and pitch angles. ADI is installed on instrument panels in front and rear cockpits.

«SDU»

ADI of KPP-1273K type (41).



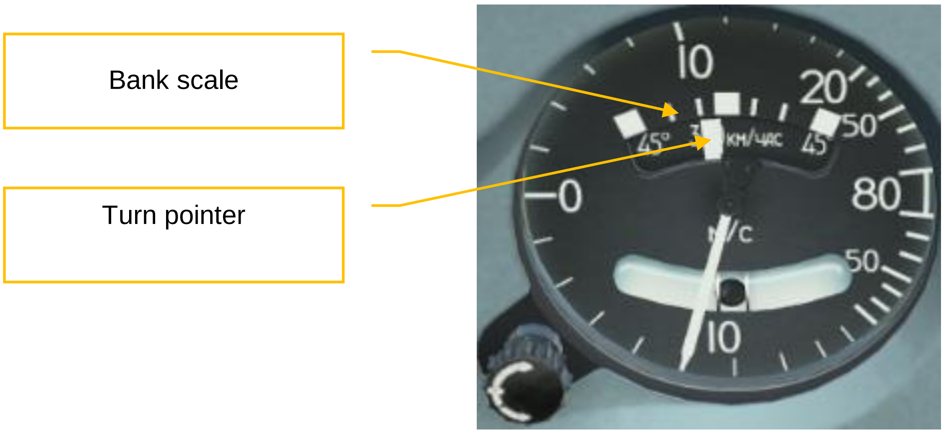
1	Heading deviation pointer	7	Red lamp indicating ADI failure, on in case of failure or when caged.
2	Warning flags, indicating absence of power in longitudinal and lateral channels of remote control landing system.	8	Command pointer of lateral channel
3	Altitude deviation pointer	9	Command pointer of longitudinal channel.
4	Bank scale	10	Airplane silhouette.
5	Pitch scale	11	Slip indicator.
6	«АРРЕТИР» lamp-button for caging ADI.	12	Knob adjusting bank scale

Trainer from rear cockpit can simulate KPP-1273K failure (pitch and roll scales) in front cockpit**.**

ELECTRICAL TURN AND SLIP INDICATOR

It is developed to determine turn and slip directions and bank angles at speed of 350 km/h. Angular velocity measurement limit is ±5,7 ^{0}/s, which corresponds to 45^0 bank angle and speed of 350 km/h. Bank scale intervals are 15^0. For enabling electrical T/S indicator is necessary to enable «BATTERY» and «ENGINE» (94) CBs on the main electrical CB panel in front cockpit. T/S gauges are installed on instrument panels in both cockpits.

Electrical turn and slip indicator (41).



ACCELEROMETER

It is used to provide pilot with information about normal G value and to give the warning signal when G exceeds + 7.5 – 3.5 G. Before flight it is necessary to check if gauge pointers are set to +1, in opposite case push pointer return button. Accelerometer is not installed in rear cockpit.

Accelerometer (41).

1. Pointer that stores maximum negative G during the flight.
2. Current G pointer.
3. Pointer that stores maximum positive G during the flight.
4. Button which resets stored maximum G value.

ACHS-1M COCKPIT CLOCK

Clock is intended to show the time of flight in hours and minutes, measure flight time in hours and minutes and to measure short periods of time. The AChS-1M is installed on the instrument panels in front and rear cockpits.

AChS-1M (42)

1. Flight time scale.
2. Time measurement scale.
3. Stopwatch scale.
4. Button for clock winding, setting the pointers, flight time mechanism starting, stopping and returning pointers to 0.
5. Button for clock starting and stopping, stopwatch starting and stopping and returning pointers to 0.

HEADING MEASUREMENT

For heading measurement the following units are installed:

- KI-13 magnetic compass;
- GMK-1AE directional gyro.

KI-13 MAGNETIC COMPASS

It is designed for airplane heading determination in case of GMK-1AE failure. Compass has individual backlight. The KI-13 compass is not installed in rear cockpit.

KI-13 (41)

GMK-1AE DIRECTIONAL GYRO

In the L-39C simulator flight can be performed with magnetic or true heading.

GMK-1AE is designed for heading and turn angles determination. Heading is indicated on Radio Magnetic Indicator (RMI).

To turn on RMI is necessary to enable «BATTERY» and «AGD-GMK» circuit breakers on the main CB panel in front cockpit. RMI is installed on front and rear cockpit instrument panels. To control the GMK-1AE system in front cockpit on the right panel PU-26E control panel is installed and in rear cockpit on right panel the KM-8 correction mechanism is installed. KM-8 is designed for entering magnetic variation in the system.

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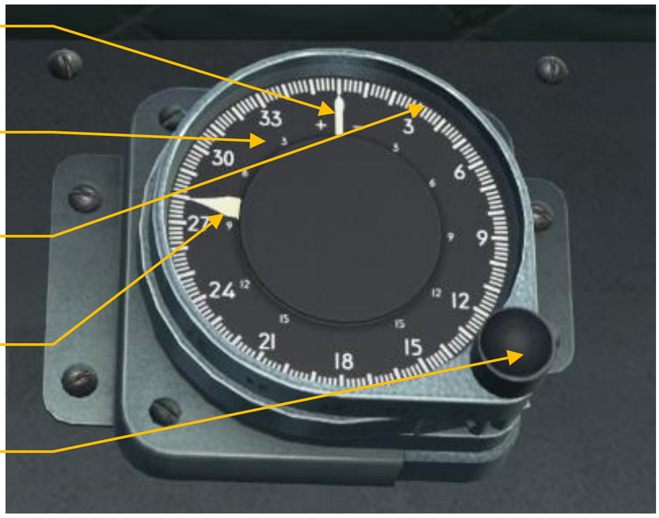
KM-8. (50)

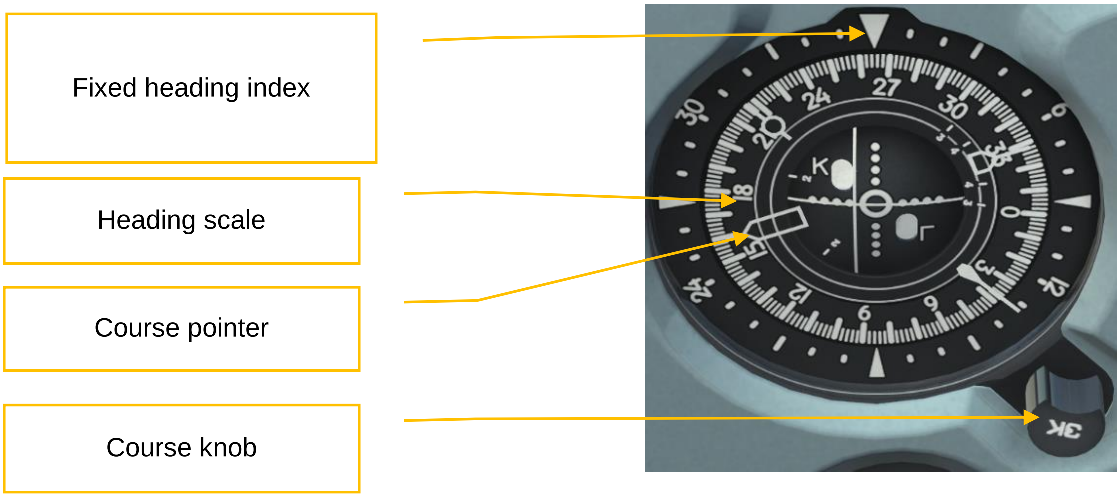


To align system with magnetic heading is necessary to press the «MC SYNCHR.» button in front or rear cockpit, or press «HDG SELECT» switch on the PU-26E control panel in front cockpit. In flight after 45 min one of pilots has to re-align system.

In case of gyroscope blockage warning light «ERROR GA» is illuminating on the panel (can illuminate after vigorous maneuvers), system has to be aligned as well. Alignment has to be performed in straight and horizontal flight with a constant speed.

«ERROR GA» lamp

GMK-1AE. (41)



PU-26E (44)

1. «ERROR GA» lamp.
2. «N - S» (NORTH - SOUTH.) switch is designed to set northern or southern hemisphere.
3. Airport latitude set handle.
4. «CHECK 0 - 300^0» switch is designed to test the system.
5. «MC – GC» (Magnetic correction-Directional gyro mode) switch.
6. Latitude scale.
7. «HDG SELECT» switch is designed for heading correction.

Trainer from rear cockpit can simulate GMK-1AE failure in front cockpit.

AIRPLANE OXYGEN EQUIPMENT

There is a certain specific in oxygen equipment usage in the L-39 simulator. A pilot flies in a helmet and oxygen mask, anti-G suit can be used as well. Oxygen mask is always attached to the helmet. Sealed helmet, high-altitude and ventilation suits are not used, as well as their controls.

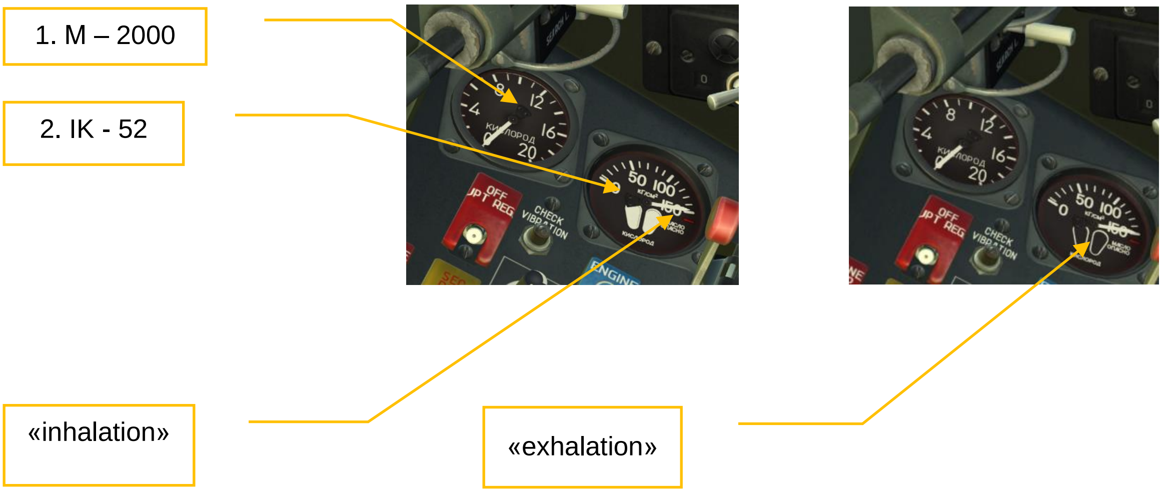
The KKO-5 oxygen equipment set is installed on the airplane.

It is designed to provide normal pilot normal operating conditions at high altitudes and to provide safe ejection at any altitude. Before flight pilots has to ensure that KKO controls are in correct positions.

The KKO-5 is installed in front and rear cockpit.

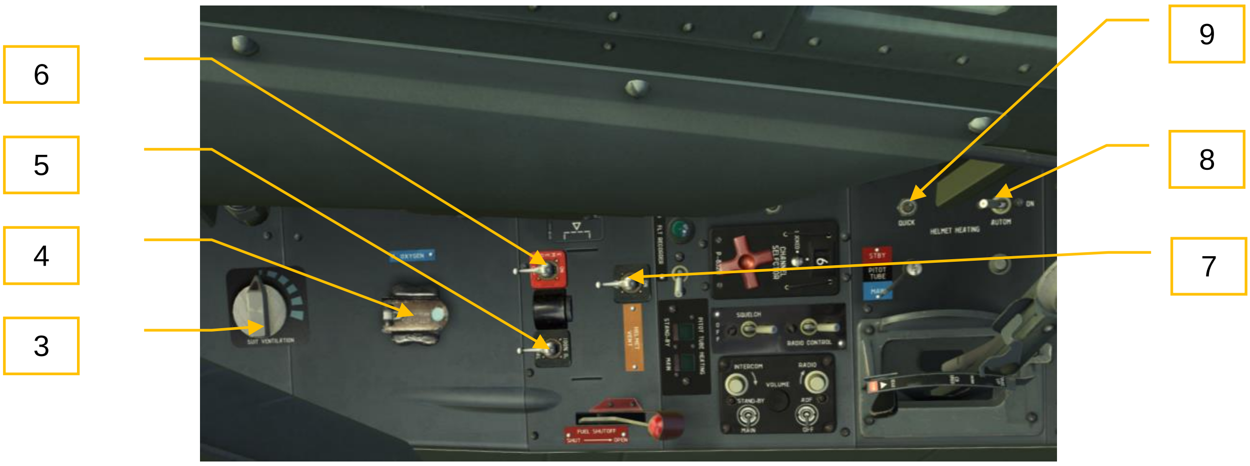
KKO-5 controls.

1. M-2000K excessive pressure pressure gauge monitors excessive pressure in breathing system. It is located on the left panel in front cockpit and not-operational in the simulator.
2. IK-52 oxygen pressure indicator and flow annunciator is used for monitoring oxygen supply for breathing as well as for measuring pressure in air tanks. It is installed on the left panels in both cockpits. Flags indicators converge during inhale and diverge when exhaling.

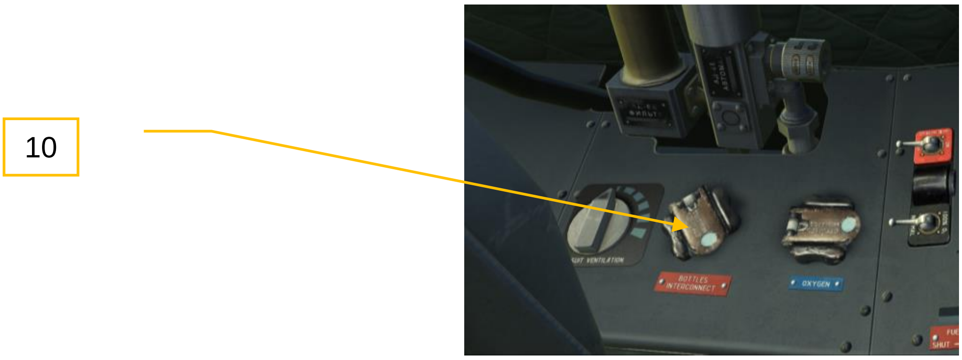


3. «SUIT VENTILATION» valve is used for VK-3M (ventilation suit) ventilation and located on the left panel in front cockpit. Not used in simulation.
4. KV-2SM oxygen valves supply oxygen from tanks to oxygen system.
5. RPK-52 oxygen regulators. The RPK-52 has the following handles:
   «100% O_2 – NORMAL» for automatic oxygen supply regulation depending on altitude, installed on left panels in both cockpits.
6. «EMERG ON- OFF» valve enables continuous oxygen supply.
7. «HELMET VENT» used for helmet ventilation, installed on the left panel in front cockpit. Not used in simulator.
8. «HELMET HEATING» – enables helmet visor heating, located on the left panel in front cockpit. Not used is simulator.
9. «QUICK HELMET HEATING» – for fast heating of helmet visor, installed on the left panel in front cockpit. Not used in simulator.
10. KV-2MS «BOTTLES INTERCONNECT» oxygen valve connects front and rear cockpit air lines. Located in rear cockpit.

Front cockpit



Rear cockpit



KKO-5 operation depending on altitude:

- up to 2 km pilot breathes in cockpit air;
- from 3 km to 8km – oxygen-air mixture;
- from 8 km to service ceiling – pure oxygen.

At altitudes lower than 2 km, if the RPK-52 «100%O_2 – NORMAL» handle is set into the «NORMAL» position, oxygen is not supplied and IK-52 oxygen pressure indicator and flow annunciator flags do not react on inhaling and exhaling.

SARPP-12GM FLIGHT DATA RECORDER

The system is designed for recording flight parameters, various systems status, and for storing information received in normal and emergency conditions.

System switching on and off is performed by the «BATTERY» switch on the main CB panel in front cockpit and by switch with inscription: «FLT RECORDER», which is placed on the front cockpit left panel. After this system is turned on, green lamp, located near the «FLT RECORDER» switch, starts blinking. If pilot did not enable the «FLT RECORDER» switch, SARPP-12GM FDR will be enabled automatically, when speed reaches 120 km/h.

In the L-39C module SARPP-12GM FDR is implemented in the following way: while watching recorded track it is possible to open window with recorded flight parameters.

«FLT RECORDER» switch and corresponding signal lamp.(38)

RADIO ELECTRONIC EQUIPMENT OF THE L-39C

Radio electronic equipment is divided on:

- communication;
- navigation;
- radar.

RADIO COMMUNICATION EQUIPMENT

- R-832M command radio
- SPU-9 intercom

R-832M COMMAND RADIO

It is developed for duplex communication between the airplanes and ATCs.

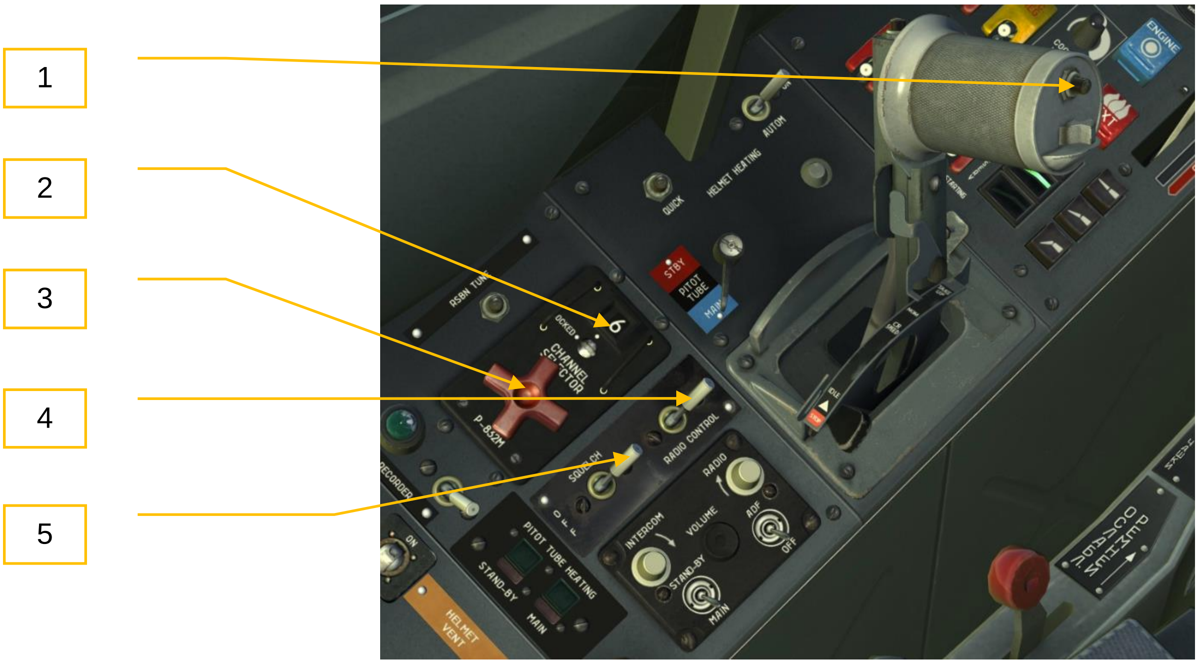
The R-839M is enabled with help of the following automatic circuit breakers on the main CB panel: «BATTERY» (94), «115V INVERTOR I», «115V INVERTOR II» (94), and «RDO» (94). After all the CBs are enabled, one should sure that channel number lamp illuminates. After 2-3 minutes the R-832M is operational.

R-832M controls:

- control unit on the left panel in both cockpits
- «РАДИО» (RADIO) PTT button on the throttle handle in both cockpits

1. «РАДИО» PTT button.
2. Selected channel number.
3. «CHANNEL SELECTOR» rotary switch to for changing channels.
4. «RADIO CONTROL» switch to connect transmitter to the front cockpit or rear one (control is performed by channel number illumination).
5. «SQUELCH» switch to turn off noise suppression system.

R-832M controls



SPU-9 INTERCOM

This intercom is designed to provide communication between the crew members and for hearing RKL-41, RSBN-5S, MRP-56P, RV-5 and accelerometer sound signals.

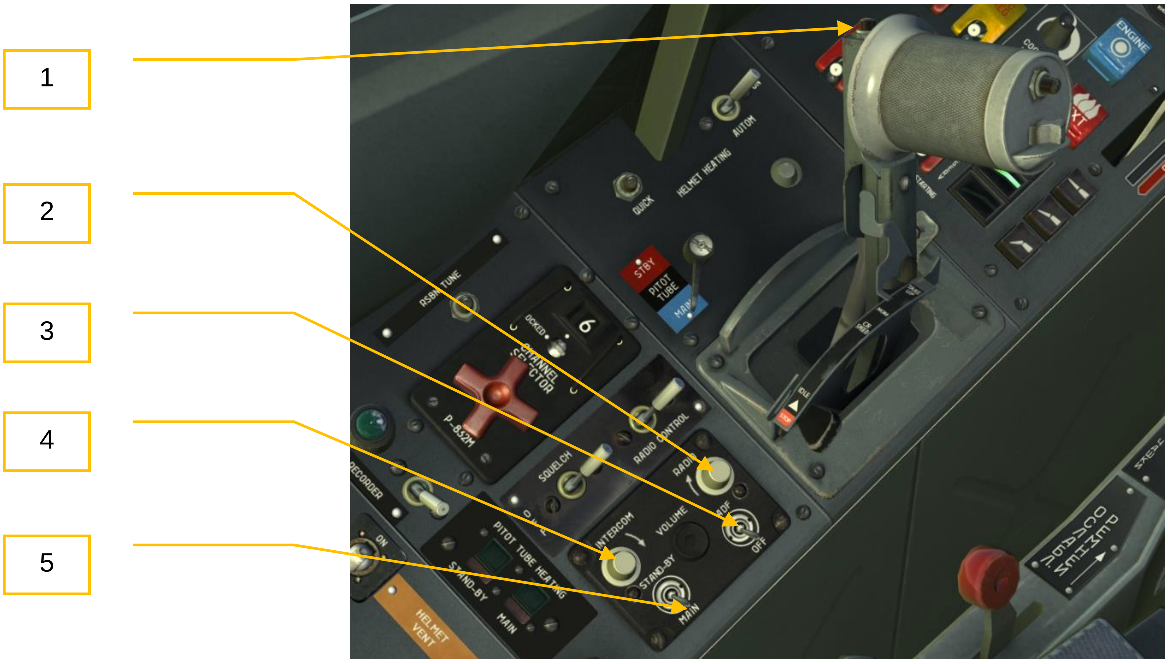
The SPU-9 is enabled by the «BATTERY», «115V INVERTOR I», «115V INVERTOR II» and «RDO» CBs on the main CB panel. To communicate with ground crew "ground" intercom is installed and can be enabled by the «INTERCOM GROUND» (97) switch, located on the right panel in rear cockpit.

SPU-9 controls:

- two control panels on the left panel in both cockpits near the R-832M control panel;
- «SPU INTERCOM» button on the throttle handle in both cockpits and on the stick in rear cockpit;
- «INTERCOM GROUND» – on the right control panel in rear cockpit.

1. «SPU INTERCOM» button
2. «RADIO» volume knob to adjust external radio channels and self-listening signals volume.
3. «ADF» switch – for listening outer and inner NDBs signals.
4. Intercom volume knob.
5. «MAIN- STANDBY» switch for switching SPUs between the cockpits.

SPU-9 CONTROLS IN FRONT AND REAR COCKPITS.



«INTERCOM» button on the stick in rear cockpit

«INTERCOM GROUND» CB on the right control panel in rear cockpit

RADIO NAVIGATION EQUIPMENT

Radio navigation equipment consists of:

- RKL-41 automatic direction finder;
- RSBN-5S («RSBN») system;
- RV-5 low altitude radar altimeter;
- MRP-56P marker beacon receiver;

RKL-41 AUTOMATIC DIRECTION FINDER

It is designed for NDBs' heading determination.

RKL-41 is enabled by the «BATTERY» (94), «115V INVERTOR I», «115V INVERTOR II» (94), and «RDO» (94) CBs located on the main CB panel.

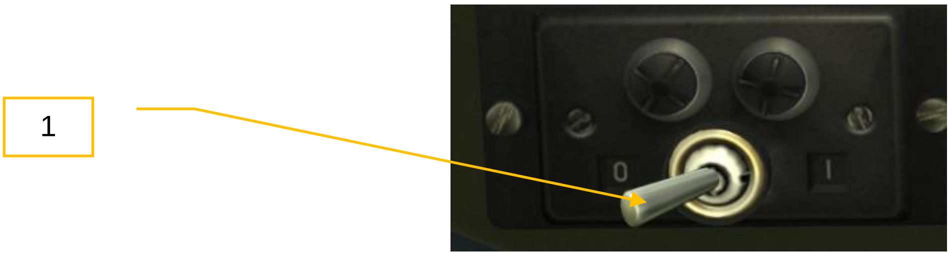
RKL-41 controls:

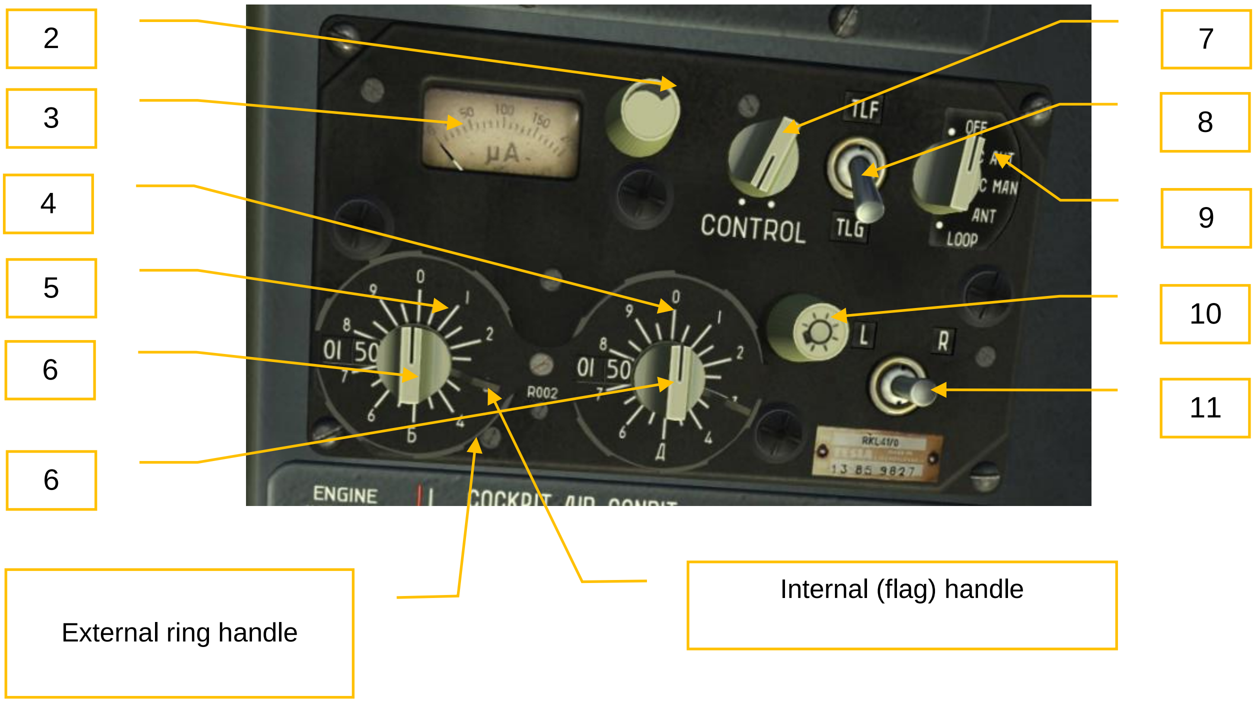
- two control panels, located on the right panels in both cockpits;
- «O-I» (Outer NDB – Inner NDB) switch, located at the bottom left from the instrument panel in front and rear cockpits;
- RKL-41 gauge, installed on instrument panels in both cockpits.

PKL-41 ADF gauge. (41)

RKL-41 CONTROL PANEL

1. «O-I» switches are located below instrument panel in front and rear cockpits (41)





2. Volume knob.
3. Tuning indicator is designed for precise RKL tuning to the required frequency based on the maximum pointer deflection.
4. Decade switch with «O» index is designed for entering frequency of outer NDB. External ring handle sets hundreds of kHz and internal handle tens of kHz.
5. Decade switch with «I» index is designed for entering frequencies of inner NDB. External ring handle sets hundreds of kHz and internal handle tens of kHz.
6. Precise tuning handle is designed for RKL tune based on maximum signals audibility in the TLF (Telephone) mode and on the maximum pointer deflection in TLG (Telegraph) mode.
7. Control panels switch is designed to switch control panels to front or rear cockpit. The RKL is connected to a control panel on which backlight lamps illuminate.
8. «TLF – TLG» switch is designed to connect reception path filters.

9. Mode switch «OFF, C AUT, C MAN, ANT, LOOP». «C AUT» (Compass automatic) and «C MAN» (Compass Manual) are RKL primary operating modes, NDBs' direction determines automatically. The only difference is that in «C MAN» mode there is no automatic switching from outer NDBs to the near one. In the «ANT» (Antenna) mode direction to the NDBs is not determined. It is used to adjust RKL ADF to the NDB frequency. The «LOOP» mode is designed for finding radio stations direction by hearing.
10. Illumination brightness adjust handle
11. «L – R» (Left-Right) switch is designed for manual antenna rotation.

RKL-41 DIRECTION FINDER CHECKING AND TUNING

Enable the «BATTERY», «115V INVERTOR I», «115V INVERTOR II», and «RDO» CBs on the main CB panel in front cockpit and perform the following actions:

a) on SPU-9 intercom control panel set the «РК – ВЫК» switch into «РК» position;

b) on ADF control panel:

- «O-I» switch on the instrument panel set in the «O» position;
- ADF control panel switch set in «your cockpit» position;
- set maximum volume, by turning the volume knob to the most right position;
- turn on ADF by turning the selector switch from «OFF» position to «ANT» position by that control panel and tuning indicator illumination will be switched on;
- «TLG — TLF» switch install in the «TLF» position;
- set outer NDBs' frequency by turning knob on the «O» decade, maximize callsigns outer NDB audibility by precise tuning knob;
- «TLG — TLF» switch set to the «TLG» position and adjust radio compass by tuning precise tune knob to the outer NDB frequency based on maximum pointer deflection to the right;
- «TLG — TLF» switch set to the «TLF» position;
- set mode switch to the «C AUT» or «C MAN» position, ADF will show outer NDB bearing;
- by setting «L — R» selector alternatively to the «L» and «R» positions, deflect pointer at 160°, return selector to the neutral position, pointer should point outer NDB heading angle.
- «O — I» set in the «I» position, perform ADF tune on inner NDB frequency by «I» decade tuning knobs and check its operation in the same way as for outer NDB.

c) after checking set the «O-I» switch in the «O» position;

d) set the «ADF—OFF» switch on the SPU-9 control panel in «OFF» position;

Trainer from rear cockpit can simulate RKL-41 failure in front cockpit.

RSBN-5S «ISKRA-K» SHORT-RANGE AERONAUTICAL NAVIGATION SYSTEM ONBOARD EQUIPMENT

The RSBN-5S (S- means airplane, russian: samolet) airplane equipment is a part of RSBN-4N (N- means ground, russian: nazemnoe) short-range radio navigation system. Airplane part together with ground equipment are used for polar coordinates determination (azimuth and distance).

With help of ground part of instrumental landing system (PRMG-4 beacon group) the RSBN-5S system assists landing.

Before instrumental flight with help of Iskra-K equipment pilot has to set navigation and landing channels on the control panel in front cockpit.

The RSBN-5S can operate in three modes: «NAV» (Navigation), «GP» (Glide path) and "LANDING".

In «NAVIGATION» mode system shows:

- airplane bearing on RMI;
- distance to ground station on PPD-2.

In the «GLIDE PATH» mode system shows:

- airplane bearing on RMI;
- distance to ground station on PPD-2.
- deviation from required course with course deviation pointer on RMI;

- programmed descending trajectory (descending curve) using glide-slope pointer on RMI;

Descend termination point is marked with «END OF DESCENT» signal on caution & advisory lights panel in both cockpits. Signal operates in continuous mode.

In the "LANDING" mode:

- indication that airplane within operating range of course and glide-slope beacons ;
- deviation from glide-slope trajectory using glide-slope pointer on RMI;
- deviation from landing course with course deviation pointer on RMI;
- distance to distance re-translator, which is included in glide slope beacon.

Detailed description on how to use the RSBN-5S system is found in chapter 3 of this manual.

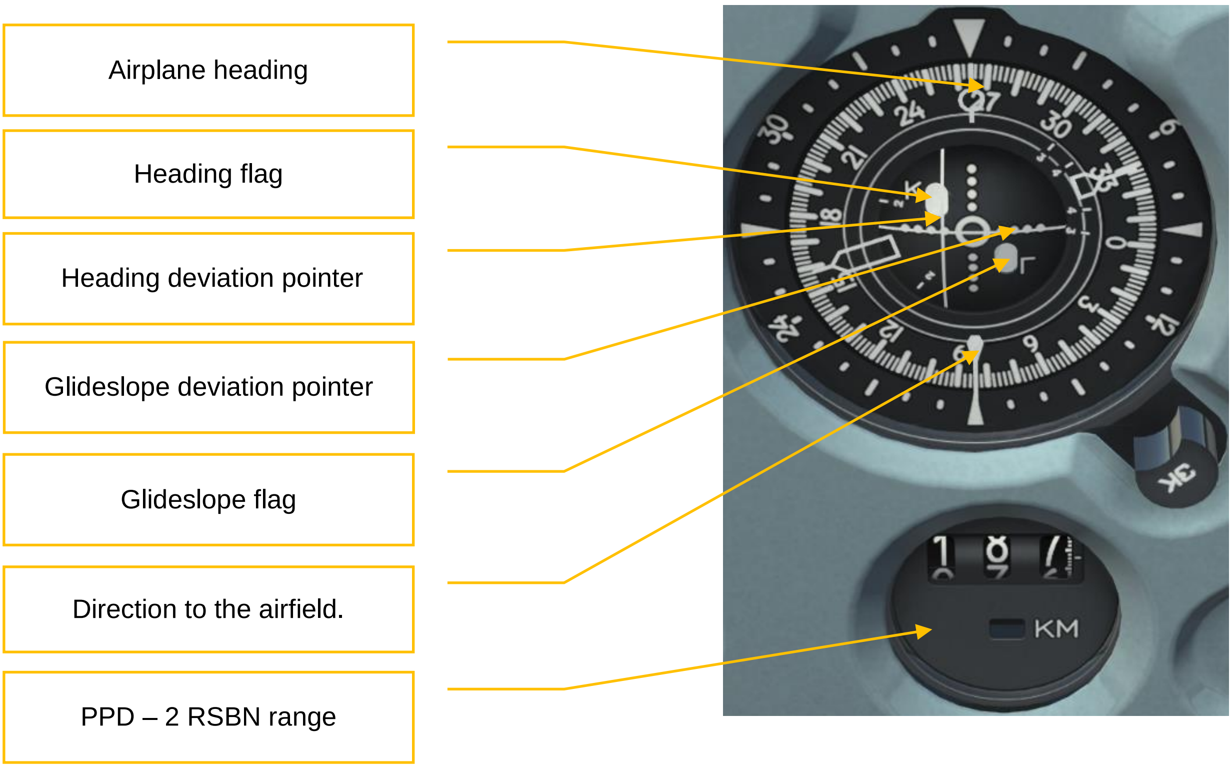
The RSBN-5S is enabled by the «BATTERY» (94), «115V INVERTOR I», «115V INVERTOR II» (94) and «AGD-GMK» (94), «RSBN» (94) (ISKRA system) switches on the main CB panel in front cockpit.

«RSBN» (Iskra) – after 3 minutes being enabled, RMI and PPD should show NDB bearing and distance to NDB. On the RSBN-5S control panel «AZIMUTH CORRECTION» and «DISTANCE CORRECTION» and in rear cockpit «AZIMUTH CORRECT» and «DISTANCE CORRECT» signals go on.

RSBN-5S controls and indicators:

- RMI device is located on both cockpits instrument panels;
- PPD-2 device is located on both cockpits instrument panels.
- RSBN-5S control unit is located on right panel in front cockpit;

RMI (41) and PPD – 2 (41)

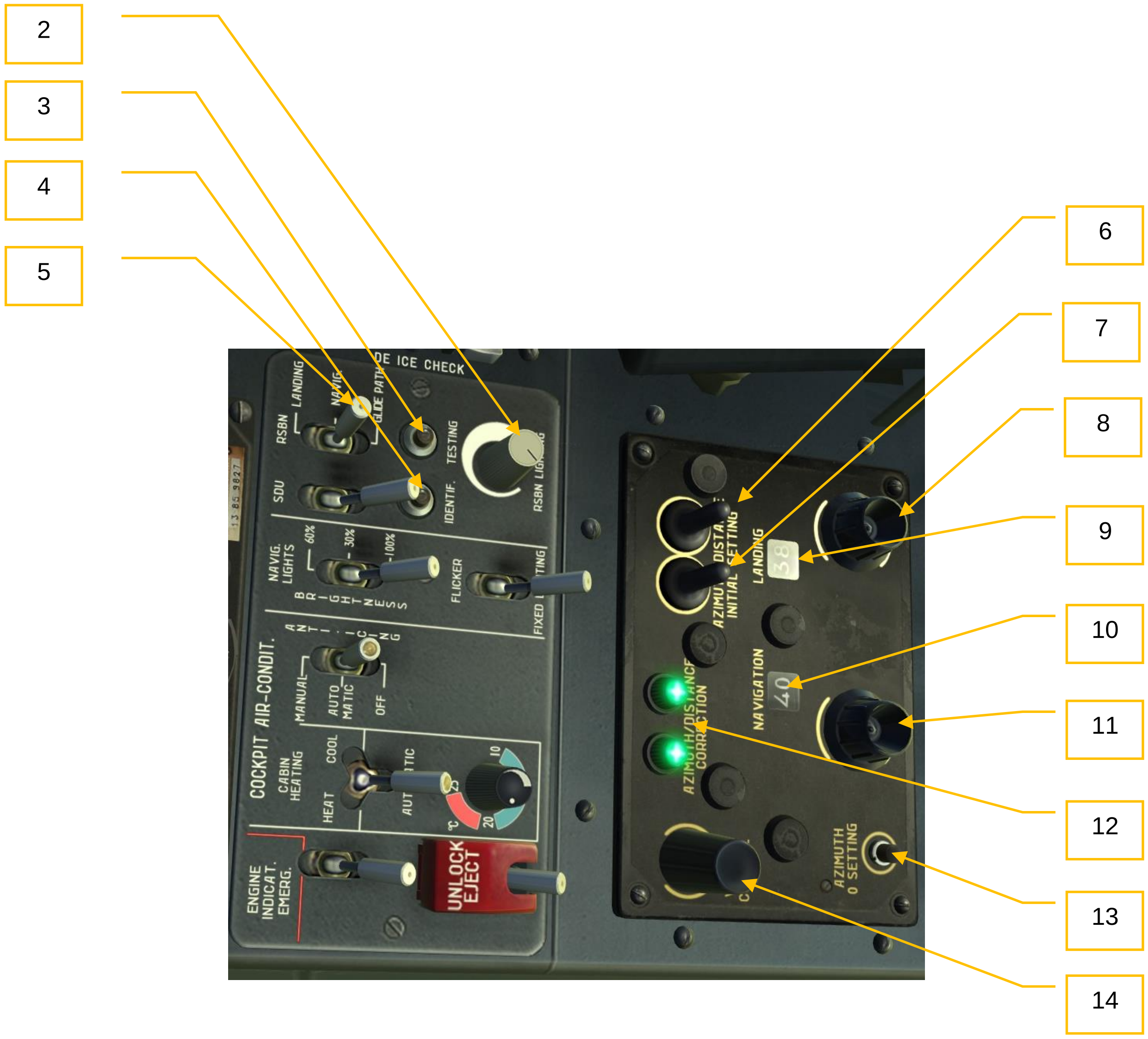


RSBN-5S CONTROLS IN FRONT COCKPIT

1. «RSBN TUNE» button. By pushing it RSBN ground beacon callsigns are heard, installed on the left panels in front and rear cockpits (38).

2. «RSBN LIGHTING» knob adjusts brightness.
3. «TESTING» button is designed to check the azimuth and distance measuring channels.
4. «IDENTIF» button by pushing it a personal identification signal is generated on the round view indicator. This function is not implemented in the simulator.
5. «LANDING-NAVIGATION-GLIDE PATH» mode selector switch;
6. «DISTANCE INITIAL SETTING» push switch which allows setting any distance.
7. «AZIMUTH INITIAL SETTING » push switch which allows setting any azimuth.
8. Landing 40-channel switch is designed to select landing channels.
9. Landing channel indication.
10. Navigation channel indication.
11. Navigation 40-channel switch, designed to select navigation channels.
12. «AZIMUTH/DISTANCE CORRECTION» signal lamps are designed to control the azimuth and distance measurement channels operation.
13. «AZIMUTH 0 SETTING» button is designed for azimuth channel calibration check.
14. «VOLUME CONTROL» knob is designed to adjust volume of RSBN ground beacons callsigns.
15. ZDV-30 is designed to set the airfield pressure (44).

RSBN-5S CONTROLS IN FRONT COCKPIT



OPERATING ISKRA-K FROM REAR COCKPIT

RSBN Iskra-K controls are mostly located in front cockpit. In rear cockpit on the right console there is an «AZIMUTH ACCORDANCE» button and «EMERGENCY SWITCH FOR LANDING» switch. To align rear cockpit azimuth (course) on HIS with that of front cockpit pilot has to push «AZIMUTH ACCORDANCE» button in rear cockpit. While aligning RMI glide-slope deviation pointer is being hold in center position and «CONFORM. AZIMUTH» signal on the front cockpit caution & advisory lights panel is on.

The rear cockpit pilot, who took over airplane control and performs landing should enable the «EMERGENCY SWITCH FOR LANDING» switch and manually set desired landing heading on RMI.

In all cases it is possible to land airplane on the airfield, frequency channel of which is set on the RSBN control panel in front cockpit.

To verify azimuth and distance channels functionality there are two signals «AZIMUTH CORRECT» and «DISTANCE CORRECT» signals on caution & advisory lights panel.

RSBN-5S controls in rear cockpit (50)

«EMERGENCY SWITCH FOR LANDING» switch

«AZIMUTH ACCORDANCE» button

RV-5 LOW ALTITUDE RADAR ALTIMETER

The RV-5 (41) low altitude altimeter is intended to determine real altitude over surface within 0-750m range. Besides that it gives information to the pilot about descent on pre-installed on the device dangerous altitude and about device failure. When airplane reaches altitude, which was set on the gauge as dangerous the «DANGEROUS ALTITUDE» signal starts blinking. If flying higher than RV-5 operating range, warning flag is seen on the altimeter gauge and pointer is set behind the dark sector of the scale.

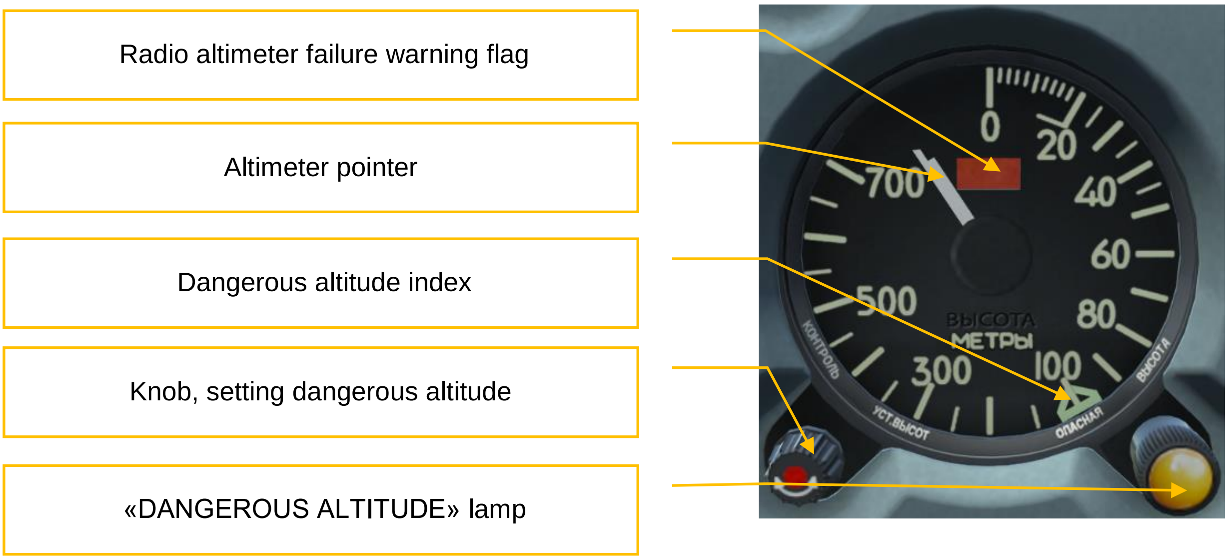
The RV-5 altimeter is enabled by the «BATTERY» (94), «115V INVERTOR I», «115V INVERTOR II» (94) and «MRP-RV» (94) CBs located on the main CB panel in front cockpit.

1-2 minutes after being enabled, the radar altimeter pointer deflects all the way to the right and returns to zero with ±1 m precision. If the radar altimeter pointer is below the «DANGEROUS ALTITUDE» index, continuous audio signal (4-9 seconds) is heard in pilot's headphones, the «DANGEROUS ALTITUDE» signal and «DANGEROUS ALTITUDE» signal lamp on the RV-5 gauge go on.

RV-5 controls and indication units

- Altitude pointer is located on the instrument panel in front and rear cockpit;
- «DANGEROUS ALTITUDE» signal is located on the warning lights panel in both cockpits.

RV-5



MRP-56P MARKER BEACON RECEIVER

It is designed to determine the fly over the marker beacon moment. When airplane flying over marker beacon, signal «MARKER» on the caution & advisory lights panel of both cockpits blinks and marker beacon callsign is heard. Marker beacons are installed on the outer and inner NDBs. MRP-56P is enabled by the «BATTERY», «115V INVERTOR I», «115V INVERTOR II», and «MRP-RV» CBs located on the main CB panel in front cockpit.

3. FLIGHT

L-39C STRUCTURAL LIMITS

№	Limitation	Limited by
1.	Maximum takeoff weight: paved runway— 4700 kg. unpaved runway— 4600 kg.	Airplane durability
2.	Maximum landing weight —4500 kg. (in special cases—4600 kg)	Landing gear durability
3.	Maximum allowed IAS (up to 1300 m) —900 km/h	Airplane durability
4.	Maximum allowed Mach (higher than 1300 m) —0,8	Airplane stability and controllability
5.	Maximum allowed G-factor: for flight weight 4200 kg and less: • positive — 8; • negative — 4; for flight weight more than 4200 kg: • positive — 7; • negative — 3,5; for flight with extended flaps: • positive — 2; • negative — not allowed	Airplane durability
6.	Minimum allowed IAS – 200 km/h	Cy slack before stalling starts
7.	Maximum allowed IAS: with extended gears — 340 km/h with extended flaps (takeoff and landing position)—310 km/h	Landing gear doors and landing gear linkage durability
8.	Maximum allowed IAS for elevator trimmer usage— 700 km/h	Excessive trimmer efficiency at higher speeds
9.	Maximum time of inverted flight — 20 seconds	Amount of fuel in fuel accumulator
10.	Minimum time of horizontal flight between consecutive inverted flights — 20 seconds	Time needed to refuel fuel accumulator
11.	The maximum lateral wind component during take-off and landing — 10 m/s	Lateral stability and controllability of the airplane
12.	Maximum speed when braking can be started - 190 km/h	Brakes capacity
13.	Maximum taxi speed during turn —10 km/h	Airplane stability
14.	Maximum allowed IAS with jettisoned canopy —350 km/h	Impact of airflow on a pilot
15.	Maximum altitude when using of takeoff mode is allowed —10000 m	Heat dissipation capacity of the engine
16.	Maximum duration of continuous operation of the engine at takeoff mode — 20" minutes	Engine durability
17.	Maximum allowed EGT: * up to 8000 m — 685°C (with anti-icing system enabled —not more 705°C); * higher than 8000 m —715°C; * at idle and during engine start at all altitudes — 600°C	Heat dissipation capacity of the engine
18.	Maximum allowed HPC RPM —107,8%	Engine durability
19.	Maximum duration of engine operation when fuel is supplied by emergency fuel system — 40 minutes	Automatics reliability

№	Limitation	Limited by
20.	Minimum HPC RPM, while fuel is supplied by emergency fuel system: * up to 2000 meters — 56%; * higher than 2000 m and more — 60%	Engine operation stability slack
21.	Maximum HPC RPM, while fuel is supplied by emergency fuel system: * up to 2000 meters — 103%; * higher than 2000 m and below 8000 m — not more than 99%	Engine operation stability slack
22.	Maximum altitude of flight, while fuel is supplied by emergency fuel system — 8000 m	Fuel system altitude performance
23.	Maximum altitude of flight with booster pump disabled — 6000 m	Engine operation stability
24.	Maximum altitude of flight with anti-icing system enabled - 8000 m	Heat dissipation capacity of the engine
25.	Maximum altitude for air engine start — 6000 m	Engine start reliability
26.	Minimum HPC autorotation RPM, needed for engine start without Sapphire-5 APU – 15%.	Engine start reliability
27.	Duration of engine operation at HPC RMP of 74—78% and 86—90% - minimal (use only as intermediate modes).	Compressor's air bleeding valves triggering
28.	Maximum wind speed blowing into the engine nozzle during engine start and testing – 10 m/s.	Engine start reliability and operation stability

BEFORE FLIGHT COCKPIT CHECKLISTS

If flight is going to be performed from the front cockpit only, all the valves, switches and circuit breakers are already set to correct positions, needed for engine start and further flight. Rear canopy is closed. In this case pilot should follow the front cockpit checklist only.
If flight is to be performed by two pilots, both front and rear cockpit checklists should be used.

In rear cockpit pilot MUST CHECK

1. *«BOTTLES INTERCONNECT» valve is opened;*
2. *«OXYGEN» valve is opened;*
3. *«SEC. REG» switch - OFF;*
4. *«EGT IND AFT FWD» is set to front cockpit position;*
5. *«ENGINE STOP» switch - OFF;*
6. *landing gear control lever is in neutral position;*
7. *the following failure simulation switches are off: отказов «AGD INKLINAT. LONGITUD.», «AGD INKLINAT. LATERAL», «GMK», «ARK». Shut-off valves of static and dynamic Pitot system lines are opened for membrane-aneroid gauges in front cockpit.*
8. *Enabled*
    - *«NETW» switch;*
    - *«SEAT» CB;*
    - *«SIGNAL» CB.*
    - *«ARMS» CB.*
    - *«INTERCOM GROUND» CB.*
9. *on KM-8 alignment mechanism set magnetic declination pointer to zero if it is planned to fly using magnetic headings or to magnetic declination(δ) value if true headings to be used during the flight.*

6. NEUTRAL POSITION

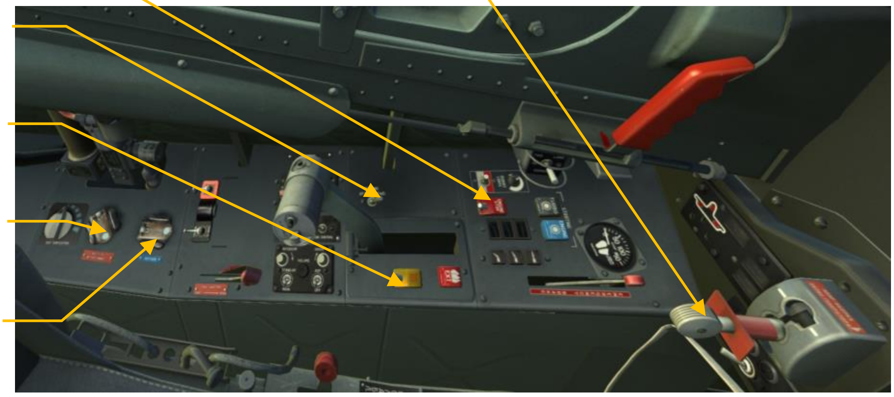
5. OFF

4. FRONT COCKPIT

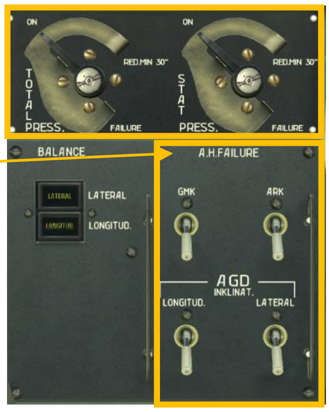
3. OFF

2. OPEN

1. CLOSED

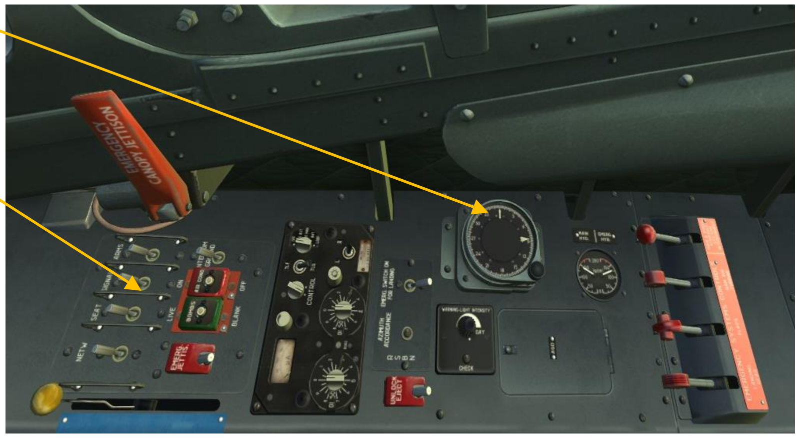


7.



9. «0» (б)

8. ON



In front cockpit pilot MUST CHECK

1. *fuel shut off lever is opened;*
2. *«100% O_2 – NORMAL» - «NORMAL»*
3. *«OXYGEN» valve is opened;*
4. *«EMERG» - «OFF»*
5. *main and emergency Pitot-system flag is «ON»;*
6. *«STARTING-PRESERV. – COLD. ROTAT» switch is in «STARTING» position and closed by protective cover;*
7. *«STOP ТУРБО» switch – OFF*
8. *«SEC. REG» switch – OFF*
9. *«ENGINE STOP» (Engine stop) switch – OFF*
10. *emergency braking lever and parking lever are in the center positions;*
11. *landing gear control lever is in extended position;*
12. *barometric altimeter pointers are set to zero, atmospheric pressure read on this gauge and actual atmospheric pressure on ground level should be the same or differ for not more than ±2 mm Hg;*
13. *cockpit pressurization and ECS lever is in the rearmost position.*
14. *all CBs are enabled on auxiliary CB panel;*

10. NEUTRAL

11. DOWN

9. OFF

8. OFF

7. OFF

6. «STARTING»

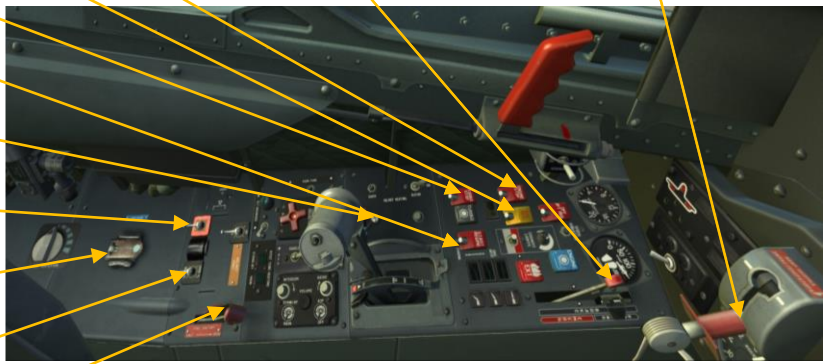
5. MAIN

4. OFF

3. OPENED

2. NORMAL

1.FORWARD



12. «0»

14. ON

13. AFT POSITION

ENGINE START PREPARATION

Engine should be started from front cockpit, because «STOP» latch, which allows moving the throttle from the «STOP» to the «IDLE» exists on the front cockpit throttle only.
Engine start with opened canopy is strictly forbidden. On the L-39 ground engineer closes and opens canopies of both cockpits. If pilot starts engine with rear cockpit opened, then to close it ground crew has to stay very close to working engine air inlet. This is very dangerous. This feature is present in the L-39C simulator.
Engine can be started using ground power or battery.

Enable:

- **«BATTERY» (Battery)** CB, the following signals should go on:
  - «ENG. MIN. OIL PRESS»;
  - «GENERATOR»;
  - «EMERGENCY GENERATOR»;
  - «DON'T START»;
  - "CANOPY UNLOCKED";
  - «INV. 115V FAIL»;
  - «AIRCONDIT OFF»;
  - «INV. 3x36V FAIL»;
  - master caution panel.

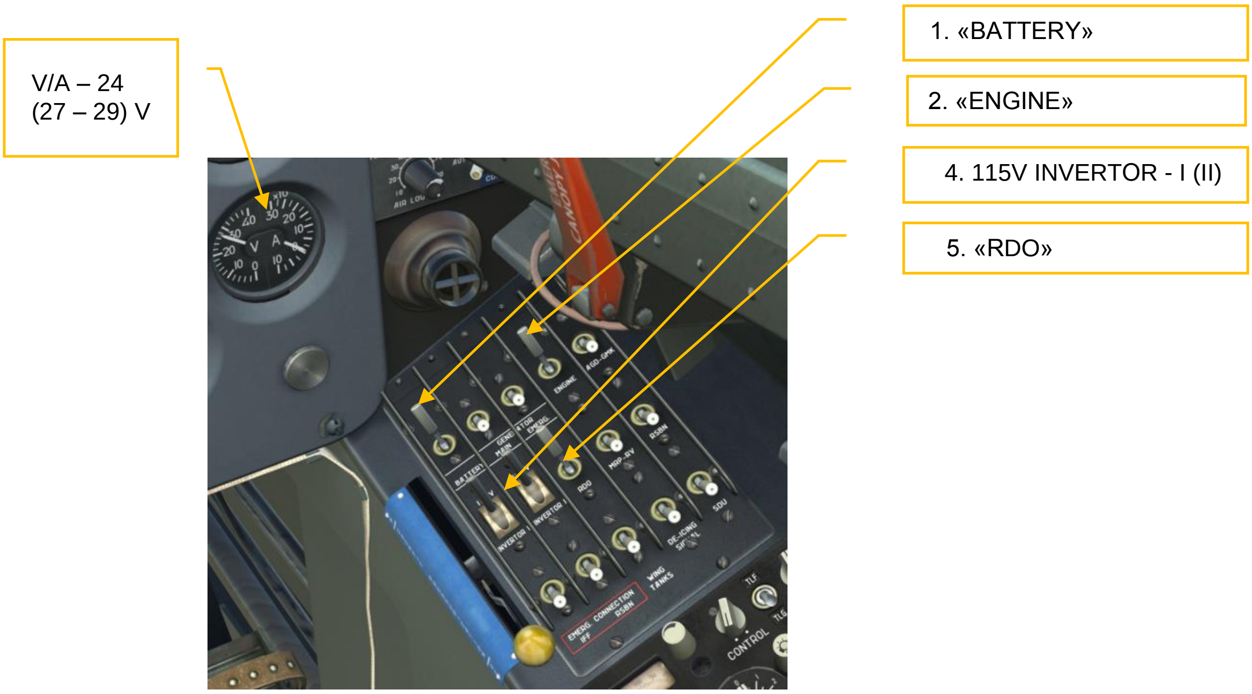
If pressure in the hydraulic system is less than 100 ±5 kg/cm^2 the «HYD. SYST. FAIL» is on.

Voltammeter should indicated not less than 24V.

If ground power is connected, signal with ground equipment icon should be on and voltammeter should indicate 27-29 V.

- **«ENGINE»** CB on main CB panel, as a result signals «DON'T START» and «INV. 3x36V FAIL» should go off.
- **«115V INVERTOR I »** and **«115V INVERTOR II »** circuit breakers (signal «INV. 115V FAIL» goes off).
- **«RDO».**
- **«FLT RECORDER».**

Before engine start pilot must:
- set inner and outer NDBs frequencies on RKL-41;
- set navigation and landing channels on RSBN-5S control panel;
- set airfield atmospheric pressure on ZDV-30;
- set required communication channel on R-832M;
- set «MC – GC» switch into «MC» position, «N – S» switch in «N», set the latitude of the airfield.



If start is going to be performed with help of ground power, pilot has to request ground power connection from ground crew.
Set the wheel chocks under the main landing gear.

Ask permission to start engine and when received, **disable** the:

- **«115V INVERTOR I» CB,**
- **«115V INVERTOR II» CB;**
- **«RDO»;**

Perform engine start.

- Make sure that throttle is in «STOP» position and that «DON'T START» and «INV. 3x36V FAIL» signals are off.
- Start Sapphire-5 APU, for that simultaneously press stopwatch button and **«TURBO»** button for 1-2 seconds.
- Listen if APU has started operating and move sight to the caution & advisory lights panel, after 23-24 seconds, «TURBINE STARTER» goes on. Now engine can be started.

DON'T START - OFF

INV. 3 x 36 V FAIL - OFF

1. «TURBO» and stopwatch

2. 23 – 24 sec. TURBINE STARTER

- Simultaneously press stopwatch button and **“ENGINE”** button for 1-2 seconds.

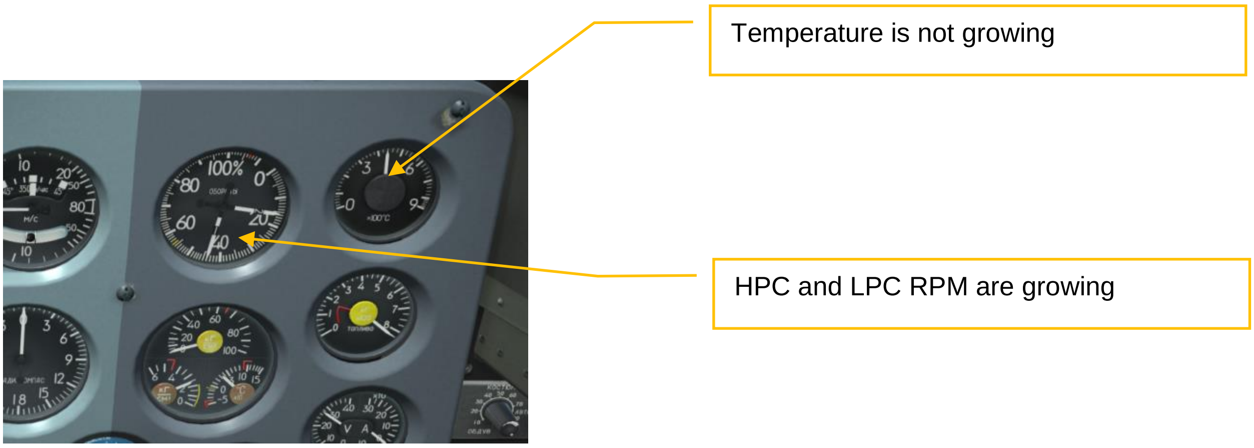
1. «ENGINE» and stopwatch

- After 3-6 seconds from the moment button was pressed move the throttle to the «IDLE» position.

2. after 3- 6 sec. set throttle to «IDLE»

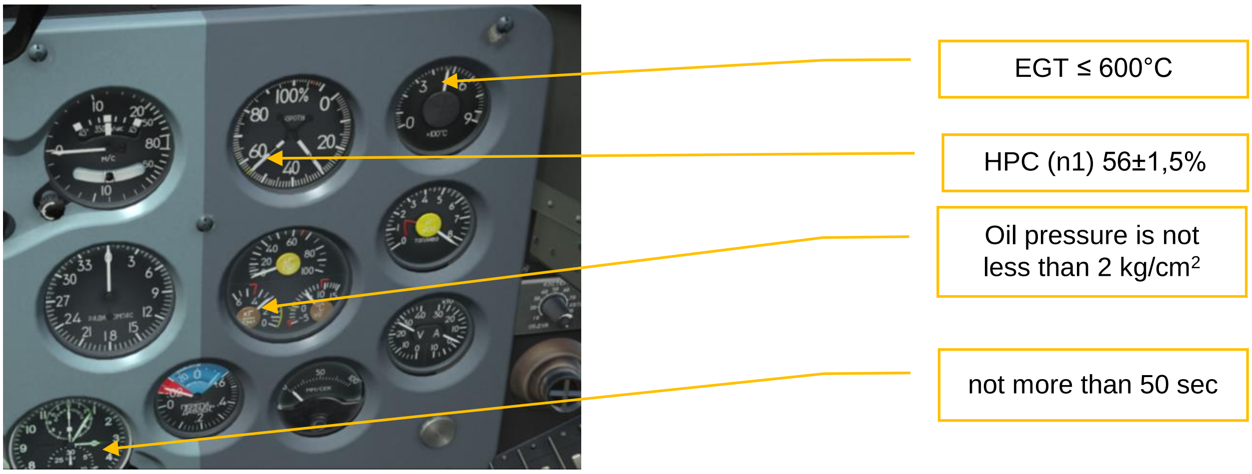
- Look at engine RPM gauge, HPC (n1) RPM should increase constantly and at 15th second, from the moment the «ENGINE» button was pressed should be not less than 20%. From this point LPC (n2) RPM starts increasing as well.

- Look at EGT gauge and as soon as temperature stop increasing, look back at engine RPM gauge, HPC and LPC RPMs should gradually increase and reach values corresponding to Idle mode.



When engine operates at «IDLE» mode, check:

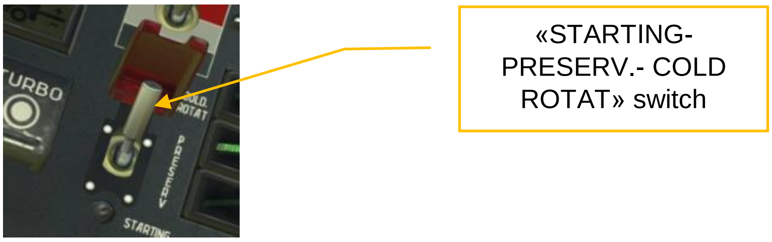
1. HPC RPM should be within 56±1,5%;
2. EGT should be not more than 600°C,
3. oil pressure is not less than 2 kg/cm^2, the «ENG MIN. OIL PRESS» is off;
4. Engine start duration should not exceed 50 seconds.



NOTE: When HPC RPM reach 41,5—44,5% within 45 seconds, the Sapphire-5 APU automatically shuts off, air starter disconnects, «TURBINE STARTER» goes off, finishing starting cycle. Engine reaches Idle mode (HPC RPM within 56±1,5%;) on its own.

NOTE: If after 45 seconds after the «ENGINE» button was pressed, HPC RPM due to some reasons do not reach 41,5—44,5%, APU automatically switches to idle mode. After unsuccessful engine start, 30 seconds after engine is completely stopped, repeat engine start procedure.

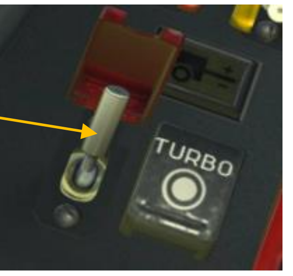
In case of unsuccessful engine start, perform cold rotation of the engine
For that set the «STARTING – PRESERV. – COLD. ROTAT» switch into «COLD. ROTAT» position. In this case, ignition is disabled and starting and working fuel is not fed to engine.



Cold rotation is used to remove accumulated fuel from the combustion chamber.
During cold rotation throttle should be kept in «STOP» position.

- press «TURBO» button for 1-2 seconds.
- when «TURBINE STARTER» signal flashes, press «ENGINE» button for 1-2 seconds.
- air starter spins up the HPC rotor within 45 seconds and automatically disables, turbine starter switches to idle mode.
- disable turbine starter by «STOP TURBO» switch;

«STOP TURBO» switch

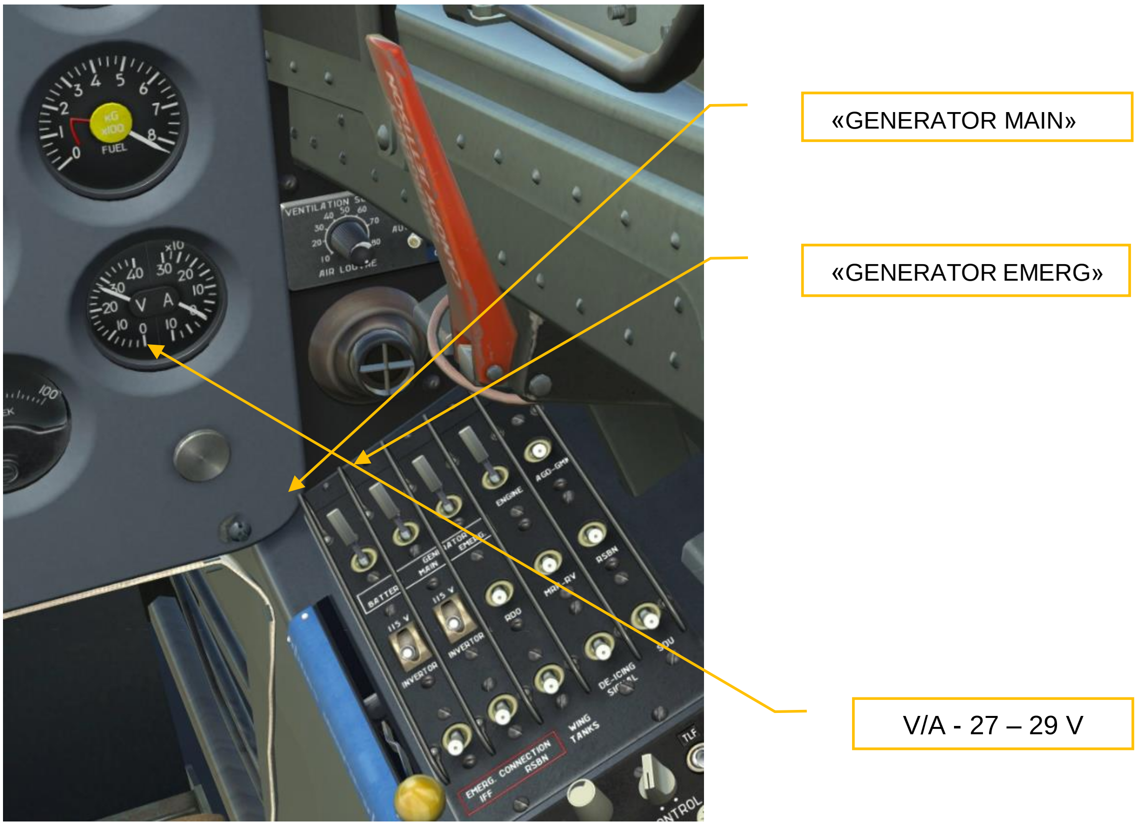


- when turbine starter is stopped return the «STOP TURBO» switch into initial position;
- set the «STARTING – PRESERV. – COLD. ROTAT» switch back into «STARTING» position;
- re-start the engine.

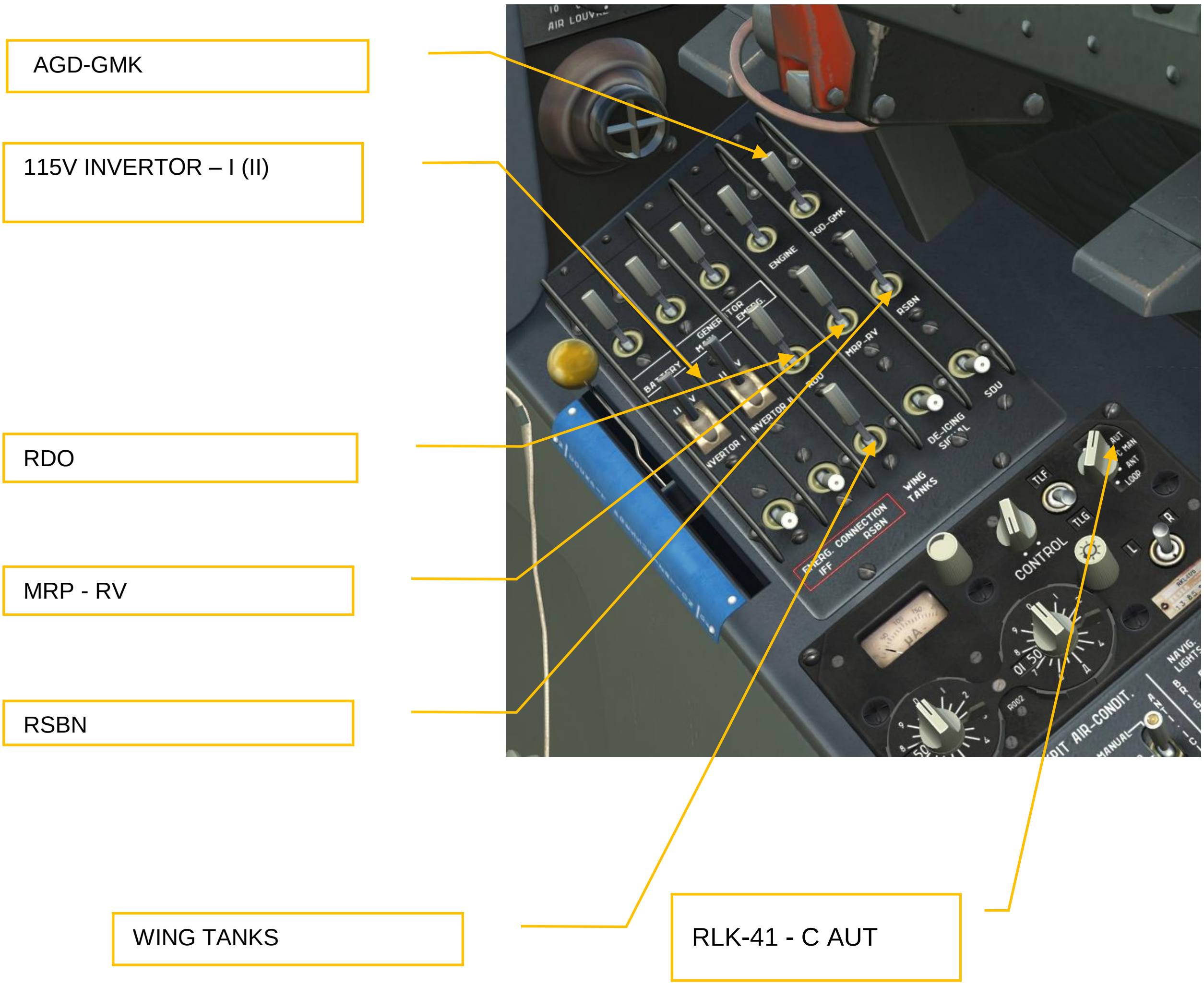
There is a possibility to do a false start, which is used for preservation and depreservation of fuel lines. During false start pilot performs the same actions as for normal start, except that «STARTING – PRESERV. – COLD. ROTAT» switch must be in «PRESERV» position. In this case ignition system is off, but all the starting units trigger in a normal (for engine start) sequence. This function is not implemented in simulator.

After engine start enable:

- **«GENERATOR MAIN».**
- **«GENERATOR EMERG»** If ground power was used for engine start, give command to disconnect ground power. The «GENERATOR» and «EMERGENCY GENERATOR» and ground power connected signals go off. Check that voltage in onboard network is within 27-29V using voltammeter.



- **«AGD-GMK»;**
- **«115V INVERTOR I», «115V INVERTOR II»;**
- **«RDO»;**
- **«MRP-RV»;**
- **«RSBN» (Iskra) ;**
- **«WING TANKS».**
- Operation mode switch on the RLK-41 control panel has to be set to **«C AUT»**. This enables backlighting of control panel and tune indicator (if panel is not backlighted, set the ADF control switch to “my cockpit” position.

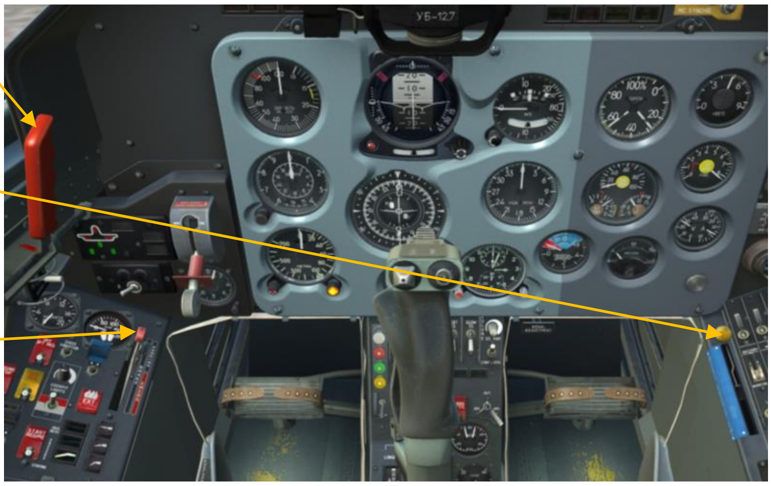

AGD-GMK
115V INVERTOR – I (II)
RDO
MRP - RV
RSBN
WING TANKS
RLK-41 - C AUT
ENGINE
AGD-GMK
RSBN
MRP-RV
RDO
SOU
DE-ICING
WING TANKS
INVERTOR I
INVERTOR II
EMERG. CONNECTION
RSBN
IFF
CONTROL
TLF
TLG
AUT
MAN
ANT
LOOP
AIR-CONDIT.
MANUAL
NAVIG. LIGHTS

- Give “Close canopy” command and when the canopy is closed, move canopy locks’ lever to the far most position, ensure that cockpit is reliably closed and the “CANOPY UNLOCKED” signal is off.
- Seal the cockpit by moving cockpit pressurization and ECS lever all the way forward, after 30 seconds «AIRCONDIT OFF» signal goes off. Check pressure difference in the cockpit, read on UVPD (0,02-0,05).
- Set emergency brake lever to the far most position (parking brake).

1. Close and lock

2. All the way forward

3. Forward



AFTER ENGINE START CHECK:
✓ *ADI shows parking roll and pitch angles, «АРРЕТИР» (Cage) lamp-button is off.*
✓ *GMK-1AE shows airplane heading. Set course select pointer to the desired landing heading.*
✓ *R-832M, SPU-9 – markings on SPU-9 and channel number on the R-832M control panel are backlighted.*
✓ *RV-5M, by altitude setting knob, set the «DANGEROUS ALTITUDE» (Dangerous altitude) index against desired tick mark, which corresponds to dangerous altitude. Press the CHECK button-lamp on radar altimeter gauge, pointer should stabilize at 15 ±1,5 m, when released, pointer should return to scale zero with ±1 m precision.*
✓ *RKL-41 – pointer shows outer NDB heading.* ✓ *RSBN-5S («Iskra-K»). Push the «RSBN AUDIO» and listen ground RSBN beacon callsign. «LANDING-NAVIGATION-GLIDE PATH» switch should be in «NAVIGATION» position. Check that navigation and landing channels are correctly set up. Push the «TESTING» button on the front cockpit right panel, gauges should show reference values of azimuth - 177±2° and distance 291,5 ±0,3 km on RMI and PPD correspondingly, lamps «DISTANCE CORRECTION» and «AZIMUTH CORRECTION» and in rear cockpit «AZIMUTH CORRECT» and «DISTANCE CORRECT» signals go on. Release the «TESTING» button. Azimuth and distance should return to their initial values, i.e. actual azimuth and distance to ground RSBN station.*

If ambient temperature is +5°C or below, before the flight in adverse meteorological conditions and night flights, enable the «PITOT TUBE HEATING MAIN and STAND-BY»,«DE-ICING SIGNAL» CB and set the «ANTI-ICING» switch into the «AUTOMATIC» position.

PREPARING FOR TAXIING AND TAXIING

- Extend flaps at 25°;
- Press braking lever, hold it pressed and release parking brake.
- Give the “Remove wheel chocks” command to the ground crew;
- Make sure that wheel chocks were removed, look to the right, to the left and make sure that other airplane is not taxiing at the same time and if there are any obstacles on the way.
- Slowly increase engine RPM so that airplane begin to move. If the front wheel was turned at the start of movement, pilot has to stop turning using brakes.
- In a straight line taxi speed should not exceed 30 km/h without external stores, and 15 km/h with external stores. Before and during turn speed should not exceed 10 km/h.

Before taking a runway pilot must look around and make sure:
- if there are any obstacles on the runway;
- if there are other planes, planning landing or performing missed approach procedure.

Ask permission to take the runway, and when permission is received take the runway and roll 10-15 meters in a straight line to align front wheel with take-off direction. Brake wheels. Check that elevator and aileron trimmers are in neutral position. Check if the RKL-41 ADF and the GMK-1AE compass show correct values (if necessary align it). Check that there are no warning signals except the «DANGEROUS ALTITUDE».
Increase engine RPM to 90% and ask ATC permission to take-off.

CIRCLE PATTERN FLIGHT

It used for practicing takeoff, turns, landing approaches and landing, as well as for visual landing approach on airfields without instrument landing system installed. Circle pattern altitude for standard landing approach is 600 meters. When landing on unknown airfield, pilot performs approach and landing using basic parameters.

Takeoff

When permission to takeoff is received, move the throttle all the way forward to the «TAKE OFF» (Takeoff) position, make sure that engine RPM reached takeoff value, release brakes and start takeoff run.
During the first phase of run airplane must be kept in a straight line with help of brakes, after 100 km/h by rudder. The stick should be in neutral position.
When speed reaches 150 km/h by smooth stick movement towards yourself lift the nose wheel to the takeoff position and keep this position until the airplane is airborne. If the wheel is lifted correctly, the horizon line will be aligned with gunsight pillow. At 190-200 km/h airplane smoothly detaches from the ground.

At height of 20 m and speed of not less than 250 km/h retract landing gear by setting the landing gear control lever in the upper position. Check if gear was retracted using L/G position indication panel (red lamps are on) and mechanical pointers (should be hidden in the wing). On circle pattern flight scheme this is the point 1. (167).

Climb

At altitude of 50-70 meters and speed of not less than 280 km/h retract flaps (point 2) 167. Check flaps retraction using corresponding signal lamp (should be on), flaps retraction button has to return to its initial position.

> *WARNING.* At IAS of 310 km/h flaps retract automatically.

After flaps retraction, at altitude of 100 m, set engine RPM to 100% (point 3) 167 and continue climbing, increasing speed to 350 km/h.

First and second turns

The first and second turns are performed together at heading opposite to the landing one.
At altitude of 300 m with bank angle of 20° at 350 km/h perform the first and second turns with climb (point 4) 167.

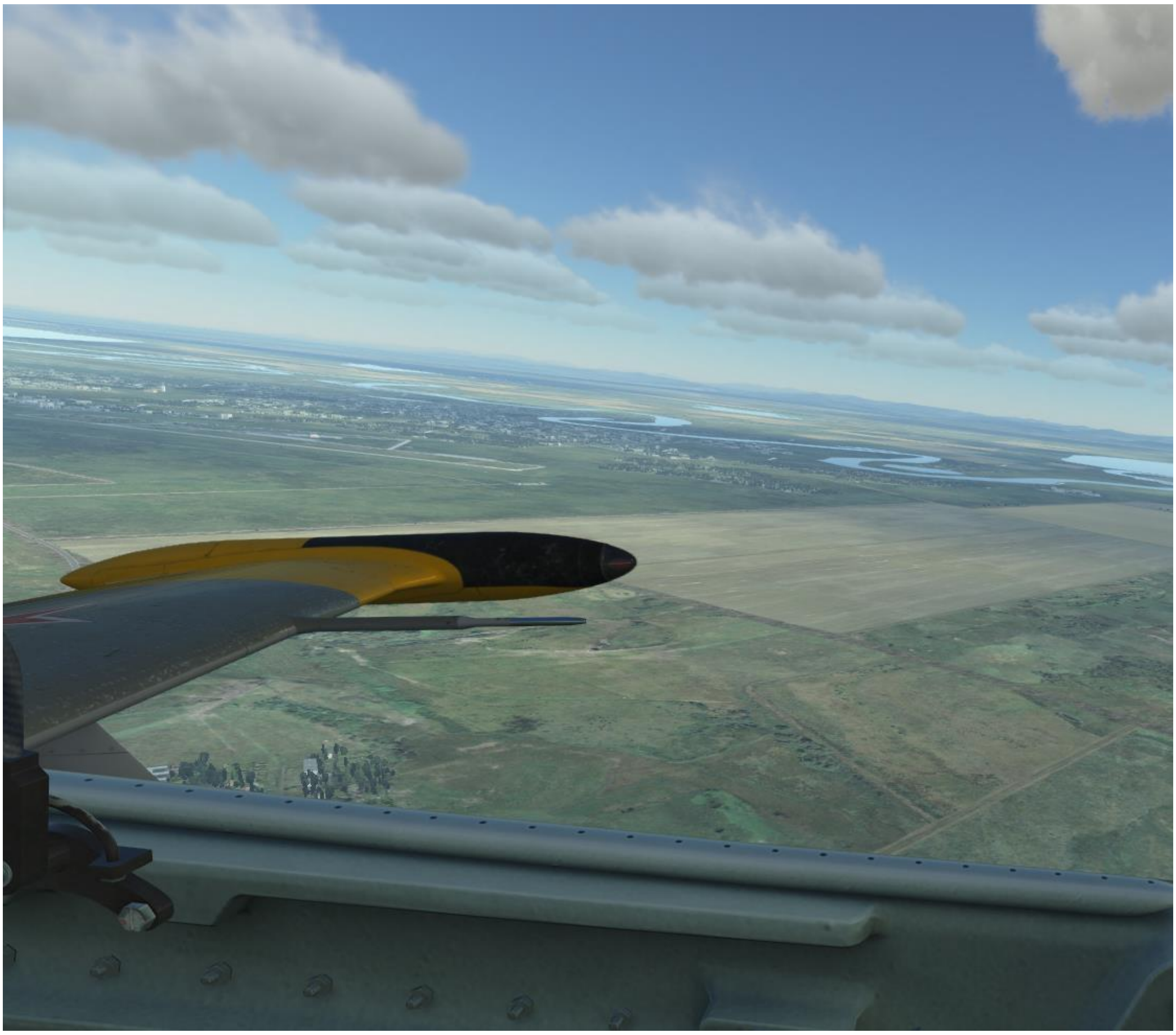
50-70 m. before required altitude (600 m) start decreasing pitch and engine RPM to 90%, thus keeping constant speed of 350 km/h, remaining part of the turn perform horizontally at speed of 350 km/h and altitude of 600 m.
Exit from the second turn should be performed at heading opposite to the landing one, taking into account slip angle.

Flight from second to third turn

Up to the moment of gear extraction fly at speed of 350 km/h, height of 600 m with heading opposite to the landing one plus (minus) slip angle (point 5) 167.

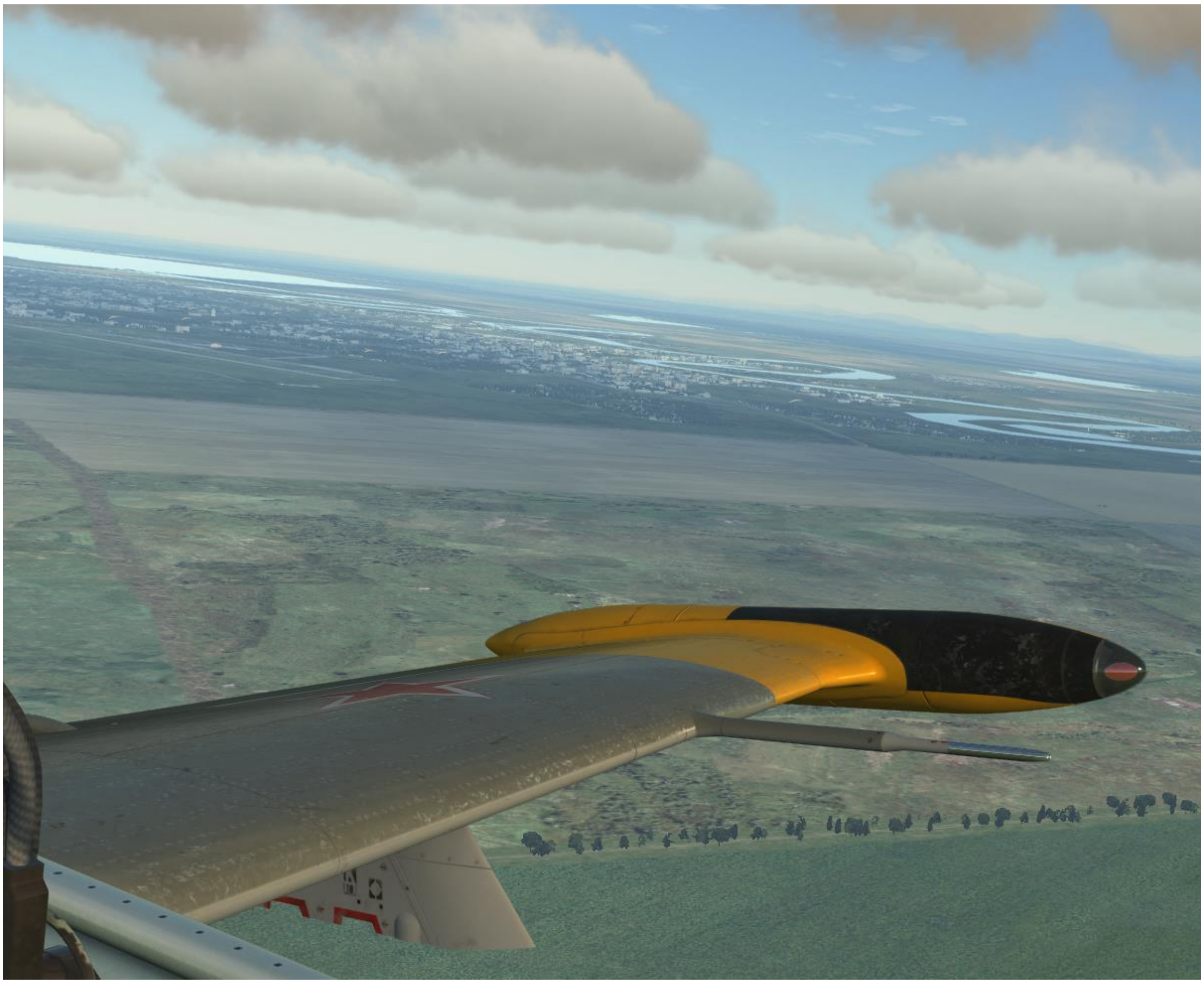
At abeam of RSBN (RSBN station bearing is 90^0 or 270^0) check lateral distance using PPD-2, should be within 5.5 – 6 km (point 6) 167.

At abeam of runway threshold, set 80% RPM and reduce speed to 330 km/h, extract gear and make sure that gear are extended completely with help of lighting and mechanical signalization. After gear were extended set speed of 300 km/h (90% RPM). (point 7) 167.



Third turn

Third turn should be started after passing abeam of outer NDB, when NBD bearing is 120° (240°). It is a 120^0 turn, performed at 300 km/h with bank angle of 30^0, before turn start set 92% RPM to keep required speed (point 8) 167.



Usually, place of the third turn is always the same and does not depend on wind speed and direction, if wind speed is less than 10 m/s. If wind speed is higher than 10 m/s, it is recommended to adjust the turn based on wind and perform the third turn earlier, taking into account airplane slip.
Perform exit from the third turn at NDB bearing of 20° (340°) towards fourth turn. Path of the airplane towards fourth turn should be 65-70° to runway centerline.

Flight from third to fourth turn

After third turn exit, reduce RPM to 85%, set speed of 280 km/h and retract flaps at 25^0, start gliding with vertical speed of 4-5 m/s (point 9) 167.
While gliding towards fourth turn, maintain direction to runway, keep speed of 280 km/h and vertical descent speed of 4-5 m/s, and monitor the altitude, estimating start of fourth turn.
Descent should be performed in such a way, that altitude before fourth turn entry was 400-420 m.

Fourth turn

Fourth turn should be started at the moment, when runway is seen at angle of 15-20^0.

Turn at speed of 280 km/h with 30^0 roll. Approach correctness during the turn should be corrected by roll adjustment (point 10) 167.

After fourth turn exit airplane should lay on the continuation of the runway centerline, at a distance of 5-5.5 km from its beginning, at an altitude of 320-330m (point 11) 167.

V=280 km/h H=320 m.

While performing fourth turn, main attention should be paid to speed maintaining, landing approach correctness and exit altitude.

If during this turn airplane descends to 300 m, increase engine RPM (up to maximum) and perform remained part of turn horizontally (without further descent).

After fourth turn exit extend flaps at 44^0 and check if they were extended correctly. When flaps are extended, increase engine RPM to 90%.

Continue descend with vertical speed of 4-5 m/s so that airplane passes outer NDB at altitude of 260 m and speed of 260 km/h (point 12) 167.

V=260 km/h H=260 m.

While gliding, ensure that runway is free, approach was carried out correctly, flaps and landing gear are extracted.

Descending after fourth turn

Perform descending into the towards runway after passing outer NDB with gradual speed reduction, so that inner NDB is passed at altitude of 60-80 m and speed of 230 km/h. (point 13) 167.

V=230 km/h H=60 m.

Outer or inner NDB overfly moment is determined by audio signal and «MARKER» signal blinking. Estimation precision should be defined by glide path direction relative to flaring point. With proper estimation airplane descends towards flaring point, located 50-70 m from the beginning of the runway.
Underfly is fixed by pulling, for that RPM should be increased so that airplane maintains speed and descends towards flaring point with constant pitch angle.
Small overfly is fixed by reducing engine RPM. If approach is performed with overfly which cannot be fixed by RPM reduction, perform missed approach procedure.

Landing

From 50 m ensure that approach estimation was correct, airplane is aligned with runway centerline and there are no obstacles on the runway.
At altitude of 30 m, check gliding speed, should be 230 km/h and move line of sight to the ground, forward in the direction of descent and to the left at 10-15°.

V=230 km/h H=30 m.

At altitude of 8-10m by smoothly pulling the stick start flaring with such a descending rate that airplane flares at altitude of 1m. At the end of flaring gradually reduce engine RPM.

During flaring, line of sight should slide over the ground, approximately 35-40 m in front of the airplane and 15—20° to the left from airplane centerline. At the end of flaring ensure that it was finished at normal altitude.

While airplane descends towards the ground by pulling the stick create landing angle so that airplanes lands on two main wheels without parachuting. Airplane lands at speed of 180 km/h

After front wheel touched the ground start braking by pressing smoothly the brake lever, pedals are in neutral position.
After landing run leave the runway, retract flaps and taxi to the parking place.

MISSED APPROACH PROCEDURE

Missed approach procedure can be performed in following cases:

- when distance to the front flying airplane is reduced;
- if there are obstacles on the runway;
- if severe mistake was made during landing approach;
- when gliding and landing are not safe.

Missed approach procedure can be performed from any altitude.

To perform missed approach procedure from altitudes higher than 50 m, pilot must:

- by not changing gliding pitch, increase engine RPM to the takeoff value by moving throttle lever all the way forward;
- not allowing speed less than 210 km/h, stop descending;
- retract gear;
- at speed of 230—250 km/h start climbing;
- at altitude of 50—70 m retract gear first at 25°, then completely, perform another landing approach.

To perform missed approach procedure from flaring altitude pilot must:

- do not move line of sight off the ground and continuing landing, increase engine RPM to the takeoff value, by moving throttle all the way forward within 2-3 seconds.
- at speed of 230—250 km/h start climbing;
- at altitude of 20 m retract gear and when 50—70 m are reached, retract gear first at 25°, then completely, perform another landing approach

WARNING: After gear was retracted sound siren triggers and signal «EXTEND UC» illuminates on the landing gear position indication panel. When flaps are retracted at 25° the siren silences and signal goes off.

CROSS WIND TAKEOFF AND LANDING

When cross wind is up to 5 m/s, takeoff and landing technique is not harder than one without wind. When cross wind is more than 5 m/s, takeoff and landing technique has some peculiarities and require special attention.

During takeoff run banking effect due to cross wind need to be compensated by deflecting the stick into the wind. As the speed increases, aileron efficiency increases as well, therefore stick should be slowly returned to neutral position. Tendency of airplane to turn into the wind should be compensated by brakes during initial phase of takeoff run and later by rudder.
After gear and flaps retraction airplane slip has to be compensated by adjusting desired heading at value equal to slip angle.
During landing gliding slip has to be compensated by adjusting desired heading at value equal to slip angle.
Flaring should be performed in a normal way, by not adjusting heading. Before touch by deflecting pedals align airplane with runway axis. After touch down, lower the nose gear, by deflecting the stick into the wind compensate banking due to cross wind and by deflecting the pedals compensate tendency of the airplane to turn into the wind.

ENGINE SHUTOFF

When arrived at parking place:

- set the throttle to idle mode;
- move the cockpit pressurization and ECS lever all the way back.
- set operating mode switch on the RKL-41 control panel set to the **«OFF»** position.
- disable all the CBs, leave only **«ENGINE»** CB, **«BATTERY»** and **«FLT RECORDER»** switches enabled.
- Set throttle to the «STOP» position.
- Open canopy locks.
- Give command “Open Canopy” to the ground crew.
- When engine RPM pointers reached scale zero, disable all remaining CBs on the main CB panel and disable the **«FLT RECORDER»** switch.

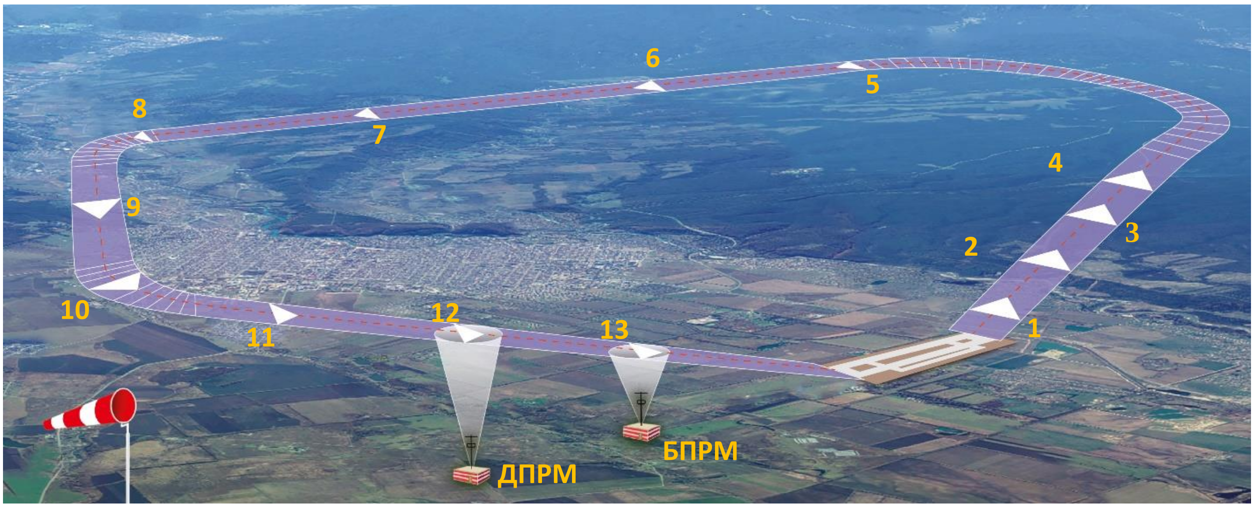


Figure. Circle pattern flight.

1. H = 20 m. V= 250 km/h. – retract landing gear.
2. H = 50 – 70 m. V = 280 km/h. – retract flaps.
3. V = 300 km/h. n_1= 100 %.
4. H = 300 m. V = 350 km/h. roll =20^0 - turn entry at downwind leg.
5. H = 600 m. V = 350 km/h. Course= $\text{Course}_{\text{downwind leg}}$ + SA.
6. H = 600 m. V = 350 km/h. abeam of the RSBN beacon. Beacon bearing = 270^0 (90^0) PPD =5,5 – 6 km.
7. Abeam of the runway threshold, n_1= 80 %. V= 300 km/h. – retract gears.
8. H = 600 m. V = 300 km/h. Beacon bearing = 240^0 (120^0), roll =30^0 – third turn entry.
9. n_1= 85 %. V = 280 km/h. retract flaps at 25^0, beginning of glide with Vy = 4 – 5 m/s.
10. H = 420 – 400 m. V = 280 km/h. Roll =30^0 - fourth turn entry.
11. H = 330 – 320 m. – fourth turn exit, retract flaps at 44^0.
12. H = 260 m. V = 260 km/h. – fly over outer NDB.
13. H= 60 – 80 m. V = 230 km/h. – fly over inner NDB.

AEROBATICS
GENERAL INFORMATION

At all altitudes minimum allowed speed is 200 km/h, at this speed airplane is sufficiently stable and controllable.

If negative or near-zero Gs are created during flight the following signals «DON'T START», «150 KG FUEL», «ENG. MIN. OIL PRESS» can go on and fuel meter can show false value. In these cases flight can be continued.

Inverted flight is allowed for not more than 20 seconds, oil pressure can drop below 2 kg/cm^2.

Consecutive inverted flight can be performed after not less than 20 seconds horizontal flight (this time is needed to refill fuel accumulator) and only after oil pressure in engine was restored to normal value, which is 3 kg/cm^2 at 95% HPC RPM and not less than 2kg/cm^2 for other operating modes.
To prevent airplane stalling during aerobatics pilot must maintain G-factor which for altitude of 4000 m are:

IAS. km/h	n_y	IAS. km/h	n_y
200	1,25	400, 500	4,0 5,0
300	2,5	600	6,0

If shaking appears, pilot must immediately push the stick forward until shaking is finished, at the same time paying special attention to engine gauges (EGT and engine RPM).

During aerobatics pilot has to avoid flying with IAS less than 200 km/h. This especially important during performing of vertical aerobatics figures. In case of speed less than 200 km/h avoid over pulling the control stick, use coordinated movements.
To accelerate entry into aerobatic figures acceleration and braking of airplane should be performed not in horizontal level flight, but with descend or climb correspondingly. For intensive braking use airbrakes.
To accelerate faster for the next ascending aerobatic figure pilot must keep engine RPM of not less than 90% on descending part of previous figure (second half-loop of inside loop, etc).
Start increasing engine RPM at dive angle of 80 — 70° so that next aerobatic figure entry would started from horizontal level flight, when reached required speed with engine RPM from nominal to takeoff value.
Vertical aerobatic figures (loop, half-loop) are not allowed at altitudes higher than 6000 m, because required entry speed exceeds Mach limitation.
To check correctness of aerobatic figures (especially during bad visibility of natural horizon) rely on ADI, which together with T/S indicator allows:

- precisely controlling required bank and pitch angles (dive and climb) and monitoring them during aerobatic figures performing;
- controlling coordination between the control stick and pedals during figure entry, performing and exit;
- determining airplane position relative to natural horizon.

CLIMB AND FLIGHT TO AEROBATICS AREA (MISSION AREA)

After takeoff, gear and flaps retraction, set the nominal engine mode and with gradual climb accelerate the airplane to speed of 400 km/h.
After reaching desired altitude, balance the airplane for horizontal flight at speed of 400 km/h and follow your mission.

TYPICAL PARAMETERS FOR AEROBATIC FIGURES.

This section provides typical parameters for aerobatic maneuvers at low, medium altitudes.

TURN WITH 45° ROLL ANGLE

Turn with up to 45° roll angle should be performed at speed of 400 km/h, n_1=95-100%, $n_{y=}$ 1,4.

TURN WITH 60° ROLL ANGLE

Turn with up to 60° roll angle should be performed at speed of 400 km/h, engine is working on nominal RPM, $n_{y=}$ 2.

SNAP ROLL

Snap roll is performed at speed of not less than 400 km/h, engine is working on nominal RPM. Before snap roll entry, set speed of 400 km/h. Create pitch of 10-15^0 and "freeze" the airplane in this position by small deflection of the stick towards neutral position, by slowly deflecting the control stick to the side rotate airplane evenly around the longitudinal axis.

30-40^0 before airplane reaches the horizontal level position start deflecting the stick back to neutral position, simultaneously estimating the decrease rate of the angular velocity. When roll angle is close to zero by short double-motion of the stick against rotation, stop the roll. While performing the snap roll one has to pay attention to evenness of rotation and exit start moment. There is no difference in performing between the left snap roll and the right one.

Diving with Q 30^0 – 60^0.

Dive entry should be performed at speed of 300 km/h, engine RPM of 90% with roll angle of 60-90^0. By coordinated stick movement initiate turn with roll angle of 60-120^0. This angle depends on dive angle. For dive with Q=30^0 entry roll angle is 60 – 80^0. If Q>30^0 entry roll angle is 120^0. By the moment when turn is finished, dive angle should be required one. Dive angle can be read on ADI.
When speed of 400 km/h is reached, increase engine RPM to takeoff value.
When desired speed (altitude) is reached, by slowly pulling the stick start exit from the dive with constant G-factor.
Exit should be finished at speed of 650 km/h.

IMPORTANT: When maneuvering is performed at low altitudes pilot has to take into consideration altitude loss while exiting from the figure. Exit should be started at an ALTITUDE which allows safe exit to the horizontal level flight for current landscape. If exit started based on desired altitude, speed after figure exit can be little bit lower (comparing to exit based on speed).

Table. Speeds of exit start and altitude loss for various dive angles and G-factors at exit.

Q=30^0	Q=45^0	Q=60^0
Vexit = 600 km/h, Ny =3 -3,5 units.	Vexit. = 580 km/h, Ny =3-3,5 units.	Vexit. = 500 km/h. Ny =3-3,5 units.
Altitude loss at exit is 300 m.	Altitude loss at exit is 400 m.	Altitude loss at exit is 500 m.
Vexit = 600 km/h, Ny =5 units.	Vexit. = 580 km/h, Ny =5 units.	Vexit. = 500 km/h. Ny =5 units.
Altitude loss at exit is 150 m.	Altitude loss at exit is 200 m.	Altitude loss at exit is 250 m.

Example: *Dive with Q=60^0, exit should be finished at altitude of 100 m.*
Exit start altitude with Ny = 3 -3,5 units is 600 m.
Exit start altitude with Ny = 5 units is 350 m.

Climb with Q 30^0 – 60^0.

The climb should be performed at speed of 650 km/h and takeoff engine RPM.
By slowly pulling the stick with G-factor of 3, create required pitch angle and fix it by deflecting the stick little bit backward.
When required speed is reached exit the climb, simultaneously reducing engine RPM to 90%. Depending on the climb angle exit can be performed by turn or by two consecutive half-rolls.
Exit with turn. When required speed is reached, create required roll angle and start turn, simultaneously lowering the nose to the horizon line, so that at pitch angle of 10^0, speed is not less than 300 km/h. Remove roll and set engine RPM to 90%.
Exit with two consecutive half-rolls. When desired speed is reached, initiate rotation around longitudinal axis with such a rate that airplane is in “wheels up” position within 2-3 seconds (perform half-roll). As soon as airplane is in “wheels up” position stop rotation and by slowly pulling the stick lower the nose towards the natural horizon line, so that at pitch angle of 10^0 speed is not less than 300 km/h, fix this pitch angle with subtle stick movement, perform second half-roll and set engine RPM to 90%.

Important: Speed of exit start depends on climb angle. The bigger the angle the earlier exit should be started.
Exit from the climb should be finished at speed of 300 km/h, and engine RPM of 90%.

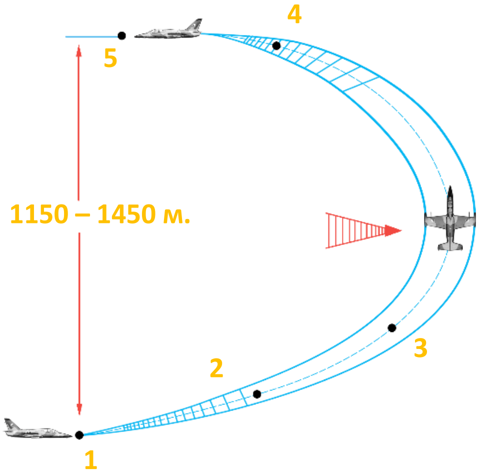
Table. Speed of exit start and the way of exit depending on climb angle.

Q=30^0	Q=45^0	Q=60^0
Vexit.=350 km/h	Vexit.=400 km/h	Vexit=450 km/h
Roll at exit start 60^0-80^0	Roll at exit start 120^0	Exit start with two consecutive half-rolls.

Combat turn.

Combat turn should be performed at engine modes not less than nominal at altitudes up to 5000 m. Combat turn should start at speed of not less than 600 km/h.
Airplane can gain about 1150 -1450 m by performing combat turn with initial speed of 600 km/h (combat turn starts at 2000 m) and takeoff engine RPM. Altitude gained at nominal mode will be 150-300m less.
By slowly pulling the control stick start climbing. When pitch angle of 10-15^0 is reached create roll angle of 10-15^0 and by coordinated movements start climbing and turning at the same time with G-factor of 3-3.5 units.
During combat turn gradually increase pitch and roll angle so that after 90^0-turn roll angle was not more than 60^0 and pitch angle - 30^0.

When speed of 350 km/h is reached, start decreasing pitch angle and lowering the airplane nose to the horizon so that at pitch angle of 10^0, speed is not less than 300 km/h. Remove any roll and set engine RPM to 90%.



1. Combat turn entry- speed is not less than 600 km/h. throttle is in the «НОМ» (Nominal) position;
2. ADI – roll - 15^0, pitch - 15^0, G-factor - 2,5 – 3 unit;
3. ADI – roll- 60^0, pitch - 30^0, speed 500 – 450 km/h, G-factor 2,5 – 3 units;
4. Speed 350 km/h. – beginning of combat turn exit;
5. Exit finished– speed - 300 km/h, engine RPM - 90%.

Split-S (descending half-loop).

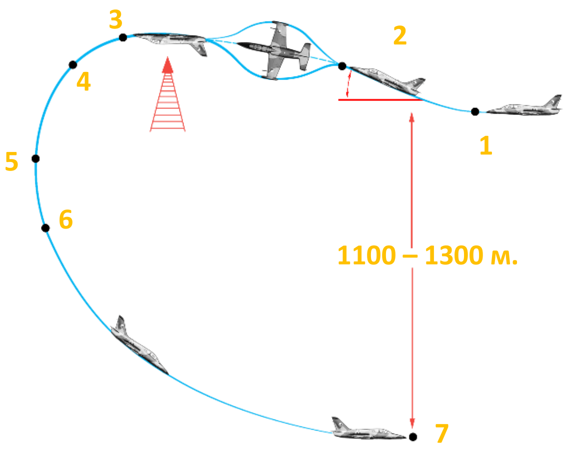
Split-S entry should be performed at speed of 300-400 km/h up to 5000m and 300km/h higher than 5000m. Altitude loss after Split-S is about 1100—1300 m from altitude of 4000—5000m and 1500—1700 m from 6000—8000.
Let us consider performing of the Split-S at speed of 300 km/h.
In horizontal flight set speed of 300 km/h, engine RPM – 90%. By slowly pulling the stick create pitch angle of 15º-20^0 and fix it by subtle stick movement to the central position.
After that by coordinated stick movement rotate airplane around the longitudinal axis so that it reaches “wheels up” position within 2-3 seconds (perform half snap-roll).
As soon as airplane is in “wheels up” position by smooth stick movements stop rotation and by pulling the stick smoothly start diving.
At dive angle of 80 - 70^0 speed should be V=450 km/h, increase engine RPM to the takeoff value and by slowly pulling the stick with G-factor of 3-3.5 units return airplane to the horizontal flight.

Table. Speed and ADI pitch angle pairs during split-S exit.

Θ =80 - 70^0	V= 450 km/h
Θ =60^0	V= 500 km/h
Θ =50^0	V= 550 km/h
Θ =40^0	V= 590 km/h
Θ =30^0	V= 600 km/h

Finish exit at speed of 650 km/h.

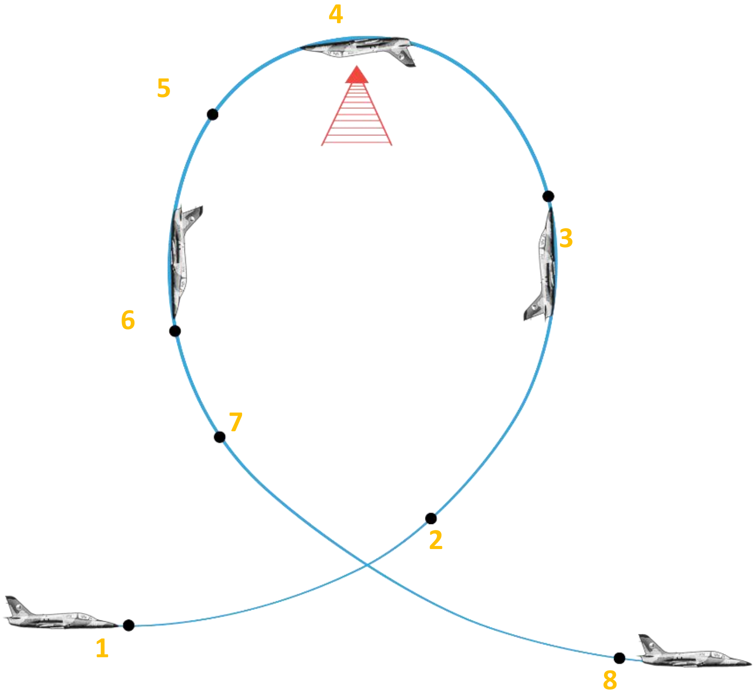
When exiting from the dive do not over pull the stick, because in this case airplane starts shaking, followed by airplane stall. In case of airplane shaking pilot has to push the stick until shaking stops and slowly exit from the dive.



1. Split-S entry – speed - 300 km/h, engine RPM - 90%;
2. ADI – make pitch angle of 15º-20^0 and do the half-roll;
3. «Wheels up» position, transition into a dive, G-factor 3 units;
4. Angular rotation relative to the ground, absence of roll;
5. ADI – dive angle - 90^0 , airplane symbol rotates at 180^0, speed is 400-420 km/h, G-factor 3 – 3.5 units;
6. ADI- dive angle 80 - 70^0, speed - 450 km/h, G-factor - 3 – 3,5 units, increase engine RPM to the takeoff value;
7. Split-S exit. Speed is 650 km/h.

Inside loop.

Inside loop entry is performed at entry speed of 650 km/h with engine operating at takeoff RPM. By slowly pulling the stick start climbing.
At pitch angle of 25-30^0 pull the control stick faster so that when pitch angle of 50-60^0 is reached, G-factor is 4-5 units. From this point pull the stick so that airplane angular velocity is maintained constant, and speed at the highest loop point (airplane is “wheels up”) is not less than 200 km/h. In the upper point of the loop, check aircraft position and when the upper part of the instrument panel aligns with the horizon line, slowly reduce engine RPM to 90% and by slowly pulling the stick, start diving. The descending part of the loop is similar to split-S (descending half-loop). Gained altitude in the upper point of the loop is 1200-1400 m.

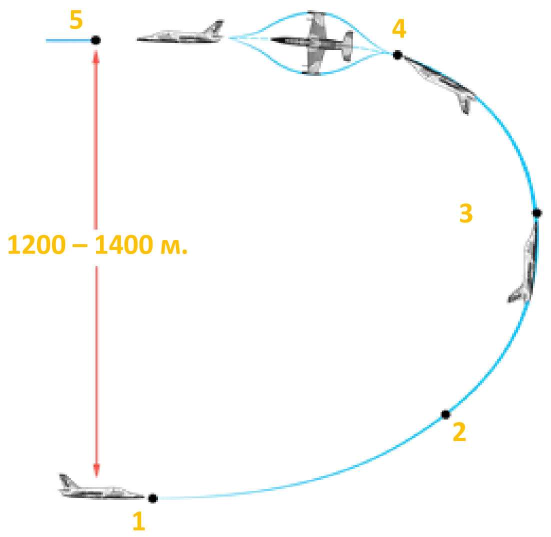


1. Loop entry – speed is 650 km/h, throttle is in the «TAKE OFF» position;
2. ADI – pitch angle is 50 – 60^0, G-factor 4,5 – 5 units;
3. ADI – climb angle is 90^0, airplane symbol rotates at 180^0, speed is 400 km/h, G-factor 3,5 – 4 units;
4. Airplane in the «wheels up» position – check if speed is not less than 200 km/h, set engine RPM to 90%, G-factor - 1,2 units;
5. Angular rotation relative to the ground, absence of roll;
6. ADI – dive angle - 90^0 , airplane symbol rotates at 180^0, speed is 380-400 km/h, G-factor 3 – 3.5 units;
7. ADI- dive angle 80 - 70^0, speed - 450 km/h, G-factor - 3 – 3,5 units, increase engine RPM to the takeoff value;
8. Loop exit. Speed is 650 km/h.

Immelmann turn.

Immelmann must be started at speed of 650 km/h with engine working at takeoff mode. By slowly pulling the stick start climbing.
At pitch of 25-30^0 start pulling the stick faster with such a speed that at 50-60^0 G-factor equal to 4.5-5 units. After that stick should be pulled in such a way that angular speed remained approximately constant and speed in the upper point of Immelmann (wheels up position) was not less than 200 km/h.

Near the upper point, when airplane nose is still higher than horizon for 10^0, be deflecting the stick, rotate the airplane around the longitudinal axis at 180^0 (do the half-roll). Deflect stick in such a way that half-roll is performed for about 2-3 seconds, reduce engine RPM to 90%.
If speed of the airplane in the upper point is less than 200 km/h, do not reduce engine RPM and do not over pull the stick, slowly lower the airplane nose below the horizon line, reach speed of 200-210 km/h, do the half-roll and set engine RPM to 90%.



1. Immelmann entry – speed 650 km/h, throttle is in the «TAKE OFF» (maximum position);
2. ADI – pitch angle is 50 – 60^0, G-factor 4,5 – 5 units;
3. ADI – climb angle is 90^0, airplane symbol rotates at 180^0, speed is 400 km/h, G-factor 3,5 – 4 units;
4. Half-roll, speed is 210 – 220 km/h;
5. Immelmann exit – speed is not less than 200 km/h, reduce engine RPM to 90%.

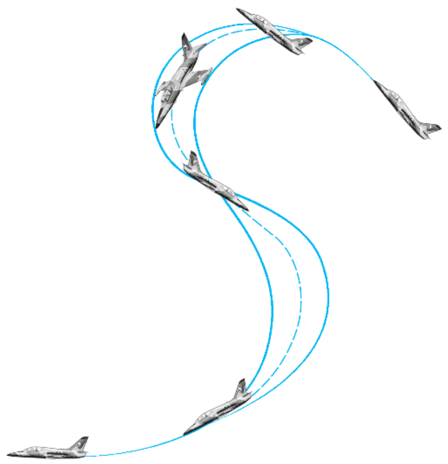
BEHAVIOUR OF THE AIRPLANE AT MINIMUM SPEEDS

Minimum IAS (stall speed with G-factor equal to 1) with retracted flaps and gears, while engine is operating at idle mode is equal to 180 km/h, with retracted flaps and gear 25^0 (44^0) – 160 (155) km/h.
With increase of the G-factor stall occurs earlier, i.e. at higher speeds.
When airplane reaches a speed which is 5-10 km/h higher than minimum one, warning shaking of the airplane and stick twitching (from ailerons) occur.
Following speed reduction is accompanied by shaking increase and appearing of roll fluctuations.
When speed of 160-165 km/h reached and stick is pulled all the way back, airplane normally lowers nose and enters parachuting mode with gradual speed increase to 200-220 km/h.
Stall of the wing occurs less often with smooth stalling to the right in the most occasions. In these cases pushing the stick behind neutral position (ailerons in neutral position) increases the speed and airplane return in controllable flight. Ailerons are efficient up to the stall moment.

Pedals deflection during stalling can lead to a spin, which can have the same with pushed pedal direction of spinning or opposite one.

SPIN

The L-39C airplane can unintentionally stall into a spin only due to rough errors in piloting technique, related to excessive longitudinal stick deflections with non-coordinated pedals deflections for more than half way from their neutral position.
Altitude loss for 1 spinning turn is equal to 300- 400 m, time of one complete turn is 6-7 seconds. Total altitude loss from the moment airplane entered a spin to the returning into horizontal flight is about 500-650 m. Total altitude loss for 2 and 3 spin turns is correspondingly 1050-1200 and 1400-1700 m.



NORMAL SPIN

To intentionally enter a spin pilot has to follow this sequence:

Set speed of 300 km/h during horizontal level flight at altitude of 4000 m:

- move throttle to the «IDLE» position and ensure that engine actually operates at idle mode;
- climb with 20° pitch and reduce speed to 170 km/h;
- deflect a pedal completely towards spin direction and pull the stick all the way back, keep pedals and stick in these positions during spinning. When entering a spin ailerons have to be in neutral position.

Exit from a spin:

- deflect opposite to a spin pedal completely, and after that return stick to the neutral position or little bit further than neutral position;
- when spinning is stopped, return pedals in neutral position and when speed reached 400 km/h, increase engine RPM to the takeoff value and exit from the dive with G-factor of 2.5 -3G.

Exit from an unintentionally entered spin should be performed in the following sequence:

- estimate altitude;
- identify the direction of spinning (ground surface moves from the right or from the left);
- set throttle to the «IDLE» mode;
- set controls as if you wanted to enter spin intentionally, i.e. deflect pedal in the direction of spinning and stick all the way back (ailerons in neutral positions);
- deflect opposite to a spin pedal completely, and after that return the stick to the neutral position or little bit further than neutral position;
- when spinning is stopped, return pedals in neutral position and when speed reached 400 km/h, increase engine RPM to the takeoff value and exit from the dive with G-factor of 2.5 -3G.

WARNING: If airplane does not exit a spin before 1500 m of altitude – pilots must eject!

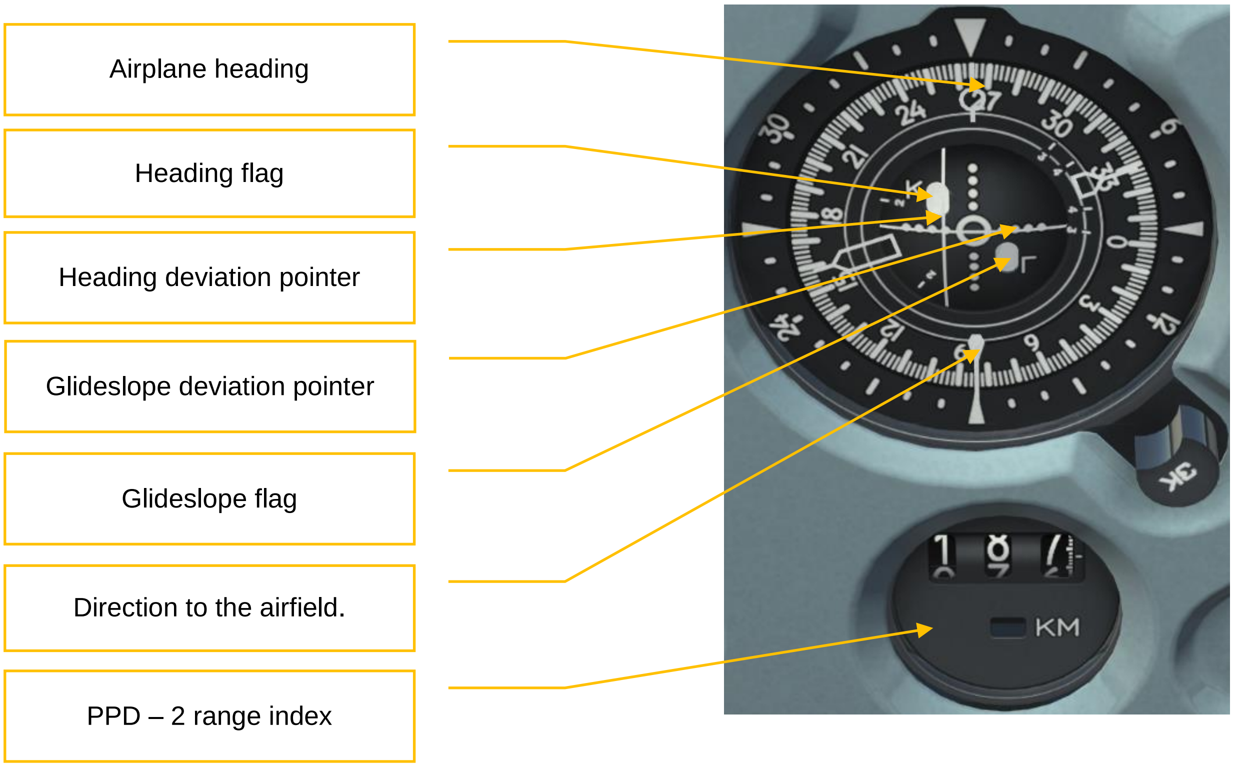
USE OF RSBN-5S («ISKRA-K») EQUIPMENT FOR FLIGHT AND NAVIGATION

Before flying with help of RSBN-5S («Iskra-K») equipment the navigation and landing channel numbers have to be set from the front cockpit.

«NAVIG» (NAVIGATION) MODE

The «НАВИГАЦИЯ» (Navigation) mode is a primary RSBN-5S («Iskra-K») mode.
Heading of the airplane is read on RMI's internal scale against pointer with circle. Distance is read on PPD-2 gauge. Using heading and distance at any time of the flight, the airplane position relative to the airfield, navigation channel of which is selected, can be determined.
To quickly determine the bearing of the airport the sharp end of the RMI pointer is used. This pointer as well as the RKL-41 pointer, shows direction of flight to the airfield.

Figure. RMI.



In the «NAVIG» mode, flight with required azimuth can be performed.

To flight from RSBN beacon:

- using course knob set heading equal to required azimuth;
- while flying from the beacon the distance on PPD-2 is increasing.

To flight towards RSBN beacon:

- using course knob set heading opposite (180^0) to required azimuth ;
- while flying towards beacon the distance on PPD-2 is decreasing.

To flight with required azimuth (required path) pilot must keep heading deviation pointer within central circle on RMI.

INITIAL APPROACH AND LANDING APPROACH USING RSBN-5S («ISKRA-K») EQUIPMENT

In the L-39C simulator the following airfields Krasnodar-Central, Maykop, Krymsk and Mozdok have RBSN beacons together with instrumental landing system equipment (russian: PRMG), consisting of course beacons and glideslope beacons. Instrumental landing system on the Krasnodar-Central airfield is installed only on landing course of 86^0 and in Maykop on landing course of 50^0.
Krymsk and Mozdok airfield have PRMG equipment for landing from both directions.
Pilots must know position of a RSBN beacon and take it into account while approaching airfield and performing landing approach. One must remember that landing course depends on window direction set in the mission editor.
To ease navigation during airfield approaching and landing approach the airfield area can be represented in the form of two imaginary sectors.

Sector «A» when approaching with landing course, or with courses that differ from landing one for not more than ± 15^0.
Sector «B» when approaching from other directions.

When mission is completed is necessary to:

- turn the airplane towards RSBN beacon;
- find out in which sector is the airplane relative to the landing airfield (as help for airplane position determination, use F10 button);
- flight to the airfield.

If decision to land on an airfield other than departure airfield was taken, pilot must:

- set new landing heading using course knob;
- on the RSBN control panel set new navigation and landing channels;
- make sure that RMI and PPD-2 indicate heading and distance relative to selected airfield and lamps «AZIMUTH/DISTANCE CORRECTION» and signals «AZIMUTH CORRECT» and «DISTANCE CORRECT» are on;
- set outer and inner NDB (arrival airfield) frequencies, RKL-41 pointer should show bearing to outer NDB.
- turn towards RSBN beacon;
- find out in which sector is the airplane relative to arrival airfield;
- approach airfield.

1. The airplane is in «A» sector:

If the airplane flies at altitude of 5000 -8000 m and distance of 50-132 km, it is advisable to use the «GLIDE PATH» mode. If distance is 12 – 30 km, and altitude is 600 – 1500 m, use the «LANDING» mode.

*The **«GLIDE PATH»** mode is used to assist navigation towards arrival airfield with descent to safe altitude, equal to 600 m, at any required RSBN **bearing** or at **landing course**.*
Descending mode is determined by cloud penetration trajectory lying in vertical surface at angle of 4—5° relative to horizon. Glide path trajectory is within 132-21 km.
At distances higher than 132 ±5 km, glideslope deviation pointer shows airplane position relative to cruise altitude, which is equal to 8000 m.
At distances from 132±5 to 21 ±3 km. glideslope deviation pointer shows airplane position relative to cloud penetration trajectory.

At distances of less than 21 ±3 km glideslope deviation pointer shows position of the airplane relative to safe altitude, equal to 600 m.

When distance of 21±3 km is reached, then in front and rear cockpits, the «END OF DESCENT» signal will be on and glideslope deviation pointer show airplane position relative to altitude of 600 m. To follow glideslope descent trajectory engage the "LANDING" mode.

For flying in glide path mode is necessary:

- check is course pointer is set to landing course;
- «LANDING- NAVIG- GLIDE PATH» mode selector switch set to «GLIDE PATH»;
- course deviation pointer on RMI and ADI bank steering pointer show airplane position relative to RSBN beacon;
- glideslope deviation pointer on RMI and pitch steering pointer on ADI show airplane position relative to glide path trajectory.
- PPD-2 indicates distance to RSBN beacon.

NOTE: Glideslope and course deviation pointers on RMI and pitch and bank steering pointers on ADI duplicate each other. To ease piloting it is advisable to concentrate attention on RMI pointers only. It is also necessary to monitor speed and altitude. Speed at glide path trajectory should be within 400 -500 km/h.

- perform horizontal and vertical maneuvers to align course and glideslope deviation pointers with central circle.
- circle in the center of RMI gauge symbolize the airplane. To follow the cloud penetration trajectory glideslope and course deviation pointers must be kept within this circle;
- when airplane is below cloud penetration trajectory, vertical maneuver can be omitted, because in horizontal level flight the airplane gradually approach penetration trajectory and glideslope deviation pointer moves from the uppermost position on RMI towards central circle.
- when distance of 21±3 km is reached, then in front and rear cockpits, the «END OF DESCENT» (Cloud penetration is finished) signal will be on and glideslope deviation pointer show airplane position relative to altitude of 600 m, set speed of 350 km/h
- to follow radio glideslope set the «LANDING- NAVIG- GLIDE PATH» mode selector switch in «LANDING» position.

Important: For correct use of the «LANDING» course pointer on RMI should be set to landing course of the arrival airfield.

"LANDING" mode engaging:

- glideslope deviation pointer moves up;
- glideslope and course warning flags are off;
- PPD-2 indicates distance to glideslope radio beacon.

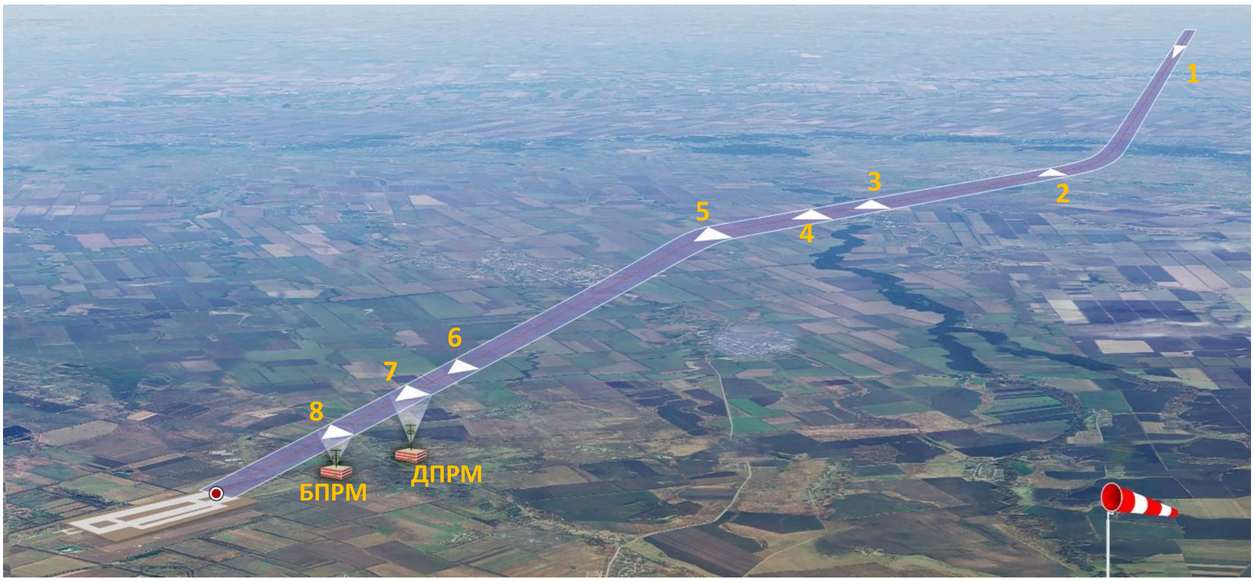
Final approach descending:

- continue horizontal level flight at altitude of 600 m.
- turn the airplane towards heading deviation pointer on RMI;
- D=15 km, reduce engine RPM to 80%, set speed of 330 km/h, retract landing gear.
- keep reducing speed to 280 km/h and extend flaps at 25^0;
- increase engine RPM to 90% and maintain speed of 280 km/h and altitude of 600 m;
- while approaching radio glideslope (D=12 km) glideslope deviation pointer will be moving towards central circle on RMI;

- D=12 km, altitude – 600 m, radio glideslope descent start, keep glideslope and course deviation pointers within RMI's central circle, maintain speed of 280 km/h, Vy – 3 – 4 m/s;

- D= 6 km, corresponds to altitude of 300 m, extend gears at 44^0, maintain speed of 260 km/h;
- keep descending following the radio glideslope by keeping glideslope and course deviation pointers within RMI's central circle, maintain speed of 260 km/h;
- fly over outer NDB, speed – 260 km/h, altitude – 200 m, overfly of outer NDB moment is marked by audio signal and «MARKER» signal lamp blinking;
- after passing outer NDB control speed reduction so that over inner NDB speed was not less than 230 km/h;
- fly over inner NDB at H=80-60 m and speed of 230 km/h, overfly of inner NDB moment is marked by audio signal and «MARKER» signal lamp blinking;
- after passing inner NDB establish visual contact with the runway, estimate airplane position relative to the runway and land.

Figure. Landing pattern using «GLIDE PATH» and “LANDING” modes.



1. Descent in cloud penetration mode;
2. Altitude - 600 m. D= 21±3 km. end of «GLIDE PATH» mode;
3. Altitude - 600 m. D = 15 km. speed - 330 km/h – retract landing gear;
4. Speed - 280 km/h – extend flaps at 25^0.
5. Altitude - 600 m. D = 12 km. Radio glideslope entry point.
6. Altitude - 300 m. D = 6 km. speed - 280 km/h – extend flaps at 44^0.
7. Fly over outer NDB, speed - 260 km/h, altitude - 200 m.
8. Fly over inner NDB, speed - 230 km/h, altitude - 60 – 80 m.

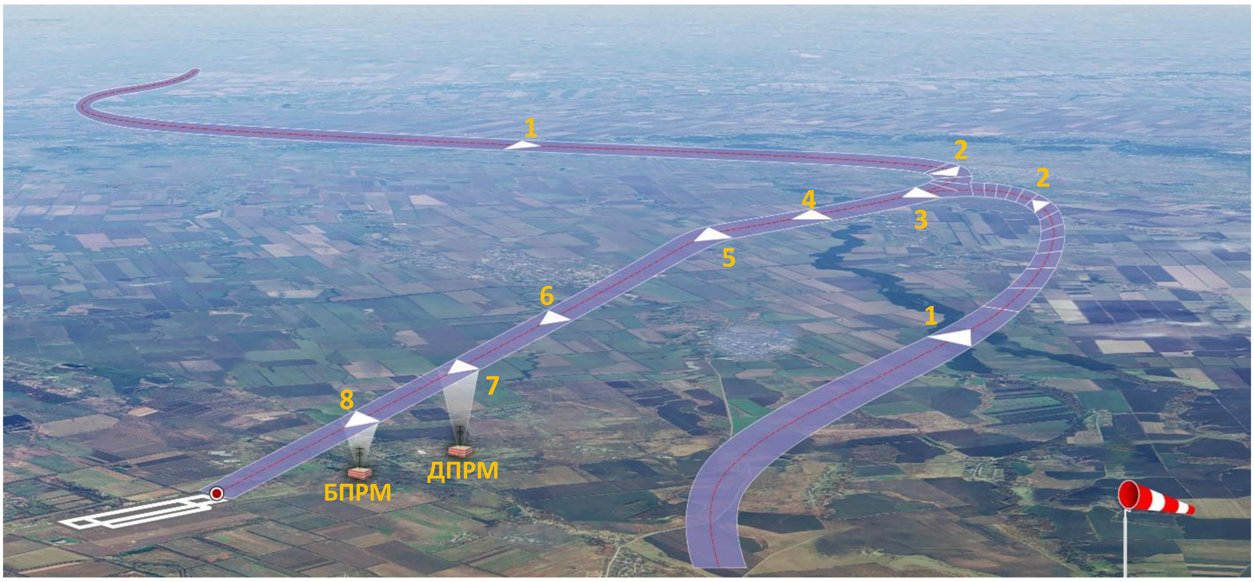
The L-39C airplane is equipped with the SDU system, which significantly ease landing approach. When course beacon signal is captured, enable the «SDU» CB and «SDU» switch. «T» и «K» warning flags will be off on ADI.

The following flight perform following the steering pointers (bank and pitch) on the ADI. If the pointers are kept in the center the airplane descends following requires glideslope. Distance to glideslope beacon is indicated on PPD-2.

2. The airplane is in the «B» sector:

If after performing task you flew far away, it is necessary to perform final leg entry at distance of 15-21 km, according to PPD-2 (as a help for determining heading map can be used (key F10)). When approaching final leg entry set the altitude of 600 m, speed of 350 km/h and perform final leg turn. Before final turn engage the «LANDING» mode. Final approach descending is described above.

Figure. Scheme of airfield approaching and landing approach using "LANDING" mode.



1. Initial approach;
2. Base turn, engaging «LANDING» mode;
3. Altitude - 600 m. D = 15 km. speed - 330 km/h – retract landing gear;
4. Speed - 280 km/h – extend flaps at 25^0.
5. Altitude - 600 m. D = 12 km. Radio glideslope entry point.
6. Altitude - 300 m. D = 6 km. speed - 280 km/h – extend flaps at 44^0.
7. Fly over outer NDB, speed - 260 km/h, altitude - 200 m.
8. Fly over inner NDB, speed - 230 km/h, altitude - 60 – 80 m.

APPROACHING AIRFIELD USING RKL-41

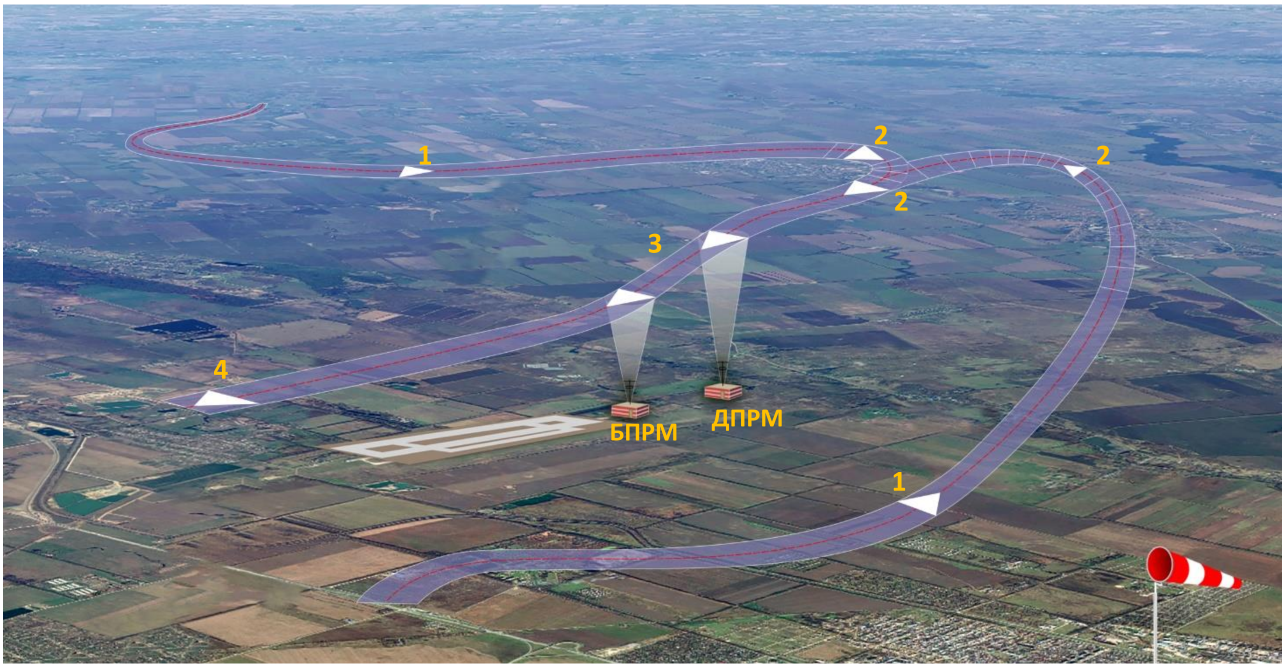
If the airfield is not equipped with RSBN and PRMG, then RKL-41 should be used for approaching.

- using course knob on RMI set the landing course;
- set outer and inner NBD frequencies;
- ensure that RKL-41 pointer points towards the outer NDB.
- using together RMI, RKL-41, map (F10) determine position of the airplane relative to airfield, turn the airplane towards the airfield;
- for early runway detection it is advisable fly at altitudes of 1000-2000m;
- after visual detection of the runway, maneuver the airplane in such a way that it flies over the outer beacon with course equal to landing one;

- descend to the altitude of 600 m, while descending set speed of 350 km/h, prepare to the first turn;
- follow the circle pattern for landing;

Take into account that during approach and landing with RKL-41, distance on the PPD-2 is not indicated.

Figure. Landing scheme with help of RKL-41



1. Airfield approaching;
2. Alignment with runway direction using outer NDB beacon;
3. Descend to altitude of 600 m;
4. First turn.

4. COMBAT EMPLOYMENT

AIRPLANE ARMAMENT

The L-39C airplane has bomb and missile armament. It has the ASP-3NMU-39 gunsight, FKP-2-2 gun camera and EKSR-46 auxiliary armament.

Armament, gunsight and photo control equipment of the L-39C are used for the following tasks:

- accurate dive bombing with 50 - 100 kg bombs;
- accurate S-5 rocket shooting at ground target during diving;
- shooting R-3S at aerial targets.

Weapon controls are concentrated on the center panel in front cockpit. Combat button is located on the stick in the front cockpit only.

BOMB ARMAMENT

Bomb armament consists of:

- L-39M-117, L-39M -118 wing pylons;
- two bombs;
- bomb release control system;

Bombs are attached to wing pylons.

With help of combat release system only armed bombs (single or salvo) can be released when speed of the airplane is higher than 310 km/h (when speed is below 310 km/h – combat system is blocked.) In case of emergency release all bombs are released simultaneously.

Bomb armament controls and signalization in front cockpit.

- «ARMS» CB – electrically supplies combat button;
- «PORT –STARB. BOTH» double-position switch is used for selecting bombs release mode. For consequent release set this switch first to the «PORT», and then to the «STARB. BOTH» position. If set to the «STARB. BOTH» two bombs will be released simultaneously.
- «EMERG. JETTIS.» switch is used for emergency jettison the stores;
- «LIVE-BLANK» switch is used for arming bombs when they to be released by the emergency bomb release system;
- «EXPLOSIVE» signal indicating that «LIVE-BLANK» CB is in «LIVE» position;
- Stores are present signals indicating that bombs are attached;
- «STAND ALERT» signal, indicating that armament control system is ready. This signal is on when speed is higher than 310 km/h.
- Combat trigger safety cover.

Bomb armament controls and signalization in rear cockpit.

- «ARMS» CB - supplies armament control system;
- «EMERG. JETTIS.» switch is used for emergency jettison the stores. This switch must be in neutral position;
- «LIVE – BLANK» switch is used for arming bombs when they to be released by the emergency bomb release system. This switch must be in neutral position.
  Note: This switch is a command one to that of in front cockpit. If switch is set to «LIVE» or «BLANK», bombs will be dropped in explode or non-explode mode, independently of switch position in front cockpit.
- Stores are present signals;
- «ARMAMENT FIRE» indicates that combat trigger is pressed in the front cockpit;
- «STAND ALERT» signal;
- «EXPLOSIVE» signal.

UNGUIDED WEAPON

Unguided weapon consist of:

- two UB-16-57U universal launchers;
- 32 rockets of S-5 type;
- PUS-36DM firing control device;
- L-39M-117, L-39M -118 wing pylons;
- fire control and signalization electrical system.

UB-16-57U universal launchers are attached to the wing pylons. PUS-36DM sends and distributes electrical pulses between rockets' electrical ignitors in both launchers. Electrical control system allows rockets launching at speeds higher than 310 km/h (below 310 km/h this system is blocked) in the following sequences:

- 32 rockets in sequence (16 per launcher);
- 4 rockets in sequence (2 per launcher);
- 2 rockets in sequence (1 per launcher).

Unguided weapon controls and signalization in front cockpit.

- «ARMS» CB – electrically supplies combat button;
- «UB-16» CB – supplies PUS-36DM, UB-16 launchers, when the «UB-16» CB is enabled the «PUS-0» signal goes on.
- «EMERG. JETTIS.» switch is used for emergency jettison the stores;
- «2RS – AUT. – 4RS» (2 rockets –Auto – 4 rockets) switch selects rocket launch mode. «2RS» (2 rockets) – every time the combat trigger is pressed 2 rockets: 1 from the left and 1 from the right will be launched with 0.025 second delay. «4RS» (4 rockets) –every time trigger is pressed, 4 rockets will be launched (2 per launcher). «AUT» – all 32 rockets will be launched when the trigger is depressed.
- Stores are present signals indicating that bombs are attached;

- «STAND ALERT» signal, indicating that armament control system is ready. This signal is on when speed is higher than 310 km/h.
- «PUS – 0» signal, indicates that PUS-36DM is ready for firing. After first rockets were launched this signal goes off.
- Combat trigger safety cover.

Unguided weapon controls and signalization in rear cockpit

- «ARMS» CB - supplies armament control system;
- «EMERG. JETTIS.» switch is used for emergency jettison the UB-16 blocks;
- Stores are present;
- «ARMAMENT FIRE» indicates that combat trigger is pressed in the front cockpit.
- «STAND ALERT» signal.

GUIDED MISSILE WEAPON

Guided rocket weapon consists of:

- two R-3S guided missiles;
- two APU-13M1 missile launchers;
- L-39M-117, L-39M -118 wing pylons;
- MP-28A G-sensor;
- R-3S missiles fire control, signalization and electric supply system.

Guided missiles can be launched at speeds higher than 310 km/h.

APU-13M1 launchers are intended for R-3S missile mounting and power supply. Missile launchers are attached to wing pylons.

The MP-28A G-sensor is designed for measuring G-factor and signaling if it is higher than 2 units.

Guided weapon controls and signalization in front cockpit.

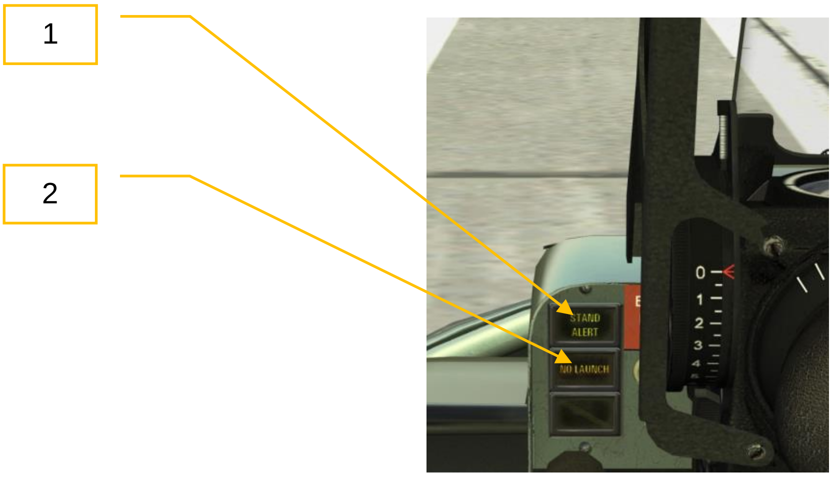
- «ARMS» CB – electrically supplies combat button;
- «HEAT SS» – supplies missile seeker heating circuit and the «ROCKETS HEATING» signal in rear cockpit.
- «GLOW SS» –supplies G-sensor, missile seeker glowing circuit and the «GLOWING ON» signal in rear cockpit.
- «EMERG. JETTIS.» switch is used for emergency jettison the stores;
- «PORT – STARB. BOTH» double-position switch is used for selecting missiles release mode. In contrast with bombs release modes, missiles can be launched only consequently one by one depending on position of the switch. Simultaneous launch is impossible.
- Stores are present signals indicating that APU launchers are attached;
- «VOLUME SS» – volume knob, regulating missile heat seeker lock audial signal volume
- «STAND ALERT» signal, indicating that armament control system is ready. This signal is on when speed is higher than 310 km/h.
- «NO LAUNCH» signal indicates that allowed G-factor of more than 2 units is exceeded. Missile cannot be precisely pointed to the target.

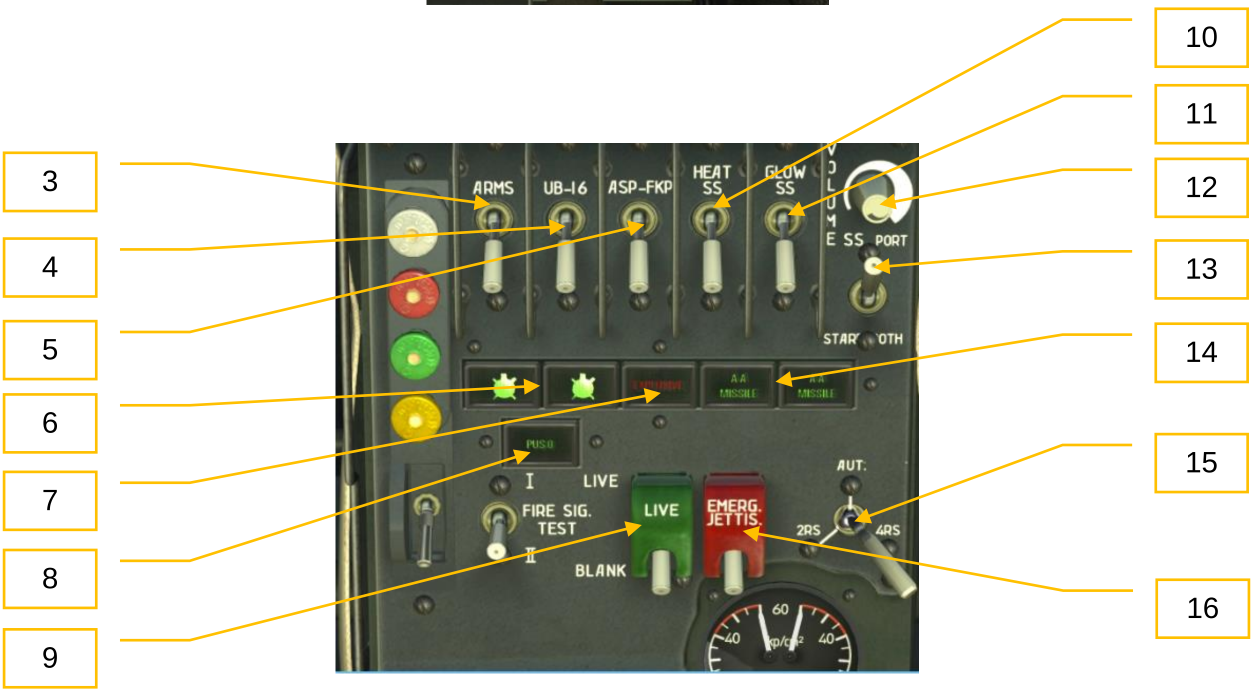
- «A-A MISSILE» signals, indicating that missiles are attached to APU launchers.
- Combat trigger safety cover.

Guided weapon controls and signalization in rear cockpit.

- «ARMS» CB - supplies armament control system;
- «EMERG. JETTIS.» switch is used for emergency jettison the stores;
- Stores are present;
- «A-A MISSILE» (SS) signals;
- «ARMAMENT FIRE» indicates that combat trigger is pressed in the front cockpit;
- «STAND ALERT» signal;
- «NO LAUNCH» signal;
- «ROCKETS HEATING» signal;
- «GLOWING ON» signal.
- «EXPLOSIVE» signal.

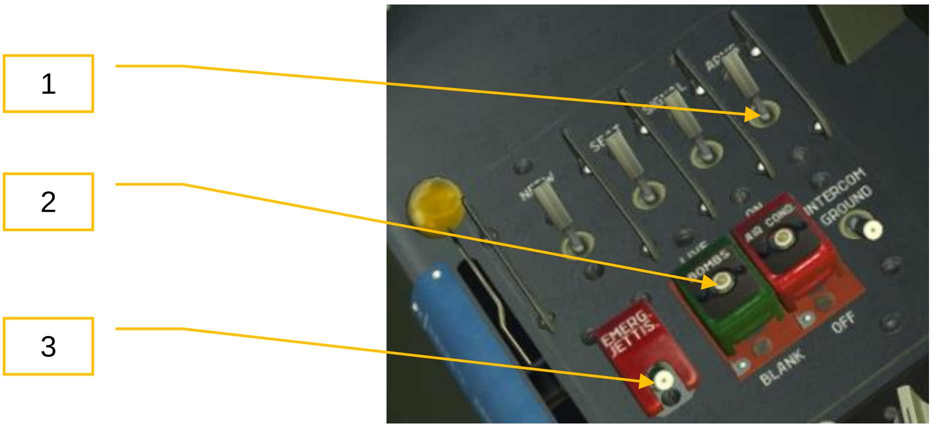
ARMAMENT CONTROLS AND SIGNALIZATION IN FRONT COCKPIT

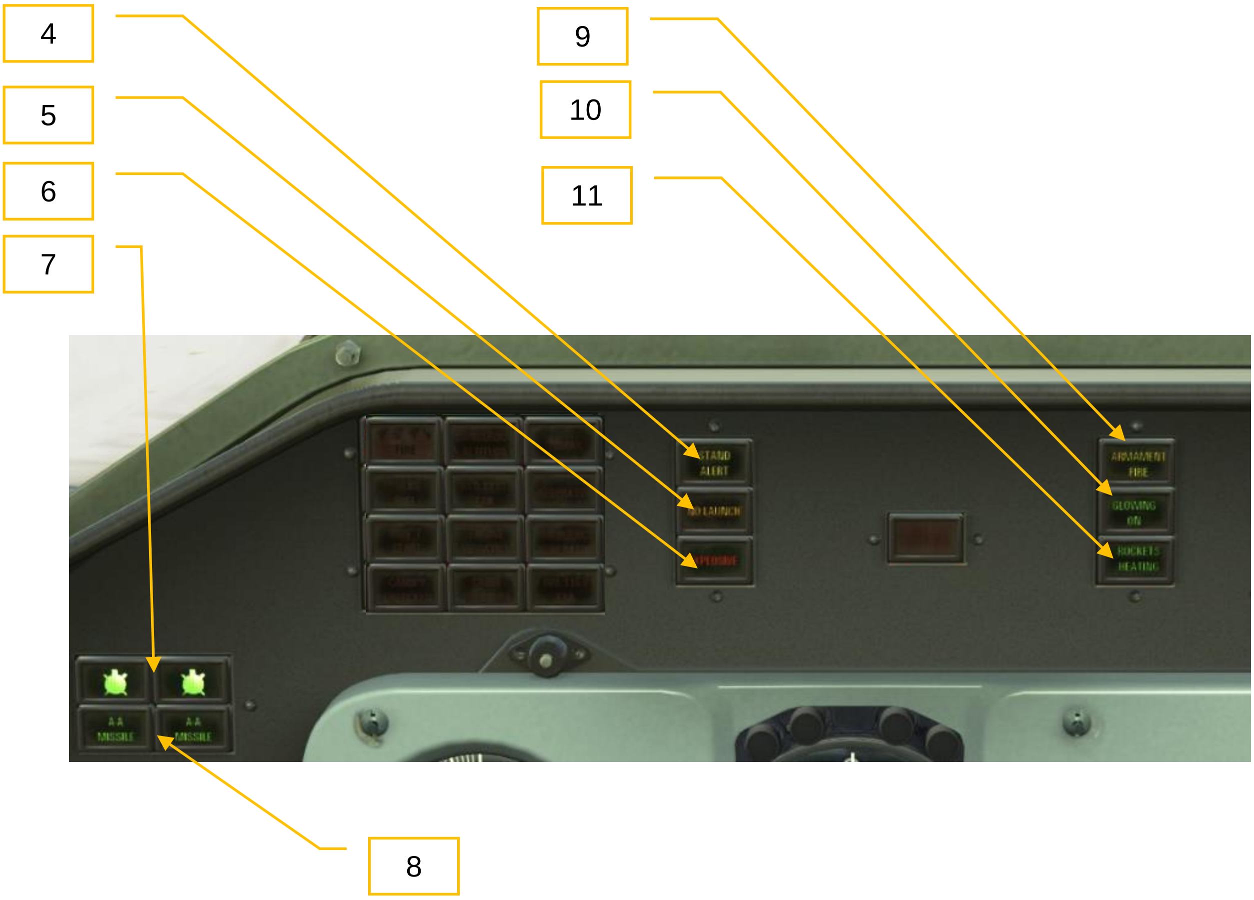




1	«STAND ALERT»	9	«LIVE- BLANK» switch
2	«NO LAUNCH»	10	«HEAT SS»
3	«ARMS» CB	11	«GLOW SS»
4	«UB-16»	12	«VOLUME SS»
5	«ASP-FKP» CB	13	«PORT- STARB. BOTH» switch
6	Stores are present	14	«A-A MISSILE»
7	«EXPLOSIVE»	15	«2RS – AUT. – 4RS»
8	PUS - 0	16	«EMERG. JETTIS.» switch

ARMAMENT CONTROLS AND SIGNALIZATION IN REAR COCKPIT





1	«ARMS» CB	7	Stores are present
2	«LIVE-BLANK» switch	8	«A-A MISSILE»
3	«EMERG. JETTIS.» switch	9	«ARMAMENT FIRE»
4	«STAND ALERT»	10	«GLOWING ON
5	«NO LAUNCH»	11	«ROCKETS HEATING»
6	«EXPLOSIVE»		

AIMING AND PHOTO EQUIPMENT

Aiming equipment includes ASP-3NMU-39 gunsight.

Gunsight management is not difficult, but requires certain skills and attention.

Aiming basically consist of two simultaneous operations: keeping central dot of aiming grid over target by maneuvering the airplane.

Distance rheostat and optical rangefinder with external base form range finding device. Operation principle of the rangefinder is based on target size measurement depending on distance to the target. Only if target base is within 14 -22 m. rangefinder can provide gunsight with distance within full range of 180-800m. For targets with bases of less than 14 m. maximum distance cannot be entered into gunsight, and for targets with bases of more than 22 m. – minimum distance. This is explained by the fact that optical rangefinder’s grid diameter is limited by 17.5 mil (maximum distance) – 122 mil (minimum distance).

Gunsight has two operating modes: «GYRO» and «FIXED». In the «GYRO» target leading angle is being calculated automatically during aiming. To use gunsight as collimator sight, the «FIXED» mode with fixed grid is used. Gunsight operation mode is selected by the switch on the gunsight.

To quickly change «GYRO» mode to the «FIXED» one, pilot must enter the minimum range in the gunsight by rotating distance grip on the stick, due to that circuit contacts closure occurs and aiming grid became fixed. To return back to «GYRO» - enter the maximum distance. There is a mechanical sight, which is a standby device and consists of a front sight and a ring with cross-hair. The gunsight has light filter and grid brightness adjustment knob.

The gunsight has rotative reflector. It allows deflection of the optical axis at angle of 0-20^0, thus entering estimated correction for shooting and bombing.

Main parameters of the gunsight:

- maximum target leading angle, calculated by the gunsight – not less than 8^0;
- target distance which can be entered in the gunsight - 180-800 m.;
- target base, which can be entered in the gunsight- 7-45m;
- angular angle of the variable grid largest circle - 122 mil;
- angular angle of the variable grid smallest circle -17,5 mil;
- angular angle of the constant grid circle - 132 mil;
- angular angle of the mechanical sight 132 mil;

For enabling gunsight enable the «ASP-FKP» CB on the center panel of front cockpit.

The photo control equipment includes FKP-2-2 gun camera, installed on the ASP-3NMU-39 aiming head and intended for checking aiming results.

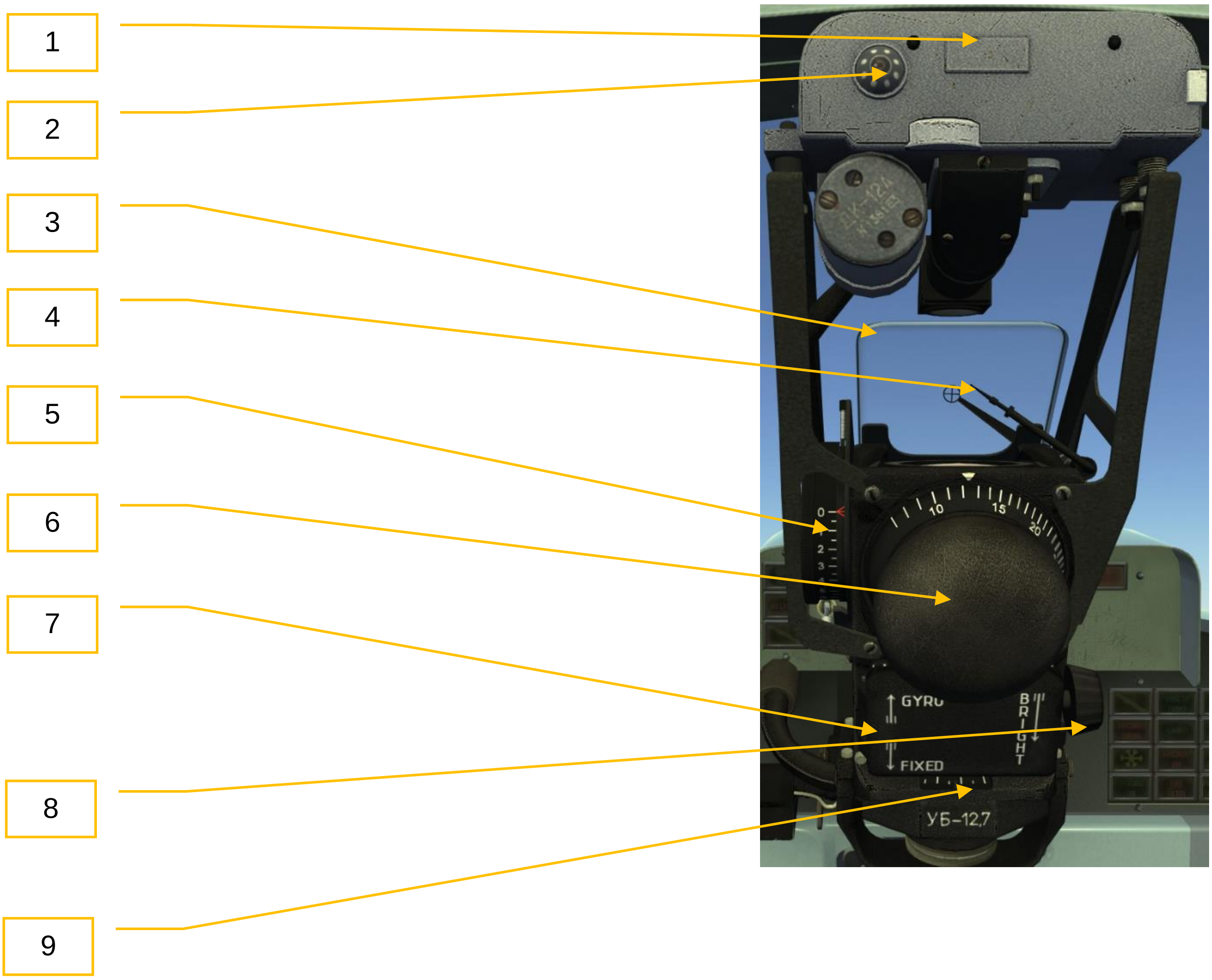
FKP-2-2 main parameters:

- maximum photographing range of target with size of 10m - 750-800m;
- maximum photographing range of target with size of 20m - 1300-1500m;
- continuous shooting duration - 12 seconds;
- number of frames - 60;

For enabling gunsight enable the «ASP-FKP» (Gunsight- Gun camera switch) CB on the center panel in front cockpit. When combat trigger on the stick is pressed the gunsight grid is photographed. The guncamera operation is controlled by rotation of the disk on the unit case. Besides that device operability can be checked by pressing the FKP button on the stick in front cockpit.

Gun camera photos are shown during track playing.

Figure. ASP-3NMU and FKP-2-2.



1 FKP.

2 FKP operating control disk.

3 Rotative gunsight reflector.

4 Mechanical sight.

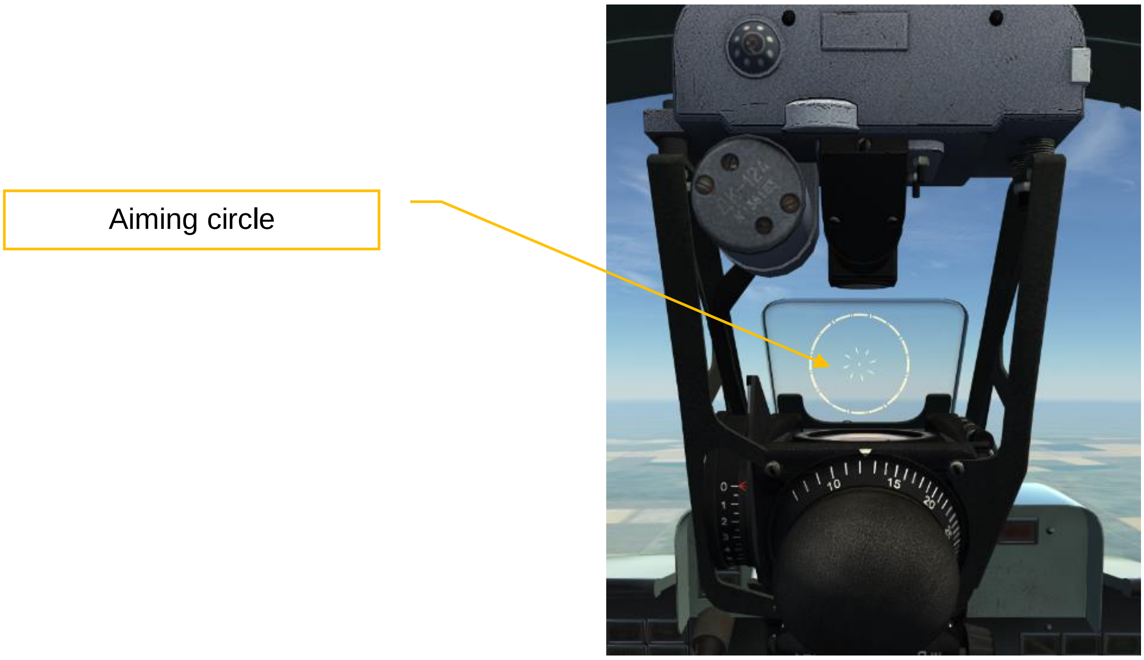
5 Reflector deflection angle knob.

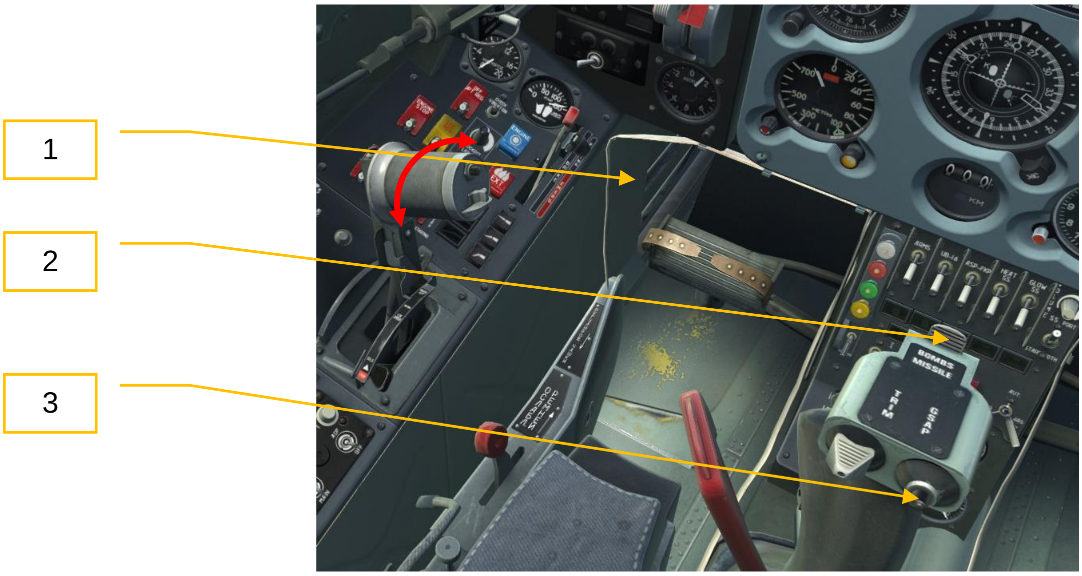
6 Target base knob

7 «GYRO– FIXED» switch.

8 Gunsight grid brightness knob.

9 Rheostat and distance scale.





1. Distance grip. By rotating this grip counterclockwise distance entered in the gunsight is reducing, clockwise – increasing.
2. Combat trigger safety cover.
3. FKP button.

EKSR-46 SIGNAL FLARES

EKSR-46 electrified signal flare cartridge is used for launching signal flares.

Flare launching system consist of PU-EKSR-46 firing control unit in the front cockpit and one four-barrel cartridge for 26-mm signal flares. Cartridge is installed on the right in the tail part of the fuselage.

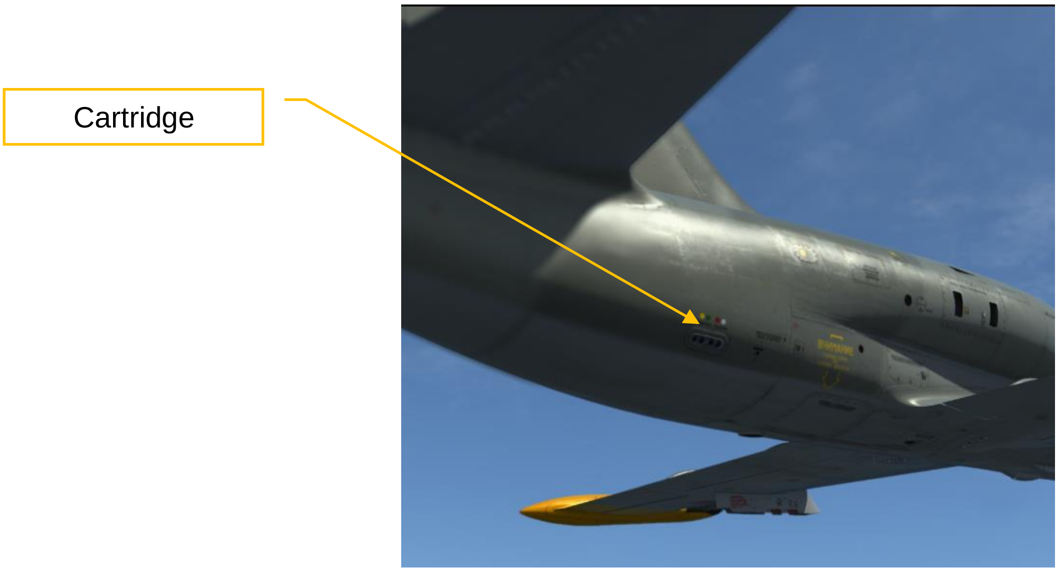


Figure. EKSR-46 control panel and signal flares installation place

For launching signal flares one must enable the «IDENT. FLARES» switch and press the corresponding button.

GROUND TARGETS ENGAGEMENT PRE-FLIGHT PREPARATION

Ground targets engagement flights are complex tasks, which require from pilot strong piloting skills and knowledge of aircraft armament operation.

Before flight examine the armament operation procedures, piloting technique, clarify aiming data (fictitious target base and reflector deflection angle).

Fictitious target base calculation

Since the recommended shooting and bombing ranges exceed maximum distance (800 m) which can be entered into gunsight, fictitious target base should be entered for external base rangefinder to operate correctly. It is defined by the following equation:

$$B_f = B_a \times D_m / D_s$$

where:

- B_f – *fictitious target base, m;*
- B_a – *actual target size, m;*
- D_m. – *maximum distance, entered into gunsight - 800 m;*
- D_s * – *shooting (bombing) distance.*

D_s * - *see Tables 1 and 2.*

Specific of aiming at small-sized targets

Small-sized target is a target with fictitious target base of less than 14.5m.

For recommended shooting distances of 1200 and 1460 m, small-sized targets are those, who have actual size of less than 22 and 27 m correspondingly.

For recommended bombing distances of 1600 and 1300 m, small-sized targets are those, who have actual size of less than 29 and 24 m correspondingly.

When shooting at such targets one must take into account the following:

- targets cannot be surrounded correctly by the moving circle at recommended distances, because their angular size at these distances is less than that of rangefinding circle;
- maximum distance cannot be entered into gunsight if fictitious target base is less than 14.5m.

Fictitious base calculation for small-sized targets:

$$B_f = Kx\ B_a\ x\ D_m/D_s$$

where:

- *multiplicity coefficient 2,3.*

*К=2 when 10m ≤ **B_a** <27(22) m и К=3 при **B_a** <10m. – for rocket shooting*

*К=2 when 10m ≤ **B_a** <30 m и К=3 при **B_a** <10m. – for bombing*

At the moment of shooting visible target size should be K times smaller than the rangefinding circle.

BOMBING FLIGHTS

Before the flight make sure that the «NETW», «ARMS» and «SIGNAL» CBs are enabled in rear cockpit.

Very important phase of dive bombing is arriving at point where turn and dive entry are performed. The accuracy of arriving at this point impacts on dive angle and release speed.

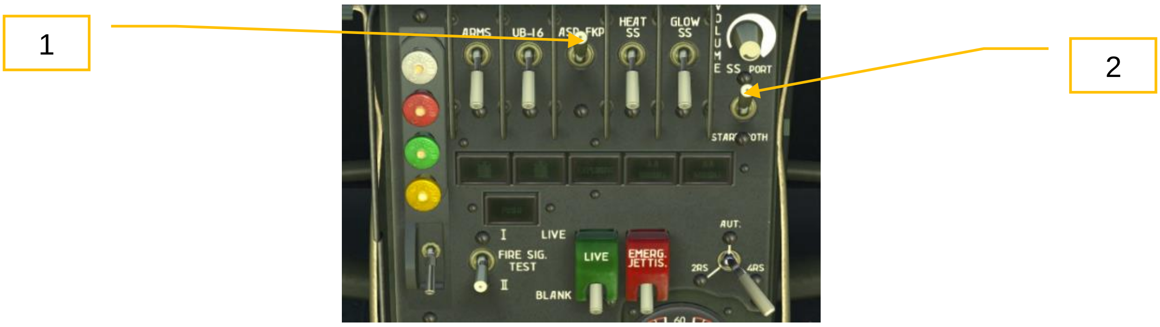
Bombing should be performed at diving angles of 20^0 and 30^0 under conditions listed in Table 1.

Table 1.

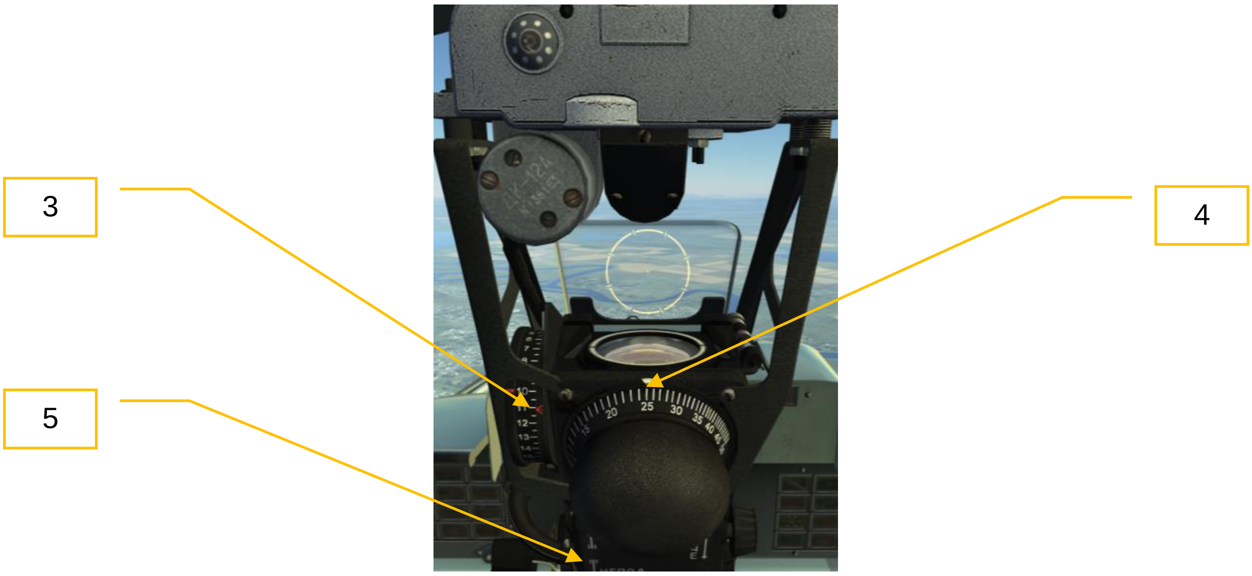
№	Parameters	30^0	20^0
1	Gunsight reflector deflection angle	11^0	13^0
2	Dive entry altitude at ingress point	1500 m.	1200 m.
3	Dive entry speed at ingress point	350 km/h	400 km/h
4	Release altitude	800 m.	700 m.
5	Release speed	550 km/h.	560 km/h
6	Bombing distance	1600 м.	1300 м.
7	Range of the actual target sizes for recommended bombing distances	29-45 м.	23-45 м.
8	Range of the fictitious target bases, entered into gunsight for recommended bombing distances	14,5-22,5 м.	14,7-27 м.

While approaching target:

1. enable **«ASP-FKP»** CB;
2. by the **«PORT- STARB. BOTH»** switch set the desired bombs release mode;



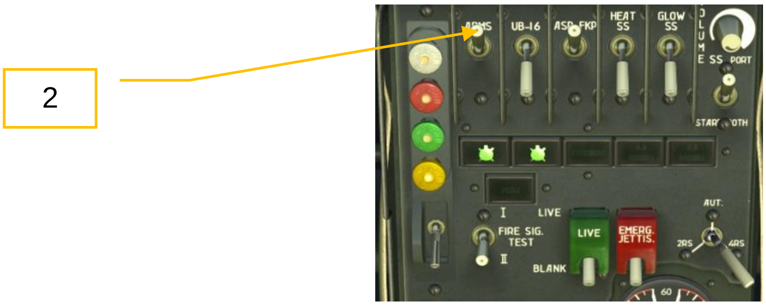
3. set gunsight reflector to angle of 13^0 and raise the seat in the upper position, so that one could see the central dot of aiming grid and upper part of the rangefinding circle. Due to that habitual view from the cockpit will change.
4. set the fictitious target base;
5. **«GYRO-FIXED»** switch set in the **«FIXED»** position.



6. enter maximum distance into gunsight;

Actions in the target area:

1. approach target at required altitude and speed;
2. enable the **«ARMS»** CB;



3. ingress maneuver should be performed in such a way that target moved to the required target viewing angle (turn starting point);

4. at the moment when target reaches required viewing angle, start turning towards attack course with 60-120^{0} roll and simultaneous dive entry. While entering the dive, set engine RPM of 90-92%;

5. turn and dive entry should be finished in such a way that aiming grid center is under the target at distance equal to 1 radius of the constant diameter aiming circle ;

6. flip the combat trigger down and while airplane is descending, the central dot of the gunsight will be moving towards the target, speed and altitude - towards the required release values;
7. when required speed and altitude are reached and central dot is aligned with the target, press the combat trigger (1 second) and release the bombs;

8. immediately after bombing exit from the dive with G-factor of 4-5 units, simultaneously increasing engine RPM to «TAKE OFF»;
9. perform maneuver for consecutive bombing run (if bombs are going to be released in single mode)
10. when bombing is finished, flip the combat trigger up, disable the **«ASP-FKP»** and **«ARMS»** CBs.

In case of tactical release system failure, armed bomb must be released using emergency system. To do that is necessary:

- set the **«LIVE – BLANK»** switch in the front or rear cockpit to the **«LIVE»** position;
- enable the **«EMERG. JETTIS.»** switch in the front or rear cockpit, bomb will be released simultaneously.

To perform bombing from emergency system with non-armed bombs, one must set the **«LIVE – BLANK»** switch to **«BLANK»** position.

TYPICAL MISTAKES DURING BOMB RUN

- Error in the dive angle of $\pm 1^0$ when bomb is dropped causes deviation of ±30 m. This occurs due to early or late dive entry;
- Error in the drop speed of ± 20 km/h causes deviation of ± 25 m. This occurs, when dive entry speed or dive angle were not kept correctly;
- Error in the release altitude of ± 50 m. – causes bomb deviation of ± 80 m.

FLIGHT FOR SHOOTING UNGUIDED ROCKETS

Before the flight make sure that the «NETW», «ARMS» and «SIGNAL» CBs are enabled in rear cockpit.

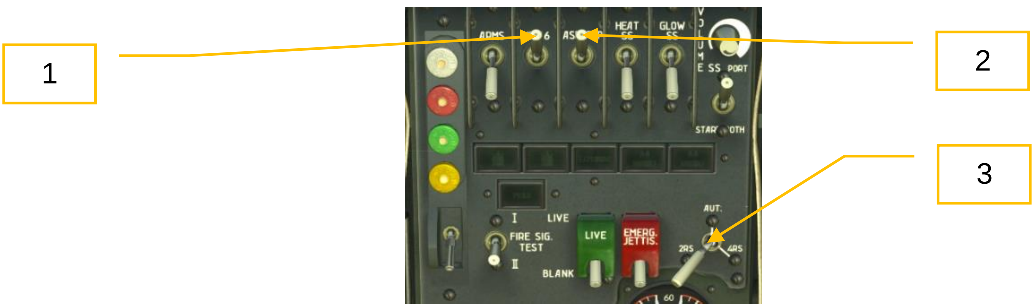
Unguided rockets should be fired at dive angles of 20 and 30^0 under conditions listed in the Table 2.

Table 2.

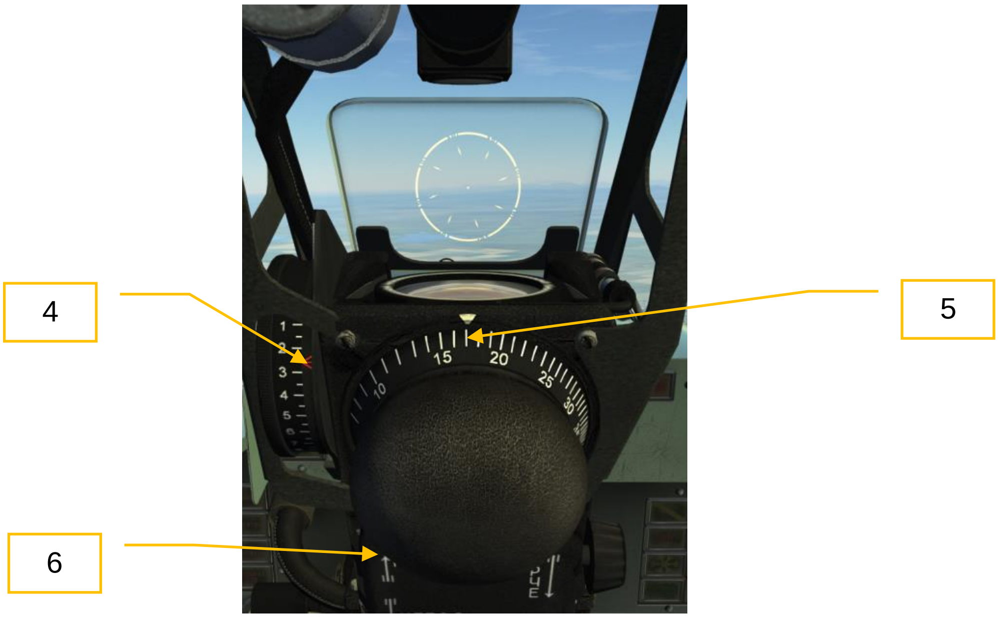
№	***Parameters***	***30^0***	***20^0***
1	*Gunsight reflector deflection angle*	*$2{,}53^0$*	*$2{,}30^0$*
2	*Dive entry altitude at ingress point*	*1200 m.*	*1200 m.*
3	*Dive entry speed at ingress point*	*300 km/h*	*400 km/h*
4	*Shooting altitude*	*600 m.*	*500 m.*
5	*Speed at shooting moment*	*550 km/h.*	*560 km/h*
6	*Shooting distance*	*1200 m.*	*1460 m.*
7	*Range of the actual target sizes for recommended shooting distances*	*22 – 45m.*	*27 – 45m.*
8	*Range of the fictitious target bases, entered into gunsight for recommended shooting distances*	*14.6 – 30 m.*	*14,8 – 24,5 m.*

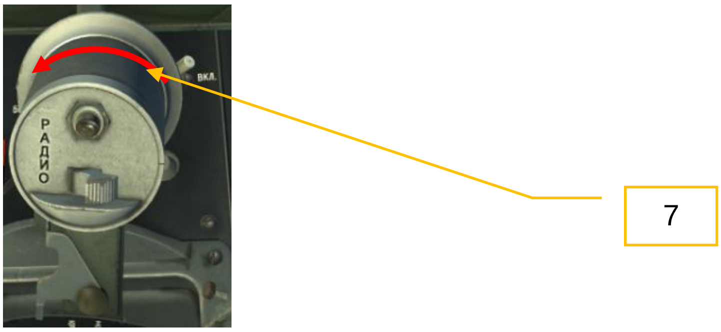
While approaching target:

1. enable the **«UB-16»** CB
2. enable the **«ASP-FKP»** (ASP-FKP) CB
3. using the **«2RS – AUT – 4RS»** select desired shooting mode;



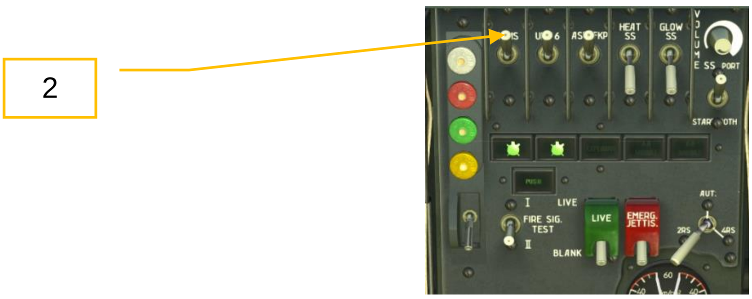
4. set required gunsight reflector angle ;
5. set fictitious target base.
6. set the **«GYRO-FIXED»** switch to the **«GYRO»** position;
7. enter the minimum distance into gunsight.





Actions in the target area:

1. approach target at altitude of 1200 m. at required speed;
2. enable the **«ARMS»** CB;



3. ingress maneuver should be performed in such a way that target moved to the required target viewing angle (turn starting point);
4. at the moment when target reaches required viewing angle, start turning towards attack course with 60-120^0 roll and simultaneous dive entry. While entering the dive, set engine RPM of 90-92%;
5. turn and dive entry should be finished in such a way that aiming grid center was under the target;

6. flip the combat trigger down, enter maximum distance into gunsight and align aiming grid center with target center;

7. while descending, keep gunsight grid central dot on the target;
8. as soon as target fits the circle, formed by the diamonds, press the combat trigger (1 sec) and shoot;

9. immediately after shooting exit from the dive with G-factor of 3-3.5 units, simultaneously increasing engine RPM to «TAKE OFF»;
10. after dive exit, enter the minimum distance into the gunsight and perform maneuver for consecutive attack run;
11. when shooting is finished flip the combat trigger up, disable the **«UB-16», «ASP-FKP»**, **«ARMS»** and set the **«GYRO-FIXED»** gunsight mode switch to the **«FIXED»** position.

Note: *For rockets shooting the «FIXED» mode can be used as well. Calculated data remains the same as for «GYRO» mode. Set the maximum distance before dive entry.*

Unguided rockets fire control system has no emergency launch option. UB-16 blocks are intended to be jettisoned only.

TYPICAL MISTAKES DURING ROCKETS SHOOTING

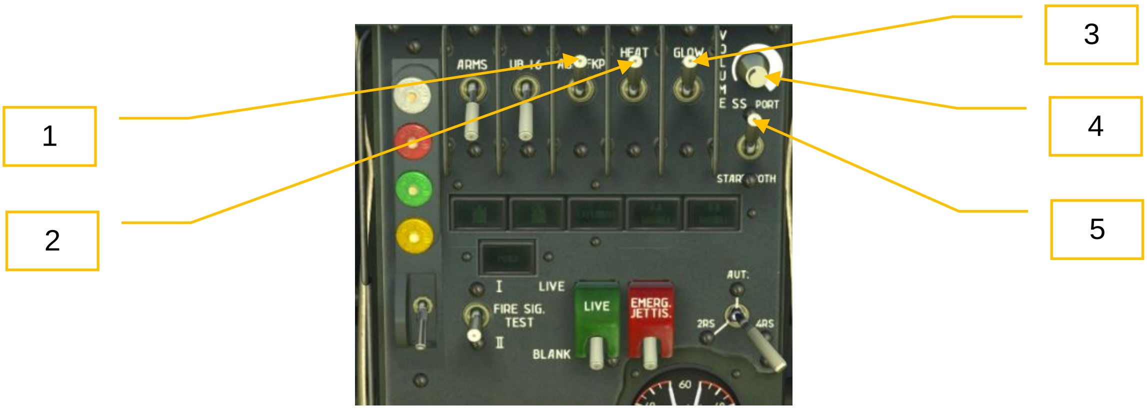
- shooting from the distance which is, bigger or smaller, than the estimated ones, leads to rocket overfly or underfly;
- abrupt control stick movements, after entering the maximum distance, cause big oscillations of the gunsight grid – aiming is difficult

COMBAT EMPLOYMENT AT AERIAL TARGETS

Before the flight make sure that the «NETW», «ARMS» and «SIGNAL» CBs are enabled in rear cockpit.

Before intercept:

1. enable **«ASP-FKP»** CB
2. enable **«HEAT SS»** CB
3. enable **«GLOW SS»** CB;
4. **«VOLUME SS»** - set the maximum volume;
5. using the **«PORT – STARB. BOTH»** select missile to be launched;



6. set the gunsight reflector angle of 0^0;
7. set the fictitious target base of 16 m;
8. **«GYRO-FIXED»** switch is in **«FIXED»** position.

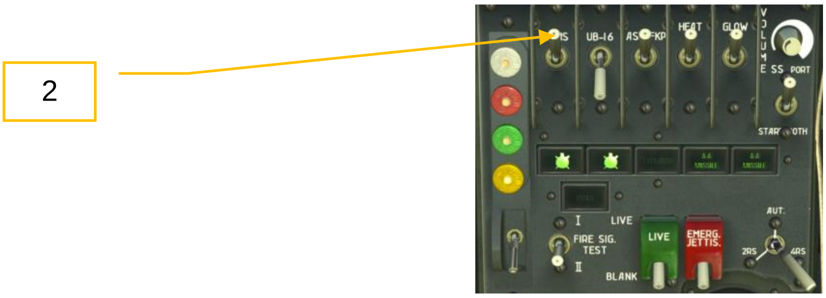
9. enter the maximum range.

Note: *Perform guided missile launch from rear hemisphere at target angles from 0/4 to 2/4, sun bearing should be not more than 20^0. Missile firing range is within 1200-2000 m, according to ASP-3NMU-39, closing speed is not more than 200 km/h. Exit from attack performs at distance of not less than 1000 m. Launch is allowed when missile seeker lock signal is at maximum level (at allowed launch distance) and G-factor is less than 2 units.*

Intercept:

1. find a target and prepare for attack: distance - 2000 m, target should be seen at angle of 50 - 60^0, altitude difference is 300 – 400 m.

2. enable **«ARMS»** CB;



3. turn towards the target with roll angle of 50-60^0, when the target reaches gunsight reflector remove roll;

4. aim, by maneuvering aircraft achieve the maximum of the audial signal;

5. «NO LAUNCH» is off;

6. when target visible size is 3-2 times smaller than the rangefinding circle, launch missile by pressing combat trigger for not less than 2-2.5 seconds;

7. exit from attack run;
8. perform consecutive attack run;
9. when second missile was launched the «GLOWING ON» and «ROCKETS HEATING» signal lamps go off;

After attack exit, flip the combat trigger up and disable the **«ARMS», «ASP-FKP», «HEAT SS»,** and **«GLOW SS**» CBs.

Guided missile fire control system has no emergency launch option. Missiles are intended to be jettisoned together with APU launcher only.

5. EMERGENCY PROCEDURES

EMERGENCY PROCEDURES

In the event of an emergency situation during the flight, pilot must check whether there was an error when working with cockpit's equipment. Pay special attention to checking CBs and switches, related to the particular case. If CBs and switches were not in correct positions, immediately set them in the appropriate positions, check if emergency situation is resolved and continue the flight. If emergency occurs due to failure or combat damage, one must using external symptoms and signalization. Identify the root cause of the issue and resolve it, following the appropriate procedure.

ENGINE FAILURE

Symptoms:

- changes in the sound of the engine operation;
- rapid drop of RPM and EGT;
- reduction of the airspeed;
- «ENG. MIN. OIL PRESS» signal is on;
- «GENERATOR» signal is on and the RAT is extending (extended);
- master caution signal is on;

Actions:

- set the throttle to the «STOP» position;
- constantly monitor speed and altitude;
- turn towards the airfield;
- start the engine.

Air start of the engine

Reliable engine start is performed at altitudes up to 6000m.
If engine autorotation RPM is lower than 15% (n_1 pointer), engine start requires air starter to be started to spin up the high pressure compressor (HPC).
If engine autorotation RPM is higher than 15% (n_1 pointer), engine start does not require air starter to be started to spin up the high pressure compressor (HPC).

Engine start with spinning up the HPC. (APU assisted air start)

- set speed of 300 – 350 km/h;
- make sure that autorotation RPM is lower than 15 %;
- press the «TURBO» button for 1-2 seconds;
- when the «TURBINE STARTER» signal is on, press the «ENGINE» button for 1-2 seconds;
- after 3-6 seconds the «ENGINE» was pressed, move the throttle from the «STOP» position to «IDLE»;
- engine RPM and EGT should start increasing;
- after engine start RPM should be not less than 54,5%, EGT – not more than 600^{0}C, oil pressure at engine inlet – not less than 2 kg/cm^2;

- when engine was started, increase RPM and make sure that engine operates correctly.

Engine start without spinning up the HPC.
(Windmill air start)

- set speed of not less than 430 km/h;
- ensure that autorotation RPM is not less than 15 %;
- press the «ENGINE» button for 1-2 seconds;
- after 3-6 seconds the «ENGINE» was pressed, move the throttle from the «STOP» position to «IDLE»;
- engine RPM and EGT should start increasing;
- after engine start RPM should be not less than 54,5%, EGT – not more than 600^{0}C, oil pressure at engine inlet – not less than 2 kg/cm^2;
- when engine was started, increase RPM and make sure that engine operates correctly.

Note: If engine start was not successful, assess the situation, take a decision to do an emergency forced landing or eject.

SPONTANEOUS CHANGING OR HANGING OF ENGINE RPM

In case of spontaneous changing or hanging of engine RPM (engine does not react on throttle movements), switch engine to emergency fuel system (EFS).

Actions:

- set throttle in the «IDLE» position;
- enable the «SEC. REG.», as a result «FUEL EMERG. DELIVERY» signal goes on;
- by slowly moving the throttle, not faster than 2% per second, set the required flight mode.

When engine operates from EFS:

- fuel regulator automatics and electrical stop valve do not operate;
- do not allow engine RPM drop of less than 56% at altitudes of up to 2000 m. and 60 % at altitudes of 2000 m;
- up to 2000 m. engine RPM should not exceed 103%, from 2000 m. and up to 8000 m. – 99%.
- changing engine operation mode from «IDLE» to «NOM» should take not less than 15 seconds;

NOTES:

If during enabling the «SEC. REG.» (Emergency fuel) the throttle is at higher mode than «IDLE» engine self-stop is possible.

If during enabling the « SEC. REG. » (Emergency fuel) or during operation from EFS, engine self-stop occurs, engine should be started from EFS.

Engine start from EFS with spinning up the HPC (APU assisted air start from EFS)

- set speed of 300 – 350 km/h;
- make that autorotation RPM is less than 15 %;
- press the «TURBO» button for 1-2 seconds;
- when the «TURBINE STARTER» signal is on, press the «ENGINE» button for 1-2 seconds;
- after 10 seconds the «ENGINE» button was pressed, move the throttle from the «STOP» position to the position marked by the triangle;
- when EGT starts increasing, by moving the throttle regulate engine fuel supply, so that engine RPM is not less than 56% up to 2000m and not less than 60% at altitudes higher than 2000m.
- when HPC RPM is 41,5 – 44,5% disable the «Sapphire – 5» by «TURBO STOP» switch;
- when engine is started, EGT should be not more than 600^{0}C, oil pressure at engine inlet – not less than 2 kg/cm^2;
- after engine was started, increase RPM and make sure that engine operates correctly.

Engine start from ESF without spinning up the HPC. (Windmill air start from EFS).

- set speed of not less than 450 km/h;
- ensure that autorotation RPM is not less than 15 %;
- press the «ENGINE» button for 1-2 seconds;
- after 3-6 seconds the «ENGINE» button was pressed, move the throttle from the «STOP» position to the position marked by the triangle;
- when EGT starts increasing, by moving the throttle regulate engine fuel supply, so that engine RPM is not less than 56% up to 2000m and not less than 60% at altitudes higher than 2000m.
- when engine is started, EGT should be not more than 600^{0}C, oil pressure at engine inlet – not less than 2 kg/cm^2;
- after engine was started, increase RPM and make sure that engine operates correctly.

FIRE IN ENGINE COMPARTMENT

Symptoms:

- «FIRE» signal is on;
- master caution signal is on;
- «J.P.T. 700^{0}C» and «J.P.T. 730^{0}C» signals are on;
- smoke tail behind the airplane (can be detected during turn).

Action:

- set the throttle to the «STOP» position
- close the shut-off fuel valve;
- press the «EXT» button;
- after fire was extinguished, assess the situation, take a decision to do an emergency forced landing or eject.

ENGINE SURGE

Symptoms:

- periodic bangs in the engine compartment;
- RPM and fuel pressure oscillations;
- increase of EGT, «J.P.T. 700^{0}C» and «J.P.T. 730^{0}C» signals go on;
- possibly, self-stop of the engine.

Actions:

- move the throttle to a lower RPM operation mode, until engine surge symptoms disappear;

LANDING GEAR NON-EXTENSION (EMERGENCY GEAR EXTENSION)

Symptoms:

- some (one or two) of three green lamps, indicating successful gear extraction, is/are off;
- mechanical flap pointers are not extended completely;

Actions:

- set speed of horizontal flight within 300 – 320 km/h;
- deflect emergency landing gear extension handle on the right panel in front or rear cockpit back;
- make sure that gear is extended by checking that all three green lamps, indicating successful gear extension, illuminate, and mechanical indicators are all the way up;
- land.

If the emergency gear release failed, set the gear extension handle in retracted position, emergency gear extension handle set all the way forward. Jettison stores and perform belly landing (with retracted gear) on unpaved runway.

- at altitude of not less than 100 m. set the throttle to the «STOP» position, close fuel shut-off valve, disable the «BATTERY», («NETW» in the rear cockpit) and «GENERATOR EMERG.»;
- land.

ADI FAILURE

Symptoms:

- ADI readings do not correspond to flight mode;
- «АРРЕТИР» (Cage) lamp-button is on;

Actions:

- set speed of 350 km/h;
- if flying in simple weather conditions, control the airplane, using natural horizon as a reference.
- if flying in adverse weather conditions, control the airplane, using T/S indicator for roll assessment. Pitch is estimated based on vertical velocity.
- approach the airfield and land.

GMK-1AE FAILURE

Symptoms:

- GMK-1AE readings do not correspond to actual heading;
- heading scale is fixed or oscillates from side to side .

Actions:

- approach the airfield using RKL-41 and KI-13;
- landing approach in adverse meteorological conditions is performed with help of RKL-41, KI-13.

FLAPS NON-EXTENSION

Symptoms:

- signal lamp, indicating that flaps are extended, is off;
- flaps extension button does not return to initial position.

Actions:

- check speed, it should not exceed 310 km/h (at speed of 310 km/h flaps extension is blocked);
- set horizontal flight speed of 280 km/h;
- deflect emergency flaps extension handle on the right panel in front or rear cockpit back;

If, due to some reasons, flaps extension is failed (main and emergency systems failures, combat damages), land with retracted flaps. Glideslope speed should be within 250-270 km/h. Glide path should be shallow.

OIL DROP AT ENGINE INLET

Symptoms:

- «ENG. MIN. OIL PRESS» signal is on;
- oil pressure is less than 3 kg/cm^2 at RPM of 95% and above;
- oil pressure is less than 2 kg/cm^2 at other modes.

Actions:

- set speed of 300 km/h and land airplane as soon as possible;
- in case of engine self-stop do the forced landing or eject.

PITOT-SYSTEM FAILURE

Symptoms:

- VD-20, KUSM-1200, VAR-80, UVPD readings do not corresponds to actual flight mode (for example: airplane is climbing but gauges show descent and vice versa, decrease or increase of speed in steady flight).

Actions:

- set the «PITOT TUBE MAIN STBU» in the «STBY» position;
- if the gauges readings were restored, continue the flight.

In case of primary and backup system failure is necessary to:

- perform horizontal flight using ADI, pitch angle should be $+2^0$, engine RPM is within 92-96% at altitudes of 1000-5000m. and 95 – 99% at altitudes of 5000 – 10 000 m. This modes corresponds to speed of 400 km/h.
- descend with pitch angle of -2^0 (ADI) at idle RPM.
- estimate current altitude, using the fact, that in this mode descend of 1000m takes approximately 2.5 min.
- use RV-5M from altitude of 750m;
- fly circle-pattern with retracted gears and pitch angle of $+2^0$ (ADI) and RPM of 90%, which corresponds to speed of 350 km/h;
- fly with extended gear and flaps extended at 25^0 after 3rd turn at RPM of 85%, pitch angle of -2^0, which corresponds to speed of 280 km/h;
- extend flaps at 44^0 over the outer NDB, set RPM of 90% and pitch angle of -4^0;
- monitor altitude over outer and inner NDBs using RV-5M.

NOTE: UVPD can be used by the pilot for altitude estimation in case of VD-20 altimeter failure. Up to 2000m. UVPD readings are equal to altitude readings, above 2000m altitude can be estimated using the following equation.

Altitude equation: H=HUVPD-2000/2+2000.

UVPD altitude	VD-20 altitude
2500 m.	2250 m.
3000 m.	2500 m.
3500 m.	2750 m.
4000 m.	3000 m.
4500 m.	3250 m.
5000 m.	3500 m.

RESERVE AMOUNT OF FUEL

Symptoms:

- «150 KG FUEL» signal is on;
- master caution signal is on.

Actions:

- assess possibility of landing at the nearest airfield, taking into account that 150 kg of remaining fuel is enough for 17 min. flight at altitude of 1000m and speed of 400 km/h.

MAIN GENERATOR FAILURE

Symptoms:

- «GENERATOR» signal is on, «EMERGENCY GENERATOR» signal can be on within some amount of time (while RAT is extending);
- distinctive sound of RAT extension («EMERGENCY GENERATOR» signal goes off);
- RSBN-5S disables automatically, if needed, RSBN-5S equipment can be enabled using the «EMERG. CONNECTION RSBN» CB.

Actions:

- make sure that generator operates correctly and voltage is within 27-29 V;
- approach airfield and land.

NOTE: If RAT was not extended, it must be extended manually. Set the RAT extension valve in back position on the right panel in front or rear cockpit. After landing and lowering the front strut, RAT will be retracted automatically.

PRIMARY AND BACKUP GENERATORS FAILURE

Symptoms:

- «GENERATOR» and «EMERGENCY GENERATOR» signals are on;
- voltage is within 23-24 V;
- RSBN-5S and SRO were disabled automatically.

Actions:

- disable the «115V INVERTOR I», «115V INVERTOR I» and «MRP-RV» CBs;
- land as soon as possible.

.
NOTE: If consumers were disabled in time, battery can provide power supply for remaining equipment for 15 min. during the day and 10 min. during the night. If needed, the «EMERG. CONNECTION RSBN» and «EMERG. CONNECTION IFF» CBs can be enabled for short period of time.
If voltage dropped to 20-21 V. extend gear and flaps manually.

CANOPY DESTRUCTION

- decrease speed to 270 km/h
- descend to altitude of less than 4000 m
- land

SMOKE IN COCKPIT. COCKPIT DEPRESSURIZATION.

- switch to pure oxygen supply, for that set the «100% O_2 – NORMAL» valve to 100% O_2 position.
- descend to altitude of less than 4000 m
- unseal the cockpit
- land

FORCED LANDING

To do a forced landing pilot must in the first place estimate the possible gliding range, taking into account altitude and distance to the landing airfield.

Airplane configuration	*V km/h*	*K maks. km*	*Vertical speed m/s*
Gear - retracted, flaps- 0^0	*300*	*10*	*10*
Gear - extended, flaps- 0^0	*300*	*7*	*11*
Gear - extended, flaps- 25^0	*280*	*5,5*	*13*
Gear - extended, flaps- 44^0	*260*	*3,6*	*15-17*

One must take into account that while gliding in flight configuration at speed of 300 km/h, altitude loss (in absence of the wind) is equal to 100 m. per 1 km. Altitude loss due to 180^0 turn with 30^0 roll is 450 m, with 45^0 roll is 350 m.

During assessment altitude over the control point must be taken into account. Control point on an airfield is outer NDB. Use the following equation for assessment:

$$L_{glide} = (H_{flight}\text{-}H_{outerNDB})*K \text{ km.}$$

Example: Airplane is 15 km away, at altitude of 2000m.

$L_{glide} = (2\text{-}1)*10=10$ *km.*

Based on this calculation pilot is sure that landing is possible.

If outer NDB is approached at angle of 90^0 or at opposite to landing course (downwind leg), one must take into account altitude loss while turning towards landing course. In this case altitude loss due to turn should be added to the altitude over control point.

FORCED LANDING AT AIRFIELD WITH NON-WORKING ENGINE

- jettison all stores;
- set gliding IAS of 300 km/h;
- turn towards the airfield;
- constantly assess opportunity of flying over outer NDB at altitude of not less than 600 m and not more than 900 m.

- if estimated altitude over outer NDB is from 1000 to 1500m, perform zigzag (snake) maneuver. At zigzag angles of 15, 30 and 45^0 additional altitude loss is 20, 50 and 100 m. and airplane flies the distance of 1,2 and 3 km correspondingly.
- when flying over outer NDB at altitudes of 1500-1800 m, turn with 30^0 roll;
- when approached outer NDB at altitudes of 1900m and above, turn at 180^0, and then back to landing course. Altitude for performing turn back to landing course can be estimated using the following equation:

$$H=H_{outerNDB}/2+500m.$$

Example: Outer NDB was passed at altitude of 1900m.

Estimate altitude at which turn to landing course should be performed: H=1900/2+500=1450m.

- when estimated altitude is reached turn at landing course;
- before outer NDB extend landing gear and set speed of 280 km/h;
- based on altitude over outer NDB take a decision to release flaps (if altitude over outer NDB is 600m landing is performed with retracted flaps or with flaps in takeoff position);
- after passing outer NDB extend flaps at 25^0 and maintain speed of 280 km/h;
- having full confidence that assessment was correct and landing on runway is still possible, extend flaps at 44^0, set speed of 260 km/h;
- descent point for estimated glideslope is located at distance of 100-200m from the beginning of the runway;
- flaring must be performed based on vertical descent speed, in case of vertical speed of 10-15 m/s, perform two-stage flaring. At altitude of 50 m do the first flaring. While flaring move descend point to beginning of the runway, vertical speed is reducing to 3-5 m/s. Second flaring is performed in a normal way at altitude of 8-10 m. If altitude over outer NDB is 600 m, flaring is performed in a standard way.
- land.

FORCED LANDING OUTSIDE THE AIRFIELD WITH NON-WORKING ENGINE

If landing cannot be performed on the airfield, pilot has to take decision on forced landing on some area, which looks suitable. Landing at unknown surface is performed with jettisoned stores, retracted gears and extended flaps;

When suitable surface is found, set speed of 300 km/h, do the initial approach, estimation and landing.

- having full confidence that estimation was correct and landing on chosen area is still possible, extend flaps first at 25^0 and then at 44^0, set gliding speed of 250-260 km/h;
- make sure that the throttle is in «STOP» position;
- at altitude of not less than 100m, close the fuel shut-off valve, disable the **«BATTERY»** (**«NETW»** in rear cockpit), **«GENERATOR EMERG.»**;
- flaring must be performed based on vertical descent speed, in case of vertical speed of 10-15 m/s, perform two-stage flaring. At altitude of 50 m do the first flaring. While flaring move descend point to beginning of the runway, vertical speed is reducing to 3-5 m/s. Second flaring is performed in a normal way at altitude of 8-10 m. If altitude over outer NDB is 600 m, flaring is performed in a standard way.
- land.

IF DURING DESCENT:

- *speed is constant, then the assessment is correct;*
- *speed is increasing, then landing at runway (surface) is possible, but altitude is higher than needed and it must be reduced to a value allowing gliding with a constant speed (perform sliding or consequent turns from side to side);*
- *speed is decreasing, then the airplane will not reach the runway (surface);*

6. FLIGHT CHARACTERISTICS

Table № 3

Main specifications		
1. Maximum allowed true air speeds in horizontal flight (flight weight is 4000 kg):		
a) engine operating at maximum thrust (n_{1hpc} =106,8±1%)		
at ground level	km/h	702*
at 5000 m	km/h	757*
at 6000 m	km/h	760*
at 10000m	km/h	737
b) engine operating at nominal thrust (n_{1hpc} =103,2±1%)		
at ground level	km/h	640*
at 5000 m	km/h	712*
at 6000 m	km/h	720*
at 10000m	km/h	694*
2. Maximum vertical speeds (take off weight is 4300 kg):		
a) engine operating at maximum thrust (n_{1hpc} =106,8±1%)		
at ground level	m/s	22
at 6000 m	m/s	10,8
at 10000m	m/s	3,4
b) engine operating at nominal thrust (n_{1hpc} =103,2±1%)		
at ground level	m/s	16,3
at 6000 m	m/s	8
at 10000m	m/s	2,6
3. Service ceiling (standard conditions, take off weight 4300 kg)	m	11 500
4. Minimum time required for reaching altitudes (standard conditions, take off weight 4300 kg)		
a) engine operating at maximum thrust (n_{1hpc} =106,8±1%)		
6000 m	min	6,4
10000 m	min	16,9
service ceiling, when from 10000m engine operates at nominal thrust	min	40
b) engine operating at nominal thrust (n_{1hpc} =103,2±1%)		
6000 m	min	8,6
10000 m	min	22,4
service ceiling	min	40,8
5. Maximum range and duration of flight, when flying at 5000 m with 5% remaining fuel		
- with empty wing tanks is 850 km and 2 h 11 min		
- with full wing tanks 1015 km and 2 h 35 min.		
6. Take off roll on paved runway with engine operating at maximum thrust needed to reach take off speed of 185-190 km/h is 480-530 m.		
7. Landing roll on paved runway with use of gear brakes when landing with IAS of 180 km/h is 650-690 m.		

*: speeds listed here are in compliance with standard conditions (ISA).

TYPICAL SPEEDS OF HORIZONTAL FLIGHT

- minimum (stall speed)
- cruise
- maximum

Minimum speed (stall speed) is a speed at which lift force is maximum (Cy- 1.31). In flight configuration with weight of 4100 kg this speed is equal to 180 km/h, in takeoff configuration -165 km/h, and in landing configuration – 145 km/h. Due to safety reasons flight is allowed at speed which is slightly higher than minimum speed. This is so called evolution speed, equal to 200 km/h.

Cruise speed is a speed at which aerodynamic drag is minimal. Horizontal flight at cruise speed is performed at optimal AoA α_{opt} - 7^0 when aerodynamic quality (lift-to-drag ration) is the highest. In flight configuration with weight of 4100 kg this speed is equal to 300 km/h at α_{opt} - 7^0.

Maximum speed of horizontal flight is reached when engine is producing maximum thrust (refer to the table №3).

MAXIMUM ALLOWED SPEED

Maximum allowed speed is a speed which never should be exceeded due to airplane's structural limits, stability and controllability.

In flight configuration with weight of 4100 kg this speed at ground level is equal to 900 km/h.

Due to stability and controllability reasons (in order to avoid being dragged into a dive) maximum speed is limited by Mach number.

In flight configuration with weight of 4100 kg in standard conditions $M_{allowed}$ = 0.8, which corresponds to speed at ground level of 982 km/h.

Up to altitude of 1300m maximum speed is mostly limited by airplane's structural limit, pilot must control IAS.

At altitudes higher than 1300 m maximum speed is limited by stability and controllability, pilot must control Mach number.

With the increase of the altitude maximum allowed speed decreases.

L-39C in the horizontal flight cannot exceed speed limitation, but it can done during descent. Therefore when Mach=0,78 ± 0,02 is reached the airbrakes extends automatically. They create moment which forces airplane to exit from a dive.

During acceleration airplane is stable and has no roll tendency. When speed is increases airplane tries to exit from a dive.

SERVICE CEILING

The service ceiling is the maximum usable altitude of an aircraft.

For the L-39C service ceiling is an altitude at which vertical speed is equal to 0.5 m/s, which is 11500m.

Routine for reaching service ceiling:

- after takeoff maintain IAS of 400 km/h up to altitude at which TAS reaches 500 km/h, maintain this speed (TAS=500 km/h) constant until service ceiling is reached.

AIRPLANE CONTROLLABILITY

Stick movement needed for changing G-factor depends on speed: the higher the speed the more sensitive the airplane.

When the speed increases from 300 to 600 km/h stick movement required to create the same G-factor reduces by 4 times.

Ailerons are efficient up to stall speeds.

Maximum roll rate when ailerons completely deflected at speed of 380 km/h is 1400/s.

Rudder control reversal is absent within the full speed range.

Maximum slide angle reached when pedal is fully deflected is equal to 10^0.

When pedal is fully deflected required balancing roll at speed of 230 km/h is approximately 10^0, at 280 km/h – 15^0.

LONGITUDINAL BALANCE OF THE AIRPLANE IN HORIZONTAL FLIGHT

In flight configuration with weight of 4100 kg, with elevator trimmer in 0^0 and neutral stick airplane is balanced at speed of 380 km/h. Small pushing forces are applied on the stick.

When speed is higher than 380 km/h to balance the airplane the stick needs to be deflected forward, pushing force increases.

When speed is lower than 380 km/h to balance the airplane stick needs to be pushed slightly forward and with further speed decrease pulled towards the pilot.

To remove static forces from the stick trimmer must be used. In flight configuration airplane can be balanced with help of trimmer within full speed range of steady horizontal flight.

Change in balance depending on configuration:

- during gear extension and flaps extension to 25^0 dive moment occurs, which should be compensated by pulling the stick.
- during flaps extension to 44^0 dive moment occurs, which normally should be compensated by pulling the stick, but simultaneously with extension servo compensator triggers and fully compensates this dive moment (pulling forces on the stick), therefore pilot must deflect the stick forward.
- during airbrakes extension climb moment occurs, which should be compensated by pushing the stick forward.

When engine RPM increases from «IDLE» to «TAKE OFF», climb moment appears, therefore stick needs to be pushed forward slightly.