S.C. AEROSTAR S.A.

OFFICIAL TRANSLATION

YAK-52 FLIGHT MANUAL

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CONTENTS

The YAK-52 Flight Manual comprises the airplane main data, its operating limitations, recommendations about the flight preparation and performance, as well as information about the operation of the airplane systems.

1. GENERAL DATA

IAK-52 is a two-seat, low-wing monoplane fitted with tricycle type landing gear retractable in flight, and designed for school and pilot training.
Its characteristics provide sport pilot training for performing simple or high class piloting figures.
The airplane has two cabins - one in front for the pupil, and one at the rear for the instructor.
When necessary, the solo flights can be performed from the front cockpit.
The airplane equipment offers the possibility of performing flights in the aerodrome zone and daytime raids, in normal weather conditions.
In order to ensure the airplane operation on snow-covered aerodromes, the airplane is also fitted with a non-retractable ski-undercarriage.
The airplane may be operated on land strips with a soil resistance of 3.5 kg/cm^2, and in ski plane configuration, on aerodromes with trodden snow, when the snow density is of minimum 0.45 g/cm^3.

1.1. MAIN TECHNICAL DATA

Overall length, m	7,745
Wheel track, m	2,715
Wheel base, m	1,860
Wing	
Area, m^2	15
Wing span, m	9,3
Plane (dihedral) angle, degrees	2
Attachment angle, degrees	2
Ailerons, total area, m^2	1,98
Aileron deflection, degrees -	
up	22
down	16
Flap area, m^2	1,03
Flap deflection, degrees	45
Horizontal tail unit	
Area, m^2	2,86
Dihedral angle, degrees	0
Attachment angle, degrees	1º30'
Elevator with trim tab area, m^2	1,535
Elevator deflection, degrees	
up	25
down	25
Elevator trim tab deflection, degrees	
up	12
down	12
Vertical tail unit	
Area, m^2	1,48
Rudder area, m^2	0,871
Rudder deflection, degrees	
right	27

left 27

Weight and alignment

a) Weight of the airplane	one pilot	two pilots
T-O weight, kg	1215	1305
Empty weight	1015	1015
Fuel load	90	90
Oil load	10	10
Crew with S-4 parachute	90	180

b) Weight of the ski plane	one pilot	two pilots
T-O weight, kg	1245	1335
Empty weight	1035	1035
Load, kg		
Fuel	90	90
Oil	10	10
Crew with S-4 parachute	90	180

Load distribution limits (for both configurations)
in % mean aerodynamic chord

Empty	18-19
At T-O and landing	24-25

NOTE: 1. Max. T-O weight is 1305 kg.
2. Tolerances admitted in operation for the center of gravity are 15-25% mean aerodynamic chord.

1.2. ENGINE TECHNICAL DATA

Registered mark	M14P
Cooling system	by air
Number of cylinders	9
Setting of cylinders	one row, star arrangement
Compression ratio	6,3+0,1
Propeller rotation direction (along flight path)	left
Propeller, type	V530TA-D35
Engine critical altitude	none
Maximum engine power	360-2% HP

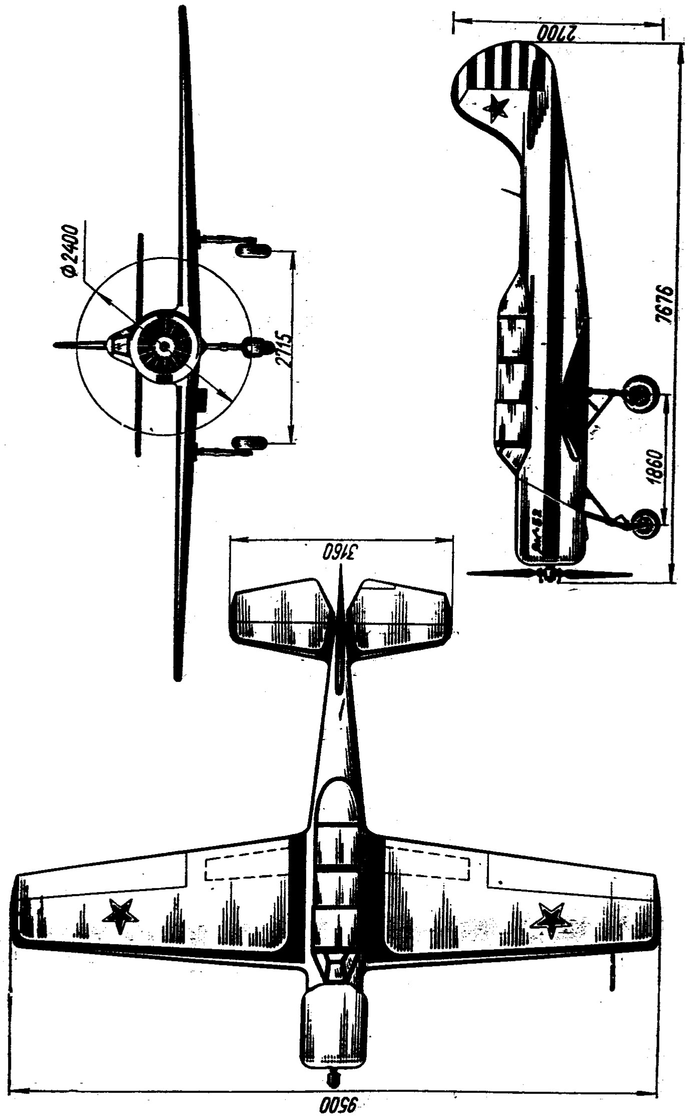

Fig.1 IAK-52 LIGHT TRAINER

Duration of continuous engine operating mode:

- in T-O condition — 5 minutes, maximum
- at maximum engine speed — 1 minute maximum
- other operating modes — unlimited

Racing capacity (time interval needed for the transition from low engine speed 26% to T-O condition) 3 sec. maximum.

Engine overspeeding when actuating the throttle momentarily (for 1 sec maximum) - % - 109

Engine running during inverted flight:

- running condition — nominal
- continuous running, minutes — 2 minimum

Fuel type B-91/115 avgas

Fuel grade 91 minimum

Oil type MK-22 or MS-20 (GOST 1013-49)

Oil pressure at engine intake, kgf/cm^2 4-6

Minimum admitted oil pressure at minimum engine speed, kgf/cm^2 - 1

Oil temperature at engine intake, Celsius degrees:

- minimum admitted — 40
- advisable — 50-65
- maximum at prolonged engine function — 75
- maximum admitted, for max. 15 minutes of continuous engine function - 85

Cylinder head temperatures:

- recommended — 140-190ºC
- maximum, at prolonged engine function — 220ºC
- maximum admitted at T-O and in climb for max. 15 minutes (total duration maximum 5% of resource) 240ºC
- maximum admitted for normal engine running — 120ºC

Recommended air temperature at carburetor intake 10-45ºC

Fuel pressure before the entry into carburetor, kgf/cm^2:

- at min. engine speed — 0,15 minimum
- running condition — 0,2-0,5

The engine operation parameters depending on running conditions are shown in Table 1:

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ENGINE OPERATION PARAMETERS DEPENDING ON RUNNING CONDITIONS

Table 1

Running condition	Engine speed (%)	Pressure: of air at engine intake mm Hg col.	Pressure: of fuel kgf/cm^2	Pressure: of oil kgf/cm^2	Temperature: of cylinder heads	Temperature: of air at carburetor intake	Temperature: of oil at engine intake	Fuel spec. consumption g/hP.hour
T-O	99 ± 1	125 - 15 (over)	0.2 - 0.5	4 - 6	120 - 220	+10 - +45	40 - 75	285 - 315
Nominal 1	82 ± 1	95 - 15 (over)	0.2 - 0.5	4 - 6	120 - 220	+10 - +45	40 - 75	280 - 310
Nominal 2	70 ± 1	75 - 15 (over)	0.2 - 0.5	4 - 6	120 - 220	+10 - +45	40 - 75	265 - 300
Cruise 1	64 ± 1	735 ± 15	0.2 - 0.5	4 - 6	120 - 220	+10 - +45	40 - 75	215 - 235
Cruise 2	59 ± 1	670 ± 15	0.2 - 0.5	4 - 6	120 - 220	+10 - +45	40 - 75	210 -
Low gas	Max. 26	-	0.15 min.	1.0 min.	-	-	-	-

NOTE: 1. Max. adm. cylinder head temperature - 240ºC (for max. 15 minutes)
2. Max. adm. oil temperature at engine intake - 85ºC (for max. 15 minutes)

1.3. FLIGHT CHARACTERISTICS

1.3.1. Max. airspeed in level flight at 1000 m height; the engine in T-O working condition:
- land plane configuration - 270 km/h
- ski plane configuration - 223 km/h

NOTE: Except for special cases, the instrumental speeds are indicated.
1.3.2. Max. flight range at 500 m height, 210-215 km/h airspeed at T-O and 1315 kg weight (119 l of spare fuel) with 10% unusable fuel supply in cruise 2 engine working condition is 510 km.
In this case, the flight duration is 2 hours and 46 minutes.
In ski plane configuration (in the traveling-transport single pilot version) at 500 m height and 175 km/h airspeed - 435 km.
Data for flight range and duration rate are given in the tables 2 and 3.
1.3.3. Stalling speed with engine power off (low gas):
- normal flight - 110 km/h
- inverted flight - 140 km/h
- flaps extended - 100 km/h

1.3.4. T-O run at 120 km/h takeoff speed:
- for land plane - 180 m
- for ski plane - 200 m

1.3.5. Landing run at 115 km/h contact speed:
- for land plane - 300 m
- for ski plane - 240 m

Table 2. Fuel consumption for various flight stages (for land plane and ski plane configurations)

Flight stages	Fuel consumption (l)	Duration, minutes	Range, km
Engine start, heating test and taxiing	2	5	-
Take-off and climb up to 500 m	3	2	3
Descent from 500 m	0.5	1	2.5
Circuit flight at V = 180 km/h	4	5	-

NOTE: Spare fuel - 121 l; 10% fuel supply - 12 l; fuel density 0.75 kg/l.

2. OPERATING LIMITATIONS

2.1. Max. adm. airspeed 420 km/h
2.2. Aerobatic max. adm. airspeed 360 km/h
2.3. Max. adm. working overloads:
- positive +7
- negative -5

For ski plane configuration:
- positive +5
- negative -2.5

2.4. When there are only 20 l left, aerobatics are forbidden.

2.5. Max. adm. flight speed
- with the landing gear extended 200 km/h
- with flaps extended 170 km/h

Maximum adm. flight range and its corresponding duration, at 500 m height and 57% engine speed

Table 3

Configuration	airspeed		Spare fuel in level	T-O spare fuel	fuel consumption		with 10% unusable supply (12 l)			
							range (km)		duration hours - minutes	
	instr.	real			per km (l/km)	per h (l/h)	level flight	real	level flight	real
Land plane one pilot two pilots	190	192	99	119	0.194	37.3	510	510	2-39	2-46
Schi plane one pilot	175	176	99	119	0.222	39.1	435	435	2-29	2-36
two pilots	175	176	45	67	0.222	39.1	200	200	1-09	1-17

Note: The fuel consumption per hour and the flight duration with 10% unusable fuel supply at 500m height (the fuel supply at T-O is 119 l) is respectively: in nominal working condition 1 (n = 82+1%; V = 279 km/h) - 99l/h; 1 hour 7 minutes - in nominal 2 (n = 70+1%, V = 240 km/h) - 67 l/h, 1 h and 36 minutes

2.6. Since the airplane is not fitted with oxygen devices, it is forbidden to perform flights at heights of more than 4000 m.
2.7. Maximum allowed wind velocity at T-O and landing:
- forward component - 15 m/sec
- lateral component at an angle of 90º / 6 m/sec

The maximum allowed airspeed in level flight is conditioned by the avoidance of sudden spins:
- in normal flight 130 km/h
- in inverted flight 170 km/h

2.9. The continuous flight duration in inverted flight is max. 2 minutes.
NOTE: After performing the continuous inverted flight for 2 minutes, the next inverted flight must be performed only after 3 minutes of normal flight.
2.10. It is forbidden to perform vertical inverted aerobatics and spins to the right without instructor.
NOTE: In case of unexpected engagement in spinning to the right, apply the instructions provided in par. 4.9.
2.11. When flying with the landing gear extended, the inverted flight and aerobatics are banned.
2.12. Temporarily; it is forbidden to perform inverted flight air-flow figures (of pendulum type).

3. AIRWORTHINESS

Before starting the checking, the pilot must receive the mechanic’s report concerning the airplane airworthiness.
He verifies if the chokes are set at the main strut wheels, and checks if there are fire protection means in the proximity.

3.1. AIRPLANE INSPECTION

3.1.1. The pilot performs the external check of the airplane and verifies (figure 2):
- that there are no objects under the engine which could be caught by the propeller;
- that there are no damages, fissures or oil leakage on the propeller blades or on the propeller sleeve;
- the presence of lock pins on the pinch bolts of the counter-load collars;
- the fastening of the propeller blades, by checking the fastening marks;
- the cowl flaps - check if no deformations are noticed;
- the engine cowl - if no deformations are noticed, and if the padlocks are well locked in (the padlock marks must coincide with the marks on the cowling); check if there are no leakages;
- if the lid of the air intake duct is removed;
- if the lid of the air intake duct of the oil radiator is removed, the condition of the air intake duct and that of the honeycomb; if there are no oil drippings;
- the wheels - if the tire pressure is normal (at normal flying weight, the nose wheel compression is 15-20 mm, while that of the main wheels is 20-30 mm);
- the absence of fissures and ice on the skis;
- the length of the polished prominence of the damper rod (normal - on the main strut - 205 mm, on the nose strut 131 mm);
- if there is no liquid leakage on the polished part of the damper rod;
- the right wing - if the wing covering and the connecting areas are not damaged, the aileron is not damaged, and check the condition of the aileron hinges); if the locks are taken out and the

free deflection of the aileron, the condition of the wing flaps - if no external damages and deformations are noticed;
- the lower side of the fuselage - if the covering is not damaged and there is no fuel leakage;

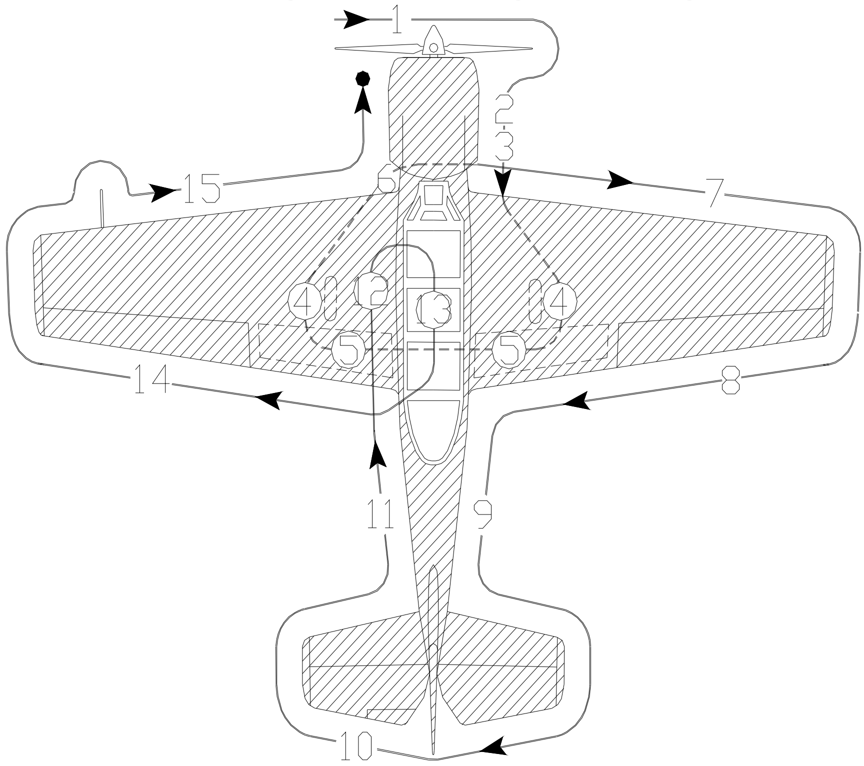


Figure 2
1 – Propeller; 2 – Cowling and shutter; 3 – Engine and air ducts; 4 – Nose leg ; 5 – Flaps; 6 - Main leg ; 7- Right wing; ; 8 – Right aileron; 9 - Right hinder fuselage and UKV antenna; 10 – Outline empennages; 11 - Left hinder fuselage and ARK-15M anntena ; 12 – Canopy; 13 – Front and rear cockpit; 14 – Left aileron; 15 - Left wing and PVD system

- the right side of the fuselage - if there are no damages at the fuselage covering;
- the setting and condition of the radio station antenna;
- the tail unit - if no damage is noticed - both on the tail unit and on the joining areas; the condition of the elevator and rudder hinges, if the locks are removed; the free and full deflection of the control areas;
- the left side of the fuselage - if the covering is not damaged and the trap-door padlocks are shut;
- if the covering, the trap-door of the left wing and the connecting areas are not damaged; the state of the aileron and its suspension; if the locks are taken out, the free deflection of the aileron, if there are no damages or distortions;
- the Pitot hose condition - if the cover is taken out;
- if the protective cover of the DS-1 takeoff transducer is taken out;
- the absence of damages on the pick-up device for incidence angle choke (SSKUA) and if it can move freely from one stop to another (without jamming);

3.1.2. The pilot verifies the fueling and the oil supply. The quantity of supplied fuel is checked visually, according to the tank fuel level and the fuel quantity indicator in the cockpit.
at full capacity (121 l), the fuel level must be below the millings on the filling nozzles with 30 mm maximum.The quantity of the oil supplied in the reservoir is checked with a gauge. The maximum

quantity of oil supplied in the reservoir is 16 l in the case of long distance flights, 10 l for aerobatic flights, and 8 l minimum.After checking the fuelling, verify the shutting off and the fastening of the filling nozzles of the fuel and oil tanks.

3.2. PILOT'S COMPULSORY CHECKS AND ACTIVITIES BEFORE SEATING IN THE COCKPIT

3.2.1. Before seating in the first cabin (Figure 3), the pilot must check the following:

- the general condition of the cabin; if the windshield and the canopy are not dirty or deteriorated;
- if there are no foreign objects in the cabin;
- if the seat is well secured and if it is not damaged;
- if the belts are in good condition;
- if the magneto switch is set to "0" position;
- if the engine start knob is covered with a safety lid;
- if all circuit breakers of network, the breakers and the switches on the electric instrument panel are switched off;
- if the landing gear cock is on "Extended" position and fastened with a ratchet, and the flap cock is on neutral position;
- if the braking lever is fastened in the lock;
- the height and duration readings on the KAP-3 (PPK-2P) device of parachute - the instrument must show a duration of 2 seconds and the height which surpasses the aerodrome altitude with 1000 m.

The parachute fastening system is adjusted according to the pilot's size, the parachute is laid in the seat cup and the carbine of the parachute instrument wire is attached at the seat cup hold.

NOTE: If the airplane is fitted with skis instead of wheels, the landing gear cock must be locked on neutral position by fixing the distance sleeve painted in red, in order to avoid the sinking of the landing gear cock handle ball.

3.2.2. Before installing in the rear cockpit (figure 4), beside the checks previously indicated, the pilot must also check the following:

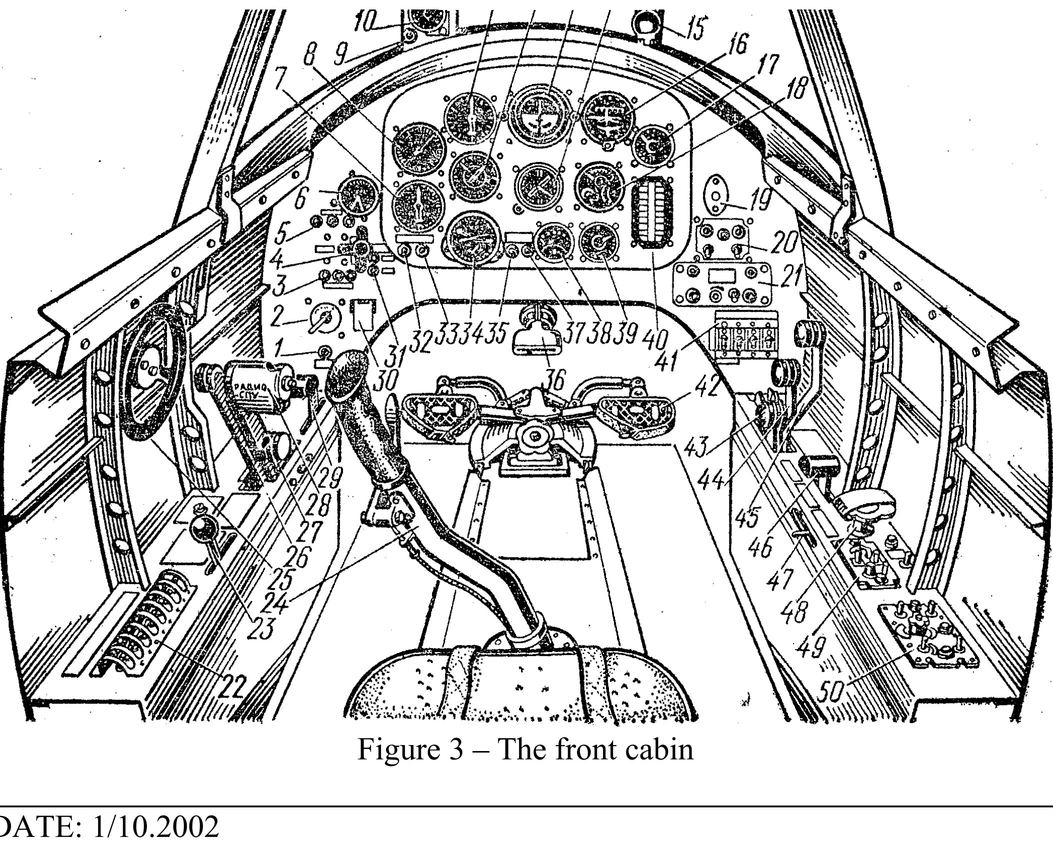


Figure 3 – The front cabin

1. Lamps control knob 2. PM-1 magneto switch 3. Landing gear extended advisory lamps 4. Landing gear extension and retraction cock 5. Landing gear retracted advisory lamps 6. 2M-80K double manometer of compressed air 7. Manovacuum gauge (MV-16K) 8. ITE-1K tachometer 9. Boundary overloading warning lamp 10. AM-9S accelerometer 11. US-450K airspeed indicator 12. VD-10K altimeter 13. AGI-1K gyrohorizon 14. UGR-4UK indicator from the GMK-1A kit 15. KI-13K magnetic direction indicator 16. DA-30 combined device 17. VA-2K voltammeter 18. EMI-3K indicator 19. Supply pump 20. SPU-9 subscriber's panel 21. Landis-5 radio station control panel 22. Electric panel of circuit breakers(the automatic safety devices of network) 23. Flaps control cock 24. Stick 25. Trim tab control steering wheel 26. Propeller pitch control lever 27. Binding handle 28. Throttle with "Radio" and "SPU" knobs 29. Fire cock control lever 30. Engine start knob 31. "Flaps up-down" signalling lamps 32. "Generator out of work" signalling lamp 33. "Borings in the oil" signalling lamp 34. ACiS-1K watch 35. "PVD heating" signalling lamp 36. Cabin venting line 37. "Don't use GMK" signalling lamp 38. TUE-48K indicator for the mixture temperature 39. TTT-13K indicator for the cylinders temperature 40. IUT-3-1 fuel level indicator 41. Electric panel for the network safety devices 42. Swing bar (rudder-pads) 43. Locking lever 44. Control lever of oil radiator hatch 45. Control lever of cowl flaps 46. Control lever of mixture heating 47. Ventillation (venting) control lever 48. Landing gear emergency extension cock 49. ARK-15M control panel 50. PU-26 control panel from GMK-1A

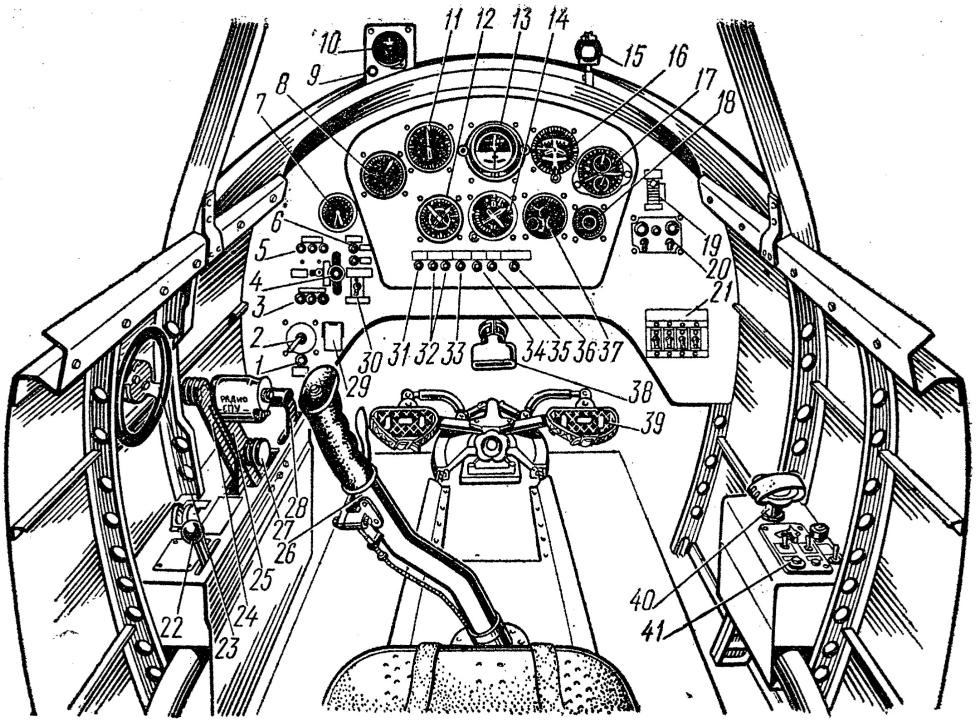


Figure 4. Rear cabin

1. Lamps control knob 2. PM-1 magneto switch 3. Landing gear extended advisory lamps 4. Landing gear extension and retraction cock 5. Landing gear retracted advisory lamps 6. "Flaps retracted" advisory lamps 7. 2M-80K double manometer of compressed air 8. ITE-1K tachometer 9. Boundary overloading warning lamp 10. AM-9S accelerometer 11. US-450K airspeed indicator 12. VD-10K altimeter 13. AGI-1K gyrohorizon 14. UGR-4UK indicator from the GMK-1A kit 15. KI-13K magnetic direction indicator 16. DA-30 combined device 17. ACiS-1K watch 18. TTT-13K indicator for the cylinders temperature 19. "Generator Cabin 1-Cabin 2" switch 20. SPU-9 subscriber's panel

21. Foulness simulation electric panel 22. Flaps control cock 23. Trim tab control steering wheel 24. Propeller pitch control lever 25. Throttle handle with “Radio” and “SPU” knobs 26. Stick with the brakes release knob 27. Binding handle 28. Fire cock control lever 29. Engine start knob 30. “Ignition Cabin 1-Cabin 2” switch 31. “Generator doesn’t work” warning lamp 32. Remainder emergency fuel “10 l fuel-left right” signalling lamps 33. “Borings in the oil” signalling lamp 34. “Battery coupled” advisory lamp 35. “PVD heating” signalling lamp 36. “Don’t use GMK” signalling lamp 37. EMI-3K indicator 38. Venting line of cabin 39. Swing bar (rudder-pads) 40. Emergency extension cock 41. ARK-15M radiocompass control panel

- if the “Ignition commutation” switch is set to “Cabin 1” position;
- if the landing gear cock is fastened with the ratchet in neutral position;
- if the flap cock is on neutral position.

NOTE: In the ski plane configuration, the undercarriage cock must be fastened in the same way as in the front cockpit.

3.3. PILOT’S DUTIES AFTER SEATING IN THE CABIN

3.3.1. The pilot must proceed as follows:

- adjust the rudder pads in compliance with the leg length;
- verify the integrity of the belt padlock;
- put on the belts and tighten the middle and inferior belts first, and then the shoulder belts;

When adjusting the length of the belts, the loose end of the belt is taken out from the adjustment buckle; the belt is adjusted, and then its loose end is inserted again in the adjustment buckle.

The pilot verifies the belt padlock fastening:

- connect the earphone coupling cord with the SPU board coupling cord;
- verify if the sliding canopy and the canopy padlocks can be easily opened and closed;
- check the smooth movement of the stick and rudder pads, as well as the rudder and aileron deflection;
- verify the smooth movement and the accuracy of the elevator trim tab deflection;
- adjust the trim tab in climbing (pitch up) position (backward);
- check the condition of the flight and navigation instruments, and that of the other devices;
- check the magnetic direction indicator (KI-3); the magnetic compass should indicate the stationary heading of the airplane;
- settle the altimeter pointers on “0” position, so that the pressure indicated on the instrument scale coincide with the real ground pressure (the maximum allowed difference is 1.5 mm Hg col)

CAUTION! When the difference between the instrumental pressure value and the ground pressure value measured at the weather station exceed 1.5 mm Hg col, the flight is postponed.

- set the overloading indicator pointers to initial position;
- check the watch; if necessary, it is winded up and settled at the right time;
- set the “Noise attenuation” switch located on the radio station control panel to “OFF” position and the tuning knob to the position appropriate for maximum intensity (the Noise attenuation switch will be on the lower position);
- if the braking lever is taken out from the stop.

3.3.2. Open the pneumatic system network cock and verify the following:

- the air pressure in the main and emergency bottles should be of 50 kgf/cm^2 minimum;
- the braking system tightness - when pressing completely the braking lever, with the rudder pads in neutral position, no noise of evacuated air should be heard;

- the operation of the wheel braking system; in order to do that, press the braking lever in the front cockpit and release the wheel brake s from the rear cabin.

3.3.3. Engine control check:

- the pilot verifies if the control levers of the engine, propeller and fire cock are easy to handle; after that, the control lever of the fire cock is set to opened position (fully forward).

NOTE: The check of the drosel choke full opening and shutting is performed with the fire cock shut.

- the pilot also verifies if the cowl flaps, the oil cooler trunk and the air heater from the carburetor entry chokes fully open and close.

3.3.4. The flight mechanic must couple the airplane to the ground supply source.

The “Ground supply - OFF - Battery” switch is commuted to the “Battery” position, the gyrohorizon knob “Press before start” is completely pressed, the PT-200 and AGL automatic circuit breakers are coupled and the board voltammeter knob is pressed (its pointer must show a voltage of minimum 24 V).

The switch is commuted to “Ground supply” position, and the pilot checks the aerodrome power unit voltage (the voltage must be of 27-28 V).

The UKV and SPU automatic circuit breakers, the “Landing gear signaling”, the “Engine devices” and ARK, GMK, “Detachment” are coupled and the pilot checks the following:

- the landing gear signaling; if the green lamps for “Extended” position are lighting;
- the condition of the signaling lamps “Landing gear extended”, “Landing gear retracted”, “Flaps retracted”, “Maximum overload”, “Detachment”, “Stalling speed”, “Borings in oil”, “Generator malfunction”, “GMK is not used”, “Pitot heating”, “DS heating”, by pressing the “Lamp control knob”;
- the condition of the electric instruments - if the pointers are on their initial positions;
- the fueling - the fuel quantity indicator must indicate the real quantity of fuel in the tanks;
- the condition of the fuel quantity indicator signaling lamps by pressing its control knob;
- the operation of the radio station, the radio navigation instruments and the lightening system;
- the operation of the incidence angle signaling system, SSKUA-1;
- the heating of the DS-1 detachment transducer of the SSKUA-A and Pitot system;

After checking, switch off the automatic protection devices UKV, SPU, AGL, “Landing gear signaling”, “PT-200”, “Engine devices”, ARK, GMK, “Detachment” and the “Ground supply-OFF-Battery” switch.

WARNING! To avoid the airplane battery discharge, perform the preparation and inspection of the electric instruments and radio devices as follows:

- from the aerodrome power source, when the engine doesn’t work;
- from the generator, when the engine works at 1200 rpm minimum.

3.4. STARTING, HEATING AND GROUND TESTING OF ENGINE

3.4.1. Engine start preparation

Before starting the engine, the pilot must do the following:

- make sure that there are no people, transportation means or objects in the vicinity, which might be caught by the propeller;
- make sure that the propeller pitch control lever is set on “low pitch” position;
- set the throttle handle to proper position, one third out of its complete stroke (28-38%);
- make sure that the fire cock control lever is set to “Open” position (fully forward);
- couple the air heating from the carburetor intake (the choke control lever fully backward), in case the ambient temperature is below 0ºC;
- make sure that the magneto is switched off (the switch is set to “0” position);
- make sure that the “Ground supply - OFF - Battery” switch is set to “OFF” position, and the automatic safety device of the “Ignition” network is switched off (in lower position);

- order to the mechanic: "Rotate the propeller!";

During the rotation process, in summertime, the mechanic pumps into the engine 5-6 fuel injections, and in wintertime 8-12 fuel injections, through the injection pump set to "Cylinder supply" position. Then he sets the injection pump to "Through-fare supply", thus getting a fuel pressure at carburetor entry of 0.2-0.5 kgf/cm^2.

WARNING! When the engine is still cold, the propeller rotation is compulsory; when it is warm, the rotation is forbidden.

It is not allowed to pump more fuel than it is prescribed, as the oil that greases the cylinder walls might be washed, leading to piston jamming, or it might accumulate in the lower cylinders, thus leading to a hydraulic shock.

3.4.2. Engine start

The engine can be started both from the airplane battery and from the ground power source.

3.4.2.1. In order to start the engine, the pilot:

- gives the mechanic the command "Free the propeller", after receiving his answer "Propeller free" he sets the "Ground supply-Uncoupled-Battery" switch to "Ground supply" or "Battery" position and couples the "AZS-Ignition", "Landing gear signaling", "Engine devices" and the "Generator" breaker;
- folds the "Start" knob cover and presses the start knob completely;

The knob must be pressed continuously for 3-5 sec.

After 3-5 propeller turns, he couples the magneto (sets the switch to "1+2" position).

NOTE: 1. For a better start, after the first bursting he must pump an incremental quantity of fuel into the cylinders by means of the injection pump.

2. While starting the engine, in case of explosions in the cylinders it is admitted to sustain the engine discharge at a steady function by to and fro movement of the throttle handle (RUD), within the range of appropriate engine speed with 28-30% (1/3-1/2 of RUD full stroke), the tempo of movement is 2-3 seconds.

3.4.2.2. If for a period of 30 seconds no explosions occur at the engine, turn off the ignition.

With the drosel choke of the carburetor fully opened, manually turn around the propeller counterclockwise for 8-10 turns, without supplying the engine and resume the start procedure.

3.4.2.3. After getting a steady working of the engine, release the start knob and bring the throttle handle to the proper position of 38-41%, watching at the same time the gauge readings. If 15-20 seconds after the engine start the oil pressure doesn't reach the value of 1 kgf/cm^2, stop the engine and try to identify the cause of this fault.

3.4.2.4. After the engine is started, the pilot secures the injection pump lever in vertical position, he covers the start knob with its protective cover, and sets the "Ground supply-Uncoupled-Battery" switch to "Battery" position.

3.4.3. Engine heating

3.4.3.1. Before initiating the engine heating procedure, the pilot must do as follows:

- bring the stick and rudder-pads to neutral position;
- press the braking lever.

The engine is heated at 41-44% engine speed until the oil temperature at engine intake begins to increase. When the oil temperature begins to rise, the engine speed is accelerated up to 41-48% (in wintertime up to 51%), and maintaining this engine speed, the engine is heated until the cylinder head temperature is 120ºC minimum and the oil temperature at engine intake is 40ºC minimum.

In wintertime, in order to speed up the engine heating, the cowl flaps and the oil radiator choke must be closed.

3.4.3.2. The engine is considered heated when the cylinder head temperature is 120ºC minimum, and the oil temperature at engine intake is 40ºC minimum.

3.4.3.3. After the engine heating, the pilot must engage the propeller sleeve heating, coupling twice the propeller from low to steep pitch and vice-versa.

3.4.4. Engine test (figure 5)
3.4.4.1. The engine test is performed with the cowl flaps and the oil radiator trap fully opened.
3.4.4.2. The engine test is carried out in nominal working condition II.
For this purpose, the pilot pushes the throttle forward till stop, and then he sets the engine speeds at 70% by means of the propeller pitch control lever. In this case, the instrument readings must meet the values of the parameters indicated in Table 1.
The engine must work steadily, without shocks.
To avoid the overheating as a result of insufficient ventilation, the prolonged running in nominal working condition is forbidden.
3.4.4.3. The pilot observes the working condition of the magneto and spark plugs, by doing the following:

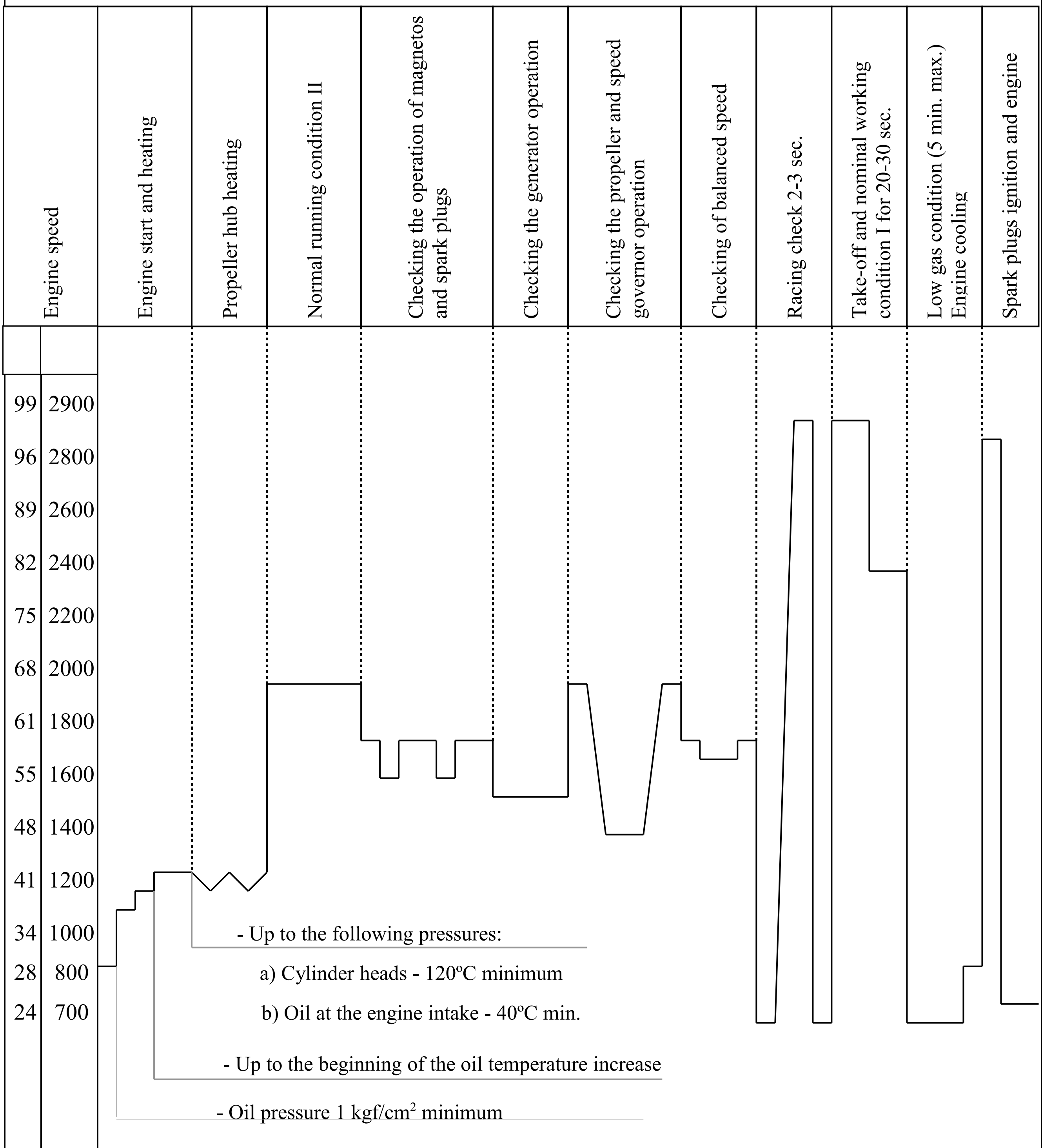


Figure 5 ENGINE TEST DIAGRAM

- setting the propeller in low pitch running configuration;
- setting the engine speed at 64-70% by actuating the throttle;
- uncouples for 15-20 sec. the second magneto and memorizes the decrease of the engine speed;
- couples both magnetos.

The decrease of the engine speed when the engine works with only one magneto must not exceed 3%.

3.4.4.4. For checking the generator working condition the pilot performs the following:

- actuates the throttle and sets the engine speed at 57-58%; when pressing the voltammeter knob, the voltage must be of 27-29 V;
- couples the electric power consumers which are used in flight;
- while the generator works, the red lamp “Generator malfunction” must not be turned on.

3.4.4.5. The pilot checks the propeller and speed governor operating condition, by doing as follows:

- verifying if the propeller pitch control lever is secured in “Low pitch” position;
- actuating the throttle and setting the engine speed at 70%;
- setting the propeller pitch control lever to “Steep pitch” position (fully backward); as a result, the engine speed must decrease at 53%;
- moving the propeller pitch control lever to “Low pitch” position (fully forward); as a result, the engine speed must increase up to 70%. For a short time the decrease of the oil pressure at the engine intake is allowed (up to 2 kgf/cm^2), when after 8-11sec. it is followed by a recovery.

3.4.4.6. The pilot checks the propeller and speed governor operating condition at balanced speed, by doing the following:

- actuating the throttle and setting the engine speed at 70% with the propeller pitch control lever in “Low pitch” position;
- actuating the propeller pitch control lever and setting the engine speed at 64%;
- moving the throttle gently, but no completely, by to and fro movements, for checking if the engine speed remains unchanged.

During the to and fro sudden movement of the throttle, the engine speed might increase or decrease, with 2-3% respectively, but after 2-3 sec the steady operation is restored.

3.4.4.7. The pilot checks the engine operation in take-off running condition for 20-30 sec. (the propeller at low pitch).

The instrument readings must coincide with the values of the parameters indicated in Table 1.

3.4.4.8. The pilot checks the engine operation at minimum speed (the propeller at low pitch, the throttle fully pulled backward)

The engine must work steadily, and the device readings must comply with the parameter values indicated in Table 1.

To avoid the oil deposits on the spark plugs, the time of engine operation at minimum speed must not exceed 5 minutes.

3.4.4.9. Verify the engine operation at minimum rpm (the propeller at low pitch, the throttle fully backward). The engine must work steadily, and the readings on the instruments must correspond to the values shown in table 1.

To avoid oil from reaching the spark plugs area and their damage, the engine operation at minimum speed must not exceed 5 minutes.

NOTE:

When moving the throttle it is allowed to have an rpm decrease to power off for a short time, provided that this doesn’t affect the steady operation of the engine.

3.5. CONNECTION AND CONTROL OF AGI-1 GYROHORIZON

3.5.1. Before coupling the gyrohorizon, fully push the "Press before start" button, and then release it..
3.5.2. Couple the AGI automatic safety device on the electric instrument panel and notice the gyrohorizon readings: the gyrohorizon must show the airplane position versus horizon.

3.6. CONNECTION AND CONTROL OF RADIO STATION

3.6.1. Switch on the UKV and SPU circuit breakers on the electric instrument panel. Two minutes after switching the devices on, the radio station is operative.
3.6.2. Verify the correctness of the communication channel selection from the radio station control panel.
3.6.3. Check the operation of the radio station by establishing the connection with the ground radio station, and if no such station is available, by the presence of radio receiver noises and by auto-reception during transmission.

3.7. PERFORMANCE OF SOLO FLIGHTS

Solo flights are admitted only in the front cockpit.
Prior to carrying out solo flights, check the rear cockpit as follows:

- ensure that no foreign objects are there;
- check if the ignition switch is in "Cockpit 1" position;
- check if the magneto switch is in "1+2" position;
- check if the landing gear selector is secured with the ratchet in “NEUTRAL” position;
- check if the automatic safety device of the "Brake release" line is in "Switched-off" position;
- check if the flap selector is in neutral position;
- check if the breakers on the "Instruments Off Simulation" position;
- check if the parachute is removed from the cockpit;
- check if the harnesses are be well fastened;
- check if the sliding canopy is closed with padlocks.

4. FLIGHT PERFORMANCE

4.1. PRE-TAXIING AND TAXIING OPERATIONS

4.1.1. Check the normal operation of the engine, the flight instruments and the radio equipment, visually check the following:

- looking rearward to the right - ensure that no obstacles or people are in the area of the rear tail unit;
- looking to the left - check if no other airplanes are taxiing at the same time;
- looking in front, to the left - see that no obstacles or people are in front of the airplane.

Perform the same checking operations, in the same sequence, looking to the right.
4.1.2. Ask for permission to taxi. Once granted permission, bring the engine speed to a minimum, check the harnesses, raise your hands and move the palms to left-right, then give the order “Remove the wheel chocks”. After receiving the mechanic's answer “Wheel chocks removed” (signaled by hands over the head), check the operation of the brakes, thus:

- pull out the parking brake lock;
- secure the rudder pedals and the control stick in neutral position;
- press the brake pedals fully, pull the parking brake handle and increase the engine speed to take-off speed, when the airplane must be kept in place by means of the brakes (in ski plane configuration, the airplane must be maintained in place until the engine speed reaches 75-90%).

4.1.3. After checking the brakes, reduce the engine speed to minimum and cast a glance around. By raising your hand, ask for your attendant's permission to taxi. After the attendant gives the signal "Clear to taxi" (his arm directed toward the taxiing direction), close the cockpit canopy, check if the padlocks are well closed (by pushing down the left handle of the padlock until it reaches the stopper, then pull back both handles of the sliding canopy).

In case of ambient temperatures below 0ºC, switch on the "DS HEATING" and "PITOT HEATING" switches, checking their connection (signaled by the lighting of the signaling lamps) and start the taxiing procedure.

CAUTION:

The heating circuit breakers on ground should be switched on maximum 5 minutes before take-off.

Gradually increase the engine speed, so that the airplane should start taxiing from its place without changing its pre-established course. When properly started off its place, the airplane has no tendency of turning around.

The taxiing speed should not exceed the normal speed of a man walking fast.

While taxiing, maintain the control stick in neutral position, smoothly operate the brakes by shortly pressing the rudder pedals several times, with the rudder pedals in neutral position. When taxiing in straight line the airplane has a slight tendency of turning to right that can be counteracted by gently pressing the rudder pedal with the left foot.

In case of a strong crosswind (8-10 m/s) at taxiing, it is necessary to incline the control stick backward as compared to the neutral position, thus increasing the loading of the nose wheel strut, so as to allow the airplane to taxi.

4.1.4. During long taxiing periods, in order to prevent the discharge of the storage battery at low engine speeds, the power users, except for the radio station must be switched off.

During short taxiing periods, the engine speed must be maintained at a level adequate for ensuring the normal operation of the generator.

4.1.5. Taxi the airplane toward the preliminary start line, establish a guiding point for take-off, then look to the left and to the right so as to check if there are no other airplanes taxiing toward the start line.

4.1.6. Driving along the take-off strip for 10-15m in order to set the nose wheel on the take-off path, reduce the engine speed to a minimum and stop the engine.

Set the GMK in GPK condition on the control panel and set the take-off heading on the UGR-4UK indicator.

Controlling the airplane from brakes, check the following:

- if the MK readings on the UGR-4UK indicator correspond to the take-off heading of the strip;
- the accuracy of the AGL gyrohorizon and of the ARK readings;
- if the propeller pitch control lever is set in "LOW PITCH" position - in wintertime, in order to warm the oil in the propeller cylinder, the engine speed is set to 2050 RPM (70%) and the propeller is brought 2 or 3 times from low pitch to high pitch and vice-versa;
- if the elevator trim tab is secured in the necessary position (fully backward);
- check if the wing flaps are retracted.

  NOTES:

  1. It is allowed to take-off with the air-heater switched off, if the air temperature at carburetor intake is min. +10ºC.

2. The position of the cowl flaps at take-off depends on the engine heating and the ambient temperature

- visually check if no obstacles or airplanes are present on the take-off, taxiing and landing runways, if no airplanes are entering a second turn in the air, or approaching to landing after a fourth turn and if they fly at altitudes below 50m.
- Keeping the control stick and the rudder pedals in neutral position, press the brake pedals, increase the engine speed to 54-55% and ask for take-off permission through radio, from the flight control officer.

4.1.7. After receiving the takeoff permit, switch on the clock and increase the engine speed to the value that allows to hold the airplane by means of brakes.

In this case the readings of the instruments must be as follows:

- the cylinder head temperature: 220ºC maximum and 120ºC minimum;
- the oil pressure- 0,2÷0,5kgf/cm^2;

If the readings of the instruments are out of the indicated limits, the take-off is forbidden.

Visually check once more the taxiing runway and begin the take-off.

4.2. TAKE-OFF

4.2.1. Release the brake pedals without changing the pre-established take-off direction and gradually increasing the engine speed start the take-off taxiing, maintaining the control stick in neutral position. During take-off taxiing, bring the engine speed to maximum. While taxiing before take-off, the airplane has a tendency to turn to the right. This turning tendency can be counteracted by pressing the left pedal of the swing-bar.

Throughout the acceleration process, carefully check the following:

- maintaining of direction toward the previously established guiding point ;
- smooth and normal operation of the engine by hearing;
- establishing the airplane lift-off moment.

From the beginning of the acceleration until the airplane lift-off moment, the pilot must look forward, along the cowling, at the horizon, having the land in sight.

4.2.2. When reaching an airspeed of 56 mph (the pilot glances at the airspeed indicator), the pilot gently pushes the stick forward, thus raising the nose wheel in take-off position.

While take-off taxiing with the tail wheel raised, carefully check the following:

- maintaining of take-off position;
- maintaining of direction;
- checking the engine operation by hearing;
- determining the airplane lift-off moment.

From the beginning of the take-off until the airplane lift-off moment the pilot must look forward, along the cowling, having the land in sight.

4.2.3. After take-off, the pilot looks at the ground, to the left with respect to the longitudinal axis of the airplane, at 25-30º and forward at 25-30 m, checking the altitude, the absence of inclination of the airplane and not allowing the wheels to touch the ground again (especially the nose wheel).

4.2.4. The airplane is maintained in level flight at low altitude until the airplane reaches an airspeed of 160 km/h.

Meanwhile the pilot's attention must be focused on:

- maintaining the direction;
- avoiding the tilting and deviations.

The deflection can be determined by the way the land seems to "run" before the pilots' eyes. If the airplane is tilted to the right, the land appears as getting out from under the airplane, while if the airplane is tilted to the left, the land seems to get in under the airplane.When reaching the airspeed of

160 km/h, the pilot gradually brings the airplane in a climbing position, simultaneously looking at the horizon, along the cowling, having in sight the guiding mark so as to maintain the take off direction.
The gain in altitude occurs at 170 km/h.
4.2.5. At minimum 20 m retract the landing gear, by performing the following operations:

- pull the landing gear cock ratchet to the left;
- bring the landing gear cock lever from “Extended” to “Retracted” position, passing over the neutral position without stopping;
- verify the landing gear retraction upon the mechanical indicators and upon the lighting of the red warning lights, when the green lamps (signaling “Retracted” position) must turn off;
- using the elevator trim tab, lift the load off the control stick.

4.2.6. After retracting the landing gear, set the engine in nominal running condition I. In order to do that, reduce the engine intake pressure with 25-30 mm Hg col, then, by slowly actuating the propeller pitch control lever, increase the engine speed up to 82%.
NOTES:
1. The takeoff from ground strips with smooth surface and of adequate strength shows no special distinctive features as compared to the takeoffs from concrete reinforced strips.
2. It is not allowed to "load" the propeller without decreasing the intake pressure first. To increase the engine operating condition, first the pilot needs to increase the engine speed up to the required value for the decrease of the propeller pitch, then to increase the intake pressure.

Takeoff in crosswind conditions

4.2.7. When performing takeoffs in crosswind conditions, even from the beginning the pilot must incline the control stick to the side from which the wind is blowing, so as to maintain an uniform loading on both main wheels.
During takeoffs in crosswind conditions, especially during tail wheel lift-off, the pilot must maintain the takeoff path without allowing the airplane to turn against wind (when the nose wheel is raised, the fuselage acts as a weathercock, being able to turn the airplane around its fulcrums - in this case, the landing gear wheels). The pedal on the side opposite to the stick inclination must not be pressed before, as this may cause the airplane turning in the wind direction. However, at the slightest tilt of the airplane, the pilot must actuate the rudder pedals with accuracy and firmness.
As the airspeed and the ailerons efficiency increase, the pilot gradually brings the control stick to neutral position, in order to avoid the airplane detachment from ground just on one wheel.
4.2.8. After the airplane lifts off, to avoid its deflection, the control stick must be kept inclined contrary to the wind direction (so as to counteract the airplane deflection), while the airplane tendency to turn will be counteracted by pressing the rudder pedals contrary to the inclination sense.
The airplane inclination after lift off must be so as to reduce the wind effect, but no higher.
After reaching the altitude of 50 m the airplane deflection is counteracted by changing the airplane heading.
Apart from that, the take-off procedure and the pilot’s attention distribution order are the same as for the regular take-off procedure, performed contrary to the wind direction.

Ski plane take-off particularities

4.2.9. The braking efficiency and the airplane maneuverability are satisfactory. In the proximity of obstacles the taxiing must be carried out carefully, as the airplane might keep on running even if the skis are completely braked.

4.2.10. The airplane is maintained in place only by means of brakes, depending on the state of the snow layer, until the engine speed is 75-90%. At take-off, in order to raise the nose ski, the force applied to the stick must slightly exceed the force applied upon take-off in landplane configuration.
The nose ski raises at 95-100 km/h airspeed.
Apart from that, the take-off procedure is similar to the take-off in landplane configuration.

Typical errors at takeoff

4.2.11. In the acceleration stage:
- failure to provide full intake pressure - the takeoff run must be increased;
- failure to counteract the airplane tendency of turning to the right - the airplane might turn
- sudden increase of the intake pressure - the airplane might rollover;
- failure to counteract the airplane tendency to turn to the right;
- excessive prevention against airplane tendency to turn to the right - the airplane will turn to the left;
- the nose wheel raises at an airspeed higher than 90 km/h - the airplane will lift off on all its three wheels;
- the control stick is pulled before reaching the airspeed of 90 km/h, the nose wheel lifts off suddenly - the airplane might lift off at a low airspeed;
- excessive lifting of nose wheel - the airplane lifts off at low airspeeds, which might lead to side slipping.

4.2.12. During level flight:
- low level, without gaining altitude - the landing gear wheels might hit the runway;
- slanted level flight - this may lead to airplane deflection;
- level flight at an airspeed higher than 160 km/h - the pilot must increase the airspeed, in order for the airplane to start climbing.

4.3. CIRCUIT FLIGHT

Climbing before the first turn

4.3.1. After the landing gear is retracted and the engine is brought to nominal running condition, the pilot verifies the readings on the engine instruments, as follows:
- cylinder head temperature: 140-190ºC;
- oil temperature at engine intake: 50-65ºC;
- oil pressure: 4-6 kgf/cm^2;
- fuel pressure: 0.2-0.5 kgf/cm^2;

4.3.2. After checking the engine instruments, the rate of climb is set at 170km/h, then the pilot looks in the following directions:
- forward left -to ensure that the sky is clear of other airplanes which might disturb the flight performance, that the flight course is maintained, and to observe the land forms suitable for emergency landing;
- laterally left (up and down) - check if no other airplanes are flying nearby.

The same sequence is observed when checking to the right and right backward.
The pilot must also ensure that the flight course is maintained with respect to the landing marks and that no airplane is engaged in the second circuit flight.
4.3.3. During climb the airspeed is checked by means of the instruments. The pilot visually checks the airplane tilting upon the position of the airplane front part relatively to the horizon, and by checking the gyrohorizon readings.
The flight path is checked upon the guide marks and the gyro-directional readings.

First turn

4.3.4. Prior to the first turn, at an altitude of 130-150 m, the pilot visually checks as follows:
- downward left, backward left, sideways left, upward left, forward left - to check if no other airplanes that might hinder the airplane turn are in the proximity, if the airplane shows no tilting, to establish the landing area in case an emergency landing would be needed in this flight stage;
- backward right, sideways right - to check if no other airplanes are in the vicinity.

This visual control checking sequence is identical for all turns.
After the visual control the pilot chooses a guiding point for the recovery from the first turn. If the wind velocity is below 5 m/sec, the guiding mark for recovery from the first turn is chosen at 90º related to the flight path; if the wind velocity is higher than 5 m/sec, the guiding mark is at an angle smaller than 90º.
In all cases the flight path after the first turn must be normal to the line of landing marks.
4.3.5. At an altitude of 150 m, check if the airspeed is of 170 km/h.
For maintaining the airspeed before entering the turn, push the control stick a little forward. Then by gently and actuating the control stick and the rudder pedals in a coordinate manner, initiate the turn.
When entering the turn, carefully check the following:
- the smooth performance of a bank simultaneously with the initiation of the turn;
- establishing and maintaining the required angle of bank;
- the instrument readings (airspeed, glide indicator ball position, heading - upon magnetic compass, bank value - upon gyrohorizon).

4.3.6. No banks higher than 30º are allowed during circuit flights. However, if the bank reaches this value, gently move the rudder pedals and the control stick contrary to the bank side so as to maintain the recommended speed, to reduce the bank angle and not to allow the slide (the slide indicator ball remains between the marks).
As soon as the recommended parameters for steady turn are settled, carefully check for:
- the maintenance of the recommended bank;
- the instrument readings (airspeed, ball position, bank value - upon gyrohorizon, heading - upon magnetic compass);
- looking in the turn direction, check if no other airplanes are close by.

4.3.7. The airplane recovery from turn begins at 20-25º before the chosen guiding mark, or before reaching the recommended heading. The airplane recovery from turn is achieved by maintaining the airspeed of 170 km/h, by operating coordinately the control areas, and by simultaneously reducing the bank and the rotational speed.
Then carefully check to ensure the following:
- simultaneous reduction of bank and rotational speed;
- instrument readings (airspeed, ball position, bank and heading).

Typical errors when performing the turn

4.3.8. When entering the turn:
- low speed when entering the turn - the turn is performed at a bigger angle of incidence ;
- the rudder is deflected on the turn side (especially at turns to the right), thus preventing the bank - the airplane enters the turn with outward slipping - the glide indicator ball moves outward);
- when the airplane enters the turn after the actuation of the rudder pedals delayed with respect to the bank performance - the airplane slipping is inward - the glide indicator ball moves inward.

4.3.9. During turn:

- failure to maintain the recommended airspeed;
- excessive deflection of the rudder on the turn side - the airplane rotates fast, with skid (the glide indicator ball moves outward);
- the rudder is insufficiently deflected on the turn side - the airplane rotates slowly (the glide indicator ball moves inward).

4.3.10. At the recovery from the turn:

- the airplane has not completed its rotation - the rudder pedals are not in neutral position yet, and there is no more bank - the recovery from turn is carried out with skid;
- the turn was performed at an angle higher or smaller than 90º - the recovery was not initiated in due time, or the operation of the control areas was not correlated with the rotational speed at the recovery.

The flight between the first and the second turn

4.3.11. After recovery, continue the climb maintaining the 170 km/h airspeed, check the direction of recovery related to the line of landing marks upon the guiding marks on ground and upon the compass readings, and , if necessary, make the required corrections.
Then, visually check as follows:

- left - forward and laterally, up and down - check the flight path, to see that no other airplanes are in the area that might hinder the flight;
- left - backward - check in no other airplanes are entering its circuit flight area;
- right - forward and laterally, up and down - see that the flight path is correct and that the flight is not disturbed by other airplanes flying in the area;
- right - backward - check if no other airplanes are approaching from behind (intending to engage in outrunning).

Continuing the climb, watch the altitude and wait for the right moment to begin the second turn.
4.3.12. If the airplane has reached 300 m before entering the second turn, the pilot must gradually move the control stick and bring the airplane in level flight. Reduce the engine intake pressure, until the airspeed reaches 180 km/h and set the engine speed at 70%.

Second turn

4.3.13. Before performing the second flight, determine the distance to the airplanes flying ahead (this distance should be of 1500 m minimum). The lagging with reference to the airplane flying ahead can be achieved by retarding the first and the second turn.
4.3.14. The second turn must commence when the angle between the airplane longitudinal axis and the aiming line at the landing tee is 45º.
4.3.15. The second turn must be performed at 170 km/h in climbing condition, and at 180 km/h in level flight condition. In order to maintain the airspeed before entering the turn, increase a little the intake pressure, and after the recovery from the turn bring the pressure back to its initial value.
When performing the second turn in climbing condition or in level flight, the attention distribution sequence is the same as during the first turn.
The recovery from the second turn must be carried out on a line parallel to the line of landing marks. The heading must be equal to the opposite landing heading.

The flight between the second and the third turn

4.3.16. After performing the second flight in level flight conditions, maintain the airspeed at 180 km/h - in this case the engine intake pressure must be within 470-490 mmHg col, and the engine speed 70%. The sequence of the pilot's actions and attention distribution during the flight between second and third turn are the same as for the flight between the first and second turn.
The pilot must always make sure that no other airplanes or obstacles are on his flight path; to this purpose, he must take repeated and attentive looks 10-15º to the right and to the left, carefully noticing the front and lateral areas.
In circuit flight the airplane flying ahead must always be within the pilot's sight, when the flight is on the left - it must be on his left, when the flight is on the right - it must be on his right.
4.3.17. During the flight in straight line, between the second and third turn, the pilot must verify the flight patch, its width and its parallelism to the line of warning marks.
The circuit width is determined by the projection of the warning marks relatively to the airplane wing.
If the airplane follows a correct flight path, the wing tip will pass on the line of landing marks, without covering them.
4.3.18. While across the landing tee, check once again if the airplanes that fly ahead do not prevent the performance of the third turn. Also check the altitude, the airspeed, the readings of the engine control instruments, the parallelism of the flight path to the line of landing marks. Increase the intake pressure and extend the landing gear: in order to do this, bring the landing gear selector control lever from "RETRACTED" to "EXTENDED" position, without stopping the lever in neutral position.
The landing gear extension is signaled by the warning lamps (the two green lamps must be ON) and by the mechanical indicators (which must completely get out of their grooves). Then secure the landing gear selector lever with the ratchet, remove the loading on the stick by means of the elevator trim tab and ask the flight controller's permission to land.
When the circuit flight is carried out with the landing gear extended, the pilot will ask permission to land when across the landing tee.

Third turn

4.3.19. The third turn begins will be initiated when the angle formed by the airplane longitudinal axis and the aiming line at the landing tee is 45º.
The accuracy of the landing gradient estimation depends on the performance of the third turn in due time.
4.3.20. If the airplane flying ahead performs the third turn far away from the landing marks or if the distance to the airplane flying ahead before engaging in the turn is smaller than 1500 m, the pilot must perform the third turn without delay, without losing sight of the airplane ahead and without losing altitude; then the pilot initiates the second circuit, advising the flight controller of this situation.
4.3.21. The sequence of actions during the third turn is the same as during the first two turns. The third turn is performed in level flight condition at 180 km/h. The trajectory described by the airplane until the fourth turn must form an angle of 70-80º with the line of landing marks.

Flight between third and fourth turn

4.3.22. After recovery from the third turn, look around, count the airplanes flying ahead of him without losing sight of them until they land and clear the landing strip. Check the engine thermal state (in wintertime the cylinder heads must not be cooled below 140ºC and the oil temperature must not fall below 40ºC). Noticing the approach of the landing marks, choose the proper moment to reduce the intake pressure with a view to passing to the gliding procedure. Before the glide

performance, set the propeller to low pitch and checking the tachometer values, check if the propeller is fully unloaded.
When the intake pressure drops, the landing gear will be projected at an angle of about 30º between the airplane transverse axis and the aiming line at the landing tee.
4.3.23. When the airplane has reached this position (related to the landing marks), gradually bring the airplane in descending attitude and simultaneously reducing the intake pressure, set the airspeed at 170 km/h.
Visually check as follows:

- forward left - verify the correctness of the flight path and to see that no other airplanes are soaring before landing;
- laterally left (up and down) - check the airplane position related to the landing marks and check if no other airplanes are in the area;
- backward left - check if no other airplanes are crossing your airplane trajectory;
- forward right - the correctness of the flight path and if there are no other airplanes approaching for landing from straight line flight;
- laterally right (up and down) - if there are no other airplanes entering the circuit flight;
- backward right - if there are no other airplanes engaged in outrunning your airplane.

4.3.24. For adjusting the landing gradient it is allowed to rotate the airplane toward the outer side, or to bring it to the landing marks, but no more than 20º, banked at 30º maximum.
If the flight route is followed correctly and if the landing gradient is well assessed, the loss of altitude from the moment of beginning the descent until the beginning of the fourth turn must not exceed 50-100m.
The vertical descent speed in soaring before the fourth turn and during the fourth turn must be of 4-5 m/sec, which can be maintained by reducing or increasing the intake pressure.

Fourth turn

4.3.25. Before performing the fourth turn, carefully look sideways and at the landing strip, so as to avoid the risk of crossing the trajectory of other airplanes that might be engaged in circuit flights or gliding. Then the pilot’s attention should be focused on the performance of the fourth turn.
The turn should be initiated when the distance between the leading edge of the wing and the line of landing marks is approximately 0.5 m, and the angle between the line of landing marks and the aiming line at the landing tee is 15-18º.
4.3.26. The entry into the fourth turn is performed at 170 km/h. The recovery from turn begins at an angle of 20-25º with reference to the line of landing marks, so that at the end of the turn the airplane should be guided precisely on the center of the landing strip. The turn must be completed at an altitude of 150m minimum.
4.3.27. During the fourth turn, mainly focus on the precise coordination of the actuation of the control areas, so as to maintain the airspeed and to enter correctly the line of landing marks.
While turning the airplane avoid pulling the control stick too much, as this may lead to the decrease of the airspeed. This situation is frequently associated with the cases when the pilot delays the fourth turn, and, noticing that the airplane is not brought exactly on the line of landing marks, he tries to hasten the turn, increasing the bank and the rotational speed. During the fourth turn the bank must not exceed 30º.

Descent after the fourth turn

4.3.28. After recovering from the fourth turn, set the soaring angle appropriate to the airspeed of 160 km/h. Set the engine intake pressure in accordance with this airspeed and verify the following:

- the correct direction on the landing path, at the recovery from turn;

- if the landing gear is extended;
- if there is no deviation from the landing direction;
- if there are no other airplanes that might hinder the landing.

Throughout the glide, the pilot must not reduce the intake pressure completely, because in case the engine has not enough capacity to pass in another running condition and if the pilot must perform a second circuit flight, especially at low altitude, when bringing the engine control lever in the previous position, the rpm needed is ensured with delay.

CAUTION: It is strictly forbidden to glide in the proximity of another airplane flying ahead of your airplane, or to land right after this airplane, considering that after landing the other airplane can clear the runway in due time. If the landing procedure is somehow hindered, the pilot must immediately enter the second circuit flight and report the case to the flight controller.

4.3.29. After making sure that there is nothing to hinder the landing procedure, extend the wing flaps by moving the flap selector all the way down. The wing flap extension is signaled by the lighting of the warning lamps. After extending the flaps, maintain the airspeed at 160 km/h.

4.3.30. Maintaining the gliding angle, assess the landing gradient. In case of a correct gradient and flight path, at a wind velocity of 4-5 m/sec., the landing tee must be projected in the middle of the windshield, on the left side, and the gliding trajectory must be directed toward the recovery point (at 100-200 m above the landing tee).

If at a steady angle of glide, when the airspeed is maintained at 160 km/h, the projection of the landing marks does not drift up or down, then the gradient was accurately chosen; if it drifts up, the landing will be “short”, if it drifts down, the landing will be too “long”, which will lead to a too long flight range.

4.3.31. The airspeed to be maintained during the glide for landing (with the wing flaps extended or retracted) depends on the wind velocity:

- at a headwind velocity below 10 m/sec: 160 km/h;
- at a headwind velocity up to 15 m/sec: 170 km/h.

In case of flight in crosswind conditions, the lateral component of the wind velocity must not exceed 6 m/sec. When the wind velocity is higher than 15 m/sec, flights are forbidden.

CAUTION:

If during the gliding, the “STALLING SPEED” warning lamp or the “DETACHMENT” lamp turns on, and an acoustic warning signal can be heard simultaneously, check if the gliding airspeed: if it is below 160 km/h:

- at H<50 m - increase the engine speed until the recommended airspeed is reached;
- at H>50 m - by tilting the stick forward, reduce the angle of incidence and increase the engine speed until reaching the recommended airspeed.

If the canopy is covered with water vapors or frost, perform the landing with the canopy opened.

If the airplane is fitted with skis instead of wheels, at the glide before landing, at an altitude of 50 m minimum, the pilot must actuate the brake lever a few times in order to avoid landing with frozen skis.

Landing slope correction

4.3.32. The path leading to a “short” landing is corrected by engine racing. The correction of minor deviations is achieved by increasing the intake pressure and by a certain lessening of the gliding angle, while the angle is maintained at 160 km/h. When the airplane approaches the landing strip very shortly, the deviation is corrected by engine racing in level flight at 160 km/h. The engine racing may be effected up to the altitude at which the recovery is initiated, i.e. up to 5 - 6 m, when initiating the recovery.

4.3.33. The glide path leading to a “long” landing is corrected by the increase of the gliding angle and the simultaneous decrease of the intake pressure, while maintaining the airspeed at 160 km/h. The descent in conditions of reduced pressure aiming with a view to adjusting the gliding path angle must be completed before reaching the altitude of 50 m; after that the gliding angle must be reduced, because when descending with the flap extended and the intake pressure reduced to a minimum, the vertical descent airspeed is 6-7 m/sec, and the gliding angle reaches 10-12º, which renders the landing more difficult.
It is not recommended to adjust the slope only through gliding, as a high rate of descent when the intake pressure is reduced to its minimum fully provides the correction of the landing path.
4.3.34. If needed, the gliding path may be corrected by skidding until reaching the altitude of 50 m, at an airspeed of 160 km/h and inclinations of 30º maximum. Before gliding, by way of coordinate actuations of the control surfaces the airplane is turned contrary to the skidding side with 10 - 15º, then by gently moving the control stick, the airplane is inclined to the skidding side. As soon as noticing the airplane tendency to turn to the inclination side, gently press the rudder pedal opposite to the bank side. The skidding direction must be parallel to the line of landing marks. The airplane skidding can be stopped by moving the stick contrary to the inclination and by bringing the rudder pedals in neutral position. The airplane recovers rapidly from skidding. If there is still deviation on the skidding side, it can be removed by leaning the airplane for a short time at 5 - 10º contrary to the skidding side.
4.3.35. If the pilot cannot correct the gliding path before reaching the 50 m altitude, he must enter a second circuit flight, after reporting this case to the flight controller.

Transition to the second circuit flight

4.3.36. The transition to the second circuit flight is performed usually at a altitude of 50 m, and, in emergency cases at any altitude. To pass to a second circuit flight from above 50 m, the pilot must gradually increase the intake pressure to the maximum, without altering the gliding angle.
Throughout the process of increasing the intake pressure, the airplane tends to bed to the right. In order to counteract this turn to the right, gently press the left rudder pedal and keep the airplane in straight line by maintaining the gliding angle. After bringing the intake pressure to a maximum, gradually bring the airplane in climbing configuration. at an airspeed of 160 km/h.
In the case of passing to the second circuit flight from the recovery altitude (only in exceptional occurrences), without losing sight of the ground and continuing the landing procedure, the pilot must increase gradually but firmly the intake pressure to the maximum and to gradually bring the airplane in climbing attitude at an airspeed of 160 km/h.
After reaching the altitude of 70-80 m, increase the airspeed to 170 km/h, retract the flap by bringing the flap selector lever from “EXTENDED” to “RETRACTED” position. The wing flaps retract gently, the loss of altitude due to this maneuver being 10 m maximum.
Before the first turn the flight path is kept parallel to the landing marks line and the pilot must carefully watch the airplanes that are taking off. The first turn is performed at 150 m.
If the performance of the second circuit flight was imposed by the inaccurate estimation of the landing path, then at the second estimation of the path, the pilot must bear in mind his errors and make the necessary corrections.

Typical errors at the approach for landing, in the estimation of the landing path, in the correction of the landing path and at the transition to the second circuit flight

4.3.37. Typical piloting errors at the approach for landing and in the estimation of the gliding path:

- at the transition to descent before the fourth turn, the intake pressure is reduced too soon or too late, the turn is performed at a higher or lower altitude than required, which may lead to a "short" or "long" leading;
- throughout the gliding preceding the fourth turn, the intake pressure is higher or lower than required (the fourth turn is performed at a smaller or higher altitude) - this may lead to a short or long landing;
- the fourth turn is not carried out in time - the airplane landing path is out of the landing strip limits (marks);
- in the case of soaring in crosswind conditions the deviation is not avoided - the airplane does not approach for landing on the line of landing marks.

4.3.38. Piloting errors of landing path estimation by the racing of the engine:
- first the gliding angle is reduced, then the intake pressure is increased, thus leading to a fast decrease of the gliding speed - the airplane may engage in a sideslip;
- the intake pressure is increased, but the gliding angle is kept unchanged - the airspeed increases;
- at the end of the engine racing the intake pressure is reduced, then the gliding angle is set - the airplane loses altitude;

4.3.39. Piloting errors of landing path estimation correction by skidding:
- the rudder is not sufficiently deflected contrary to the skidding side - the airplane rotates on the inclination side;
- the stick is pulled or pushed too hard - the recommended airspeed is not maintained;

4.3.40. Piloting errors at the transition to the second circuit flight:
- first the gliding angle is reduced, then the intake pressure is increased - this leads to stall;
- while increasing the intake pressure, the airplane tendency to turn to the right is not sufficiently counteracted - the airplane banks to the right and laterally drifts with respect to the line of landing marks;
- the intake pressure is not fully increased or the propeller is not fully unloaded - the airspeed decreases, and the airplane climbing is too slow;
- during the transition to the second circuit flight at a low altitude the pilot loses sight of the ground - the undercarriage wheels may hit the ground

4.4. LANDING
Recovery

4.4.1. At 30 m altitude, check once again if the landing strip is clear, if the airspeed is within normal limits and look at the ground on the left side of the canopy when the recovery begins. Without losing sight of the ground, maintain the gliding angle (if the landing gradient is correct), permanently checking the gliding path, make sure that there are no banks and deviations and observe the airplane approach to the ground so as to determine in due time the altitude from where to initiate the recovery.
4.4.2. At 5-6 m, by pulling the stick gently, start the recovery, so that at an altitude of 0.75-1 m the gliding angle should be annulled. Simultaneously, gradually reduce the intake pressure so that when the airplane is out of the gliding attitude at 0.75-1 m the throttle quadrant (the engine control handle) should be completely pulled. The faster the ground approaches, the stronger the handle should be pulled.
During recovery the pilot's entire attention should focus on assessing the ground clearance, without being distracted by anything else. During recovery the pilot must look at 20-25º to the left with respect to the airplane longitudinal axis and at 25-30 m ahead.

Before and during the recovery, the pilot must not cast glances at the ground "running" under the airplane, but he must look attentively at the ground trying to assess the ground clearance precisely. So, the pilot must not stare at a certain point on ground, but he must watch the entire runway so as to estimate the ground clearance more easily.
During recovery, his attention must be distributive, so as to achieve the following:

- assessing of the altitude and of the vertical descent speed of the airplane;
- gradually reducing of the intake pressure;
- determining of inclinations and deviations;
- the flight path control.

Flattening out

4.4.3. After recovery, quickly check the altitude to see if the recovery was not ended too high. The height must be 0.75-1 m maximum. The flattening out is performed from this height (the airplane is maintained at this height in order to reduce the airspeed prior to landing.
The pilot must bear in mind that after ending the recovery, when the intake pressure is fully reduced, the airspeed decreases fast and the duration of the flattening out will be short.
Throughout the flattening out, do not bend your head laterally, as it might make you wrongly assess the airplane position with respect to the ground, which might lead to sudden banks of the airplane and to loss of direction.
The pilot must hold his back straight, slightly turning its head to the left. He must also take into account that due to the transversal V of the wing, a false impression is created that there is a bank to the right. The disregard of this aspect may result in the pilot's wish to correct the airplane apparent bank to the right, thus generating a bank to the left.
The banks that might appear may be corrected by means of the ailerons and by strongly pressing the rudder pedal contrary to the bank side, and, as soon as the bank is annulled, by bringing the control surfaces to neutral position.

Landing

4.4.4. As the airplane descends from the height of 0.75-1m, approaching smoothly and steadily to ground (by pulling the control stick), bring the airplane in landing position so that the ground contact should occur from 0.15-0.25 m, without banks, on the main wheels. The landing speed with the wing flaps extended is 115-120 km/h. When the airplane wheels touch the ground, keep the control stick firmly. After the ground contact by gently pulling the control stick keep the airplane in landing position until the airplane loses speed and lowers on the nose wheel.
4.4.5. If the airplane touches the ground with all its three wheels, during taxiing, the pilot must pull the stick gently, thus reducing the loading on the nose wheel; in this case, it is forbidden to let the nose wheel detach from the ground.
If the landing has been performed from above 0.25 m, the airplane may get down hard on the main gear wheel. In this case, it is forbidden to push the control stick (so as to avoid the hard impact of the nose wheel to the ground).

Landing run

4.4.6. After landing, when the airplane is also supported by the nose wheel and runs steady, the pilot may begin the braking procedure. While braking, the pilot must make sure that the rudder pedals are in neutral position. The braking action is performed by short actuations of the brake levers.
While taxiing, the direction is maintained by following the reference marks on the horizon. If the airplane changes its direction when pressing the brake lever, then interrupt the braking action.

During taxiing the airplane is steady both on two and on three wheels, and it has no tendency to turn. When landing on a soft ground runway, the brakes must be actuated cautiously.
4.4.7. After finishing the taxiing procedure, look to the left (to the right) backward, to see if no other airplane is coming from the left or right, increase the engine speed, and continue taxiing so as to clear the landing strip.

Landing in crosswind conditions

4.4.8. In case of gliding for landing in crosswind conditions, the deviation that occurs may be neutralized by inclining the airplane contrary to the wind direction; in order to prevent the airplane turning as a result of its bank, deflect the rudder contrary to the bank.
The bank amplitude will only be so high as to prevent the airplane deviation.
At recovery the pilot must maintain the airplane bank at the same value necessary during gliding.
4.4.9. During the flattening out procedure, while gradually bringing the airplane in landing position (at the required angle), simultaneously reduce the inclination (bank) so that when it touches the ground, the airplane bank should be completely annulled. To keep the course, as the bank decreases, gradually release the rudder pedal. If at the end of the flattening out a new deviation tendency occurs, right before the ground contact on the two main wheels (but no sooner) it is necessary to smoothly press the pedal from the deviation side so as to diminish the side load on the landing gear.

Landing particularities in ski plane configuration

4.4.10. Throughout the glide preceding the landing procedure, at 50 m minimum, press a few times the brake lever so as to avoid landing with frosty skis.
After the ground contact on the main skis, almost instantly the nose ski touches the ground, too.
During taxiing, the airplane is stable.
The airplane behavior does not indicate any distinctive particularities from the behavior in land plane configuration.

Typical piloting errors at landing, causes and corrective actions

4.4.11. The recovery takes place at a too high altitude. Possible causes:
- pilot's inability to estimate the real ground clearance;
- incorrect sighting during landing (too near to the wing or fuselage);
- tendency to land sooner, disregarding the altitude and the airspeed (especially in the case of a too "long" landing path);
- excessive caution (in case of uncertainty regarding the right assessment of the ground clearance).

4.4.12. Corrective action in case of recovery from a too high altitude:
If the pilot notices that the recovery is performed at a too high altitude, he must keep the stick in place to allow the airplane descent, then he must continue the recovery by actuating the stick in such a way as to finish the recovery at 0.75-1 m.
In case the recovery is ended too high i.e. at 1.5-2 m, the pilot must slightly push the stick so that the airplane should get down to 0.75 m, then by pulling the stick he shall perform the normal landing on the main wheels.
It should be noted that, after a high recovery, when the intake pressure has already been reduced to its minimum, the airplane approaches the ground with increased speed; therefore the stick must be pulled more vigorously, but not suddenly.
4.4.13. Vertical jump. Possible causes:
- higher gliding speed than required (especially at too long landings);

- incomplete reduction of the intake pressure while flattening out;
- the pilot looks does not look at the ground;
- incorrect sighting (too close to the airplane wing leading edge);
- distraction from the ground viewing;
- late start of the flattening out; therefore the flattening out is performed by a strong pull of the stick.

4.4.14. Ways to correct the vertical jump:
As soon as the pilot notices the vertical jump, he stops the airplane from getting farther from the ground by gently pushing the control stick.
If the airplane has not lifted higher than 1.5 m, stop pushing the stick and as the airplane approaches the ground, by gently pulling the stick, perform a normal landing.
In case of a vertical jump of about 1.5-2 m, the pilot must gently push the stick so as to stop the increase of the ground clearance, then, as the airplane goes down, he must perform a normal landing procedure, by gently pulling the stick.
After carrying out the jumps, the airplane approaches the ground with increased vertical speed; for this reason the stick must be pulled faster, correlated with the airplane descent, so as to ensure the landing position at 0.15-0.25 m. For this purpose, the airplane direction must be maintained, without allowing the excessive inclination or pulling of the stick.
If the jump was not interrupted in due time and the airplane has lifted off up to 2m or higher, the pilot must counteract the side slipping by actuating the swing bar and the stick accordingly, without losing sight of the ground. Then he must continue the landing procedure and simultaneously increasing the intake pressure, he must perform the flattening out until reaching a speed of 160 km/h, then carry out a second circuit flight.
4.4.15. While performing the landing procedure, the pilot must observe the following rules:

- whenever changing the airplane position the pilot must not lose sight of the ground;
- when the wheels touch the ground the stick must be maintained in position;
- during vertical jumps, the stick should not be actuated more than necessary;
- when the airspeed decreases, the airplane tendency to sideslip is counteracted by the quick actuation of the stick and the rudder pedals;
- at the airplane descent, as the airplane approaches the ground, pull the stick so that the landing should be performed easily on both main wheels, at the appropriate angle of attack for landing.

Taxiing

4.4.16. While taxiing, look ahead of you, at the runway and notice the airplanes that are landing, taking off or taxiing. If there is another airplane taxiing ahead, from the landing runway toward the taxiing runway, you must give priority to this airplane. During taxiing watch the cylinder head temperature and the oil temperature.
Retract the wing flaps, and then switch off the AZS, PITOT HEATING, WATCH and DS HEATING circuit breakers.
In case of prolonged taxiing, in order to avoid the discharge of the storage battery, switch off the radio compass. The taxiing speed must not exceed the speed of a man walking fast.
4.4.17. The taxiing toward the airplane stationing place or the preliminary line of departure must be performed with a companion, who will meet the airplane 30 m before any obstacle. When the pilot is accompanied by a companion, he must watch carefully the signals of this companion.
After reaching the parking line or the preliminary line of departure, stop the engine (if the takeoff is not repeated)
CAUTION:

It is forbidden for the pilots to change their places when the engine runs.

4.5. ENGINE STOPPAGE

4.5.1. Prior to stopping the engine switch off the radio, the radio compass, the Intercom unit and then, if necessary, cool the engine.
The following operations are necessary when cooling the engine:
- fully open the engine cowl flaps and the oil radiator trapdoor;
- reduce the engine speed to 28-34% (propeller at low pitch) and maintain this working condition until the temperature of the cylinder heads drops to 140-150ºC. It is not advisable to stop the engine when the cylinder head temperature is higher than 140-150ºF.

Before stopping the engine the pilot must avoid the prolonged running of the engine at low speed.
4.5.2. After the cooling of the cylinder heads, stop the engine.
To stop the engine proceed as follows:
- increase the engine speed to 65-68% for 20-30 seconds for the ignition of the spark plugs;
- by actuating the engine throttle lever, decrease the engine speed to 28-34%;
- uncouple the magneto by setting the switch on "0" position;
- smoothly push the engine throttle lever (the drosel choke of the carburetor is opened).

4.5.3. After stopping the engine, bring the engine throttle lever in the position corresponding to the minimum operating condition (fully backward) and close the fire cock (while the airplane is stationing between flights).
Switch off all the other circuit breakers, switches and micro-switches on the electrical instrument panel.
CAUTION:
It is forbidden to stop the engine:
- right after cruising or higher operating conditions;
- by closing the fire cock and using the carburetor fuel (to avoid the flareback and the fire).

4.6. CLIMB

4.6.1. The climb is performed with the engine in nominal operating condition I, at an airspeed of 170 km/h. During climb, check the instrument readings, which should be as follows:
- cylinder head temperature 140º-190ºC (max. admitted 220ºC);
- oil temperature at engine intake 50º-60ºC;
- oil pressure 4-6 kgf/cm^2;
- fuel pressure 0.2-0.5 kgf/cm^2.

4.6.2. If throughout climbing the heat condition of the engine exceeds the allowed limits, even when the oil radiator flap and the cowl flaps are fully opened, the airplane must be brought in level flight, the airspeed increased, and the engine speed reduced.
If these actions do not lead to a temperature drop, then the pilot must interrupt his mission, to announce the flight controller through radio, and, depending on each particular case, to land on the home airfield or on an auxiliary airfield.
4.6.3. In order to achieve a faster climbing, the following airspeeds are advisable:
- from ground to 500 m - 170 km/h;
- between 500 m and 2000 m - 160 km/h;
- between 2000 m and 4000 m - 150 km/h.

In ski plane configuration it is advisable to maintain the airspeed at 150 km/h.

4.7. LEVEL FLIGHT AND DESCENT

4.7.1. The level flight may be performed at any airspeed ranging from 130 km/h up to the maximum airspeed in level flight (300 km/h).
4.7.2. In case of long flights in steady operating conditions, at low ambient temperatures, in order to avoid the increasing of the oil viscosity in the propeller hub cylinder, it is advisable that periodically, after 25-30 m of flight to shift the propeller 2-3 times from low to steep pitch and vice-versa.
The engine speed should vary within the limits of 67-55%, then it sets back to its initial value. In this case it is allowed to have a short decrease of the oil pressure at the engine intake up to 2 kgf/cm^2 (with subsequent recovery within 8-11 sec).
4.7.3. During flight, check from time to time the generator working condition by watching the “Generator out of order” warning lamp and the voltage as read by the instruments.
At least once in a flight and, in case of long flights, every hour check the charging current of the storage battery, by watching the voltammeter readings.
If the value of the charging current is equal to or exceeds 30 A, switch off the storage battery and do not switch it on until the end of the flight.
NOTE: The use of the storage battery at a voltage higher than 30 A leads to intense heating of the battery above the allowed temperatures or even to its complete breakdown, as well as to its ignition as a result of the occurrence and development of the “heat acceleration” process (fast increase of the temperature).
In case of a generator breakdown, switch on the storage battery that has been previously disconnected and continue the flight, in accordance with the indications in paragraph 5.11.
When the flight ends, the malfunctioning battery must be removed from the airplane.
4.7.4. When 12 l of fuel are left in each of the main fuel tanks the "Fuel 12 l left, right" signaling lamps turn on to show the remaining emergency fuel. In this case, you must abort the mission and perform the landing, as this fuel quantity is only enough for 15-20 minutes of flight at the airspeed of 170-180 km/h and altitudes of 500-1000 m.
4.7.5. When performing the training flight in circuit, on horizontal, the airspeed of the airplane with extended or retracted landing gear should be maintained at 180 km/h.
4.7.6. In prolonged descending, when the propeller is fully unloaded, the oil radiator trapdoor closed, the cowl flaps closed and the engine running with a reduced volume of gas, the cylinder head temperature may drop below the allowed limit (140ºC). To avoid that, the descent should be performed either at a high running condition, or by periodical reheating of the engine.

4.8. AEROBATIC FLIGHT

Generalities

4.8.1. Aerobatics is performed in the airfield area. First, the altitude is increased during the circuit flight, then along the route, so that the airplane should reach the advisable altitude in that area.
The climb is performed according to paragraphs 4.6.1-4.6.3.
The route inside and outside the area is performed so as to avoid passing nearby the boundaries of the neighboring areas.
The going out from the circuit flight is carried out tangentially to the closest turn in the zone direction.
On the linear course from circuit to zone, the pilot performs sinusoidal maneuvers on left and right, at 15-20º, banking the airplane at 20-25º, checking the air space and the airplane position with respect to the airfield.
4.8.2. When approaching the zone, evaluate the weather conditions (the altitude of the low limit of the clouds and the visibility) and make sure that no other airplane is present in the area.

After ensuring that the zone is clear, enter this zone and check the airplane position by the zone reference points.
Check the engine heat condition and the altitude.
Stabilize the airplane in level flight at 200 km/h so that no pulling or pushing forces should appear on the stick in this working condition.
4.8.3. When carrying out a mission in this zone, the initiation of the aerobatic maneuvers is made in the airfield direction or contrary to it.
In strong wind conditions the entry into maneuver must be performed in headwind.
Throughout the aerobatic maneuvers, periodically check the readings on the engine control instruments, the flight altitude and the airplane position in the area.
CAUTION: While performing the aerobatic maneuvers, when the airspeed drops below 130 km/h, the “STALLING SPEED” and “STALL” lamps may work discontinuously, thus engaging the acoustic warning.
In this case, to prevent the stall, push the control stick (increasing the airspeed) until the acoustic and light signals are interrupted.
4.8.4. If another airplane approaches the area, thus disturbing the piloting process, the pilot must interrupt the aerobatic flight and get away from the newly-arrived airplane.
Without losing sight of this other airplane, report the situation to the flight controller and act according his instructions.

Turns with 45º and 60º bank angles

4.8.5. The turn with 45º bank angles is performed at airspeeds of 190 km/h and 82% engine speed.
Before approaching the turn, the pilot chooses reference points on the entry and recovery direction, and sets the engine speed and the intake pressure appropriate for the airspeed. By a gradual and coordinated actuation of the control stick and rudder pedals, the airplane engages in turn. As the bank grows steeper, gradually increase the intake pressure so that the bank of 45º should be maintained at the airspeed of 190 km/h. When reaching the required bank and rotational speed, the pilot must maintain the bank by slightly pushing the stick in the turn direction and forward, while on the other hand he must simultaneously actuate the swing bar contrary to the rotation so as to prevent the airplane tendency to increase its rotational speed.
During the stabilized turn the pilot should check the cowling position with respect to the horizon, the bank value, the instrument readings (the airspeed indicator, the position of the slip indicator ball, the vertical speed indicator, the AGL-1), maintaining the steady rotational speed of the airplane.
At 20-25º ahead of the set reference point, by a coordinate actuation of the swing bar and stick contrary to the airplane rotation, the pilot begins the recovery from the turn.
As the bank diminishes, smoothly reduce the intake pressure to the required value.
When the airplane ends its rotation and its bank is removed, the control surfaces are brought in neutral position. At the recovery from turn the airplane tends to lift its nose; for this reason the pilot must slightly push the stick so as to maintain the airspeed.
Now the airplane is engaged in turn and passes easily from one turn to another.
In case of turning to the right, the airplane tends to increase its bank and its rotational speed.
4.8.6. The turn with a 60º bank is carried out at an airspeed 210 km/h and 82% engine speed.
Before performing the turn, the pilot must establish some reference elements on the entry and recovery direction and he must set the engine speed and intake pressure corresponding to the airspeed of 210 km/h. The entry into steep turn is carried out in the same way as in the case of normal turns. As the bank increases, increase the intake pressure, so as to reach a maximum when the airplane is banked at 45-50º.
When the airplane bank is 45º and as it gradually increases, slightly pull the stick and release the swing bar to slightly modify the bank that was set at the entry into turn.

When the airplane is banked at 60º, the turn is maintained by the coordinate actuation of the stick and rudder pedals. The rotational speed is maintained by means of the stick, while the normal position of the cowling with respect to the skyline. Throughout the turn it is forbidden the pull the stick excessively.
The recovery begins at 30º before the preset reference point, by coordinate movements of the stick and rudder pedals contrary to the airplane rotation. To do that, incline the stick forward on diagonal, avoiding the raising of the front part of the airplane.
As the bank decreases, smoothly reduce the engine intake pressure till it reaches the given value. After recovery, in level flight, the stick and the rudder pedals are brought in neutral position.
The distribution of the pilot's attention is the same as in the case of performing turns with a bank angle of 45º.
4.8.7. Typical errors when performing the turns:

- the engine power is not appropriate for the bank value - the airplane loses or gains altitude (the airspeed increases or decreases);
- the stick was pulled too much - additional loads appear - the airplane loses altitude;
- the cowling is not maintained along the skyline by the rudder pedal - the pedal is inclined too much on the turn side, which causes the lowering of the airplane fore part, the increase of the airspeed and the loss of altitude;
- the pedal is inclined too little on the turn side, thus leading to the elevation of the airplane fore part and to the increase of altitude;
- the pilot does not coordinate the actuation of the control surfaces with that of the throttle lever at the entry and recovery from turn, which results in an in-or outboard slip and a failure to maintain the given airspeed;
- the modification of the flight path after recovery (imprecise recovery).

Combat turn

4.8.8. The combat turn is performed at an airspeed of 300 km/h, 82% engine speed and a maximum intake pressure. Before engaging the airplane in turn, the pilot must look around and choose a reference point for recovery (on the tail unit direction).
At the recommended airspeed, by smoothly pulling the stick, bring the cowling on the skyline, then by a strong and gradual actuation of the stick backward on the combat turn side, at the same time with the actuation of the swing bar on the same side, the pilot brings the airplane in a climbing attitude, with an initial bank of 15-20º.
The tempo of the combat turn must be so that after banking it at 130º, the airplane should have the inclination and the elevation angle of 50º. Increasing the bank, maintain this position. Banking the airplane at 150º, 30º before reaching the reference point for recovery, by simultaneously moving the stick and rudder pedal in the opposite direction, the pilot initiates the recovery so that the airspeed is at least 140 km/h.
After the recovery from combat turn in level flight, reduce the intake pressure to the recommended value.
4.8.9. Typical errors wile performing the combat turn:

- low airspeed when entering the combat turn - the airspeed decreases fast and the gain in altitude is insufficient;
- the stick is pulled too much - the airplane loses altitude fast;
- at the beginning of the turn and during its first half, the swing bar is not inclined enough and the stick is not pulled enough - slow initiation of turn, small rotational speed;
- uncoordinated actuations of the control surfaces throughout the turn - the turn is performed with tail skid or side slipping;
- the airplane is banked too much throughout turn - wing skid may occur and the gain of

altitude is too small;
- the bank is not maintained in the second half of the turn - small gain of altitude;
- the recovery is performed at a high angle of incidence - loss of speed is possible.

Nose dive

4.8.10. The initiation of dive is performed from horizontal flight or from turn, at an airspeed of 140 km/h. The dive can be performed with the engine in idle or higher running condition, up to an airspeed of 360 km/h maximum at the recovery end.

Throughout the nose dive the following conditions are not allowed:
- the decrease of the cylinder head temperature below 120ºC and decrease of the oil temperature at engine intake below 40ºC (in case of excessive cooling, the pilot performs a short level flight with increased engine speed in order to heat the engine);
- the continuous running of the engine at an engine speed higher than 86% for more than 1 minute;
- the sudden racing of the engine.

The recovery from dive is performed by gently pulling the control stick, without allowing the increase of the overloading above +7g. During recovery it is advisable to increase the intake pressure smoothly to its maximum value within 2-3 seconds.

4.8.11. Typical piloting errors while performing the nose dive:
- at the transition to dive from turn, the pilot does not actuate the control surfaces coordinately and pulls the stick too much - the airplane may lose speed;
- the sudden transition to dive from straight line flight - a negative overload may appear;
- sudden movements of the control surfaces during dive - the angle of dive is altered;
- overlooking of altitude during dive - the recovery is performed at a lower altitude than necessary;
- sudden recovery from dive by excessive pull of the stick - high overloads occur;
- slow recovery from dive - significant increase of the airspeed and high loss of altitude;
- the recovery from dive is performed with turn - the loss of altitude at recovery is increased.

Zooming (chandelle)

4.8.12. The chandelle can be performed at various elevation angles, including in vertical attitude.

The performance of the chandelle is initiated at the airspeed of 300 km/h, 82% engine speed and maximum intake pressure, by a gentle pull of the stick.

When the airplane has reached the climbing attitude chosen for this mission, the pilot stabilizes the airplane position and controls it by means of the gyrohorizon.

The recovery from chandelle begins at 170 km/h minimum by pushing the stick, without changing the engine running condition. The transition to the level flight must be completed at the airspeed of 140 km/h minimum.

4.8.13. Typical piloting errors when performing the chandelle:
- sudden transition of the airplane to the climbing attitude - high overloads and premature loss of airspeed;
- the pilot forgets to check the airplane position by means of the gyrohorizon - the preset angle of elevation is not observed;
- late recovery from chandelle - loss of airspeed.

Volute

4.8.14. The volute is performed at 180 km/h airspeed, and a bank of 45º.

Before performing the volute, the pilot sets the airspeed at 180 km/h and at the given angle of descent. Then, actuating the stick and the swing bar coordinately, the airplane is engaged in a volute.

The given angle of inclination is maintained by watching the gyrohorizon, not allowing the skidding (the ball is maintained in the middle). The airspeed is maintained by changing the inclination angle of the flight path.
During volute the attention is distributed in the same way as during turns.
At low ambient temperatures the pilot verifies the heat condition of the engine, without allowing the decrease of the cylinder head temperature below 120ºC and that of the oil temperature below 40ºC.
The recovery from volute is achieved by coordinated actuation of the stick and the swing bar.
During the transition to level flight, increase the engine working condition.
At the recovery from steep volute, at an inclination angle of trajectory above 45º, the pilot must first reduce the inclination and then bring the airplane in horizontal flight.
4.8.15. Typical errors when performing the volute:

- non-coordinated initiation of volute - the airplane rotates with in-or outward skidding;
- after initiating the volute, the inclination is not maintained - the airplane may perform a steep volute, with increased airspeed;
- the heat running condition of the engine is not checked - excessive cooling may result and the engine may exhibit malfunctioning.

Skidding

4.8.16. The skidding is performed at an airspeed of 170 km/h.
Before performing the skidding, the pilot chooses a reference point for maintaining the direction, then he brings the airplane in descent attitude at an airspeed of 170 km/h, and rotates the airplane 10-15º contrary to the skidding.
He slopes the airplane on the skidding side, up to 30º, counteracting the airplane tendency to continue rotating by actuating the swing bar accordingly. While performing the skidding, the flight path is maintained by watching the selected reference point.
The recovery from skidding is achieved by actuating the stick contrary to the inclination and by smoothly bringing the rudder pedals to neutral position as the slope decreases.
4.8.17. Typical errors while performing the skidding:

- at the initiation of the skidding, the swing bar was inclined too early on the opposite side - the airplane rotates contrary to the skidding direction;
- the airplane was inclined too much - the airplane rotates on the skidding side;
- the stick was pulled too much - the airplane loses speed;
- the control stick was not kept pulled - the airspeed increases;
- the stick and the swing bar are not tilted coordinately at the entry and recovery - the flight path is not maintained.

Tilting with slow half-rolling

4.8.18.The entry into tilting is performed at 170 km/h airspeed, and 82% engine speed, from level flight.
Before performing the tilting, the pilot must watch the sky, paying special attention to the zone below the airplane and choose a reference point. Then, he brings the airplane in a “nose lift” attitude with an angle of about 15-20º and stabilizes the altitude by the gentle pull of the stick and by bringing it back to neutral position.
By a coordinate and smooth actuation of the stick and swing bar on the desired side, he begins to rotate the airplane around its longitudinal axis.
When the airplane tilting angle exceeds 45º, the pilot must push the stick without allowing the airplane deviation relative to the reference point, and, when the airplane is in “wheels-up” position, it is forbidden to lower the cowling.
When the airplane is in “wheels-up” position, the swing bar is brought in neutral position and the stick is actuated contrary to the rotation so as to stabilize the airplane in inverted flight.

The existence of the bank and the maintenance of the flight path relative to the preset reference point are checked upon the position of the canopy elements with respect to the horizon and upon the AGL-1 gyrohorizon.
While performing the half-rolling, the pilot's attention must be focused on the coordination of the stick and swing bar inclination, the position of the visible canopy elements against the skyline, the maintaining of the flight path with respect to the preset reference point, and the maintaining of the airplane rotational speed.
After the rotation has ceased, reduce the intake pressure with 2/3 of the throttle lever stroke, and by slightly pulling the stick, initiate the dive. When the airspeed is 200-210 km/h, start the recovery from dive, smoothly so that the airspeed at the recovery in horizontal flight is 280 km/h.
At the recovery from dive, the pilot's attention should be focused on: the airspeed control, the tempo of pulling the stick, the absence of the bank, the flight path after the recovery and choosing the right moment for increasing the engine intake pressure.
The intake pressure increase should begin after the airplane exceeds the 45º angle of dive.
4.8.19. Typical errors when performing the tilting with half-rolling:

- the stick is pulled too early or too late when performing the half-rolling - the airplane is deflected laterally from the reference point;
- the ailerons or the rudder are actuated too late or too early for the recovery from rotation - the airplane engages in inverted flight with bank;
- excessive pull of the stick at the recovery from dive - the airplane engages in spinning;
- slow recovery from dive - too high airspeed and too much loss of altitude.

Tilting with fast half-rolling

4.8.20. This maneuver is carried out at 180 km/h airspeed and 82% engine speed.
At 180 km/h, by a firm pulling of the stick the airplane is brought in a "nose lift" attitude at an angle of 10-15º and, without stabilizing the airplane in this position, the swing bar is actuated on the desired side. As soon as the airplane starts rotating, incline the stick diagonally on the rotation sense, and then push it.
30º before completing the half-rolling, stop the airplane rotation by the strong actuation of the stick and swing bar contrary to the sense of rotation.
Right after that, bring the stick and the swing bar in neutral position. The accuracy of the recovery (with respect to the flight path) is established upon the cowling position relative to the preset reference point and upon the distance between the wing cantilevers and the horizon.
After performing the half-rolling, the maneuver is completed by smoothly pulling the stick until the airplane is brought in horizontal flight at 280 km/h.
4.8.21. Typical errors when performing the tilting with fast half-rolling:

- incomplete and weak actuation of the swing bar at the beginning of the fast half-rolling - slow engaging of the airplane in fast half-rolling;
- insufficient pushing of the stick during rotation - side deviation of the airplane relative to the reference point;
- the stick is not brought back in neutral position or is pushed too late during half-rolling - big tilting angle in inverted flight.

Diving turn

4.8.22. This maneuver is performed at 280 km/h, 82% engine speed and maximum intake pressure.
First of all the pilot chooses the position mark to engage in this maneuver and for recovery.
After checking the airplane position for tilting or slipping, pull the control stick strongly, and start performing the aerobatic figure.
In the initial stage of zooming, the absence of tilting is recognized by the position of airplane parts in sight against the skyline; above an angle of 30º, watch the AGL-1 readings.

When the airplane reaches an angle of climb of about 60-70º, this attitude is stabilized by pushing the stick.
When the airspeed is 160 km/h, start rotating the airplane around its vertical axis, by gently and fully actuating the swing-bar on the desired side.
The airplane tendency to revert (in the wheels-up position) is avoided by inclining the control stick diagonally, contrary to the rotation direction.
After the nose lowers below the skyline with 20-30º, fully reduce the intake pressure (to minimum) and set the dive angle to equal the angle of nose lift.
When the airspeed is 190 km/h, start the recovery from dive in level flight.
4.8.23. Typical errors when performing the dive turn:

- the tilting is not counteracted by the actuation of the control stick - the airplane reverts in "wheels-up" position;
- the rudder is not actuated in due time (either too early, or too late) for the recovery from diving turn - when it is actuated prematurely, the airplane does not turn 180º, and, in case of delayed actuation, the airplane turns more than 180º;
- the stick is pulled too slowly or too strongly in dive - in the first case, the airspeed increases too much, while in the second case, there are high overloads.

Nesterov loop

4.8.24. This maneuver is performed at 300 km/h, 82% engine speed and maximum intake pressure.
While in level flight, before carrying out this maneuver, choose a reference point for recovery, check the absence of inclination and slipping, carefully watch the sky, especially above the airplane.
At 300 km/h, by pulling the stick, engage the airplane in looping.
The control stick must be pulled in such a way as to keep the airplane rotational speed approximately steady, and the airspeed at the upper point of the loop should be 140 km/h. If the airplane shows signs of instability at the upper point of the loop, push the stick a little, and then pull it completely.
As soon as the airplane passes over the skyline, gradually reduce the intake pressure and by smoothly pulling the stick, bring the airplane in horizontal flight, so that the airspeed at recovery should be of 260-270 km/h.
When performing the Nesterov loop, the pilot's attention must focus on:

a) when entering the loop:

- the airspeed and the engine working condition;
- the absence of inclination;
- maintaining of direction;

b) in the first half of the loop:

- on reaching the necessary rotational speed;
- the absence of inclination;
- the airspeed;

c) at the upper part of the loop:

- maintaining of direction;
- the absence of inclination;
- the airspeed;
- choosing the right moment to reduce the intake pressure;

d) at the recovery from the loop:

- the angle of dive:
- the airspeed;
- maintaining of direction;
- choosing the right moment for increasing the intake pressure with a view to making the transition to horizontal flight or another maneuver.

4.8.25. Typical errors when performing the Nesterov loop:

- when engaging the airplane in a loop, the stick is pulled suddenly - the airplane loses speed in the first half of the loop, and, if the stick is pulled too slowly, at the approach to the upper point, the airplane may lose speed and a sideslip may occur;
- in the wheels-up position the stick is pulled too much - the airplane performs an improper loop and it may sideslip;
- at the upper point of the loop, when the airplane shows signs of instability, the stick is pushed too much - the airplane may "hang up";
- at the upper point of the loop, the intake pressure is reduced too early - the airplane loses airspeed and may engage in a stall dive;
- throughout dive the stick is pulled too slowly - the airspeed increases too much and loses altitude at the recovery;
- the airplane recovery from dive is sudden - high overloads appear, the airplane may engage in a sideslip or spinning.

Immelmann with slow half-rolling

4.8.26. This maneuver is performed at 320 km/h, 82% engine speed and maximum intake pressure.

The half-rolling is carried out in the same way as the first half of the Nesterov loop, but the stick must be pulled more forcibly.

Approaching the upper point, when the airplane is in the "wheels-up" position and the cowling is 10-15º above the skyline, the airplane must be stabilized in this position for a short time, and by the coordinate actuation of the stick and the swing bar to the desired side, the airplane starts rotating.

As soon as the airplane reaches the horizontal position, its rotation is stopped by the coordinate actuation of the stick and the swing bar contrary to the rotation. Then, the stick and the swing bar are brought back in neutral position.

Before performing the half-rolling the airspeed must be at least 150 km/h.

If the airspeed is below 150 km/h, the pilot must perform the second half of the loop.

When performing the Immelmann, the pilot must focus on:

a) at the entry in half-loop:

- the airspeed and the engine working condition;
- the absence of inclination;
- the way in which the overload modifies.

b) when performing the half-rolling:

- choosing the right moment to initiate the half-rolling;
- the recovery direction;
- the airspeed.

4.8.27. Typical errors when carrying out the Immelmann with slow half-rolling:

- excessive pulling of the stick - loss of airspeed and the airplane may engage in a stall dive;
- the ailerons and the rudder are actuated too early when entering the half-rolling - the airplane leaves the Immelmann at a large angle of climb, it may lose airspeed and it may engage in spinning;
- the ailerons and the rudder are actuated too late when entering the half-rolling - the airplane leaves the Immelmann with a descent;
- the ailerons and the rudder are not actuated on time (either too early or too late) for the recovery from half-rolling - the airplane goes out of the Immelmann with a certain inclination;
- the airplane is inclined at the entry - the Immelmann is not performed in vertical plane;
- when the airplane is in "knife" position the pilot doesn't push the stick - the recovery from Immelmann is performed with deviations from the preset reference point.

Immelmann with fast half-rolling

4.8.28. This maneuver is performed at 320 km/h, 82% engine speed and maximum intake pressure.
The half-loop is performed in the same way as the first half of the Nesterov loop, but the stick must be pulled in a more energetic manner.
Near the upper point, when the airplane is in inverted position and the cowling is 30º above the skyline, by pulling the stick energetically, bring the cowling toward the horizon line and actuate the rudders pedals all the way on the desired side for performing the half-rolling.
When the airplane begins to rotate, incline the stick on the rotation side.
In the “knife” position, the stick must be pushed strongly beyond the neutral position.
30º before the half-rolling end, the pilot actuates the stick and the swing bar contrary to the rotation, and, when the rotation ceases, he brings the controls back in neutral position.
The entry in half-rolling is performed at 170km/h minimum. If the airspeed is higher than 190 km/h, the pilot will perform a slow half-rolling.
When carrying out the Immelmann with fast half-rolling, the pilot must focus upon the following:
a) at the initiation of the half-loop:

- the airspeed and the engine running condition;
- the absence of inclination;
- the nature of the overload changes;

b) when performing the half-rolling:

- the airspeed;
- choosing the right moment to initiate the half-rolling;
- the recovery direction.

4.8.29. Typical piloting errors:

- excessive pull of the stick - fast and premature loss of speed, which at incidence angles leads to sudden stall dives;
- too early actuation of the control surfaces for initiating the half-rolling - the airplane is out of the Immelmann with an angle of climb, it rapidly loses airspeed and may be engaged in a stall dive;
- too late actuation of the control surfaces for initiating the half-rolling- the airplane recovers from Immelmann in descending attitude;
- the control surfaces are not actuated on time (too early or too late) for recovery - the airplane recovers with a certain inclination;
- the presence of inclinations at the entry into half-loop - the Immelmann is not performed in vertical plane;
- in the “knife” position of the airplane, the stick is not pushed enough - the cowling deviates on the rotation side, the airplane does not recover from Immelmann is not carried out on the direction of the preset reference points;
- irregular rotation caused by insufficient speed before the entry into fast half-rolling.

Slow rolling in horizontal flight

4.8.30. This maneuver is performed at 230 km/h, 82% engine speed and maximum intake pressure.
In horizontal flight the pilot chooses a reference point ahead of the airplane, relative to which the rolling will be performed. At the required speed, when pulling the stick the airplane is brought in a climbing attitude (nose lift), at an angle of 10-15º. After that, by strongly moving the stick on the rolling side, the pilot starts rotating the airplane around its longitudinal axis, also actuating the swing bar in the same direction.
When the airplane bank exceeds 45º, start pushing the stick without reducing the rotation speed. First this operation is necessary to prevent the airplane deviation from the preset direction and, when the airplane is in inverted position, to prevent the cowling lowering below the skyline.

In “knife” position (90º and 270º) the pilot must press a little the upper pedal of the swing bar in order to keep the cowling above the skyline.
In inverted position, the swing bar must be in neutral position to avoid the airplane deviation laterally from the reference point. At 30-20º before completing the rolling, pull the stick so as to maintain the airplane on direction and to prevent the lowering of the cowling below the skyline.
When the airplane is almost in horizontal position, start the recovery by actuating the stick contrary to the rotation and, when the rotation has ceased, by bringing it in neutral position.
Throughout the rolling, the pilot’s attention should focus on the cowling position with respect to the skyline, on the way the airplane rotates and on maintaining the direction relative to the pre-established reference point.
4.8.31. Typical errors:

- the lowering of the cowling below the skyline when the airplane is in inverted position - the figure is initiated at a low angle of nose lift (climb angle) or the stick is not sufficiently pulled throughout rotation;
- lateral deviation of the airplane with reference to the preset guiding point - at the rotation completion was pushed too early or too much;
- irregular rotation - the stick was released during rotation;
- conical rotation - the swing bar was inclined too much.

Fast rolling in horizontal flight

4.8.32. This maneuver is carried out at an airspeed of 170-190 km/h, and 82% engine speed.
At the recommended airspeed the pilot pulls the stick shortly and strongly, brings the airplane in a nose lift attitude, at an angle of 15-20º, then, without stabilizing this angle, he moves the swing bar in the rolling rotation direction, taking care to stop the stick actuation when pressing the swing bar.
As soon as the airplane begins to rotate, the pilot inclines the stick in the rotation direction, toward the dashboard.Throughout the airplane rotation, the position of the control surfaces and the throttle lever remain unchanged.
The pilot should look along the cowling, toward the horizon, keeping in sight the wing leading edge so as to choose the right time to start the recovery.
At 20-30º before completing the rolling, the pilot starts the recovery. He simultaneously and strongly inclines the swing bar and the control stick contrary to the rotation. The tempo and the force of actuation of the control surfaces depend on the rotation speed. The more energetic the rotation during rolling, the sooner and more strongly should the pilot actuate the control surfaces for recovery.
In fact the rolling is performed without losing altitude, but with a loss of airspeed of about 20-30 km/h.
The procedure of performing the rolling on the left is similar to that of rolling on the right, but the tempo of airplane rotation is more energetic than in the first case.
As soon as the rotation is finished, bring back the control surfaces in neutral position.
4.8.33. Typical errors :

- the stick was pulled too slowly when bringing the airplane in the nose lift attitude at 15-20º - the airplane is not engaged in the rolling;
- the stick is pulled too much - slow rotation, with a big radius;
- the swing bar is not fully pressed after setting up the nose lift angle - slow rotation;
- the control surfaces are released during rotation - the rotation is unsteady, slow and with a big radius;
- the stick is still pulled, even after pressing the swing bar - slow rotation, unsteady, with a big radius;
- delayed actuation of the control surfaces for recovery - recovery in horizontal flight with the airplane banked on the rotation side.

Spinning

4.8.34. An unexpected stall dive is possible only if the pilots commits severe piloting errors. In this case the stall occurs without preliminary trepidation of the airplane.
For training purposes it is allowed to perform the spinning in maximum two tours, from a minimum altitude of 1500 m.
Before performing the spinning, the pilot must ensure that no other airplanes are in the proximity, particularly checking the area under the airplane.
In horizontal flight condition, at 170 km/h, the pilot stabilizes the airplane by means of the elevator trim tab and checks the readings on the engine control instruments. Then he chooses a guiding point for the airplane recovery from spinning.
In horizontal flight the intake pressure is completely reduced, and, as the airspeed decreases, the pilot gently pulls the stick until reaching 110 km/h, restraining the airplane against side slipping.
When entering the spinning, the pilot's attention should focus on:

- the airspeed indicator readings;
- the vertical speed indicator readings.

At 110 km/h, the pilot lowers the cowling below the skyline, fully actuating the swing bar in the spinning direction. As soon as a side slipping is noticed and the airplane lowers its nose, the pilot pulls the stick behind the neutral position (the ailerons in neutral position).
At the entry into spinning the control surfaces must be actuated gently.
The spinning is initiated identically on the right and on the left.
Throughout spinning the control surfaces are maintained in the same position as at the entry.
The spin is steady, the rotation is strong, without jerks. During spinning, the inclination angle of the airplane longitudinal axis with reference to the horizon is of 50-70º. Actually there are no differences between the spinning on the right and the spinning on the left. During the spinning, the pilot looks at 25-30º with reference to the airplane longitudinal axis, on the rotation sense and 30-40º downward with respect to the skyline.
For recovery, 30º before the pre-established reference point, the pilot must press strongly and completely the swing bar contrary to the airplane rotation and then to push the stick beyond neutral position, right along the longitudinal axis of the airplane.
As soon as the rotation has ceased, the pilot brings the swing bar and the stick in neutral position; then he increases the airspeed to 160-170 km/h, and, by gently pulling the stick, he takes the airplane out of the dive.
When the airplane approaches the skyline, the pilot increases the engine intake pressure and brings the airplane in horizontal flight.
During a tour of spinning (with recovery in horizontal flight), the airplane loses 250-300 m, while during two tours of spinning the loss of altitude is 500 m (with recovery in horizontal flight).
The airplane goes out of spinning without delay at any actuation of the control surfaces for recovery, and even when bringing the control surfaces in neutral position.
4.8.35. Typical errors while performing the spinning:

- prior to actuating the control surfaces for engaging the airplane in spinning, the engine cowling does not lay against the skyline, resulting in the initiation of the stall at the nose lift angle (the angle of pitch-up) at which the airspeed started to decrease - that makes the orientation in space very difficult, and the spinning is performed with a variable angle of inclination of the longitudinal axis with respect to the horizon;
- the control surfaces are actuated suddenly at the entry - the stall dive is very strong;
- high airspeed when entering the spinning - the airplane performs a gliding rolling, after which it engages in spinning;
- sudden reduction of the intake pressure - the engine may stop;

- throughout spinning the stick is slackened forward - the airplane leaves unexpectedly the spinning attitude, with a bank and a tail skid;
- at the recovery from spinning, the swing bar was actuated completely, contrary to the sense of rotation and the stick was maintained pulled - after the interruption of the rotation, the airplane performs a steep volute on the side on which the swing bar was pressed;
- the control surfaces were not actuated in time for recovery (either too early, or too late) - the recovery is not carried out in the given direction.

WARNING! After performing intricate aerobatic maneuvers in horizontal or vertical plane, in straight line horizontal flight the pilot must tune the heading system and bring back the gyrohorizon in neutral position.

5. IN-FLIGHT EMERGENCY CASES

5.1. PILOT'S ACTIONS IN CASE OF ENGINE SHUT DOWN DURING FLIGHT

5.1.1. If the engine stops in climbing, before the first turn, proceed as follows:
- bring the airplane in gliding flight;
- retract the landing gear;
- shut up the fire cock;
- switch off the magneto, the storage battery and the ignition;
- open the canopy.

The landing is performed straight ahead. If it is obvious that the straight landing endangers the pilot's life due to risks of collision with obstacles, the pilot must change the landing direction.

5.1.2. If the engine stops in circuit flight after the first turn, and/or during aerobatic maneuvers in the zone, the pilot must act as per the airfield specific instructions and in accordance with paragraph 5.17.

5.1.3. If the engine stops during inverted flight:
- perform a half-rolling and bring the airplane in normal flight;
- set the gliding speed at 170-180 km/h;
- bring the throttle lever at about one third of stroke;
- bring the injection pump handle at 45º to the left and supply fuel until the fuel pressure at carburetor intake is 0.1-0.2 kgf/cm^2.

NOTE: To make the engine start easier, it is advisable to pump fuel in the engine cylinders.

5.1.4. As soon as the engine starts running again, bring the throttle lever in take-off condition for 1-2 seconds, then set the required flight condition.

WARNING: Upon transition from inverted flight, with the engine stopped, to normal flight and starting the engine, the airplane loses about 300-350 m of altitude.

5.2. PILOT'S ACTIONS UPON DECREASE OF THE OIL PRESSURE IN THE ENGINE

5.2.1. If the pilot notices the decrease of the oil pressure in the engine, he must check the oil temperature. If the oil temperature increases when the airplane is flying in the airfield area, the pilot must perform the landing immediately and switch off the engine.

5.2.2. If the flight is performed outside the aerodrome zone, the pilot will perform the landing on a auxiliary aerodrome or on another ground chosen for landing, informing the flight controller about the airplane position, through the radio station.

The emergency landing on another ground is carried out with the landing gear retracted.

NOTE: If the oil pressure decrease is not accompanied by a temperature increase, carefully check the thermal state of the engine, perform the circuit flight and the landing on the home-aerodrome.

5.3. PILOT'S ACTIONS IN CASE OF FUEL PRESSURE DECREASE

5.3.1. The fuel pressure decrease is signaled by:
- discontinuous engine running accompanied by the deceleration of the engine speed, the reduction of the intake pressure and trepidations;
- the decrease of the fuel pressure as read on the control instruments, below allowed limits.

5.3.2. In case of fuel pressure decrease the pilot must:
- report to the flight controller;
- rotate the fuel pump lever 45º to the right and start fuelling the fuel system, checking the pressure by reading the pressure gauges;
- interrupt the mission and land on the home- or auxiliary aerodrome.

5.4. PILOT'S ACTIONS IN CASE OF ENGINE JARS

5.4.1. In case of engine jars the pilot must act as follows:
- in all cases (except for fuel pressure decrease) the pilot must pull the throttle lever completely, bring the airplane in gliding flight and set the needed airspeed;
- if the engine jar stops, he must gently push the stick and set the engine operating condition appropriate for the horizontal flight;
- if after changing the engine running condition the jars don't stop, the pilot must increase the up to 70% by means of the throttle and "ignite" the spark plugs;
- if even after that the jars do not disappear, the pilot sets the engine speed at the value that induces minimum jars (by using the throttle lever and the propeller pitch control lever) and performs the landing on the home or additional aerodrome.

5.5. CORRECTIVE ACTIONS IN CASE OF WRONG PROPELLER PITCH (WITH OVERSPEEDING OF ENGINE)

5.5.1. Signs of irregular propeller pitch:
- slight jar at the engine;
- engine speed increase;
- sudden change of engine rattling.

5.5.2. If the propeller pitch has become unsteady during takeoff, the pilot must act as follows:
- during taxiing - the pilot must postpone the takeoff and perform taxiing to the standing line in order to trace out the cause of the malfunctioning (in safe taxiing conditions);
- after takeoff - by slightly pulling the propeller pitch control lever, he "loads" the propeller and continues the takeoff without reducing the intake pressure;
- at 15-20 m, he must retracts the landing gear
- and perform a normal circuit flight, landing on the home aerodrome.

5.5.3. In case of unsteady propeller pitch during dive, the pilot must:
- reduce completely the intake pressure and "load" the propeller;
- fly the airplane out of the dive;
- interrupt the mission and land on the home aerodrome.

5.6. PILOT'S ACTIONS IN CASE OF IN-FLIGHT FIRE

5.6.1. In case of in-flight fire, the pilot must proceed as follows:
- close the fire cock, switch off the magneto, the ignition and the generator;

- bring the airplane in gliding flight and, if necessary, perform skidding in order to remove the flame;
- report the case to the flight controller, by radio;
- if it is not possible to land on the aerodrome, choose a suitable ground and land outside the airfield;
- the forced landing outside the airfield, on unknown ground will be performed only with retracted landing gear;

5.6.2. If the pilot hasn't succeeded to put out the fire and the emergency landing would put pilot's life at risk, the pilot must leave the airplane, by jumping with the parachute.

5.7. LANDING GEAR EMERGENCY EXTENSION

5.7.1. If it is not possible to extend the landing gear by using the normal procedure, the pilot must use the emergency extension system. In this case, he must:

- check the intake pressure in the emergency air-bottle (normally the pressure should be 40-50 kgf/cm^2;
- set the landing gear selector levers in "NEUTRAL" position in both cockpits;
- open the emergency extension cock on the right desk of the cockpit;
- check the landing gear emergency extension signaled by the lightening of the green lamps;
- when the flight is ended and the engine stopped, shut the emergency extension cock.

WARNING: After an in-flight emergency extension it is forbidden to retract the landing gear.

5.7.2. In case of malfunction of both extension systems (main and emergency system), the pilot must perform a belly landing only on the emergency ground strip.

5.8. LANDING WITH WING FLAPS RETRACTED

The gliding speed with flaps retracted after the fourth turn and before initiating the recovery must be about 160-170 km/h.

The landing procedure with wing flaps retracted does not differ much from the landing gear with wing flaps extended.

In this case, the pilot must take into account that the gliding range, the duration of the flattening out and the landing speed will be a little higher than the landing with wing flaps extended.

5.9. PILOT'S ACTIONS IN CASE OF RADIO CONNECTION DISRUPTION

5.9.1. In all cases of sudden interruption of the radio link, the pilot must do as follows:

- check if the "AZS-UKV" circuit breaker is switched on;
- check the link of the headphone coupling cord;
- check if the knobs for volume tuning are set to maximum intensity;
- verify the accurate tuning of the radio communication channel;
- if the radio communication cannot be restored, interrupt the landing mission and perform the landing.

5.10. PILOT'S ACTIONS IN CASE OF ARK-15M RADIO-COMPASS MALFUNCTION

5.10.1. An in-flight malfunction of the radio-compass can be recognized by the following symptoms:

- the radio-compass pointer does not move when the pilot changes the flight course;
- the radio station to which the radio-compass is tuned cannot be heard;
- high oscillations or uninterrupted rotation of radio-compass pointer.

5.10.2. In case of radio-compass malfunction, the pilot must proceed as follows:

- check if the AZS, ARK, SPU and PT-200 are switched on, and if the switch on the ARK control panel is set in "COMP." position;

- ask the flight controller if the tracker station is in operating condition and check the radio-compass tuning;
- report the radio-compass failure to the flight controller;
- ask for the heading of the home-airfield, and periodically check the correctness of the heading to be followed, upon GMK and compass determination.

5.11. PILOT'S ACTIONS IN CASE OF GENERATOR MALFUNCTION

5.11.1. The in-flight generator malfunction is indicated by the lightening of the "GENERATOR OUT OF ORDER" signaling lamp and by the deflection of the voltammeter pointer to the right side from the "0" position.

5.11.2. In case of alternator malfunctions, the pilot must proceed as follows:

- report to the flight controller, by radio;
- switch off the generator;
- switch off the radio transmitter for a short time (as necessary);
- interrupt the mission;
- perform landing on the hme-airfield.

NOTE: 1. If the storage battery has been disconnected as a result of the charging current increase above 30 A (signaled by the lightening of the "Generator out of order" signaling lamp), reconnect the battery and act as per the instructions at point 5.11.2.

2. The storage battery can provide power for all the electric power users for maximum 30 minutes.

3. When some of the power users are disconnected, the supplying time of the other users will be extended.

5.12. PILOT'S ACTIONS IN CASE OF AIRSPEED MALFUNCTION

5.12.1. The airspeed indicator malfunction may occur not suddenly, but gradually. Because of that, the pilot must check first if there is a real malfunction. That is why the airplane must be gradually brought in a climbing or descending attitude, without changing the engine running condition, watching the readings on the gyro-horizon and altimeter.

If the airspeed indicator readings are not in accordance with the flight condition and the other instruments are well functioning, the pilot can be sure that the airspeed indicator is out of order.

5.12.2. In this case, the pilot must take the following actions:

- report the case to the flight controller;
- interrupt the mission;
- prepare the airplane for landing by flying toward the airfield;
- check the flight condition by the readings on the gyrohorizon, the engine speed indicator, the manovacuum gauge (for the intake pressure) and the altimeter.

The indicated values for engine speed and intake pressure, for various flight conditions (landing gear extended) are given in table 4 below.

TABLE NO. 4

Flight condition	Airspeed as read on the instruments (km/h)	Vertical speed (m/sec)	Engine speed %	Intake pressure mm Hg.col.
Climbing	160	5	70	700
Level flight	170	0	64	500
Turns in level flight	170	0	64	500
Gliding	160	3	41	300

5.13. PILOT'S ACTIONS IN CASE OF ALTIMETER MALFUNCTION

In case of altimeter malfunction, the pilot must:

- report the case to the flight controller;
- abort the mission and return to the airfield for landing;
- the flight condition is checked by watching the readings on the airspeed indicator, and the manovacuum gauge (for the intake pressure).

5.14. PILOT'S ACTIONS IN CASE OF VERTICAL SPEED INDICATOR MALFUNCTION

In case of vertical speed indicator malfunction, the pilot must:

- report the case to the flight controller;
- abort the mission and return to the airfield for landing;
- check the flight condition by watching the readings on the airspeed indicator, the gyrohorizon, the altimeter, the engine speed indicator and the manovacuum gauge, as well as by observing the cowling position against the skyline.

5.15. PILOT'S ACTIONS IN CASE OF DS-1 TAKEOFF TRANSDUCER HEATING DEVICE

5.15.1. The malfunction of the DS-1 device is shown by the switch off of the "DS HEATING" signaling lamp on the dashboard.
5.15.2 Then the pilot must check the connection of the "DS HEATING" circuit breaker and the lamp operation, by pressing on the "LAMP CONTROL" knob. If the "DS HEATING" circuit breaker and the lamp are OK, then the pilot is sure that the takeoff transducer is out of order.
In this case, the pilot must carefully check the airspeed, especially in the approach stage.

5.16. PILOT'S ACTIONS IN CASE OF EMERGENCY ABANDON OF THE AIRPLANE BY PARACHUTE JUMP

5.16.1. In all flight cases directly placing the pilot's life at risk, the pilot must leave the airplane by jumping with the parachute.The decision to abandon the airplane is taken by the crew commander.
To abandon the airplane, the crew commander gives the following orders:
To abandon an airplane that responds to controls:

- the preliminary order "Prepare for jump", and then "Jump";

To abandon an airplane that doesn't respond to controls:

- "Jump"

5.16.2. Before leaving the airplane that responds to controls the pilot must:

- bring the airplane in horizontal flight;
- shut the fire cock, disconnect the magneto, the ignition, the storage battery and the generator;
- set the airspeed to 200 km/h maximum;
- open the cockpit canopy;
- unfasten the belts and the radio station coupling cord;
- release the rudder pedals and draw his feet near the seat cup;
- open the canopy.

5.16.3. The abandon of the airplane in horizontal flight is performed by the pilot in the following sequence:

- by catching the left side of the front canopy with his right hand, and leaning his left hand against the left board;
- by leaning his body forward, he lifts and takes the parachute out of the seat cup;
- still inclined, he draws his legs in the seat cup and turns his body to the left;
- he lays his left hand on the upper part of the sliding canopy;

- he lays his left knee on the left board, and uses his right foot and hands to push himself out of the airplane, in upside down position, over the trailing edge of the wing;

CAUTION! 1. The first one to leave the airplane will be the pilot in the front cockpit, followed by the pilot in the rear cockpit.

2. If the airplane is abandoned by jumping over the right board, the pilot's actions will be similar, symmetrical to those performed in case of abandon over the left board.

5.16.3a. To abandon an airplane which does not respond to controls, the pilot will rapidly perform the following actions:

- unfasten the seat belts and the headphone cord;
- release the rudder pedals and draw his feet toward the seat cup;
- open the canopy;
- leave the airplane over the trailing edge of the wing, following the sequence indicated at paragraph 5.16.3, and taking into account the airplane attitude (normal or inverted flight, climb, rotation to the right or left), perform the jump;
- in turning, spinning etc. the jump is performed outside the rotation side;
- in inverted flight, after unfastening the belts and the headphone coupling cord and after opening the canopy, the airplane is abandoned by pushing with the legs in the seat cup.

5.16.4. In case of a fire on board, when the altitude is high enough, after leaving the airplane the pilot will wait at least 3-5 seconds before opening the parachute.

In order to rapidly abandon an airplane that is on fire, the pilot should observe the following procedure:

- unfasten the seat belts and the headphones;
- open the canopy;
- revert the airplane in inverted attitude;
- push the control stick strongly and leave the cockpit.

5.17. SPECIAL AIRPLANE FEATURES WHEN LANDING WITH DAMAGED ENGINE

5.17.1. In case of engine failure, the pilot must perform the landing on the home-airfield, or on a chosen ground. In case of a forced landing on a rough or unknown ground, the landing will be performed with the undercarriage retracted.

5.17.2. The gliding distance in case of an engine failure depends on the aerodynamic features of the airplane and on the altitude limitations.

The gliding should be performed with the landing gear and the wing flaps retracted, at the airspeed of 160km/h; in this case, the aerodynamic quality coefficient and the rated gliding distance will be as follows:

$K=7$, $L=7H$

where: L - the rated gliding distance; H - the flight altitude; 7 - the aerodynamic quality;

When estimating the gliding distance available and the chances to land on the aerodrome, the pilot must take into account the shortening of the gliding distance due to the performance of the turn (heading the airplane to the airfield) and the pre-landing maneuvers. When making a 180º turn with the airplane banked at 45º, the rated gliding distance is about 1 km shorter.

To ensure the approach to the airfield at 400 m of altitude, which will ensure the performance of the pre-landing maneuvers, the rated gliding distance must be shortened with about 3 km. This way, the gliding distance available, taking into account the provisional altitude necessary and the turn to the airfield direction is as follows:

At H=2000 m - 10 km;
At H=3000 m - 17 km;
At H=4000 m - 24 km.

The turns are carried out with the airplane banked at 45º, which ensures a minimum loss of altitude. In this case, the turn radius is 200 m, the rate of vertical descent is 8 m/s and the loss of altitude during a 360º turn is 220 m.
When the landing is extended, the aerodynamic quality and the rate of vertical descent vary very little.In the landing gear and wing flaps extended configuration, the aerodynamic quality is 5,5.
In case of approach flight in headwind conditions, the available gliding distance decreases, so that when the wind velocity is 5m/s, the gliding distance decreases 10%.

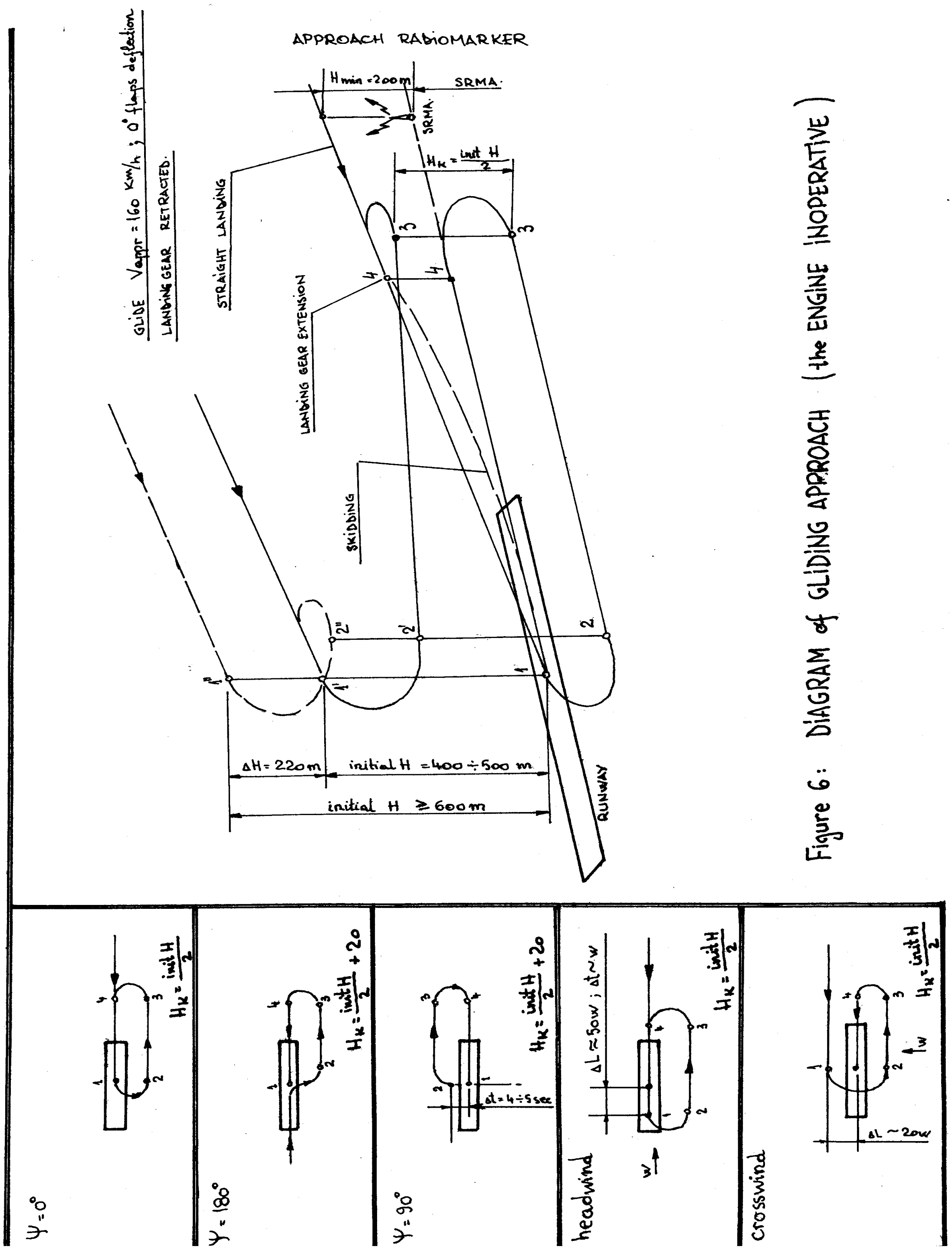


Figure 6: DIAGRAM of GLIDING APPROACH (the ENGINE INOPERATIVE)

5.17.3. The configuration of the pre-landing maneuver for various heading positions at arrival (Ψ) are shown in figure 6 (the height of arrival above the centerline of the airfield should be of minimum 400 m.

When getting above the airfield with course of arrival, it is advisable to perform the landing maneuver by two turns at 180º, initiating the first turn above the center of the runway (aerodrome) and the second turn from the control height:

$H_K = \frac{H_{INITIAL}}{2}$, where $H_{INITIAL}$ - the arrival height of the airplane above the landing strip center (m);

At the arrival of the airplane above the landing strip, with a heading opposite to that of arrival, the pilot must perform two turns at 90º, engaging the airplane on a trajectory parallel to the landing direction; after reaching the control height, the pilot performs a 180º turn with the course of arrival.

In this case, the control height is:

$$H_K = \frac{H_{INITIAL}}{2} + 20$$

In case of arrival under an angle of 90º with respect to the course of arrival, the control height is:

$$H_K = \frac{H_{INITIAL}}{2} + 20$$

In this case, the turn with heading opposite to that of arrival must be initiated 4-5 sec after passing over the landing strip center.When the wind blows, the point of initiating the landing maneuver must be moved from the runway center, against the wind, to the following distance (no matter of the course of arrival on the runway center): ΔL=approx. 50W

where W is the wind velocity in m/s.

When approaching the strip at 400-600m and a headwind of 5m/s, the initiating point of the pre-landing maneuver will be moved with 250 beyond the runway strip center, corresponding to a time delay of 5 sec. between the moment of runway center crossing and the initiation of the maneuver.

In 5 m/s crosswind conditions, the airplane must be brought across the runway center with 100 m side displacement.

5.17.4. In case of emergency landing and engine failure, the pilot must perform the following operations:

- make a 45º banked turn to the airdrome;
- set the instrumental airspeed to 160 km/h;
- report to the flight controller the engine failure and his decision to land on the aerodrome;
- ask information about the weather conditions at the aerodrome (air pressure, the velocity and prevailing direction of the wind);
- shut the fire cock, switch off the magneto, the generator, and the ignition);
- determine the height of flight (the altimeter is set at the aerodrome air pressure) and calculate the available gliding distance so as to assess the possibility of landing on the aerodrome.

NOTE: In case of insufficient spare height, the pilot will perform the landing on a ground outside the aerodrome, by carrying out either the pre-landing procedure, or the direct landing.

When the pilot estimates that the engaging of the airplane above the runway center will take place at less than 400 m altitude, then the landing can be performed only in direct contact way.

In this case the pilot must engage the airplane in “meanders” (sinusoids) and slides in such a way as to ensure the landing path toward the runway center.

If the pilot has directed the airplane to the runway center at an altitude of 400-600 m, then the pre-landing maneuver will be performed taking into account the course of arrival.

After engaging the airplane on the landing path at more than 600 m altitude, the airplane will be engaged in turns-spirals above the runway center, with heading of arrival.

After the arrival on the landing path (in case of direct landing at 1km from the runway center), extend the landing gear and check if the descent is directed exactly toward the point of recovery initiation, i.e. the runway end.
When noticing that the descent trajectory is too long, and the airplane goes beyond the point of recovery initiation, use the skidding maneuver, taking care to engage the airplane in the point of recovery initiation;

- at minimum 50 m, switch off the storage battery and open the cockpit canopy;
- at 10-15 m, by gently pulling the stick, start the recovery, taking care to end this maneuver at 0.5-1 m from the ground. In this case the landing speed will be 125-130 km/h.

5.17.5. In case of forced landing with inoperative engine, on an airfield fitted with ground direction locating station (SRMA marker radio station), it is advisable to use the ARK readings for the arrival and the performance of the pre-landing maneuver - when the SRMA is in standard location, 1000 m from the runway end).
The pre-landing maneuver is carried out observing the SRMA readings.
The minimum height for the arrival at SRMA must be 550 m minimum, and the control height

$$H_K = \frac{H_{INITIAL}}{2} + 120$$

In case of arrival at SRMA at 800 m altitude, the pilot shall perform spiral turns in order to drive out the airplane at SRMA with arrival heading at 550-700 m altitude.
The minimum altitude to surpass the SRMA in case of direct landing is 200 m, in normal weather conditions, which ensures the landing on runway at 100-200 m from its end.
In headwind conditions, the minimum altitude to surpass the SRMA at direct landing increases 5 m for each meter per second of wind velocity.
5.17.6. The maximum extra altitude at direct landing is 50 m, when the available distance for maneuver is 1000 m. This extra altitude is cancelled by the performance of a skidding with an inclination angle of 5º.
When it is obvious that the estimated contact point is overrun, in order to annihilate the extra altitude, the pilot must extend the wing flaps.

6. AIRPLANE SYSTEMS OPERATING INSTRUCTIONS

6.1. CONTROLS

Airplane controls consist of elevator, ailerons, rudder and trim tab controls.
The elevator and the ailerons are controlled by means of the control sticks mounted on the control shaft in the front and rear cockpit.
The elevator control is of combined type: rigid between frames #2 and #10 and flexible (with cables) from frame #10 to the elevator sector.
The ailerons are controlled by means of sticks and by the stiff system consisting of rods and rockers.
When inclining the sticks, the rocker that is rigidly fastened to the horizontal shaft as well as the rods and rockers mounted in the wing and conveying the motion to the control rockers of the ailerons should rotate.
The trim tab is installed on the left half of the elevator and its adjustment ensures the corresponding lessening of the stick loadings. The trim tab control wheels are mounted on the left board in both cockpits. The elevator trim tab control system is of combined type: in the fuselage - flexible (by cables) and inside the elevator - rigid.
The rudder control (by cables) is ensured by means of the rudder pedals.
The rudder pedals, of parallelogram type are installed in the front and rear cockpit and can be adjusted to fit the pilot's size. Adjustment range:

- forward - 40 m,
- backward - 60 m

The rudder control system consists of eight cables fastened to the rudder pedals and attached by forks to the rudder horns (steering gears).

6.2. LANDING GEAR

The landing gear is of tricycle type, provided with tail wheel, in-flight retractable nose gears and a shock absorber system that operates with fluid and gases. It consists of a nose strut with a 400 x 500 mm wheel and of two main gears with 500 x 150 mm wheels fitted with brakes.
The auxiliary strut is installed in the front part of the fuselage and retracts in flight, rearward under the belly, on the air course sense. The main struts are installed in the wing cantilevers and are retractable in flight, under the wings, forward, contrary to the air course.
In retracted configuration the gears are fastened by padlocks.
The extension and the retraction of the landing gear can be performed from either cockpit, using the landing gear cocks that convey the compressed air to the padlocks and strut actuators.
The position of the struts can be checked by means of the mechanical indicators and of the signaling lamps “LANDING GEAR DOWN” of green color and “LANDING GEAR UP” of red color.
For the operation on snow-covered airfields, the airplane is fitted with skis instead of wheels (not retractable).
The fastening of skis in flight is ensured by the assembly of two shock-absorbers with springs on each ski.
The main skis are fitted with brakes. The brake systems of skis are manufactured in the shape of turning sectors (spurs). On each ski are mounted two sectors. The spurs are actuated by the pneumatic actuator, which is supplied by the airplane brake system. The control of the ski brakes is similar to that of the wheel brakes.
Main data about skis:

Length, mm	1035
Width, mm	450
Area of active part, m	0,42
The weight of the nose ski comprising the fastening units, in kgf	21
The main skis comprising the fastening units, in kgf	25

NOTE: All skis are the same dimension.

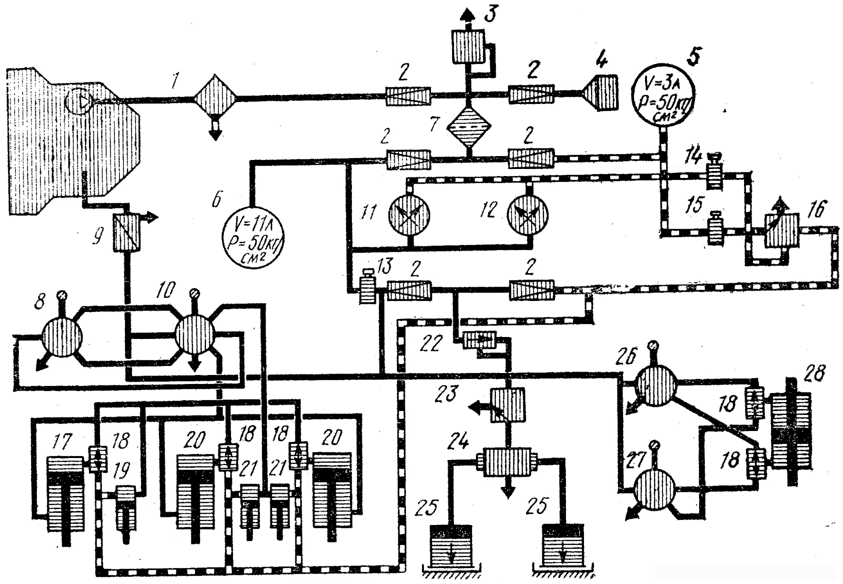
6.3. AIR SYSTEM

The air system ensures the landing gear extension and retraction, the engine start, the control of the wing flaps, and the control of the wheel brakes.
The schematic diagram of the air system is shown in figure 7. The air system comprises two autonomous systems: the main and the emergency system connected by the common line of ground compressed air loading.
The supply of each system is provided by the individual bottles on board:

- for the main system - by the spherical bottle of 1 l capacity;
- for the emergency system - by the spherical bottle of 3 l capacity;

The operating pressure of the air in both systems is 50 kgf/cm^2. In flight the main system bottle is recharged by the AK-50T compressor installed on the engine.
The air pressure in the main and emergency system is checked by watching the 2M-80K double pressure gauges mounted on the left panels of the dashboards in both cockpits.
The main pneumatic system consists of main bottle, charging and recharging system lines, the main cock (selector) mounted on the left side desk in the front cockpit, the landing gear cock, the flap

cock, the EK-48 electro-pneumatic valve, the U139 (PU-7) pressure relief valve, the UP53/1M brake release valve, the U135 (PU-8) differential and the flap actuator with two emergency valves.



Retraction-extraction Nose undercarriage | Retraction-extraction Main undercarriage | Braking and unbraking Wheels | Retraction-extraction Flaps

Figure 7 – Pneumatic system of M-14P engine

1 – FT filter; 2 – Pressure switch AD-50; 3 – One way valve; 4 – Reducing valve; 5 – Charging stud; 6 – Air bottle for damage system; 7 – Air bottle for main system; 8 – 31VF3A filter; 9 – Three ways joint – 625300M; 10 – EK-48 Electropneumatic valve; 11 – Undercarriage driwitg joint; 12,13 – 2M-80K Manometer; 14 - 992AT-3 joint (for charging system); 15,16 - 992AT-3 joint for landing gear emergency extension cock; 17 – Outletvalve 562300; 18 – Jack; 19 – Damage valve; 20 – Nose undercarriage lock jack; 21 – Main undercarriage jack; 22 – Lock jack; 23 - PU-7 (U139) pressure relief valve; 24 – UP-53/1M valve; 25 - PU-8 (U135) differential and the flap actuator with two emergency valves; 26 – Brake wheel for main undercarriage; 27,28 Three ways joint – 625300M; 29 – Flaps extension and retraction jack;

When pressing the engine starting pushbutton in the front cockpit, the electromagnetic valve is released and the air is supplied to the engine start distributor.

When retracting and extending the landing gear, the air enters the landing gear cocks mounted on the left panels of the dashboards in both cockpits, then it reaches the gear actuators and the padlock actuators. Both cocks are interconnected by pipes.

By setting the rear cockpit selector in neutral position, the landing gear can be extended or retracted from the front cockpit.

In case of wrong control of the landing gear from the front cockpit, the pilot in the rear cockpit can correct this error by setting the landing gear lever in proper position; in this case the landing gear cock in the front cockpit is switched off simultaneously. Then the landing gear control can be operated only from the rear cockpit. When extending and retracting the flaps, the compressed air passes through the U139 (PU-7) valve, where the air pressure is reduced from 50 kgf/cm^2 up to 8^{+1} kgf/cm^2, through the brake release valves (which is connected to the control stick in the rear cockpit) and reaches the differential; from there, it is supplied to the brakes of the left and right wheels of the main struts).

The pressure relief valve and the brake release valve are controlled by the levers mounted on the control sticks.

To brake the main strut wheels in upright position, bring the brake levers on the control sticks in pressed-in position.
The differential, controlled by the swing-bars ensures the individual braking of the wheels.
The emergency air system is operated in case of main system failure.
The emergency system comprises: emergency bottle, charging line, two cocks for landing gear emergency extension mounted on the right desks in both cockpits, exhaust valve and emergency valves.
At the same time the compressed air reaches the pressure relief valve, ensuring the wheel braking by means of the emergency system.

6.4. POWER PLANT

The power plant comprises: an M-14P engine with V530TA-D35 propeller, engine base, exhaust manifold, control systems of the engine and units, as well as cooling and starting systems, fuel and oil systems.
The M-14P engine is a four-stroke engine, with fuel injection, air-cooling, radial nine-cylinders in a single row and carburetor for mixture control.
The engine is fitted with a reduction gear that decelerates the speed of the propeller shaft and a mechanically driven centrifugal supercharger of single-stage type.
The engine is cooled by the air breathed out through the cowl flaps on the cowl front part. The homogenous cooling of the cylinders is ensured by the air-deflectors mounted on each cylinder. The engine parts are greased with compressed oil and by splashing.Compressed air is used to start the engine. The magneto and the ignition wires of the engine are shielded. Two spark plugs and one pneumatic valve for start are mounted on each cylinder head.
The engine is fastened by means of its mount to the frame #0 of the fuselage (the firewall).
The engine mount consists of: engine ring and four struts (two upper and two lower), made of steel pipe.On the ring are welded eight lugs for fastening the struts and eight boxes for the rubber shock absorbers and the engine fastening studs.The strut tubes are welded in pairs to the mount fastening forks.At the opposite ends of the tubes are welded the strut forks for fastening to the ring.
When mounted on the airplane the engine is covered with the fairing - the collapsible cowling consists in upper and lower cowling, joined together with padlocks.
The upper cowling area is within the fuselage outline. The other part of the cowling protrudes out of the fuselage outline, forming a cavity between the fuselage skin and the cowling (on the rear edge) for evacuating the air that cools the engine cylinders. On the upper cowling there is an access door to the oil tank filling cap, while on the lower cowling there are some flanged grooves for the exhaust manifold fittings. The cowling is attached to the fuselage by means of four brackets.
The air-intake duct of the cowling is covered with adjustable cowl-flaps, designed to adjust the amount of air that cools the engine.
The exhaust manifold is designed to collect the exhaust gases from the engine cylinders and to exhausting them to an area free of risk of fire.
The exhaust manifold fittings are of welded design, they are made of stainless steel sheet metal and attached by collars. The power plant control consists of: semi-rigid type pull rods connected with levers and handles located on the left and right desks in the front and rear cockpit.

Fuel System

The fuel system provides the necessary fuel supply of the airplane and the engine fuelling in all working conditions.
The schematic diagram of the fuel system is shown in figure 8.

Fuel pump

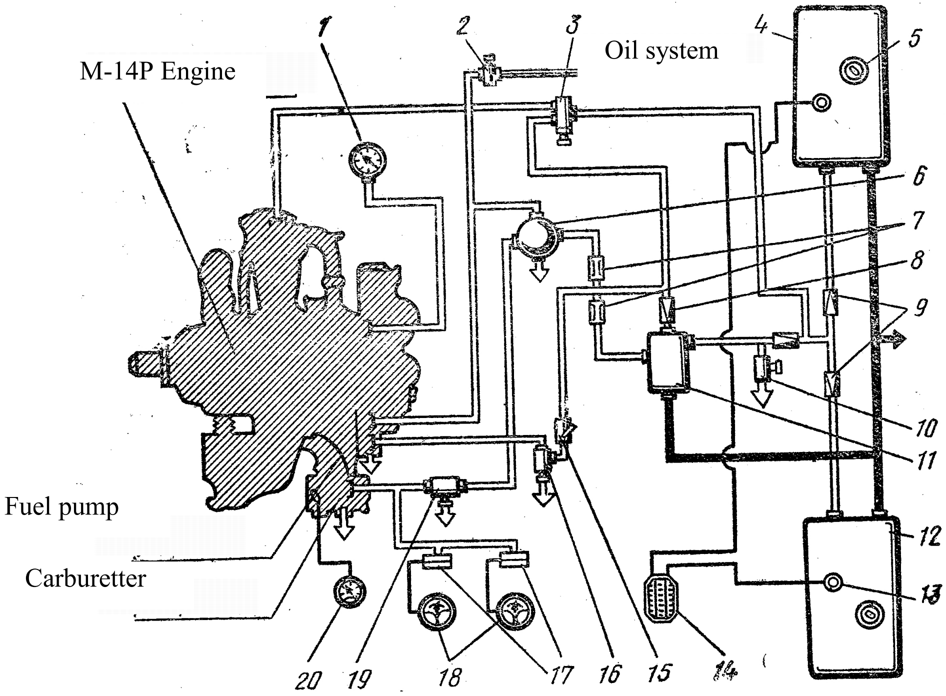


Figure 8 – Fuel system

1 – Manovacuumgauge – MV16K; 2 – Oil dilution valve; 3 – Primer pump; 4 – Right fuel tank; 5 – Feeding hole; 6 – Compensation tank; 7 – Throttle; 8 – One way valve; 9 – One way valves block; 10 - Draining valve; 11 – Consumption fuel tank; 12 – Left fuel tank; 13 – DSU-1-2 – Litermeter tranmitter; 14 – IUT-3-1-Litermeter indicator; 15 – Unfire valve; 16 – Fuel filter; 17 – P-1B – Fuel pressure transmitter; 18 – EMI-3K-Triple indicator; 19 – Filter; 20 – TUE-48 – Mixture temperature indicator;

The M-14P engine is fuelled with B-91/115 gas type. The fuel is distributed in two main tanks, each of 61±l capacity.
The consumption tank of 5 l capacity is mounted in the fuselage and ensures the fuelling of the engine during inverted flight and during flights in negative overloading conditions.
From the tanks the fuel flows (due to gravity) through the one-way valve block into the consumption tank. Two one-way valves prevent the leakage of the fuel from one tank into another, while the third one-way valve does not allow the fuel to pass from the consumption tank into the fuel tanks when the airplane is engaged in diving. Further on, the fuel from the consumption tank passes through the one-way valve that ensures the operation of the 740400 fuelling pump, through the fire cock and the fuel filter and reaches the 702 ML fuel pump, then into the compensation tank, from where, through the fine screening filter, it reaches the engine carburetor.
For fuelling the engine cylinders and for filling the main fuel line before starting the engine, the pilot uses the injection pump, actuating its control lever located on the front cockpit dashboard.
The electro-pneumatic valve for oil dilution, which is controlled by the knob in the front cockpit is mounted on the firewall.

Oil System

The oil system is designed to ensure the greasing and cooling of the rubbing parts of the engine, by means of MK-22 and MC-20 oil types. The oil flowing into the system is forced by the two-stage pump with gears, which is mounted on the rear cover of the engine crankcase.

The schematic diagram of the oil system is given in figure 9.
To ensure a continuous operation of the airplane in all flight conditions, the oil and air collectors of the oil tank are pivoted.
The oil cooling takes place inside the air-oil radiator.
For system operation at low ambient temperatures (below 0ºC), the airplane is fitted with an oil dilution system, which enables and speeds up the engine start.

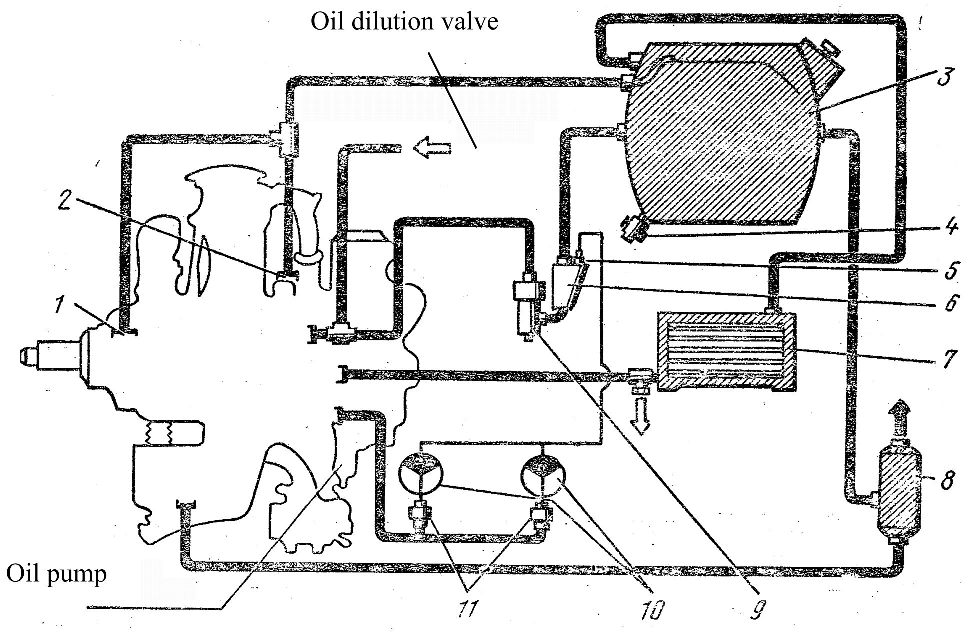


Figure 9 – Oil system

1 – Front vent; 2 - Rear vent; 3 – Oil tank; 4 – Oil trickle valve; 5 - P-1-Temperature transmitter 6 – Oil colector; 7 - Oil cooler; 8 – Draining tank; 9 – Oil filter; 10 – Indicator for EMI-3K system; 11 – P-15B – Oil pressure transmitter;

6.5. ELECTRIC INSTRUMENTS

The main continuous current source of 28.5V voltage is the GSR-3000M generator, installed on the engine.
The generator voltage is adjusted automatically, by the R-27 coal-column regulator and by the TS-9M2 stabilization transformer. The network protection against over-voltages is ensured by the AZP-1MB circuit breaker. The switching on and off of the generator is enabled by the DMR-200D within the electric board on the firewall.
The R-27 and AZP-1MB units are installed on the lower side of the firewall, and the TS-9M2 and the DMR-200D within the electric board on the firewall.
The auxiliary source of continuous current is the Warley (or 12ASAM 23) storage battery, which is installed on the left wing bracing side, between the main and rear outrigger. This one is also used for the engine start.
To power the gyrohorizon from the front cockpit and the DA-30 device from the rear cockpit also with alternative three-phase current, of 36V and the frequency of 400 Hz, there is the PAG-1FP converter that is mounted on the left board of the fuselage, near frame #5.
To power the gyrohorizon from the rear cockpit, and the DA-30 from the front cockpit, the GMK system and the radio-compass, there is the PT-200T, installed on the right board, between frames #11

and #12. The network current and its voltage control are ensured by the VA-2K voltammeter installed on the dashboard.

6.6. GMK-1A COMPASS COURSE SYSTEM

The compass course system is used for the determination and the indication of the airplane heading and turning angles, and for the compass hearing transmission. The system can operate in magnetic correction configuration (MK) and in gyro-half-compass configuration (GPK).
The main operating configuration of the system is the gyro-half-compass (GPK) with recurrent correction of heading by means of magnetic corrector.
Beside the MP and GPK main working configuration, the heading system also has auxiliary some configurations: "Start", "Automatic calibration" and "Check".
The "Start" configuration ensures the automatic tuning of the system with respect to the heading - no matter of the configuration "MP-GPK" switch position.
The "Automatic calibration" configuration ensures the automatic connection of the fast speed tuning when switching the configuration from "GPK" to "MK" position.
The "Check" configuration is achieved in "MK" configuration and ensures the fast and effective pre-flight and in-flight check of the compass course system by setting the control switch in "0" or "300" position.
In order to connect and use the compass-course system:
1. Connect the DC and AC power sources.
2. Set the switch in "MK" position in "Start" configuration.
3. Switch on the GMK circuit breaker; the heading indicator must show the airplane standing heading in 70 seconds.
4. Check the magnetic correction condition (MK) as follows:
   - set the "Check" switch on the control panel to "0"; the pointer must read a 0 + 10 heading;
   - set the "Check" switch to "300"; the pointer must read a 300 + 10 heading;
   - when the "Check" switch is on "0" or "300", on the control panel the signaling lamp "GA failure" must be lit;
   - after checking the control angles, set the ZK heading transmitter switch on the control panel to any limit position; the pointer must tune rapidly (6/sec minimum) to the airplane compass course.

NOTE: When the system operates in MK configuration, the ZK switch operates as a fast tuning knob; in GPK configuration it operates as a heading transmitter.
5. Check the gyro-half-compass configuration, thus:
   - set the configuration switch in "GPK" position;
   - switch off the ZK switch - the heading pointer must rotate with 2-7°/sec. rotational speed.

When turning the ZK switch to left or right, the pointer must show the sense of increase or decrease of the readings.
Operation preparation duration:
   - in MK configuration, 3 minutes maximum
   - in GPK configuration, 5 minutes maximum

6. Set the take-off heading in GPK configuration by means of the heading transmitter and check the pointer reading at start.
7. Disconnect the AZS GMK and the power sources after the landing run.

6.7. KI-3 MAGNETIC COMPASS

The magnetic compass is used as an auxiliary device for determining the airplane heading. When the compass is used in flight the pilot must take into account that the error magnitude at certain compass courses might be up to 10.

6.8. SSKUA-1 INCIDENCE ANGLE WARNING SYSTEM

This system is designed to warn the flight crew that the airplane is approaching a stall attitude, by light and acoustic warning.
The light signaling from both cockpits consists of two warning lamps: yellow for the “STALLING SPEED” and red for the “STALL DIVE”.
The acoustic warning is achieved by emitting a continuous acoustic signal in the pilots’ headphones.
The operating principle of the system is based on determining the position of the airflow fully braked point with respect to the leading edge of the wing.
Table 5: Turning on of the “STALLING SPEED” and “STALL DIVE” warning lamps depending on the airplane flight configuration and the engine operating condition:

Airplane configuration	Landing gear and flaps retracted	Landing gear and flaps extended	
Engine working condition	Power off	Power off	Nominal I
Airspeed at which the “STALLING SPEED” lamp turns on (km/h)	127	119	109
Airspeed at which the “STALL DIVE” lamp turns on (km/h)	115	108	98

The system kit comprises the following:

1. Stalling dive transducer (DS-1) mounted on the lower side of the left wing leading edge;
2. BVS-1 output signal unit, mounted behind the front cockpit dashboard, on the firewall;
3. Warning lamps, above the dashboard:
   “STALLING SPEED” - yellow
   “STALL DIVE” - red
   “DS HEATING” - green
4. The “STALL DIVE CONTROL” knob mounted in the front cockpit, on the left side of the dashboard;
5. The “STALL DIVE” and "DS HEATING" circuit breakers located on the right desk in the front cockpit.

In order to switch on and control the system operating capacity, the pilot must carry out the following operations:

1. Switch on one of the “GROUND SUPPLY” and “STORAGE BATTERY” switches and then the UKV, SPU and “STALL DIVE” circuit breaker: in this case, the “STALLING SPEED” signaling lamps and the warning lamp will flicker.
2. Press the “STALL DIVE CONTROL” pushbutton: in this case the “STALL DIVE” signaling lamps will flicker in both cockpits and an acoustic signal will be heard in the headphones. When releasing the pushbutton, the “STALL DIVE” warning lamps turn off and the acoustic signal ceases.
3. Check the proper heating of the choke and that of the front panel for fastening the stall dive transducer, thus: switch on the “DS HEATING” circuit breaker - then, the signaling lamp and the “DS HEATING” warning lamp in both cockpits will turn on. After performing the checking, switch off the “DS HEATING” circuit breaker.

WARNING:
In case of ground check, the “DS HEATING” circuit breaker must not be switched on for more than 5 minutes.

6.9. "LANDIS-5" (BAKLAN-5) RADIO STATION

On of the two radio stations is mounted on the airplane, and their control panels are mounted on the dashboards of the front and rear cockpits (which are similar).
Before connecting the radio station, its control parts must be set in the following positions:
- the "PS-OFF" breaker in "Switched-off" position;
- the noise intensity regulator - on maximum intensity position.

To connect the radio station, proceed as follows:
- connect the circuit breakers of the SPU and UKV network on the electric instrument panel (two minutes later, the radio station will be operative);
- set the appropriate intercom channel on the radio station control panel.

To carry out a transmission the pilot must press the "Radio" knob that is mounted on the throttle handle.
To switch on the noise suppressor, set the "PS-OFF" circuit breaker on the control panel in "PS" position.
To switch off the radio station, set the UKV circuit breaker in OFF position.

6.10. INTERCOM STATION

The airplane intercom station ensures the bilateral connection between the crewmembers, their connection to the external link by radio station, and also the possibility to listen the radio-compass signals.
The SPU device ensures the following:
1. Simultaneous reception of each crewmember, with 100% audibility:
   - of outside link transmissions;
   - of intercom transmission inside the airplane;
   - of radio compass signals, when the "RK - Switched off" breaker on the subscriber' s panel is set in "RK" position.
2. Bilateral phone connection inside the airplane, between the crewmembers, in case anyone presses the "SPU" knob (the "SPU" knobs are mounted on the throttle handles in each cockpit).
3. The connection of each crewmember to the outside radio connection, when pressing one of the "Radio" knobs installed on the throttles.
4. The possibility for each member to switch on his phone to the other subscriber's panel by setting the "REZ" switch in upper position (the coupled position), in case one of the subscriber's panels is out of order.
5. The possibility to uncouple the pilot's microphone from the radio station in the front cockpit, when the pilot in the rear cockpit presses the "Radio" knob for the purpose of a radio transmission.
6. The slow and distinct tuning of the conversation level on intercom (inside the airplane), by the "SPU" faders, and on external connection by the "RAD" faders.

The signals received in the SPU system from the radio compass cannot be tuned.
The faders are installed on the subscriber's panel.
The "SPU" system supply is assured by the continuous power source of 27V, which is connected by means of the SPU circuit breaker.
Pre-flight check of SPU:
For the connection and checking up of the SPU, proceed as follows:
- switch on the "SPU" circuit breaker;
- turn to maximum right position the "SPU" faders installed on the subscriber's panels in both cockpits;
- check the intercommunication inside the airplane by pressing the SPU knobs successively in the front and rear cockpit, then set the desired sound level by means of the "SPU" faders.

6.11. ARK-15M AUTOMATIC RADIO COMPASS

The automatic radio compass allows the guidance of the airplane by the high power tracker stations and by the beam beacon.
The control panel of the radio compass comprises:

- behavior switch, with "Compass" and "Antenna" positions;
- TLF-TLG switch;
- "Sound level" fader;
- "ARK channels" switch, with "1", "2", 3", "4" and "P" positions;
- "Frame" knob.

To check and to connect the radio compass, the pilot must proceed as follows:

- switch on the "PT-200" circuit breaker (the network main circuit breaker);
- switch on the ARK circuit breaker;
- switch on the SPU circuit breaker;
- set the "RK-Switched off" breaker on the subscriber's panel in "RK" position;
- set the "TLF-TLG" switch in the "TLF" position; in this case a specific noise should be heard in the headphones and the radio compass pointer has small oscillations.

The radio compass total capacitance is reached 1-2 minutes after the radio-compass connection.

- set the "Near - Distant tracker radio station" in the "Distant" position and the "ARK channels" switch in the appropriate channel;
- set the behavior switch in the "Antenna" position and turn the tuning regulator to maximum right position; the distant station signals should be heard in the headphone. When the tuning regulator is turned, the sound level must change;
- set the "TLF-TLG" switch in the "TLG" position;
- set the behavior switch in the "Compass" position; the pointer must follow the "distant" station direction with a precision of ±5º;
- set the "Near-Distant tracking radio station" switch to the "Distant" position and the "ARK channels" switch to the proper channel;
- press the "Frame" knob and bring the pointer to 160º. When the knob is released, the pointer should slide back to the former position at a speed of 30º per second minimum;
- set the "RK-Switched off breaker on the SPU subscriber's panel to the "Switched off" position.

In-flight operation of the radio compass

1. The pilot checks the validity of the ARK and GMK readings (the radio compass pointer should read KUR=180º at UGR-4UK and the heading scale - the value of takeoff heading) throughout taxiing on the takeoff strip.
2. The flight in "Distant" mode is carried out by the passive method, maintaining the UGR-4UK at KUR=0º.
3. When the airplane crosses the "Distant" station vertically, the pointer must pass from KUR=0º to KUR=180º.
4. When ARK is switched to "Near" position, the radio compass pointer should be directed to the "Near" position.
5. To set the radio compass on the auxiliary airfield frequency in flight, proceed as follows:
    - ensure that the switch is set to "Distant" position;
    - turn the fader (tuning regulator) to maximum right position;
    - set the operating condition switch to "Antenna";
    - listen the calling signals of the "Distant" tracking station of the auxiliary airfield;
    - set the operating condition switch to "Compass". The pointer must be directed toward the "Distant" position of the auxiliary airfield direction.

APPENDIX

High aerobatic techniques and various combinations

The techniques of high aerobatic flights and their combinations are described in this appendix and are used for training the pilots and sportsmen with a view to performing aerobatic maneuvers during sport flight competitions.
The high aerobatic maneuvers and their combinations are performed in accordance with the recommendations and limitations given in chapter 2 of this manual.

1 ¼ turns spinning

The performance of this maneuver is similar to that of the one-turn spin. The loss of height is about 270-300 m.
The guide mark for recovery must be established at 90º to the left (in case of a spin to the left) and at 90º to the right (in case of a spin to the right).

1 ½ turns spinning

The performance of this figure is similar to that of the one-turn spin. The loss of height is about 300-350 m. Fore recovery the pilot must choose a guide mark opposite to the guide mark for entry.

1 ¾ turns spinning

The performance of this figure is similar to that of the one-turn spin. The loss of height is about 350-400 m. For recovery, the pilot establishes the guide mark at 90º to the left in case of a spin to the right, and at 90º to the right, when performing a spin to the left.

2 turns spinning

The performance of this figure is similar to that of the one-turn spin. The spin is uniform and the angle of bank is 10-15º larger than that of the one-turn spin. This difference is due to the fact that the control surfaces are actuated at 60-80º before the guide mark because the airplane rotates faster.

Looping with slow rolling performed at the upper point

The pilot glances around and chooses guide marks for entry and recovery in the front and back of the airplane.
The entry into looping with slow rolling is operated at 300-330 km/h, 82% engine speed and full intake pressure.
The first half of looping is performed in the same way as the first half of the Nesterov loop, but the control stick is pulled more strongly.
The rolling performance is initiated when the airplane is near the upper point, and the cowling 20º ahead of the skyline. For that, the pilot actuates the control stick and swing-bar in the desired sense of rotation. The entry speed must be 150 km/h minimum. The control surfaces should be actuated is such a way that after the performance of the first half of rolling, when the airplane reaches the horizontal position, and after performing the second half, the cowling should be 20º below the skyline. While performing the rolling, the pilot must pay attention to the following: the coordinate actuation of the control surfaces, the tempo of rotation around the longitudinal axis, the airplane movement along the rolling path, the maintaining of direction with respect to the guide mark and the position of the front part of the canopy versus horizon.
In order to complete the rolling (when the airplane is in 'wheels up' position), the pilot coordinately actuates the control surfaces, discontinues the rotation, reduces the intake pressure with 2/3 by means of the throttle stroke, then, without maintaining this position, he pulls the control stick slowly, so as to fly the airplane out of dive, in level flight, at the instrumental airspeed of about 300-320 km/h.
Typical errors:

1. While performing the first half of loop, the pilot doesn't pull the stick strongly - this results in: low speed at the upper point, unsteady rolling, 'pulled upward' looping, and the airplane tends to enter in spinning.
2. The rolling is carried out in straight line - non-observance of the looping scheme.
3. When performing the first part of rolling, when the airplane is in the 'knife-edge' position, the stick is not pulled enough - this results in a deflection from the right path in the rotation sense.
4. The rolling performance is initiated too early or too late - non-observance of the figure scheme.
5. The control stick is actuated too shortly or is slackened during rotation - the airplane slows its rotation.
6. Slow or too energetic tempo of stick pulling - the shape of looping is not observed, the recovery height is lower that that of the entry.

Looping with fast rolling

This figure is performed at the entry speed of 300 km/h, 82% engine speed, and full intake pressure.
Before the entry into this maneuver, the pilot sets the reference points (guide marks) in the front and rear of the airplane.
In level flight, at entry speed, he pulls the stick and initiates the maneuver (after making sure that there is no airplane bank or side slip).
The first half of the looping is performed as the first half of the normal looping, but the stick is pulled more vigorously in this case.
When approaching the upper point of loop and when the cowling is at 20º ahead of the skyline, the pilot pulls the stick strongly in order to 'draw' the cowling over the skyline and presses the rudder pads so as to initiate the rotation.
The entry speed into rolling must be 170 km/h minimum.
After initiating the rotation, the pilot tilts the control stick to the desired direction. The airplane rotates fast.
Throughout the rolling performance, the pilot looks along the cowling, slightly sideways, to the rotation side.
In the 'wheels up' position (20-30º before completing the rolling, the pilot fully tilts the control stick and the rudder-pads, contrary to the rotation.
When the rotation has stopped, the control surfaces are brought back to neutral position, and, without maintaining this position, the pilot starts pulling the stick slowly, so as to fly the airplane out of dive in horizontal flight, at 300 km/h airspeed and the same altitude as at the entry into this maneuver.
The recovery speed may be set by reducing the gas by quickening or slowing the tempo of control stick pulling at the recovery from dive.
Typical piloting errors when performing the looping combined with fast rolling:

- loss of airspeed at the upper part of looping and slow rotation - if the control stick was pulled too slowly or too strongly in the first half of looping;
- slow detachment, which is due to the slow 'drawing' of the cowling toward the skyline or to slow or incomplete inclination of the rudder pads at the entry into the rolling;
- premature or late detachment, which causes a rolling drift on the loop trajectory versus the upper point;
- the rotation deceleration, because of the release of control surfaces throughout the rolling performance;
- the recovery from rotation with bank, due to a failure to actuate the controls in due time to perform the recovery.

Square looping

While performing this maneuver the airplane trajectory describes a square in vertical plane.
The pilot observes the surrounding space and chooses the reference points for entry and recovery

(in the front and back of the airplane).
The entry into square looping is performed at 300-320 km/h airspeed, 82% engine speed and full intake pressure.
First the airplane is trimmed in horizontal flight.
In horizontal flight the pilot pays attention to the absence of banks, side slipping, and to maintain the flight path and the altitude.
The checking-up of the vertical attitude is carried out by noticing the position of the wings against horizon and by watching the AGI-1 readings.
Three seconds later the pilot pulls the stick and brings the airplane in inverted horizontal flight, stabilizing it in this attitude.
The airspeed must be 150 km/h minimum.
The pilot looks at: cowling-horizon, reference point-bank, instruments, and reference point.
This stage lasts 4 seconds, after which the pilot pulls the stick and brings the airplane in a steady vertical dive.
To ensure a proper vertical attitude, watch the position of the wings against skyline and the AGI-1 readings.
After three seconds, the pilot pulls the stick strongly and engages the airplane in horizontal flight.
Typical errors when performing the square looping:

- the first vertical side is too long - the speed is too low at the upper point, the airplane becomes unsteady during inverted horizontal flight, and loses altitude;
- deflections from the right path (due to shifting of the vertical flight axis);
- vertical path flight with positive or negative overloading, upwards or downwards - the figure shape is not observed;
- the duration of side performances is longer or shorter than indicated.
- excessive pull of the stick for transition from one side to the other (mainly at the upper points, when the airspeed is low) - the airplane exceeds the incidence angles and might enter in spin.

Hexagonal looping

Throughout this maneuver, the airplane trajectory describes a hexagonal shape in vertical plane.
The pilot looks around and set the reference points.
The entry speed is 330 km/h, the engine speed 82% (of its nominal value), and the intake pressure is fully increased.
The pilot brings the airplane in level flight and makes sure that there are no banks and sideslips.
Then, by an energetic pull of the stick, he brings the airplane in a steady climb attitude, at an angle of climb of 60º.
After 1.5 - 2 seconds, the pilot pulls the stick and engages the airplane in inverted flight, in climb at an angle of 60º, and maintains this attitude. After 2.5 seconds he engages the airplane in horizontal inverted flight.
The pilot looks at: cowling-skyline, reference point.
To properly perform this figure (the sides must be equal), the airplane is maintained a little longer in the 'wheels-up' position (for three seconds).
Then, by pulling the stick, the pilot engages and stabilizes the airplane into a 60º dive, and then in level flight. The 60º angles are checked by watching the position of the wings against skyline and the AGI-1 readings.
The tempo of stick pulling at the transition from one side to another becomes faster as the airspeed increases.
Typical errors when performing hexagonal looping:

- failure to observe the recommended duration when performing the figure sides - the airplane describes an incorrect polygon;

- the stick is inadequately pulled at the transition from one side to another - the airplane shakes. In this case, the pilot must slacken the stick pulling, resuming the pulling actuation;
- very long sides in the first part of looping (the upward prolonging of the looping first part) - this leads to low airspeed at the upper point, unsteady airplane, and loss of altitude during the inverted horizontal flight;
- incorrect setting of angles - the figure shape is not observed.

Octagonal looping

During this maneuver the airplane describes an octagonal figure in vertical plane.
The octagonal looping can be divided in the following stages: horizontal flight, straight-line 45º climb, vertical climb, inverted 45º climb, inverted horizontal flight, inverted 45º descent, vertical descent, 45º dive, normal horizontal flight.
Before performing this maneuver, the pilot looks around and chooses the reference points.
The octagonal looping is performed at 340 km/h airspeed, 82% engine speed and full intake pressure.
The procedure for performing the octagonal looping and the attention distribution are similar to those for hexagonal looping.
In horizontal, normal and inverted flight the pilot watches: the cowling position against skyline, the reference point, the absence of banks and sideslips.
The magnitude of the 45º angles of side is checked upon the position of wings against skyline and the AGI-1 readings.
Similarly, the pilot checks if there are no banks or slips.
The duration of the low side performance is about 1.5 seconds, while that of the upper sides is slightly longer, as the speed is lower (the horizontal flight lasts the most).
The transition from one side to another must be carried out energetically, and the sides must be distinct.
While performing the octagonal looping, the typical piloting errors are similar to those encountered in the hexagonal looping.

Eight with climbing half-rolling

This maneuver has to be performed at 260-280 km/h airspeed, 82% engine speed and full intake pressure.
Prior to the entry into this maneuver, the pilot sets the reference point ahead of the airplane and in relation to the heading.
When the airplane has reached the needed speed (the entry speed), he checks if there are no banks and pulls the stick, bringing the airplane in a climb attitude, at a 45º angle of climb.
The angle value is observed upon the position of wings against skyline and by watching the gyrohorizon. Then, the pilot looks at the airspeed indicator. When the instrumental airspeed is about 220-250 km/h, he inclines the stick and initiates the airplane rotation around its longitudinal axis (in order to perform the half-rolling).
When the airplane reaches the 'knife edge' position, he must tilt the stick not only sideways, but also forward, along the board. From the 'knife edge' position, the pre-established reference point is in good sight. Depending on the cowling position against this point, the pilot can assess how much he has to push the stick.
By a lateral actuation of the stick further on, the half-rolling is completed.
The recovery from half-rolling is performed by actuating of ailerons contrary to the rotation.
The pilot checks the correctness of recovery by watching the position of the left and right wings. The angle value and the absence of banks can also be observed on the gyrohorizon.
The half-rolling is performed strongly enough by actuating the control stick; while performing the half-rolling, the rudder pads are kept in neutral position.

After checking the accuracy of the half-rolling performance, the pilot looks the guiding marks and pulls the stick, maintaining the maneuver performance.
As the airspeed increases, the tempo of stick pulling is also accelerated.
After flying the airplane out of vertical dive, the pilot reduces the power so that, when crossing the skyline, the airspeed must be equal to that of recovery from half-rolling.
Without altering the tempo of stick pulling, the pilot sets again the 45º angle, increases the engine speed up to full power and performs the second half of flight the same way as he did for the first half.
After that he pulls the stick and engages the airplane in horizontal flight.
While performing the eight with climbing half-rolling, the pilot must check the accuracy of the figure shape.
For that, it is very important to actuate the appropriate controls upon the gas sector (the throttle), in order to equalize the entry speeds in the first and second part of the eights.
Typical errors when performing this maneuver:

- decrease or increase of the angle after half-rolling, respectively the stick was pushed too much or too short for the performance of the half-rolling after the airplane has passed beyond the 'knife edge' position;
- deflection, opposite to rotation, during the half-rolling performance because the stick was pushed too much at the 'knife edge' position;
- angle of rotation larger or smaller than needed for the half-rolling performance - incorrect determination of the airplane position in space; the two parts of the eight will be performed in distinct planes;
- an inequality of the first and second part radii might occur when the speeds at the moment of skyline crossing before setting the angle are unequal.

Eight with fast climbing half-rolling

This maneuver is performed at 260 km/h airspeed, 82% engine speed and full intake pressure.
First of all, the pilot establishes the guide marks, in front of the airplane, and checks the absence of banks.
Then, he pulls the stick strongly and brings the airplane in a steady 45º climb. The climb gradient (45º) can be determined by watching the position of wings against skyline and/or by watching the AGI-1 readings.
Then, the pilot checks the instrumental speed. When it reaches 190 km/h, he pulls the stick by a short and energetic movement and tilts it strongly, and fully actuates the rudder pedal to the chosen sense of rotation.
When the airplane approaches the 'knife edge' position, he strongly tilts the stick diagonally to the sense of rotation, and pushes it beyond the neutral position.
At 30º before the half-rolling end, the pilot actuates the stick energetically, and the rudder pedal at the same time, contrary to the sense of rotation, and stops the airplane rotation.After that, he brings the control surfaces back to neutral position.

The accuracy of the fast half-rolling performance is observed by watching the cowling position against the guide mark and (visually), by watching the distance between the wings and the skyline.

Then, the pilot begins to pull the stick. When the cowling crosses the vertical dive line, he reduces the engine power, so that at the lower part of the eight, before setting the angle, the airspeed should be 260 km/h.

Without altering the tempo of stick pulling, he sets again the 45º angle, by gradually increasing the engine speed up to full gas, and performs the second half of the eight (likewise the first part).

Piloting errors:

- slow entry into rolling - because the rudder pedal was not tilted completely and energetically at the entry into half-rolling, as well as a change of the entry speed;
- deflection to the sense of rotation during the fast half-rolling - because the stick has not been pushed enough when the airplane was in 'knife edge' position;
- the increase of the climb gradient during the fast half-rolling - the stick was not pushed when the airplane reached the 'knife edge' position, but later;
- the two parts of the eight are not equal, as a result of unequal airspeeds when passing beyond the skyline, before setting the angle;
- large deflection to the sense of rotation, as a result of stick pulling simultaneously with pressing the rudder pedal, before the entry into half-rolling.

CAUTION! In all fast rotations, the rudder pads shall be actuated only after the stick pulling has been stopped.

Eight with slow, stabilized and descending half-rolling

This maneuver is performed at 270 km/h airspeed, 82% engine speed and full intake pressure.

In horizontal flight, at the given speed, the pilot makes sure that there are no banks or sideslips and bears in mind the altitude. Then, he pulls the control stick and initiates the maneuver.

He compares the position of the visible parts of the airplane against the skyline, without allowing the airplane to bank.

As soon as the skyline has disappeared under the wings, the pilot must watch the gyrohorizon, to see when the airplane passes beyond the vertical position. Then he watches the skyline approach. When the airplane passes beyond the 'wheels up' position, he reduces the engine speed with 2/3 of the throttle stroke, and at the same time he pulls the stick.

When the 45^0 dive angle is obtained, the pilot pushes shortly the stick and stabilizes this attitude of airplane, noticing the guide mark whereupon he will perform the slow descending halfrolling.

After a short maintenance of the dive angle, he actuates the stick laterally and forward and begins to rotate the airplane , taking care to avoid the cowling deflection in respect of the chosen guide mark. 90^0 after the initiation of rotation , the pilot pushes the stick shortly and energetically and presses smoothly the upper pedal, keeping the airplane in this position for a short time, then keeps on the rotation until the halfrolling is completed.

When the rotation ceased, the stick and the rudder pedals are brought back to the neutral position.

The stoppage of halfrolling must be effected at 45^0 dive angle . After the stabilization , the pilot looks at the altimeter and, at 70-80 m over the entry altitude (which was memorized at the entry into manoeuvre) begins the performance ao the second part of figure by pulling the stick and by the simultaneous acceleration of the engine speed.

When this manoeuvre is completed, the pilot drives the airplane out in horizontal flight, at the entry altitude.

Typical errors:

- the decrease or the increase of angle in halfrollings-respectively the stick is pushed too shortly or too much during rotation;

- the radii of the first and the second half of eight are not equal-the speeds at the passing beyond the skyline are not equal;
- indefinite and inaccurate stabilizations – the pilot has not been careful when determining the “knife edge” position.

Eights with climbing halfrollings, stabilized at 45^0 and 90^0

These figures are performed at 310-320 km/h airspeed , 82% engine speed and admission total pressure.

Before the entry into manoeuvre, the pilot sets the guide mark in front of airplane. Reaching the needed speed, he pulls the stick strongly and brings the airplane in a climb attitude, at a steady 45^0 gradient of climb.

This Attitude is obtained observing the wings position versus skyline and upon the gyrohorizon indications.

When the climb path was set at an angle of 45^0 , the pilot inclines the stick laterally and a little forward, and initiates the airplane rotation around its longitudinal axis.

When the bank is 45^0 (or 90^0) , he stabilizes the airplane a short time in this attitude by the short and energetic actuation of the stick contrary to the sense of rotation.Then the rotation is continued.

Similarly, the pilot astabilizes the airplene at 90^0, 135^0 and 180^0 (an angle of bank).

If the halfrolling was correctly performed, the distances between both wings and the skyline must be equal (that is observed on the gyrohorizon and upon the wings position versus skyline).

Then the pilot pulls the stick smoothly and continues the performance of the figure shape.

The tempo of the stick pulling is accelerated at the same time with the speed acceleration.

As the cowling gets near the skyline, the pilot actuates the stick more energetically and when the cowling crosses the vertical dive line he reduces the engine speed so that , when approaching the skyline, the airspeed should be equal to the entry airspeed.

Without slowing the tempo of the stick pulling, he sets again the 45 angle, increasing at the same time the admission presure completely and performs the second part of the eight (in the same way as the first half).After that, he pulls the stick and drives the airplane out in horizotal flight.

Typical mistakes:

- the decrease of angle after the halfrolling – the stick was not enough pushed during the halfrolloing performance and the upper pedal wasn’t pressed when the “knife edge” position was stabilized;
- lateral deflection throughout the halfrolling performance, causedby the insufficient or undue push of stick during the rotation, as well as a result of rotation over or bellow the necessary angle value;
- inaccurate and indefinite stabilizations – because of the oncorrect distribution of attention and the incorrect application of controls, as well as the incorrect determination of the airplane position;
- the radii of the first and the second part of the eight are not equal , as a result of speede inequality when passing beyond the skyline, before the angle stabilization.

Immelman with halfrollong, stabilized at 90^0

Before the performance of this manoeuvre, the pilot brings the airplane in level flight condition and sets the guide mark for recovery.

He makes sure that there are no banks or slips and observes very carefully the upper hemisphere.

The entry into half-looping is performed at 320 km/h airspeed, 82% engine speed and admission total pressure.

The first part of looping is performed from the recommended speed, by pulling the stick faster than in the normal looping performance.

When approaching the upper point, the airplane is in the “wheels up” position and the cowling is 10^0-15^0 ahead of skyline, the pilot maintainns the airplane in this position for a short time.

The speed in this point of the aerobic figure shall be minimum 160 km/h.

For the execution of the stabilized halfroll one selects a reference point at the horizon , then by a strong movement of the throttle in one side and forward, the roll of the airplane is started along its longitudinal axis , keeping the reference point within the visual field.

When the airplane reaches the inclination at 90^0 , by a strong and brief movement of the throttle in the opposite direction, this position is being stabilized keeping the cowling not to lower by a slight push of the upper pedal .

After maintaing for a short while (approx. 1 sec)the position “as a knife”, the roll of the airplane is continued until the halfroll is finished.

The roll is stopped by the coordinated movement of the throttle and rudder in the direction

opposite to the rotation , followed by bringing the cxontrol surfaces back in the neutral position .

To take the airplane out from this figure , the reference point must be exactly on airplane heading while the position of the airplane should corespond to normal horizontal flight .

At the entry in half-looping the attention is distributed in the same way as in a looping . At the execution of the stabilized immelman , the speed is controlled , one pursues to determine the moment to start the execution of the halfrolland of the stabilization moment, as well as the direction to get out of it.

Typical errors :

- exaggerated movement of the throttle – loss of speed too quickly and too early , which in case the critical angles of attack are exceeded , can cause going into an unexpected spin ;
- the control surfaces are oriented too early for entry in halfroll -the airplane get out of half looping with hight lift angle , loses speed quickly , wich can cause going into spin;
- the control surfaces are orientated late foe entry in halfroll , the airplane gets out from the halflooping while going down ;
- imprecise stabilization of the position “as a knife” the side inclination is higher (or smaller) than 90^0.
- indefinite stabilization as a result of low speed in the upper point
- deflection on the rotation side during the halfrolling – the stick was not pushed enough in the “knife edge” position;
- the presence of bank at the entry – the immelman is not performed in the vertical plane.

3 / 4 looping with descending slow halfrollong with an 45^0 angle of dive

The entry into manoeuvre is performed at 270 km/h airspeed, 82% engine speed and admission total pressure.The first part of looping is performed in the same way as the Nesterov loop.

After the airplane entry into inverted dive, at an 45^0 angle versus the skyline, the pilot pushes shortly the stick and stabilizes this position of the airplane , watching the ground guide merk by looking along the cowling. He redices the power up to 1 / 3 from the throttle stroke.

The dive angle is checked upon the gyrohorizon and by the value of the longitudinal axis inclination versus the ground.

After the short stabilization , the pilot actuates the stick shortly , laterally and forward, performing the halfrolling, trying to rotate the airplane around the established guide mark.

After that, he maintaines a short time the 45^0 angle , then drives the airplane out in level flight.

At the entry into the halfflooping and in the “wheels up” position, the attention is distribuited in the same way as in looping.

While performing the halfrolling, the pilot watches upon: the determination of the right moment for the halfrolling initiation (it must be performed at an inverted dive angle of 45^0), the recovery path and the airspeed.

Typical errors:

- excessive pulling of the stick – fast and premature loss of speed, which might cause the unexpected engagement in spinning when the incidence angles are exceeded;
- the presence of inclinations at the entry – the 3 / 4 looping isn’t performed in vertical plane;
- when the airplane is in the “knife edge” position at the 45^0 angle of dive, the stick is not pushed enough – the cowling deflects to the rotation side;
- the dive angle was incorrectly set, larger or smaller than 45^0 – the figure shape is not respected.

3 / 4 looping with halfrolling, on descendent path with an 45^0 dive angle

This manoeuvre is performed analogically to the preceding one, excepting the following particularities;

- after the airplane rotation initiation for the halfrolling performance, when the bank reaches at 90^0 , the pilot stabilizes this position by the short, energetic and contrary actuation of the stick. After the short maintenance of the “knife edge” position , the rotation is continued until the halfrolling is completed.
- while performing the halfrolling , the pilot pays attention also to the determination of the right moment for the 90^0 position to be stabilized.
- The supplementary typical error is the inaccurate stabilization of the airplane position throughout the halfrolling performance when the airplane is banked at 90^0.

3 / 4 looping with slow halfrolling performed on vertical descending path

The first half of this manoeuvre is performed in the same way as the Nesterov loop. After passing out the upper point, the pilot brings the airplane into vertical dive position.

The dive angle is checked upon the wings position versus skyline and on gyrohorizon.

When performing the vertical dive , the pilot pushes the stick shortly and stabilizes this position , chooses the reference point on ground (for the halfrolling performance) and reduces the power at 1/3 from the throttle course.

After the short stabilization of the descending vertical position , he pushes the stick laterally and a little forward and initiates the airplane rotation around its longitudinal axis.

The rotation is performed around the reference point which was set on ground. The pilot must rotate the airplane energetically , considering the fast increase of speed and the great loss of height.

When the halfrolling was completed , he actuates the stick contrary to the rotation sense and a little forward, then brings the control surfaces back on the neutral position.

After the short maintenance of the descending vertical position, the pilot pulls the stick and drives the airplane in level flight, increasing in the same time the power.The loss of height throughout this manoeuvre performance is about 250-300 m.

At the entry into the halflooping the attention is distributed in the same way as at the entry into the normal looping.During the halfrolling performance, the pilot pays attention to the recovery accuracy and to the speed.

The typical errors when performing the first half of manoeuvreare the same as when performing the looping.

When performing the second half, the typical errors are:

- inaccurate stabilization of the vertical dive attitude – the airplane doesn’t perform the halfrolling on the vertical path;
- slow rotation when performing the halfrolling and the throttle is completely reduced – great loss of height.

Tilting with stabilizations at 90^0 (45^0)

This manoeuvre is performed at 200 km/h airspeed, 82% engine speed and admission total pressure.

The sequence of the surroundings watching is similar to the normal slow tilting.

The airplane drives the airplane into a 15-20^0 pitchup (climb) attitude and stabilizes it. Then , he actuates the stick energetically, lateral and a little forward and initiates the angular rotation around the longitudinal axis. When the airplane reached the 90^0 bank, he actuates the stick shortly and energetically, contrary to the rotation sense, stabilizing the 90^0 bank. The duration of the stabilization is equal to the rotation around the longitudinal axis up to 90^0 (1 sec approx). During this stabilization , the pilot observes the cowling position versus the reference point.

Then he pulls the stick laterally and forward and completes the halfrolling. He stabilizes this position by the short actuation of the stick opposite to the rotation way.

After the halfrolling was completed, the rudder pads must be in the neutral position. The cowling must be 15-20 cm higher than the skyline and precisely above the established reference point.

The pilot verifies the absence of inclinations observing the position of the canopy visible parts versus skyline and regarding the AGI-1.

Then , he pulls the stick slowly and drives the airplane out in level flight, at 280 km/h ; the recovery speed is obtained by the actuation of the throttle handle (the reduction of gases).

The performance of the tilting up in front with stabilizations at 45^0 is similar to that at 90^0 stabilizations.

Typical errors:

- inaccurate stabilization (more or less than 90^0), the inability to set the airplane position correctly in space in report to the visible parts of the canopy versus skyline;
- the deflection versus the reference point because the stick was pushed too much or too little in the "knife edge " position ;
- the unclear stabilization – as a result of the inadequate entry speed "pancaking" because the stick was not pushed enough after the passing out of the "knife edge" position or because the airplane nose wasn't lifted before the halfrolling performance.

Controlled tilting (up in front) with climbing halfrolling

This manoeuvre is performed at 280 km/h airspeed, 82% engine speed and admission total pressure. Before its performance, the pilot observes the air space , especially on the tilting side, sets the required speed and checks the absence of inclinations. Then he pulls the stick energetically and stabilizes the airplane in a climbing attitude at an 45^0 angle. The angle is checked on AGI-1 and upon the wings position versus skyline. At 180-190 km/h airspeed, the pilot actuates the stick and the rudder pedal at the same time and performs the halfrolling. When reaching in the wheels up position, he brings the rudder pads back in the neutral position and stops the rotation by a short and enegetic actuation of the stick contrary to the rotation sense.

After the interruption of the rotation, the control surfaces are brought in the neutral position. While performing the halfrolling the pilot watches the tempo of the airplane rotation and takes care to maintain the climb gradient and the flight path.

After the rotation ceased, the pilot verifies the angle maintenance and the absence of bank on the AGI-1 and upon the wings position versus the skyline point; and the maintenance of the flight course upon the cowling position versus the reference point.

After a short maintenance of the 45^0 climb angle, pulls the stick gently and starts the recovery.

As the speed increases, the tempo of the stick pulling is accelerated. By the reduction of the engine power , after passing beyond the vertical dive position , the pilot sets the recovery speed in horizontal flight at 280 km/h.

Typical errors:

- the decrease of the angle during the rolling rotation – the stick was pushed too little after the passing beyond the "knife edge" position:
- the insufficient or excessive rotation during the halfrolling performance (at the recovery the distances between the wings and the skyline are not equal) – caused by the incorrect determination of the airplane position in space;
- the stick isn't pushed enough in the "knife" position of the airplane ; that causes deflection to the rotation way during the manoeuvre performance;.
- the increase of the climb angle after the halfrolling – the stick was pushed too much during rotation.

Tilting with stabilizations at the 90^0, with climbing halfrolling

This manoeuvre is performed at 290-320 km/h airspeed, 82% engine speed and admission total pressure.At the given speed, the pilot brings the airplane in a climbing attitude, at an angle of 45^0. Then , he pulls the stick laterally and a little forward, initiating the angular rotation of the airplane , until the 90^0 bank is obtained. In this position (knife edge) he inclines the stick shortly and energetically, contrary to the rotation sense and presses the upper pedal of the swing bar in order to avoid the cowling lowering, stabilizing the 90^0 bank.

The stabilization duration is 1 sec (equal to the duration of the rotation up to 90^0). In this position the pilot verifies the course with respect to the reference point.

Then the rotation is continued by the actuation of the stick laterally and forward. The “wheel up” position is stabilized by the short actuation of the stick contrary to rotation.

In the moment when the halfrolling is completed, the rudder pads must be on the neutral position . The pilot watches the wings and checks the precision of the stoppage. The angle is checked upon AGI-1 and upon the wings position versus skyline. After the end of the halfrolling, the pilot pulls the stick slowly and drives the airplane out in the level flight at 280 km/h.

Typical errors:

- unprecise stabilization (at more or less than 90^0 – due to the incorrect actuation of the control surfaces;
- the increase or the decrease of the angle – the upper pedal was pushed too little or too much in the invrted position;
- lateral deflection versus the reference point – the stick was actuated too little or too much in the “knife edge” position (of the airplane).

Tilting with fast climbing halfrolling

This manoeuvre is performed at 280 km/h airspeed, 82% engine speed and admission total pressure.

At the given speed, the pilot brings the airplane in a climb attitude at an 45^0 angle. When the climb gradient was set and the 190 km/h speed was abtained, he performs the fast halfrolling. In this purpose , he pulls the stick shortly and energetically and lifts the airplane at great incidence angles, inclines the rudder pads energetically and completely. Then, he pushes the stick diagonally, to the rotation way. During rotation the pilot will look along the cowling.

30^0 before the halfrolling completion, he stopps the airplane rotation by an energetic actuation of the stick and of rudder pads towards the opposite sode. After that, the control surfaces are brought back in the neutral position, in the position which ensures the flight at an 45^0 angle. The precision of recovery on the correct direction is checked upon the cowling position versus the reference point. The climb angle maintenance is verified upon the wings position versus horizon.

After the rotation stoppage, the pilot pulls the stick slowly and starts the recovery. As the speed increase , the tempo of the stick pulling is quicker. The speed at the recovery is regulated by the reduction of the engine power after the passing beyond the vertical dive position.

Typical errors:

- unsteady entry – incomplete and weak inclination of the rudder pedal at the entry and the maintenance of the entry speed;

- deflection on the rotation side during the halfrolling – the stick was pushed too much in the “knife edge” position;
- the increase of the climb gradient – after the rotation stoppage the stick was not brought in the initial position, or was pushed too late for rotation;
- deflection to the rotation sense at the entry into the halfrolling –the pedal was pushed too early to the rotation sense at the entry into the fast halfrolling.

Horizontal rolling with stabilizations at 90^0

This manoeuvre is performed at 250 km/h airspeed, 82% engine speed and admission total pressure.The first part of the figure is performed in the same way as the slow rolling. In the “knife edge” position (90^0) , the pilot actuates the stick shortly counterwise and pushes the upper pedal; so he stabilizes the airplane in this position. The stabilization duration is equal to that of the airplane rotation up to 90^0 and it is 1 sec approximatively. The bank is determined on AGI-1 and visually upon the airplane visible parts position versus skyline.

Then the pilot actuates the stick energetically laterally and forward and continues to rotate the airplane up to the “wheels up” position.

Nearing this position, he brings the rudder pads on the neutral position. The stabilization of the 270^0 position is made by the stick actuation contrary to the rotation sense and by pressing the upper pedal.

30^0 before reaching in normal horizontal flight configuration, the pilot begins to pull the stick and at the same time presses the swing bar to the rotation side.

Typical errors:

- deflection from the reference point, on the rotation side – the stick was not pushed enough at the halfrolling initiation or was pushed too much at the end of the halfrolling performance;
- deflection from the reference point counterwise to the rotation sense – the stick was pushed too early at the end of the halrolling performance;
- the halfrolling is performed with “pancking” and with recovery under skyline – the pitchup (climb) angle is small before the rolling performance, the stick was pushed too little within the 90-270^0 angles interval;
- unprecise stabilizations – the incorrect distribution of attention during the halfrolling performance and the incapacity to determine correctly the airplane position versus skyline;
- unclear stabilizations – incorrect actuation of the control surface in the moment of the 90^0 stabilizations.

Horizontal rolling with stabilizations at 120^0

This manoeuvre is performed at 250 km/h airspeed, 82% engine speed and admission total pressure. The initial part is performed in the same way as the first part of the controlled rolling .

When the airplane is banked at 120^0, the pilot stabilizes this position by a short and energetic actuation of the stick contrary to rotation. The banks of 120^0 and 240^0 are checked on AGI-1 and visually upon the wings position versus skyline. The duration of the stabilization is equal to that of the rotation between stabilizations.

Then the pilot continues the rotation up to 240^0 by the actuation of the stick further on laterally and forwards.When the airplane approaches the inverted position the rudder pads must be on the neutral position. The 240^0 position is stabilized by the usual procedure.

30^0 before the level flight position, the pilot begins to pull the stick , at the same time with the pressing on the pedal from the rotation side. After the rotation stoppage the control surfaces are brought on the neutral position.

Typical mistakes:

- deflection from the reference point, to the rotation side – the stick was not pushed enough at the rolling initiation or was pushed too much at the end of the rolling performance;
- deflection from the reference point, counterwise to rotation – the stick was pulled too early at the end of the rolling performance;
- the rolling is performed with “pancakings” and the recovery is made below the skyline – the climb angle is small before the entry into rolling, the stick was not pushed enough within the 90-270^0 angles interval;
- unprecise stabilizations – incorrect distribution of attention when performing the rolling and incapacity to determine correctly the airplane position versus the skyline;
- unclear stabilizations – incorrect actuation of the control surfaces in the moments of the 120^0 and 240^0 banks stabilizations.

Horizontal rolling with stabilizations at 45^0

This manoeuvre is performed at 250 km/h airspeed, 82% engine speed and admission total pressure.

Its initial part is performed in the same way as the controlled rolling . When the airplane reaches at the 45^0 bank, the pilot actuates the stick shortly contrary to the rotation sense and stabilizes the airplane in this attitude for a short time.

The stabilization duration is equal to that of the rotation up to the 45^0 bank. Then the pilot continues the rolling performance by the lateral and forward actuation of the stick (up to 90^0 position).

At 90^0 bank, the pilot stabilizes the airplane in this position by the actuation of the stick contrary and the pressing of the upper pedal.The banks are checked on the AGI-1 and visually, upon the airplane visible part position versus skyline.

The pilot assesses how much to push the stick in the “knife edge” position of the airplane in order to maintain the airplane on the reference point direction upon the cowling position versus the reference point.He continues to rotate the airplane up to 135^0 by the stick actuation.Then he brings the airplane in the inverted position (180^0).

In this position the rudder pads must be on the neutral positions. The 180^0 bank position is stabilized in the usual manner; the pilot tries to keep the 15^0 climb angle and keeps the cowlind above the reference point. In order to maintain the cowling above the skyline, he must push the stick when the airplane is in the inverted position.

By the further actuation of the stick laterally and forward, the airplane rotation is continued, the pilot stabilizes also the 225^0 and 270^0 bank position.

The 270^0 position stabilization is operated by the actuation of the stick and of the upper pedal.

During stabilization the pilot checks the cowling position versus skyline. After passing beyond the “knife edge” position (270^0) , the pilot reduces the stick push.

The pull of stick begins after the 315^0 stabilization, at the same time the pilot presses the pedal from the rotation side.After the rotation completion , the rudder pads are brought in the neutral position.

Typical mistakes:

- deflection versus the reference point, to the rotation side - the stick was not pushed enough at the rolling initiation or was pushed too much at the rolling end;
- deflection versus the reference point, counterwise to the rotation – the stick was pulled too early at the end of the rolling performance;
- the rolling is performed with pancaking and the airplane recovers from rolling below the skyline – the climb angle before the rolling is small, the stick was not pushed enough within the $90\text{-}270^0$ angles interval;
- inaccurate stabilization – the incorrect distribution of attention during the performing and incapacity to determine correctly the airplane position versus skyline;
- incorrect actuation of the control surfaces in the moment of the 45^0 stabilizations.

Controlled rolling climbing at 45^0

This manoeuvre is performed at 300 km/h airspeed, 82% engine speed and admission total pressure.

In level flight , at the given speed, the pilot sets the reference points. Then he pulls the stick and drives the airplane into a climbing attitude. When the climb gradient is 45^0, (the angle value is checked on gyrohorizon and upon the skyline), he stabilizes this attitude by a short push of the stick.

He initiates the rolling by the smooth actuation of the stick to the desired side and by the simultaneous inclination of the swing bar in the same side (the actuation of the rudder pads at the same time with the stick actuation is operated in the purpose to facilitate the rolling performance). When the airplane reaches at the $45\text{-}50^0$ bank, he starts to push the stick without slowing the rotation.

In the first moment is necessary to avoid the turn, then , when the airplane will be in the inverted position , to avoid the cowling lowering (the decrease of the climb angle).

After passing beyond the inverted position, with $50\text{-}40^0$ before the recovery from rotation, the pilot increases the swing bar inclination a little, in order to maintain the 45^0 climb angle and, as the airplane approaches the position when is when is $30\text{-}20^0$ banked, he pulls the stick in order to maintain the cowling on the 45^0 climb direction.

For the rolling completion, the pilot actuates the control surfaces for recovery, the stick and the swing bar are actuated to the opposite direction of rotation. The accuracy of the recovery is checked on gyrohorizon and upon the position of the airplanevisible parts versus skyline. After the rolling, the pilot stabilizes the 45^0 climb angle.

Typical errors:

- the stick is not actuated enough for the entry (laterally) or it is slacken during the rolling performance – the airplane slows its rotation and the cowling gets lower;
- the control surfaces aren't actuated in time for recovery – the airplane recovers from rolling with bank;
- low speed at the entry into rolling – slow rotation ;
- in the inverted position the stick is not kept in pushed position – after the rotation at 180^0 the cowling gets lower (the elevation angle decreases);

- with 30^0 before the rolling end the stick is not pulled – at the recovery the angle is decreased and the airplane deflects to the opposite direction of rotation;
- the upper pedal is not pressed when the airplane is in the “knife” position – the climb angle is reduced.

Controlled rolling descending at 45^0

In level flight the pilot sets the 120 km/h airspeed, reduces the admission pressure up to 1/3 and drives the airplane in a 45^0 dive configuration by the push of the stick.

The angle of dive is stabilized by the short pull of the stick.The angle value is checked upon the wings position versus skyline and on AGI-1.

The pilot sets a reference point for recovery upon the airplane heading and when the speed is 140 km/h starts to perform the rolling.

For the performance of this manoeuvre, the pilot must take into account that the control surfaces deflections are bigger at the entry than in the second half of the rolling, because the entry speed is low, and as the airplane decends the speed is increasing continously.

The pilot actuates the stick to the rolling direction and start the airplane rotation around its longitudinal axis; in order to facilitate the rolling performance, he inclines the swing bar in the same direction at the same time.

When the airplane is banked at 45-50^0, he begins to push the stick without slowing the rotation. In the first moment, that is necessary to avoid the tilting up in front, then, when the airplane has reached in the inverted position, to avoid the angle decrease.

After passing beyond the inverted position, with 50-40^0 ahead of the reference point, in the purpose of the 45^0 dive angle maintenance, the swing bar is inclined more on the rotation side..

To end the rolling , the pilot actuates the stick contrary to rotation and interrupts it.

Typical errors:

- the stick is pushed too much during the first half of the rolling – the dive angle is diminished;
- the swing bar was inclined too much during rotation – rotation in conical shape with skid;
- slow rotation – fast increase of airspeed, great loss of height;
- the control surfaces were not actuated in time foe recovery – the airplane recovers from rolling with bank;
- the control surfaces deflections are diminished during rotation uneven rotation with slowing down;
- -immediatelyafter the rotation interruption the pilot pulls the stick – the 45^0 dive angle isn’t stabilized.

Controlled rolling, in climbing at 45^0, with stabilizations at 90^0

This manoeuvre is performed at 320-340 km/h airspeed, 82% engine speed and admission total pressure.

In level flight, at the required speed, the pilot chooses the reference point in front of him . Then, he pushed the stick energetically and sets the 45^0 climbing angle, and maintains it by a short push of the stick. The angle value is checked on the AGI-1 and upon the wings position versus horizon.

The airplane rotation is initiated by the energetic actuation of the stick laterally. Meanwhile , the pilot looks to the rotation direction to determine the wing position versus horizon. When the airplane is banked at 90^0, he stabilizes for a short time this position by the stick actuation contrary to rotation. After the 90^0 angle stabilization, he continues the rotation up to the airplane inverted position , and stabilizes also this position by the stick actuation.

Then, he looks at the horizon in order to determine the cowling position versus the reference point.

The horizontal metalic structure of the canopy must be parallel to the skyline when the airplane is 180^0 banked.

Further, the pilot actuates the stick laterally , continuing to rotate the airplane up to the “knife” position (270^0) , in which the airplane is stabilized by the usual manner.

In the 90-270^0 positions, the pilot presses the upper pedal, to avoid the cowling lowering.

After the stabilization of the 270^0 position, the airplane rotation is completed; at 360^0 around its longitudinal axis .

In the inverted position (180^0) , the swing bar must be in the neutral position and the stick must be pushed beyond the neutral position in order to maintain the climbing angle. After the rolling end , the pilot must maintain the climbing angle, when reaching the 130-140 km/h airspeed, he brings the airplane in horizontal flight by pushing the stick.

Typical errors:

- the decrease of the elevation angle after the rolling performance – as a result of the insufficient push of stick during rotation;
- unprecise satbilization of the 90^0 and 270^0 positions – the airplane deflects laterally;
- the stick was pulled too early after passing beyond the 270^0 position deflection contrary to the rotation side;
- the 45^0 elevation angle is not maintained after the rolling.

Fast rolling , descending at 45^0

In level flight , the pilot sets the 82% engine speed , 120 km/h airspeed and reduces the admission pressure smoothly up 1/3.

Then , he pushes the stick and drives the airplane in a dive attitude, at an 45^0 angle of dive. This configuration is maintained by the short pull of the stick.

The angle value is checked on AGI-1 and upon the wing position versus horizon. The pilot must look along the cowling, higher and at the land strip which is seen at the middle of the distance between the cowling and the skyline approximatively.

He establishes the reference point and at 150-180 km/h speed, stars the fast rolling. The control surfaces are actuated in the same way as in the fast horizontal rolling performance.

After the entry into the rolling, he looks to the rotation side, under an 50-60^0 angle. 30-35^0 ahead the reference point, the point starts the recovery from rolling. When the rotation has stopped, the rudder pads are brought on the neutral position and the pilot maintains shortly the 45^0 dive angle by the actuation of the stick.The recovery from dive is performed slowly , with the gradual increase of the admission pressure. In the rolling to the right the airplane rotates faster. The loss of height due to the performance of this manoeuvre is about 300 m.

Typical errors – are similar with those from the fast horizontal rolling performance.

Fast rolling , in climbing at 45^0

This manoeuvre is performed at 260-280 km/h airspeed, 82% engine speed and admission pressure. At the required speed, the pilot pulls the stick smoothly and sets the 45^0 elevation angle; total

and maintains this configuration of the airplane by the short push of the stick.

The value of the elevation angle is checked on AGI-1 and uppon the wings position versus horizon. When setting the elevation angle , the pilot must watch that there are no inclinations and the direction is maintained. At this angle of elevation , the horizon will be projected a little above the leading edge of wings. When reaching the 180-220 km/h airspeed, the pilot performs the fast rolling.

The control surfaces will be actuated in the same way as at the performance of the fast horizontal rolling but the airplane rotates faster. The control surfaces position is not changed during rotation.

30^0 before the rolling end, the pilot actuates the control surfaces for recovery as at the performance of the fast horizontal rolling recovery.

After a short stabilization of the elevation angle , the pilot drives the airplane out in level flight by the short push of the stick.

Typical errors – are similar to those of the fast horizontal rolling performance.

Controlled (slow) rolling on ascending verticale

This figure is performed at 360 km/h airspeed , 82% engine speed and admission pressure. Before its performance, the pilot sets the reference point for entry and recovery. At the required speed, after checking the absence of inclination and slip, he pulls the stick energetically and starts the climb on vertical. Up to 30^0 , the absence of bankis checked upon the position of the airplane visible parts versus horizon. From 30^0 up to 70^0 , the check is operated regarding the AGI-1.

After passing beyond the 70^0 angle, the pilot watches the wings and slows the tempo of the stick actuation. He drives the airplane on a vertical path and stabilizes this position by a short push of the stick . This path it's determined upon the wings position versus horizon and on AGI-1. When reaching the vertical attitude, the pilot sights out the reference point at 90^0 ; in the rolling to the right – upon the left wing ; in the rolling to the left – upon the right wing.

The vertical speed decelerates very fast and therefore, after the vertical setting and after its check, the pilot must initiate the rotation immediately, by the actuation of the stick on the rolling direction.

The stick must be actuated in an accelerated way (the sudden push of the stick doesn't facilitate the energetic rotation of the airplane around its longitudinal axis, but on the contrary, decreases the speed . As the speed decreases , the pilot pushes the stick a little, along the board. The inclination of the rudder pedal is not needed. The pilot must only press the rudder pads to the rotation sense .

When the rolling is performed to the right, the pilot must look to the left wing (a little ahead of it with 25-30^0) ; in the case of the rolling to the left – to the right wing.

When the wing lowers , he pushes the stick without slowing down the rotation ; when the wing outdistances the skyline he pulls the stick along the board in order to set again the correct position of the airplane.

When the wing approaches the reference point , he inclines the stick precisely contrary to the rolling direction and begins the recovery.

After the rotation cancellation , he brings the stick on the neutral position and tries to maintain the airplane in the vertical position . After a short stabilization of the vertical trajectory (1 sec approximatively , at 160 km/h airspeed) the pilot pushes the stick smoothly and drives the airplane in level flight.

The airplane tendency to bend to the right , caused by the influence of the gyroscopic moment , is avoid by pressing the left pedal of the swing bar.

Typical errors :

- unprecise stabilization of the vertical path: the vertical position is not reached – at the rotation to the right the left wing lifts off; deflection from the vertical position: at the rotation to the right , the left wing lowers;
- the stick is pushes too much during rotation – the airplane deflects from the vertical path with positive overloading ; rotation in funnel shape;
- the stick was pushed too little during rotation – the airplane deflects from the vertical path "on back" (with negative overloading), funnel shape rotation ;
- the rudder pads are pressed during rotation – displacement of the airplane longitudinal axis; rotation in funnel shape.

3/4 controlled rolling ascending vertical path

This figure is performed at 340-360 km/h airspeed, 82% engine speed and admission total pressure.

It will be performed above a liniar reference mark, or the pilot establishes a guide mark , at 90^0 precisely.

At the required speed , the pilot drives the airplane on a vertical path. The recovery from the vertical configuration is performed in the same way as that from the controlled rolling on an ascending vertical path performance.

After reaching the vertical position , without overlooking the wings, the pilot starts to push the stick , first smoothly , then strongly , laterally and a little forward, in order to start the airplane rotation around its longitudinal axis.

In all cases of rotations on vertical path, the swing bar must be on the neutral position ; only the pedal from the rotation side must be pressed a little. The pilot must look : in case of rotation to the right – at the left wing ; in case of rotation to the left – at the right wing.

As soon as the airplane has been rotated up to 270^0 around its longitudinal axis , the pilot actuates the stick shortly , contrary to rotation and interrupts it. After the rotation ceased , he doesn't press more the rudder pedal and regards the airspeed indicator. When reaching 160 km/h airspeed , he pushes the stick and drives the airplane in normal level flight. The airplane tendency to bend to the right is avoided by pressing upon the left pedal of the swing bar.

Typical errors – are similar to those from the controlled rolling on ascending vertical path performance.

Halfrolling on ascending vertical path

This figure is performed at 320 km/h airspeed , 82% engine speed and admission total pressure . It is performed in the same way as the controlled or 3/4 controlled rolling on ascending vertical payh performance.

After the airplane has been driven out on the ascending vertical path , the pilot sets the reference point for recovery: in case of rotation to the right – upon the right wing ; in case of rotation to the left – according to the left wing.

Typical errors – similar to those which might occur when performing the controlled rolling on ascending vertical path performance.

1/4 controlled rolling on ascending vertical path

This figure is performed at 300 km/h airspeed , 82% engine speed and admission total pressure. It is performed likewise the controlled rolling on ascending vertical path.

The reference point for recovery is established in level flight: backward when the rotation is performed to the right and in the front when the rotation is performed to the left.

Typical errors – are similar to those of the controlled rolling on vertical path performance.

Controlled halfrolling on ascending vertical path with stabilizations at 90^0

This figure is performed at 340 km/h airspeed minimum, 82% engine speed and admission total pressure.

Before the halfrolling performance , the pilot sets the reference points on the entry and recovery direction. At the required speed , he drives the airplane into the vertical configuration. After that , he chooses the reference points at 90^0 with respect to the right and the left wing. Then , he actuates the stick to the rotation side . He looks to the left wing – in case of rotation to the right , and to the right wing – in case of rotation to the left , with $20\text{-}25^0$ in front of wing , in order to sight the reference point.When the wing approaches the reference point , the pilot actuates the stick shortly and energetically and stops the airplane rotation for a short time (up to 1 sec) , then he continues the rolling performance.

The airplane rotation and the stabilization are performed only by the actuation of one single stick.

It is not necessary to actuate the swing bar , the pilot must only press slightly the pedal from the rotation side .

After the rotation ceased , the pilot touches shortly the vertical path and at 160km/h airspeed , he pushes the stick slowly and drives the airplane out in level flight.

The airplane tendency to bend to the right , under the influence of the gyroscopic moment , is avoided by pressing on the left pedal.

Because the airplane has tendency for side slipping at low speeds and high incidence angles , the ailerons must be actuated more energetically , as their efficienty is smaller at the low speeds.

Typical errors :

- untrue stabilization of the vertical path, because of the incorrect distribution of attention;
- in the rotation to the right the left wing gets down – the stick was insufficiently pushed during rotation;
- in the rotation to the right the left wing raises – the stick was pushed too much;

- funnel shape rotation – due to the fact that during rotation , one of the rudder pads was actuated too much;
- too long maintenance of the vertical path before the rotation – low speed after rotation , at the recovery in horizontal flight.

1/4 contolled rolling on descending vertical path with stabilizations at 45^0

In level flight , the pilot checks carefully the low hemisphere and sets the 120 km/h airspeed and the engine speed at 82%.

Then , he pushes the stick firmly , simultaneuosly reducing the admission pressure , and drives the airplane in an 90^0 dive angle.During the transition into the dive position , the sudden actuation of the stick is not permitted , to avoid the loss of stability.

When the airplane is on a vertical path , the pilot pushes the stick shortly in the opposite direction and stabilizes the dive configuration and at the same time establishes the reference point on ground , exactly along the airplane cowling . After that , he pushes the stick laterally and starts the airplane rotation . When the airplane has been rotated up to 45^0 , he pushes the stick shortly and energetically in the opposite direction and stops the airplane rotation for a short time (1 sec approximatively) , then keeps on the rotation performance , until the 1/4 rolling is completed. When the rotation has been completed , the pilot checks if the swing bar is on the neutral position , touches for a short time the vertical path , then pulls the stick and begins the recovery in level flight. He verifies if there are no inclinations and watches the speed increase. The loss of height due to this figure performance is 450 m.

The pilot must bear in mind that the great loss of height occurs at the performance of this figure with the admission pressure total reduced ; that is way , at the entry , the admission pressure is not reduced completely , but only up to 1/4 from the throttle handle course.

Depending on the required speed for the manoeuvre performance , the increase of the engine speed at the recovery , up to total or half , facilitates the acceleration of the recovery tempo (for the recovery in level flight).

Also , that facilitates the decrease of pancaking at the recovery, the decrease of the arc radius and the decrease of the height loss during the figure performance.

Typical errors :

- fast speed before the entry – fast increase of speed on the descending vertical path, the rotation becomes difficult , the pilot has not the the possibility to touch the vertical path correctly before and after rotation , the recovery speed increase fastly. In this case , the recovery must be performed with the admission pressure reduced ;
- very slow tempo of the vertical setting – fast increase of speed ;
- to energetic tempo of the vertical stabilization – might lead to the loss of stability;
- the swing bar is inclined during rotation – funnel shape rotation.

Halfrolling on descending vertical path

In horizontal flight , at 120 km/h , the pilot checks the surroundings and makes ready the halfrolling performance . He pushes the stick precisely and reduces the admission pressure (up to 1/4) at the same time bringing the airplane into a 90^0 angle of drive.

By actuating the stick contrary , he sets this vertical configuration and watches at the same time the reference point , from ground , which is chosen precisely along the cowling . The descending vertical path is checked on AGI-1 and upon the left wing position (with PVD) versus horizon . The cowling deflection from the reference point is corrected by actuating the stick . When the halfrolling is completed , the pilot stops the rotation by actuating the stick on the opposite direction to the rotation . After the rotation ceased , he checks if the rudder pads are on the neutral position and touches for a short time (up to 1 sec) the vertical path . He starts the recovery in level flight by the stick pulling and watches the absence of inclinations and the aiespeed acceleration . The loss of height due to this figure performance is about 450-550 m . The pilot must bear in mind that the great loss of height occurs when performing this figure with the admission pressure reduced completely , that is way at the entry the admission pressure is not reduced completely , but only up to 1/4 from the throttle handle stroke . Depending on the required speed for the figure performance , the increase of the engine speed at the recovery , up to total or half , facilitates the acceleration of the recovery tempo , decreases the pancaking at recovery , decreases the arc radius and accordingly reduces the loss of height during the descending halfrolling .

Typical errors :

- fast speed before the entry – fast increase of speed on the descending vertical path , the rotation becomes difficult , the pilot has not the possibility to touch the vertical path correctly before and after rotation , the recovery speed increases fastly and suddenly ; In this case the recovery will be performed with the power reduced;
- very slow tempo of the vertical stabilization – fast increase of the airspeed;
- too energetic tempo of the vertical stabilization – might lead to the loss of stability or its severe decrease ; in this case the reduction of the admission pressure must be initiated later ;
- rotation in funnel shape if the pilot has actuated the swing bar during rotation performance.

1/4 controlled rolling on descending vertical path

The entry into this figure is operated at 120 km/h .

The figure is performed likewise the controlled halfrolling ; but unlike the controlled halfrolling , the rotation is finished at 90^0 .

Typical errors – are also similar to those which might occur while performing the halfrolling .

Diving turn

This figure is performed at 270-300 km/h airspeed , 82% engine speed and admission total pressure .

First of all , the pilot must set the orientation mark for entry and recovery . When reaching the necessary speed , he brings the airplane energetically in a vertical attitude (in climbing).

At 70 km/h airspeed (when performing the diving turn to the right) , and 90 km/h (when performing diving turn to the left) , he actuates the swing bar completely , energetically but not suddently , and initiates the turn . He will look to the right wing (in case of diving turn to the right) or to the left wing (in case of diving turn to the left).

In case of the execution of a correct inverted flight , the wing tip must “draw” a line perpendicular on the horizon .

Unless the airplane over turns on its back, when the turn is started, the throttle should be inclined to the left (in case of inverted flight on the right), and to the right respectively (in case of inverted flight to the left).Once the airplane turns with 35-40^0, the slow reduction of the input pressure is initiated and after it is found out that the airplane turns in stability conditions, gas is totally cut off.

In inverted flight , with 10-15^0 before the descending vertical ,by pushing on the (opposite) pedal of the rudder the turngets interrupted, then the rudder pedal is brought to neutral position while the throttle is brought in the position which provides the flight of the airplane exactly on the descending vertical.

The control of the descending vertical is executed based on the position of the wings and AGI-1.

The engine is reduced to the initial RPM and a and a distance is run equal to the distance run on the ascending vertical.

When getting out to the horizontal flight, attention will be directed to no inclinations, glides(plides), speed, overload.

Typical errors :

- “overdue”(extended) vertical – the inverted flight is executed with overturn on the back;
- the speed to enter into the turn is high – at the inclination of the rudder pedal for turning the airplane continues to go upwards, with slide/glide(skid);
- during the inversion the inclination is not counter balanced from the throttle – the airplane goes overturn “on the back” ;
- after the 180^{0}turn, the axis of the airplane does not reach in the vertical position; the opposite rudder pedal was acted upon too early for stopping; if the vertical is already post , the opposite rudder pedal was acted upon too late;
- the airplane has covered a small distance on the descending vertical path – the two vertical sides (ascending and descending) are not equal .

Diving turns with controlled and stabilized rollings with elements of controlled and stabilized rollings on ascending or ascending trajectories

These figures are performed at 82% engine speed and admission total pressure , at the suitable airspeeds for the entry into rolling or into rolling elements , which are performed on ascending trajectory . The controll points for the recovery from rollings or from their elements are established as in the case when these figures are performed apart . At the necessary speed , after checking the absence of inclination and slips , in horinzontal flight , he pulls the stick strongly and drives the airplane into a vertical attitude .(Prior to that he has set the guide marks on the entry and recovery direction of the diving turn performed in combination with rolling or rolling elements)

In the initial stage (up to 30^0) , he checks the absence of inclination upon the position of the airplane visible parts versus skyline .From 30^0 up to 70^0 , he looks at the AGI-1 , and after passing beyond 70^0 he looks at wing and slows the stick pulling tempo.

After reaching the vertical path , the pilot stabilizes the airplane on this ascending vertical by a short pulling of the stick.

The correctness of the airplane vertical position is checked upon the wings position versus horizon and on AGI-1 .

After a short maintenance of the airplane in this position , he inclines the stick on the desired sense and starts to rotate the airplane around its longitudinal axis , trying to avoid the errors which occur usually during vertical rotations . In this case , the pilot will look at 15-20^0 ahead the wing from the opposite side of rotation (at the rotation to the right he will look towards the left wing , and viceversa) . When the wing approaches the control point , he stops the rotation . Then , he looks at the airspeed indicator . Furtheron , he will concentrate his attention upon : the airspeed indicator – the wing , the final cancellation of errors , waiting for the suitable speed to perform the turn .

When reaching 70 km/h airspeed , he inclines the right pedal of swing bar completely and stongly , and at the same time looks at the right wing . As soon as the airplane begins to turn , he inclines the stick exactly to the left , in order to avoid the influence of the gyroscopic moment which appears . After turning the airplane around its vertical axis with 40-50^0 , the pilot reduces the admission pressure in order to ease the rotation performance . At 10-15^0 before the end of rotation , he presses the left pedal and stops the airplane in the descending perpendicular position , bringing the stick on the neutral position . He increase the admission pressure up to one third from the throttle stroke and glances simultaneuosly at the wings , in order to determine the correctness of the descending vertical setting .

Then he looks at the airspeed indicator , and when it shows the airspeed of 140-150 km/h , he starts the airplane rotation up to the control point . When reaching at the control point , he interrupts the rotation and pulls the stick , beginning the recovery in level flight at the required speed , which is regulated by the throttle handle actuation and by the stick pulling .

When performing diving turns combined with rolling elements on ascending or descending path , the pilot must pay special attention to the rotation phases (rollings) , in order to obtain a correct recovery on the desired direction . When performing these figures the errors which can be made are those characteristical for diving turns , rolling on ascending or descending vertical path .

All combinations of diving turns with all possible types of rollings are performed in the same way . The only differences consist of the entry airspeeds and the height need .

1. Diving turn with ascending rolling : entry speed 360 km/h , without gain or loss height .
2. Diving turn with 3/4 ascending rolling : entry speed 350 km/h , no loss of height .
3. Diving turn with 1/4 ascending rolling : entry speed 300 km/h , no loss of height .
4. Diving turn with descending rolling : entry speed 270 km/h , recovery speed 320 km/h . loss of height 300 m .
5. Diving turn with ascending rolling and descending halfrolling : entry speed 360 km/h , recovery speed 320 km/h , without loss of height .
6. Diving turn with 3/4 ascending rolling and descending halfrolling : entry speed 350 km/h , recovery speed 320 km/h , loss of height 100 m .
7. Diving turn with 1/4 ascending rolling and descending halfrolling : entry speed 300 km/h , recovery speed 320 km/h , loss of height 300 m .
8. Diving turn with 1/4 descending rolling : entry speed 270 km/h , recovery speed 300 km/h , loss of height 250 m .
9. Diving turn with 3/4 ascending rolling and 1/4 descending rolling : entry speed 350 km/h , recovery at 300 km/h , without loss of height .
10. Diving turn with ascending rolling and 1/4 descending rolling : entry at 360 km/h , recovery at 300 km/h , without loss of height .
11. Diving turn with ascending halfrolling and 1/4 descending rolling : entry at 330 km/h , recovery at 300 km/h , loss of height 100 m .

12. Diving turn with 1/4 ascending and descending rolling : entry at 300 km/h , recovery at 300 km/h , loss of height 100 m .
13. Diving turn with two stabilizations at 45^0 upward and 1/4 descending rolling : entry at 300 km/h , recovery at 300 km/h , loss of height 100 m .
14. Diving turn with halfrolling set on the ascending vertical and controlled on the descending vertical : entry at 350 km/h , recovery at 320 km/h , without loss of height .

Inverted aerobic flight

In inverted flight , the pilot can perform straight path flight (level flight , climb and gliding) or flight on curviliniar trajectories (returns , turns , ascending or descending figures) .

First of all , the pilot must master very well the normal flight pilotage technique . It is advisable to begin the inverted aerobatic flight in the aerodrome area , by horizontal flight with returns at $90\text{-}180^0$ under the flight controller's survey .

Inverted horizontal flight

This manoeuvre will be performed within the airspeeds of 180 km/h up to the maximum admitted speed in level flight .

After reaching the required speed , the pilot sets the nose lift (climb , angle of $15\text{-}20^0$ and actuates the stick gently and the swing bar to the desired side , to reverse the airplane with 180^0 (in the inverted position) .

WARNING: When the oil pressure decreases or the airspeed increases fastly , the pilot must return immediately the airplane in the normal position by performing a halfrolling .

To bring back the airplane in normal level flight , the pilot will push the stick , he sets the $15\text{-}20^0$ nose lift angle and then actuating gently the stick and the swing bar , he rotates the airplane with 180^0 around its longitudinal axis .

45^0 bank inverted turn

This manoeuvre will be performed at 210 km/h airspeed and 82% engine speed . In case of high increase or decrease of airspeed , while performing the inverted turn and when it's difficult to avert the errors , the pilot must cancell the bank and bring the airplane in straight line inverted flight and set the minimum 180 km/h airspeed .

Then he reverts the airplane in normal level flight .

60^0 bank inverted turn

It's advisable to perform this figure with 210 km/h airspeed and 82% engine speed .

During inverted level flight , the pilot actuates the stick and the rudder pads coordinately and initiates the turn .While banking the airplane , he increases the admission pressure gently so , when the airplane is banked at 45^0 , the admission pressure should be increased completely .

Keeping on to bank the airplane , the pilot pushes the stick a little in order to accelerate the rotation and actuates the swing bar in the purpose of the cowling maintenance on the skyline .

The excessive push of the stick leads to the airspeed deceleration . The recovery from turn begins with 30^0 ahead the control point by the inclination of the stick and of the swing bar coordinately and contrary to the rotation sense .

As the bank diminishes , the pilot pulls the stick on the diagonal , preventing the nose elevation , reduces the admission pressure up to the required value . After the recovery in inverted level flight , the stick and the swing bar are brought on the neutral position .

Climbing inverted looping from inverted level flight

It's advisable to perform this figure with 340 km/h airspeed , 82% engine speed and admission total pressure .

When the required airspeed has been obtained , the pilot pushes the stick gently and energetically and initiates the looping . As the nose lift (climb) angle increases , he accelerates the stick pulling until the airplane approaches the horizontal position .

In order to avoid the stall dive as a result of low speed (below 100 km/h) , it is advisable to pull the stick shortly when approaching the upper point of looping , so that the overloading will be almost anulled .After passing beyond the upper point and the fore part of the airplane lowers with $15\text{-}20^0$ below skyline , the pilot reduces the admission pressure gently . After passing out the vertical position , he pulls further on the stick , so that the recovery speed be 280-300 km/h .

When the cowling approaches the skyline , he increases the admission pressure up to the required value .

Inverted descending looping from normal horizontal flight

It's advisable to set the 82% engine speed , to reduce the admission pressure first , and when reaching the 150 km/h airspeed to push the stick , initiating the looping .

After passing beyond the vertical position , the pilot increases the stick push so that , in the low point of looping the airspeed be 340 km/h . $20\text{-}30^0$ ahead the inverted position , he increases the admission pressure so that in the moment of inverted level flight it should be total .

The second half of looping is performing in the same way as the first half of the climbing inverted looping from inverted flight .

The recovery speed must be 150 km/h minimum .

NOTE: If in the upper point the speed is lower than 150 km/h , the recovery from looping in horizontal flight will be performed after passing beyond the upper point .

Pendulum

The ingress into pendulum is operated from normal or inverted flight .

Pendulum from normal flight , forward fall

First of all the pilot sets the engine speed at 82% and ensures the admission total pressure .

At 260 km/h airspeed , he drives the airplane in a 90^0 climb (on vertical path) , stabilizes it , and maintains this angle exactly .

The airplane position versus horizon is checked upon the wings projection on the skyline .

When the airplane is stabilized on vertical path and its position versus horizon is controlled , the pilot reduces the admission pressure gently , so when the airplane is "hung up" the admission pressure is reduced completely (propeller in low pitch condition) .

At 45-50 km/h , the elevation angle is decreased up to 87-85^0 (with 5^0 maximum) by the push of the stick .When the speed is almost "0" (in the hung up moment) the pilot pulls the stick completely (the airplane doesn't react to this control) and keeps the rudder pads on the neutral position .

The stick and the rudder pads are kept in these position by a small effort , because when the airplane falls on its tail , the control surfaces are subjected to important overloadings .

After the nose fall and the passing in dive , the pilot pushes the stick up to the neutral position ,

increases the admission pressure and at 190 km/h minimum initiates the recovery from dive in horizontal flight .

Pendulum from normal flight , "on back" fall

For the performance of this figure , unlike that of the pendulum with forward fall , the pilot pulls the stick when the speed is 40-50 km/h and increases the elevation angle from 90^0 up to 93-95^0 . When the airplane is hung up (at almost 0 speed) , he pushes the stick completely . After the "on back" fall and the lapse in dive , he brings the stick in the neutral position , increases the admission pressure and drives the airplane out in horizontal flight at the required speed .

Pendulum from inverted flight

The entry speed – 280 km/h . The sequence of performance is similar to that of pendulum from normal flight .

Inverted spinning

This figure may be performed in training purposes from 1500 m height minimum . In horizontal flight condition , at 170 km/h airspeed and 82% engine speed , the pilot equilibrates the airplane and

sets the control point for recovery from spinning .

When the speed is 180 km/h , he performs a halfrolling and brings the airplane in inverted horizontal flight .

He reduces the admission pressure slowly and doesn't allow the airplane to rotate . He maintains the airplane in horizontal flight until the airspeed is 140 km/h . Then he actuates the rudder pads gently and completely on the desired sense , pushes the stick and initiates the spinning . During the inverted spinning , the control surfaces must be kept in their position from the entry .

The loss of height for one-turn spin is about 100-150 m .

To drive the airplane out from the inverted spin , at 30^0 before reaching at the control point , the pilot actuates the rudder pads contrary to the rotation sense and pulls the stick beyond the neutral position.

As soon as the rotation ceased , he brings the rudder pads in the neutral position and pushes the stick beyond the neutral position .

The loss of height at the recovery is about 300-400 m . To drive the airplane in normal flight after the rotation interruption , the pilot pulls the stick gently , so that the recovery in the horizontal flight take place at 240-250 km/h ..

WARNING: After high class aerobatics on horizontal or vertical trajectories , the pilot will tune the compass course system and will bring the gyrohorizon on “Neutral” in normal straight line horizontal flight .