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AIRCRAFT МиГ-21БИС

PILOT'S FLIGHT OPERATING INSTRUCTIONS

МиГ-21БИС

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AIRCRAFT МиГ-21БИС

(FITTED WITH POLYOT-OИ SYSTEM)

PILOT'S FLIGHT OPERATING INSTRUCTIONS

With publication of the present Instructions, the МиГ-21БИС Pilot's Flight Operating Instructions No. ГК-359 and all supplements thereof become ineffective and are subject to destruction in the using units in the established order.

The book contains 220 pages and 2 unclassified insets.
Inset 1 between pages 74 and 75;
Inset 2 between pages 74 and 75.

Section One

BASIC INFORMATION ABOUT THE AIRCRAFT

The МиГ-21БИС aircraft is a front-line (tactical) interceptor fighter powered by one turbojet engine. It is fitted with instruments and electronic equipment ensuring flights by day and at night under fair and bad weather conditions.

The aircraft is an all-metal, cantilever mid-wing monoplane featuring a delta wing, swept-back tail unit and controllable stabilizer.

The aircraft is furnished with:

(a) engine P25-300 provided with second (emergency) reheat and developing static thrust of 7100 kgf with second reheat (or 9900 kgf in flight at Mach 1 near the ground with second reheat on), 6850-kgf static thrust with full reheat on and 4100-kgf static thrust at full throttle;

(b) boundary layer control system (BLC);

(c) drag chute;

(d) communication radio set, type P-802Г, automatic radio compass (ARC), type APK-10, marker beacon receiver МРП-56П and aircraft distance transponder СОД-57 (also referred to as the "air traffic control (ATC) transponder");

(e) pitot-static tubes: type ПВД-18-5М (main) and type ПВД-7 (emergency);

(f) pressure altimeter ВДИ-30 and low-level radio altimeter PB-УМ;

(g) combined instrument, type ДА-200, consisting of a vertical speed indicator, turn indicator and slip indicator;

(h) built-in gun ГШ-23;

(i) sighting system consisting of radar ALMAZ A-23Б and optical sight АСП-ПФД fitted with an additional fixed reticle and transparent range scale;

(j) automatic pitch channel transmission ratio controller АРУ-3ВМ which improves the aircraft maneuvering characteristics and controllability at transonic and supersonic airspeeds and reduces stick forces, as compared with the АРУ-3В controller;

(k) angle-of-attack indicator УУА-1 and limit angle-of-attack warning unit СУА-1;

(l) radar illumination warning system СПО-10;

(m) automatic flight control system (AFCS) САУ-23ЕСН;

(n) short-range radio navigation and landing system POLYOT-ОИ;

(o) centralized dangerous conditions warning system СОРЦ-1;

(p) system of JATO units and an automatic device for their switching-on (the JATO unit attachment fittings are removed from the aircraft and put in the set of spare parts, tools and accessories);

(q) airborne IFF interrogator/transponder, type CP3O-2, intended for identification of aircraft (whether friend or foe).

The following electrical power sources and inverters are installed on the aircraft:

(a) DC generator ГСР-СТ-12,000 W;

(b) AC generator ГО4ПЧ4;

(c) storage batteries 15СЦС-45Б;

(d) DC/AC inverters ПО-750А (two), ПТ-500Ц, ПТ-125Ц, ПО-250-ВЧ-М.

The aircraft has four external store stations on which the following stores can be carried (in compliance with Table 7):

(a) guided missiles Р-3С, Р-3Р or Р-13М;

(b) type УБ-32 or УБ-16-57 rocket pods with folding-fin air rockets;

(c) free rockets of the С-24 type;

(d) incendiary tanks of the ЗБ-500 type;

(e) aerial bombs of the 50-kg caliber (practice bombs), 100-kg caliber (e.g. high-explosive/fragmentation, incendiary, smoke, illumination bombs, etc.), 250-kg caliber (e.g. high-explosive, high-explosive/fragmentation, incendiary, illumination, cluster bombs, etc.) and 500-kg caliber (e.g. high-explosive, incendiary, illumination, cluster bombs, etc.);

(f) drop tanks of 490-L capacity.

A ventral drop tank can be also carried, its capacity being either 490 or 800 L. The 490-L drop tanks can be either of the modified version or otherwise. The modified drop tanks are provided with a delay device in the rear attachment unit, delaying tank release at that unit during jettison, in order to prevent the tank from kicking against the aircraft.

The pilot's cabin is pressurized; it is fitted with an ejection system, type КМ-1М, which can ensure safe ejection throughout the range of operating altitudes as well as during takeoff run and landing roll, when the speed is higher than 130 km/h; the cabin is also provided with a set of high-altitude (life support) outfit ensuring normal activity of the pilot through the entire range of flight altitudes.

A periscope is installed on the collapsible canopy in order to improve observation of the rear hemisphere. The device permits the pilot to view the zone with the following boundaries:

(a) without turning the head: 10° up, 2° down and $\pm 10^\circ$ sideways;

(b) with inclining and turning of the head: up to 20° up and up to $\pm 40^\circ$ sideways.

Note. It is difficult to use the periscope for viewing the rear space while performing maneuvers at g-loads exceeding 3 g; and at 5 g this is impossible altogether.

WARNING. It is forbidden to use the periscope in level flight at altitudes below 200 m in manual control, as the aircraft might descend to an inadmissibly low altitude in the meantime.

The powerplant features a center-body air intake. The intake passage area is varied by means of a controllable intake cone.

The aircraft is equipped with a hydraulic system and a pneumatic system. The hydraulic system is subdivided into the booster system and the main system. The pneumatic system is subdivided into the main system and the emergency one.

The present Instructions deal with basic directions mandatory for the pilots in operating and piloting the МиГ-21БИС aircraft under normal conditions and in emergencies. It is assumed that in all other complicated situations, not covered by the Instructions, the pilot will use his own judgement to cope with the actual situation.

To operate the aircraft with due efficiency and confidence and to fully utilize its combat capabilities, the pilot shall acquire profound and thorough knowledge of the design of the aircraft and its component assemblies and systems, using the Technical Description and other relevant publications.

Employment of the graphs and nomograms contained in the present Instructions, in preparing for a flight mission, will permit the flying personnel to utilize completely the high flying and combat performance of the aircraft, provided the latter is operated competently.

If not otherwise specified, the present Instructions refer to indicated airspeed values as read off the УС-1600 airspeed indicator, indicated Mach number and true airspeed values as read off the УИСМ-И instrument, and indicated altitude values as read off the ВДИ-30 altimeter.

The aircraft external view is shown in Figs 1 through 3.

CHARACTERISTICS OF FLIGHT RANGE AND ENDURANCE

Indicated airspeed is the main parameter to be maintained in level flight at an assigned altitude in order to obtain the optimum range and endurance.

As flight altitude is increased, the range and endurance grow, reaching the maximum values at altitudes close to the aircraft ceiling at full throttle power. Thus, for the aircraft carrying either no external loads or two missiles the maximum range is attained at 11,000 m, for the aircraft carrying two missiles and a drop tank the maximum range is reached at 10,000 m, and it is reached at 5000 m for the aircraft carrying eight bombs ОФАБ-100.

When calculating the flight range and endurance for some given flight conditions, or when determining the fuel consumption in flight on the assigned route, refer to the Instructions on Calculation of Flight Range and Endurance for single-aircraft flight of the МиГ-21БИС aircraft powered by the Р25-300 engine.

Also, the aircraft flight range and endurance capabilities can be assessed approximately, with reference to Tables 1 through 3. Then the following should be taken into consideration:

(a) amount of fuel consumed by the engine on the ground (engine starting, trial running, taxiing to the line-up position), 13 L/min;

(b) fuel consumption, distance and time required for takeoff and climb, in accordance with the data contained in Table 1; the table has been compiled on the assumption that the aircraft takes off with full reheat power, using this power until reaching the 600-km/h airspeed, then it continues to climb with full throttle power at a true airspeed of 870 km/h, or 650 km/h if it carries bombs on multi-shackle racks;

(c) per-kilometer fuel consumption and hourly fuel consumption under the maximum range and maximum endurance flight conditions, in accordance with Table 2;

(d) fuel consumption, distance and time for descent at an airspeed of 500 - 550 km/h (the engine set at idle power) down to the circuit height (1000 m) or to the predetermined point at an altitude of 2000 m, in compliance with Table 3;

(e) fuel consumption in descent from the predetermined point, i.e. from the 2000-m altitude and a distance of 40 kilometers, to the airdrome (for landing approach from a predetermined line), 260 L;

(f) fuel consumption in circuit flight before landing or in go-around, 45 L/min averagely (i.e. 30 to 40 L/min with the LG up, and 60 to 70 L/min with the LG down);

(g) fuel consumption in climb to an altitude of 2000 m (with the LG down, the engine set to FULL THROTTLE) for ejection (should landing prove impracticable after going around), 100 L;

(h) guarantee fuel reserve (7 per cent of the consumable capacity of the inner tanks), 210 L; this reserve allows for probable deviations of the actual fuel consumption characteristics from those given in the present Instructions; the deviations might be caused by variations in the engine performance and aircraft aerodynamic characteristics.

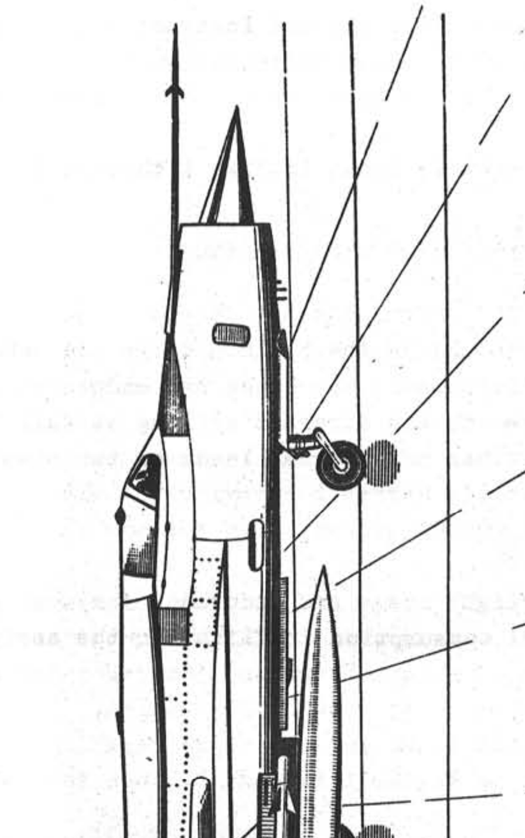


FIG. 1. AIRCRAFT МиГ-21БИС (SIDE VIEW)

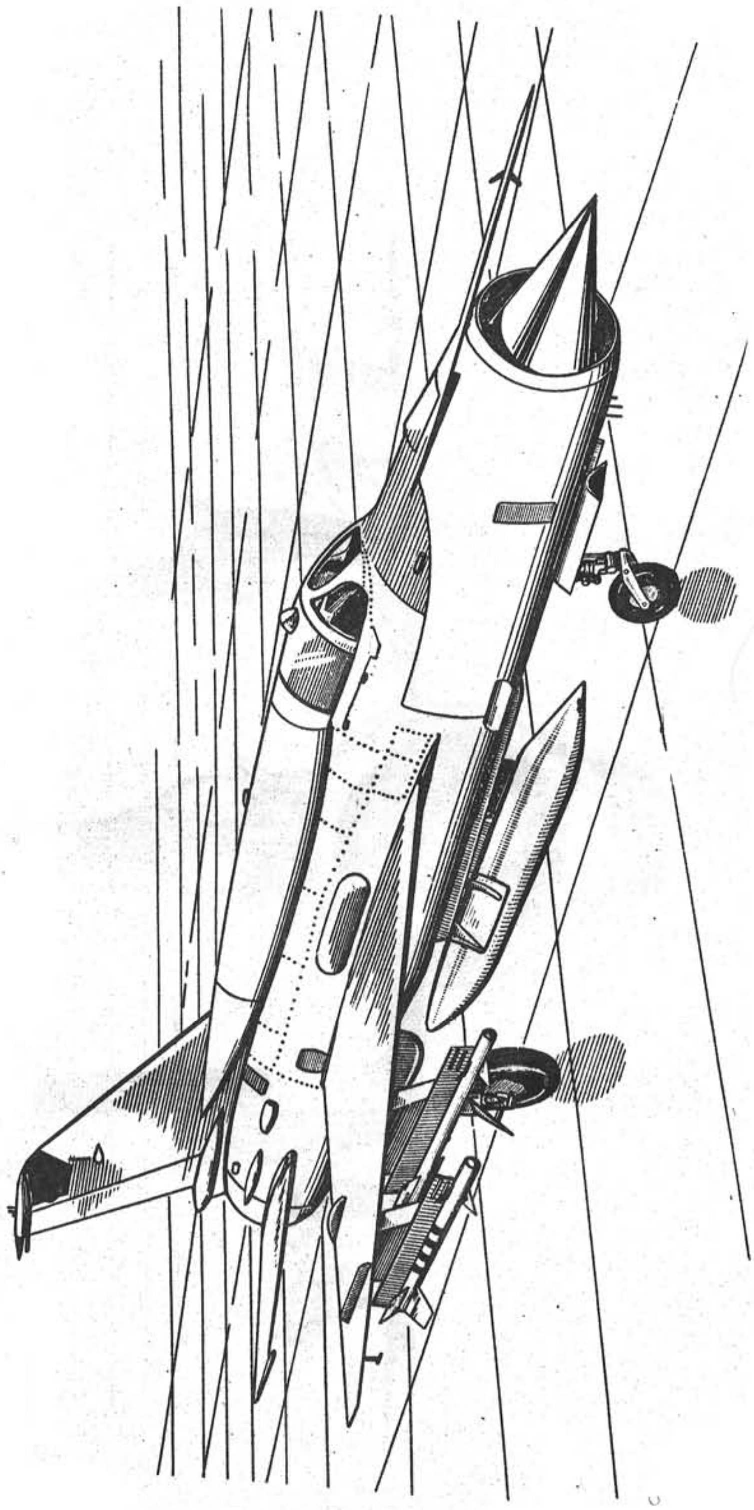


FIG. 2. AIRCRAFT МиГ-21БИС (3/4 FRONT VIEW)

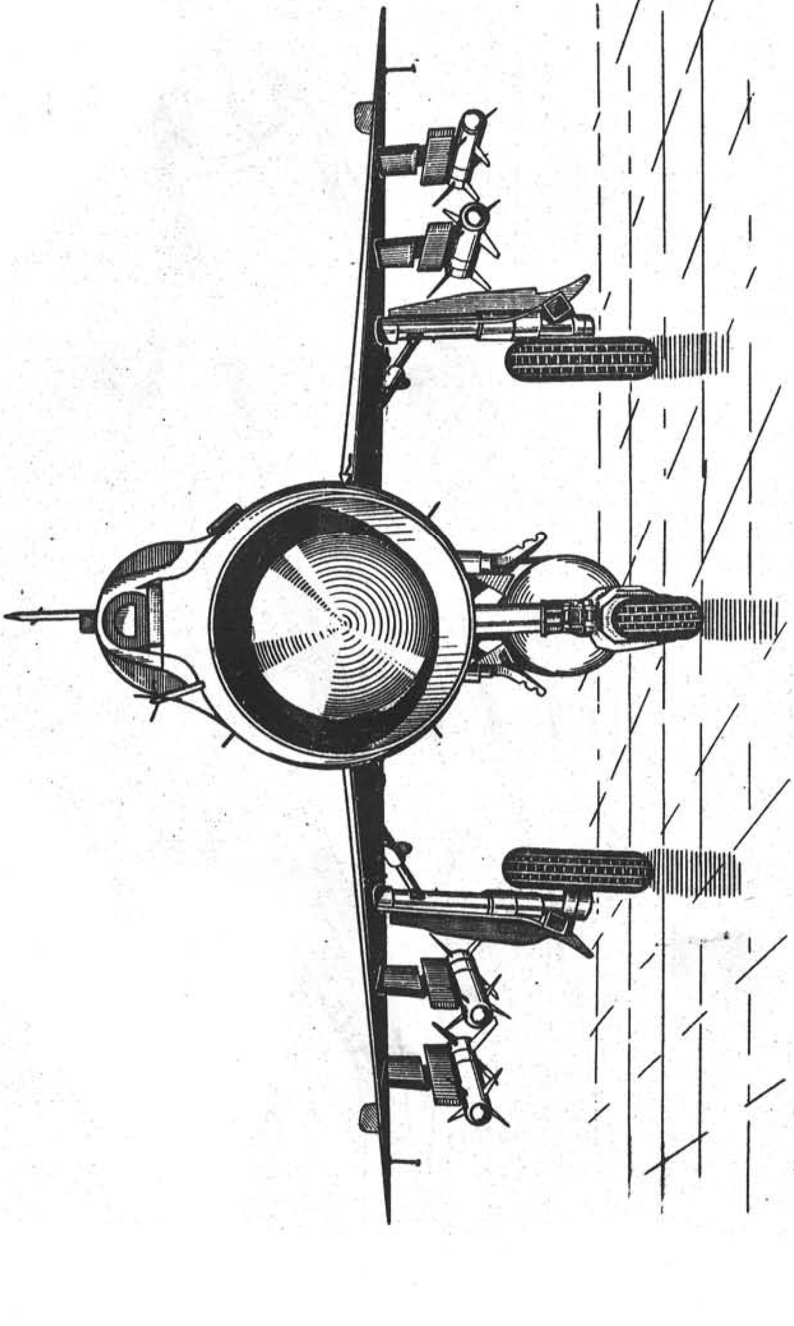


FIG. 3. AIRCRAFT МиГ- 21БИС (FRONT VIEW)

The data for calculating the flight range and endurance are given in Tables 1 through 3. In calculating the range and endurance, one should proceed from the usable fuel capacity of the inner tanks equal to 2750 L, and from the fuel specific gravity of 0.775 gf/cm^3.

Table 1

Final climb altitude (m)	Aircraft carries two missiles or 490-L drop tank (or no external stores)			Aircraft carries two missiles and 490-L drop tank			Aircraft carries eight ОФАБ-100 bombs		
	Time (min-s)	Fuel consumption (L)	Distance (km)	Time (min-s)	Fuel (L)	Distance (km)	Time (min-s)	Fuel (L)	Distance (km)
500	1-10 (1-05)	220(220)	-	1-10	245	-	1-35	285	-
1000	1-20 (1-35)	245 (245)	-	1-30	270	-	1-55	335	-
3000	2-10 (2-05)	320 (300)	12 (11)	2-30	350	14	3-55	480	24
5000	3-20 (3-00)	390 (360)	28 (25)	3-40	425	31	7-10	670	62
7000	4-40 (4-10)	465 (425)	47 (40)	5-20	515	55	-	-	-
9000	6-40 (5-50)	570 (500)	77 (65)	7-50	630	90	-	-	-
10,000	8-10 (7-00)	620 (540)	98 (82)	9-50	710	120	-	-	-
11,000	10-30 (8-50)	700 (600)	130 (105)	-	-	-	-	-	-

Notes: 1. The data contained in the table are true for climbing under the standard atmosphere conditions without jettisoning of the drop tank.

2. The data put between brackets refer to the aircraft carrying no external stores.

Table 2

External load variant	Maximum range conditions			Maximum endurance conditions		
	IAS (km/h)	Fuel consumption per km (L/km)	Hourly fuel consumption (L/h)	IAS (km/h)	Fuel consumption per km (L/km)	Hourly fuel consumption (L/h)
Flight Altitude is 500 m						
No external stores	690	3.50	2570	480	3.73	1900
Two missiles	690	3.64	2680	480	3.88	1970
Two missiles and 490-L drop tank	690	3.80	2800	480	4.0	2040
Eight bombs ОФАБ-100	690	4.93	3300	480	5.12	2610

Table 2, continued

External load variant	Maximum range conditions			Maximum endurance conditions		
	IAS (km/h)	Fuel consumption per km (L/km)	Hourly fuel consumption (L/h)	IAS (km/h)	Fuel consumption per km (L/km)	Hourly fuel consumption (L/h)
Flight Altitude is 5000 m						
No external stores	620	2.31	1870	480	2.45	1560
Two missiles	620	2.53	2050	480	2.60	1680
Two missiles and 490-L drop tank	620	2.70	2200	480	2.80	1780
Eight bombs ОФАБ-100	620	3.61	2760	480	3.77	2390
Flight Altitude is 10,000 m						
No external stores	530	1.69	1510	480	1.74	1430
Two missiles	530	1.93	1740	480	1.96	1640
Two missiles and 490-L drop tank	530	2.12	1910	480	2.14	1810
Flight Altitude is 11,000 m						
No external stores	510	1.65	1510	480	1.69	1460
Two missiles	510	1.80	1640	480	1.81	1550

Note. The per-kilometer and hourly fuel consumption values are given for an average flying weight of the aircraft on level flight legs without jettisoning of the external loads.

Table 3

Initial descent altitude (m)	Elapsed time (min-s)	Fuel consumption (L)	Distance (km)
18,000	13 - 30	180	140
11,000	9 - 00	100	100
10,000	8 - 10	97	90
9000	7 - 30	90	80
7000	5 - 50	70	60
5000	4 - 00	55	40
3000	2 - 10	30	20
2000	1 - 10	13	10

Note. The elapsed time, fuel consumption and distance values relate to descent from the given altitudes to an altitude of 1000 m.

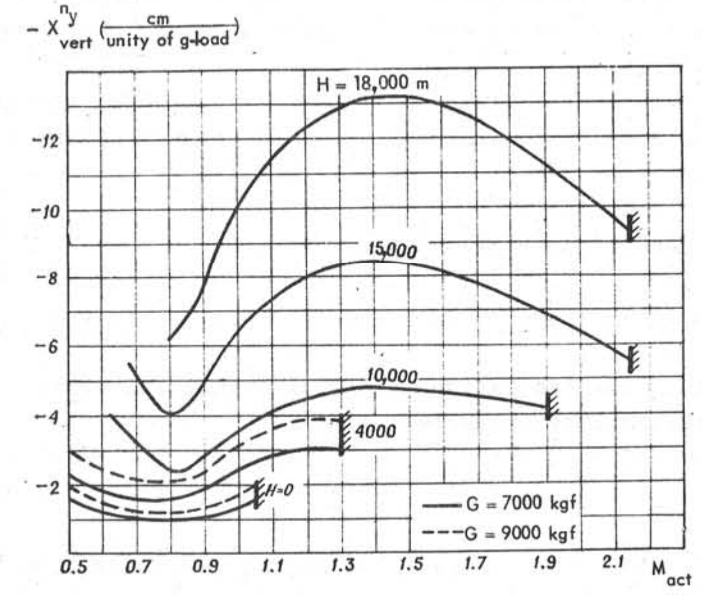


FIG. 4. EFFECT OF FLIGHT ALTITUDE AND MACH NUMBER ON STICK TRAVEL PER UNITY OF G-LOAD ($\bar{X}_{cg}$ = 29–31% MAC)

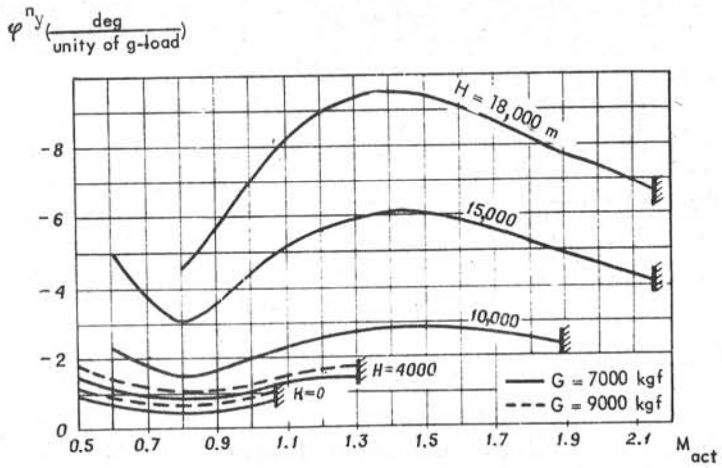


FIG. 5. EFFECT OF FLIGHT ALTITUDE AND MACH NUMBER ON STABILIZER DEFLECTIONS PER UNITY OF G-LOAD

($\bar{X}_{cg}$ = 29–31% MAC)

It should be remembered that an increase of the ambient air temperature would involve a decrease in the flight range and endurance owing to the changes that take place on the climbing leg; the higher the flying altitude, the stronger the effect of the air temperature.

Under the maximum-range flight conditions, variation of the aircraft weight by 10 per cent involves a corresponding change in the per-kilometer fuel consumption:

(a) by 10% at an altitude of 10,000 - 11,000 m;

(b) by 5% at an altitude of 5000 m;

(c) by 0.5% at an altitude of 500 m.

BRIEF INFORMATION ON AIRCRAFT STABILITY AND CONTROLLABILITY

When the aircraft carries various external loads, it retains essentially adequate stability and controllability characteristics.

Given in Figs 4 and 5 is the effect of the flight altitude, Mach number and aircraft weight on the stick travel and stabilizer deflections required to build up a unity of g-load.

The variation of the aircraft lift coefficient (C_y) with the Mach number is shown in Fig. 6.

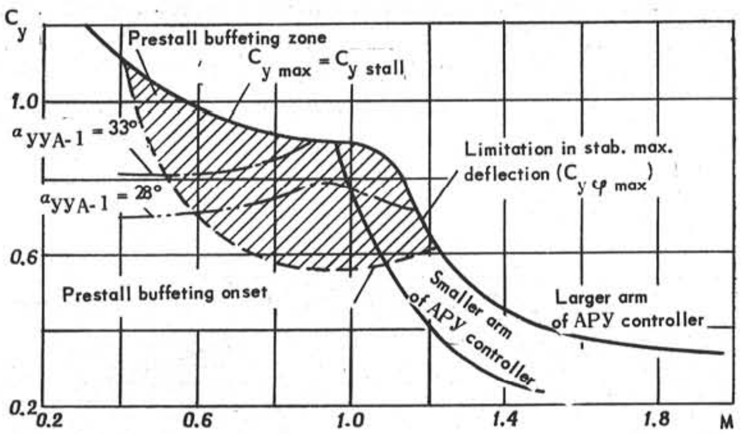


FIG. 6. LIFT COEFFICIENT VS MACH NUMBER

Prestall buffeting in straight-and-level flight at 5000 m begins at an airspeed of 370 to 340 km/h (depending on the weight of the aircraft, its CG position, kind of the external stores carried and the aircraft configuration). This buffeting is slight and its intensity stays practically the same up to the moment of stall. Prestall buffeting does not develop at all when the aircraft flies at altitudes below 5000 m at the above mentioned airspeeds ($M < 0.4$).

When the airspeed becomes less than 280 km/h, the effectiveness of the ailerons deteriorates considerably.

As the airspeed reaches the 230 to 240-km/h value, rocking from wing to wing develops (with insignificant pitching oscillations). The intensity of rocking increases as the airspeed is further reduced, and at an airspeed of 200 km/h the rocking oscillations may be as large as $\pm 50^\circ$.

When the airspeed is reduced to 220 - 230 km/h, the control stick being deflected fully backward, the aircraft starts pancaking, with almost symmetrical oscillations in roll; the angular rate of the oscillations may be as high as 6 - 10 deg/s.

The aircraft minimum (stall) airspeeds under these conditions (i.e. without opposing of the roll oscillations by aileron and rudder deflections) are as follows:

(a) 220 to 230 km/h in the flying configuration, the engine set at IDLE;

(b) 190 to 220 km/h in the takeoff configuration,the engine producing full throttle power;

(c) 190 to 210 km/h in the landing configuration, the engine running at IDLE.

As the aircraft is being decelerated in straight flight in the flying or takeoff configuration, it features an adequate stability in speed down to the minimum (stall) airspeed.

When in the landing configuration, the aircraft has certain instability in speed within the range of airspeeds from 260 to 320 km/h (the control stick has to be moved forward in the process of speed reduction); yet, the margin of stick travel remains sufficient for execution of nosing-down maneuvers.

In the process of holding-off (before touchdown) with the boundary layer control system on, a considerable pitchdown tendency develops at airspeeds of less than 250 - 260 km/h (due to an increase in the speed stability). To oppose this tendency, a considerable stick deflection is required 1 to 3 s before touchdown and the stick forces vary considerably, too.

One of the peculiar features of this aircraft is major deterioration of the longitudinal stability characteristics when the УБ-32 pods are carried together with other external stores or when bombs are carried on the МБД2-67 multi-shackle racks.

When two pods УБ-32, or two pods УБ-32 and two pods УБ-16-57 are carried (with the 490-L ventral drop tank carried or otherwise); or when four bombs ФАБ-250 or four С-24 rockets are carried, or eight bombs ФАБ-100, or two ЗБ-500 incendiary tanks and two guided missiles (two УБ-16-57 pods or two ОФАБ-100 bombs), or three drop tanks are carried, the aircraft is stable in g-load up to an n_y of 2 - 3 g in the subsonic flight airspeed range (M = 0.5 to 0.9). As the g-load is further increased, especially when fuel remaining on board is 700 - 1100 L, which brings about the rearmost operating CG position, the aircraft features neutral g-load stability up to an n_y of 3 - 4 g (it tends to increase the angle of attack of itself, with slight juddering; the pilot has to timely cut it short by moving the control stick forward). Once the n_y in excess of 3 - 4 g is reached, the aircraft becomes stable in g-load again, but the margin of g-load stability is scarce.

At fuel remainders of 700 - 1100 L which result in the rearmost operating CG position, when the 490-L ventral drop tank is attached and two С-24 rockets (two ФАБ-250 bombs) and two missiles are carried, or two type УБ-32 pods and two bombs ФАБ-100 (two УБ-16-57 pods) are racked, or when the 800-L ventral drop tank is attached and four УБ-16-57 pods (four ФАБ-100 bombs) are carried, or when two УБ-16-57 pods (two missiles or two ФАБ-100 bombs) and two ЗБ-500 incendiary tanks (two 490-L drop tanks) are carried, the aircraft is stable in g-load up to an n_y of 2 g; when the g-loads become higher, the aircraft features neutral stability in g-load with the above-mentioned external stores. Therefore, when vigorous maneuvers are being performed at low and medium altitudes, the pilot might inadvertently exceed the maximum permissible g-load or stall the aircraft due to the above peculiarities in the aircraft longitudinal stability.

Therefore, handling of the aircraft under the above conditions demands that the pilot would keep an eye on the value of the g-load or angle of attack.

When in the landing configuration, the aircraft carrying eight bombs on the multi-shackle racks or carrying loaded rocket pods, type УБ-32, is neutral or unstable in g-load at an n_y in excess of 1.2 g; therefore, it is forbidden to execute maneuvers under those conditions with normal g-loads in excess of 1.2 g.

The above peculiarity in the aircraft longitudinal stability demands that the pilot would be especially cautious in handling the aircraft lest the permissible angles of attack might be inadvertently exceeded. The aircraft shall be handled exactly and proportionately when it carries the above variants of external stores, especially during takeoff, landing at night, flying in clouds and under limited visibility conditions.

Note. The aircraft stability margin is somewhat increased when the aircraft is flown with the AFCS engaged in the STABILIZATION mode.

During performance of banked turns at altitudes of 8000 to 10,000 m at Mach numbers of 0.6 to 0.8 M, the fuel remainder being less than 1000 L, the stick deflections and stick forces required for pulling a unity of g-load become perceptibly less; yet the aircraft is still stable in g-load.

In the process of aircraft deceleration during performance of a banked turn with the control stick deflected all the way back (from the $M_{max.alw}$ to 0.9 M) at altitudes of 13,000 to 15,000 m slight juddering occurs within the range of 1.15 - 1.2 M; the pilot can easily neutralize it by reducing the deflection of the control stick.

Maneuvering at transonic airspeeds and Mach numbers (at 0.8 to 1.2 M) is peculiar for sharp changes in stability and controllability characteristics as well as for changes in the required control stick deflections and stick forces per unity of g-load (see Fig. 4). These changes derive from mixed (i.e. subsonic and supersonic) airflow around the aircraft.

Owing to the above peculiarities, a spontaneous increase of g-load (perceived by the pilot as instability in g-load, i.e. "tuck-in"), takes place at a time of performing maneuvers at transonic airspeeds with deceleration to 0.87 - 0.9 M with the control stick in the fixed position as to pitch control, irrespective of the flight altitude or kind of the maneuver being performed. The rate and magnitude of g-load spontaneous increase depend on the following factors:

(a) rate of the aircraft deceleration during maneuver performance;

(b) g-load initial value.

The time within which the aircraft reaches the maximum allowable operating g-load in the process of "tuck-in" during performance of maneuvers with the recommended g-loads (i.e. at n_y = 4.5 to 5.5 g), either carrying no external stores or carrying guided missiles, the control stick being fixed in position, is equal to:

(a) 2 s while performing zooms, loops and half-loops;

(b) 1.6 s while performing wingovers and dive recoveries;

(c) 1.2 s when decelerating the aircraft in a banked turn (the engine running at IDLE, the air brakes being extended).

It should be borne in mind that during deceleration maneuvers launched at supersonic airspeeds (M >1) the initial g-load will diminish by approximately 0.5 to 0.7 g in the course of deceleration with the control stick fixed in position. It is not recommended to attempt at maintaining the initial g-load by pulling the control stick back, since this would involve a vigorous increase of g-load at 0.87 to 0.90 M.

The pilot's intervention into aircraft control with the aim of opposing the spontaneous increase of g-load in the transonic airspeed zone at altitudes of 100 to 7000 m, would not involve any progressive oscillations of the aircraft.

The range of maximum available g-loads is given in Fig. 7.

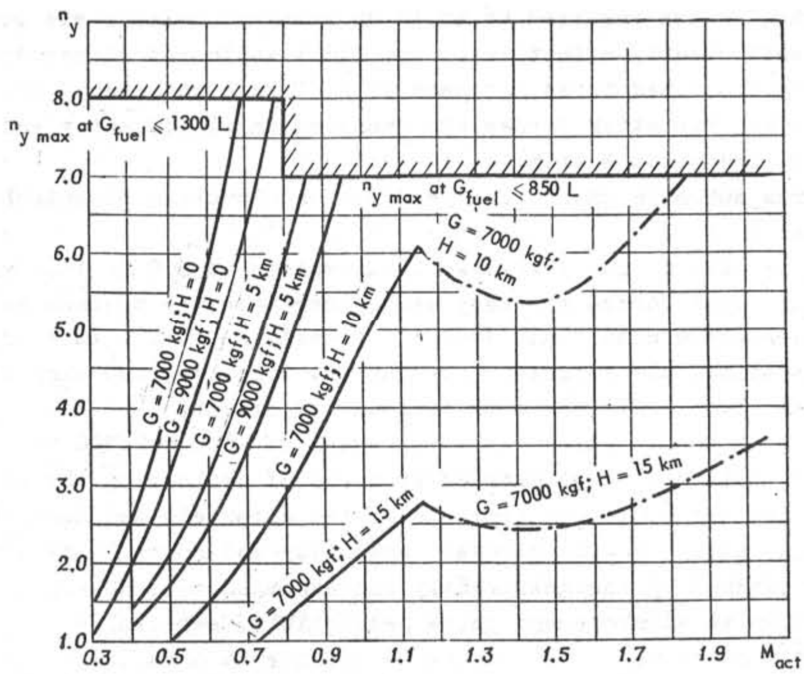


FIG. 7. MAXIMUM AVAILABLE G-LOADS VS MACH NUMBER ($\bar{X}_{cg}$=29–31% MAC), AIRCRAFT CARRYING MISSILES OR NO EXTERNAL LOADS

SYMBOLS: ——— n_y at C_y corresponding to $\alpha_{УУА-1}$ = 28°
—·— n_y at C_y corresponding to φ_{max}

Owing to high effectiveness of the ailerons, the aircraft is highly sensitive to lateral deflections of the control stick; therefore, when flying in bad weather conditions, especially at low altitudes and transonic speeds, the pilot should exercise greater caution in handling the aircraft.

Vigorous deflections of the ailerons alone for aircraft bank reversal at Mach numbers equal to or exceeding 1.7 M would involve considerable sideslips, and this requires particular care on the part of the pilot in performing maneuvers under such flying conditions.

With the AFCS engaged in the STABILIZATION mode, the aircraft lateral control becomes easier due to increase of the stick travel required for developing a desired bank.

The aircraft displays an increased response in roll to rudder deflections throughout the range of operating airspeeds and Mach numbers, especially at high angles of attack. Therefore, the pilot should handle the aircraft with greater care during take-off and landing.

When the aircraft carries a ventral drop tank, its roll response to rudder deflections increases. Thus, with the ailerons neutral and rudder pushed aside, the aircraft starts rolling vigorously about its longitudinal axis; this rolling is accompanied by a decrease in the airspeed and increase of the g-load. As soon as rolling of the above nature occurs, the pilot must set rudder neutral and fix it there.

With the AFCS engaged in the STABILIZATION mode, as the rudder is pushed aside vigorously through 2/3 of the full travel, the aircraft will enter a bank, then will start sideslipping or rolling slowly.

Cancellation of reheat at high Mach numbers may entail sideslipping (with deflection of the slip indicator bubble through up to 2 diameters) which will not hamper piloting of the aircraft.

The МиГ-21БИС aircraft possesses adequate longitudinal and directional stability and controllability during acceleration to and in flying at an IAS of 1300 km/h and

Mach 2.05. The stick forces required to build up vertical g-loads are acceptable. The ailerons are sufficiently effective at the limit indicated airspeeds. While the aircraft is being accelerated to an airspeed of 1300 km/h and Mach 2.05, it remains longitudinally stable; the stick forces are changing insignificantly and they can be removed by means of the pilot's trim.

Transition from subsonic speed to supersonic one involves no notable disturbance of the longitudinal trim.

The aircraft is directionally stable. At airspeeds of 800 to 1300 km/h and Machs of 1.4 to 2.05 M the foot forces are very high, therefore the maximum possible deflection of rudder under these conditions does not exceed 1/4 of the full travel range.

During acceleration, the aircraft carrying two missiles, two wing drop tanks and an 800-L ventral drop tank, has some tendency to sideslip.

In the process of acceleration, at an airspeed of 1000 to 1300 km/h drop-wing is likely to occur; this can be eliminated by means of deflecting the ailerons.

Extension of the air brakes at limit indicated airspeeds and Mach numbers produces practically no effect on the aircraft stability and controllability. In this case the aircraft pitches up insignificantly and experiences some small buzz; the aircraft deceleration is vigorous and quite perceptible, especially at low altitudes.

At limit Mach numbers the aircraft can be maneuvered with the control stick pulled fully back; however, this results in aircraft deceleration.

Increase of the g-load at supersonic speeds entails an additional extension of the air intake cone, bringing about considerable noise in the air intake duct.

With some of the aircraft, when they are flying at airspeeds corresponding to Machs of 1.85 - 1.95 M and higher, sideslipping may occur with rudder neutral; the direction of this sideslipping may vary; besides, directional oscillations or smooth drift of the aircraft as to course and roll may occur. These oscillations must not exceed 1.5 diameters of the ЭА-200 instrument slip indicator bubble at 2.05 M.

Should such oscillations occur, fly the aircraft, at airspeeds exceeding the Mach number of the oscillations onset, only straight forward, making no maneuvers.

The above peculiarity derives from some reduction of the aircraft static directional stability margin due to installation of an enlarged dorsal (top) fuel tank.

As a normally trimmed aircraft is being accelerated at low and medium altitudes, the pull stick forces get reduced, and they become nearly zero at airspeeds of 650 - 850 km/h. As the aircraft is being further accelerated, push stick forces develop; they grow with airspeed.

<u>Note</u>. With the pilot's trim neutral, the aircraft must get trimmed in flight at an altitude of 3000 m at airspeeds of 650 to 850 km/h.

In flight it is required to check periodically functioning of the APУ pitch channel transmission ratio controller automatic elements, referring to the stick forces and to the APУ controller indicator.

To avoid exceeding the maximum permissible airspeed when flying at Mach numbers close to 0.92 M, mind that there is the so-called "discontinuity zone", i.e. the zone of unstable readings of the airspeed indicator. The ranges of airspeeds corresponding to the discontinuity zone are given in Table 4 (versus the flight altitude).

Table 4

Flight altitude (m)	IAS range corresponding to discontinuity zone (km/h)
500	1120 to 1230
1000	1090 to 1200
1500	1060 to 1170
2000	1030 to 1140
2500	1000 to 1110
3000	980 to 1090
4000	930 to 1030
5000	870 to 970

PECULIARITIES OF AIRCRAFT BEHAVIOUR UPON ENTRY INTO ANOTHER AIRCRAFT'S WAKE

The wake is a perturbed zone trailing aft of the flying aircraft. The perturbed zone is caused by slippage of a vortex sheet off the wing, by turbulent air aft of the fuselage and by the engine jet blast.

During flight within an airspeed range of 400 to 800 km/h, the vortex sheet forms two small-diameter (1 to 2 m) vortices at a distance of 15 to 40 m from the aircraft (the distance increasing with airspeed); the intensity of the vortices grows with g-load and decreases with increase of airspeed. As they lag behind the aircraft, the vortices descend by 10 to 15 m every 1 to 1.5 km, increasing in the diameter and gradually disintegrating.

The turbulent zone trailing behind the fuselage does not cause pronounced air perturbance, attenuation taking place at a distance of 50 to 100 m aft of the aircraft.

The jet blast creates a perturbed zone amounting to 2 - 2.5 diameters of the jet nozzle exit area, attenuation taking place at a distance of 50 to 100 m behind the aircraft.

Entry into the wake of a type МиГ-21 aircraft flying at an airspeed of 400 to 800 km/h, 10 to 20 s after it has flown off (the longer time corresponds to the higher speed), will cause spontaneous banking or rolling accompanied by an altitude loss of 50 to 100 m. The intensity of the wake effect on the aircraft will grow with decrease of the distance between the aircraft; the effect will also be more pronounced when the aircraft creating the wake experiences a greater g-load and/or flies at a lower airspeed.

Entry into the wake of a type МиГ-21 aircraft, occurring later than 10 to 20 s after the latter has flown off, will be sensed as flight through high turbulence. Entry into the turbulent zone aft of the fuselage and into the zone affected by the jet blast will be also sensed by the pilot as flight through high turbulence.

When the aircraft enters the wake, the sound produced in the air intake will somewhat change; besides, the jet-pipe temperature will fluctuate within $\pm 20^{\circ}$, the engine speed varying within $\pm 2\%$. The engine will run steadily both at sustained and transient non-reheat settings.

Entry of the wingman into the leader's wake, while they are performing a maneuver at $n_y = 3$ to 5 g, will cause the wingman's vertical g-load to increase by 2 to 3 g, with alternating intensive lateral g-loads (up to $n_z = 0.8$ g); and an increase of the maneuver g-load will result in a more intensive effect of the wake on the wingman. Therefore, during execution of a maneuver at a g-load close to the maximum permissible value, entry into the wake is likely to cause an increase of the g-load in excess of the permissible value.

In the course of takeoff run (before the aircraft unsticks), the wake disintegrates practically immediately aft of the aircraft (the wake life not exceeding 1 to 1.5 s).

After the aircraft unsticks, in still air conditions or in the presence of gentle head wind, the wake may be dangerously intensive at a height above 5 m for 20 s after the aircraft flies off.

When flight is being performed at short side and rear intervals, the aircraft smoothly approaching the wake from aside, is fenced off the wake while rolling outside; when the aircraft approaches the wake from below, it is forced downward, whereas approach from above will draw the aircraft into the wake. Approach to the wake from below and aside, or from above and aside, is likely to result in fencing the aircraft off the wake, accompanied by rolling either outward or inward.

When flying in the wake at a short rear interval, the aircraft might display a tendency to approach the leader, accompanied by loss of rolling controllability. Under these conditions, one has to apply a positive g-load or to turn away in the direction of the roll.

The effect of the wake created by aircraft of other types, on the МиГ-21 aircraft, will depend on the angle of sweep and on the wing loading, the wake intensity increasing with the angle of sweep and with the wing loading.

Section Two

OPERATING LIMITATIONS

The maximum permissible indicated airspeeds, Mach numbers and g-loads for the aircraft carrying various external loads are given in Table 5; other limitations are presented in Table 6.

Table 5

Parameter	External load variants					
	No external loads, or missiles only	Pods, type		Bombs, rockets С-24, inc. tks ЗБ-500	Drop tanks	Eight bombs ОФАБ-100
		УБ-16-57	УБ-32			
Airspeed (km/h)	1300			1000		800 (or 1000 when reinforced racks БДЗ-60-21Д1 are used)
Mach number	2.05	1.7	1	1.3	1.6	1
G-load	At $M \leqslant 0.8$: with two missiles: 8 g at $G_{fuel} \leqslant 1300$ L; 7 g at $G_{fuel} > 1300$ L (as well as with four missiles) At $M > 0.8$: 7 g at $G_{fuel} \leqslant 850$ L, with two missiles; 6 g at $G_{fuel} > 850$ L, with two or four missiles		5		5 g with 490-L drop tank; 4 g with 800-L drop tank	5

Notes: 1. In flight with various external loads, the maximum permissible airspeed values, Mach numbers and g-loads are established with reference to the kind of external load for which more strict limitations exist.

2. The M = 1 limitation (i.e. the maximum Mach number obtained during flight tests) is tentative.

WARNINGS: 1. It is not recommended to build up a g-load in excess of 3 g in flight with two УБ-32 pods, or two УБ-32 pods and two УБ-16-57 pods, or eight 100-kg caliber bombs, or two ЗБ-500 incendiary tanks and two guided missiles (or two УБ-16-57 pods, or two ОФАБ-100 bombs), or with four 250-kg caliber bombs, or four С-24 rockets (carrying the ventral drop tank or otherwise, or with three drop tanks) due to the fact that the margin of g-load stability decreases under those conditions.

2. Until further notice, in order to prevent aerodynamic overheating of the rocket motors of type С-5 free rockets, the duration of flying under the below flight conditions should not exceed:

(a) 17 min at airspeeds higher than 900 km/h, at ambient air temperatures from 0 to +20°C;

(b) 20 min at airspeeds of less than 900 km/h, or 10 min at airspeeds higher than 900 km/h, at ambient air temperatures from +20 to +35°C;

(c) 10 min at airspeeds of less than 900 km/h, or 5 min at airspeeds exceeding 900 km/h, at ambient air temperatures from +35 to +50°C.

Table 6

Limitation	Cause
Aircraft	
1. Maximum takeoff weight when using concrete runway, 9800 kgf.	Landing gear strength
WARNING. It is permissible to take off with the load variants mentioned in Table 7A under no-wind conditions at or below an ambient air temperature of +15°C; if the ambient temperature is above +15°C, takeoff is permissible only if there is head wind, every 3-m/s increment of the head wind velocity corresponding to ten degrees of temperature surplus over +15°C. When the runway length corresponds to that of a second-class airdrome, takeoff with the above variants of external stores shall be accomplished at second reheat power only (when full reheat power is used, the required runway length is 2000 m)	Not to exceed liftoff ground speed of 370 km/h for КТ-92Д LG wheels fitted with tyres, model 42A
2. Takeoff weight when using perforated steel plate (PSP), unpaved or snow-covered runway, 8800 kgf, max.	Landing gear strength
Note. The number of takeoffs from PSP, unpaved or snow-covered runways with the given takeoff weight must not exceed 20% of the total number of takeoffs from those runways	

Table 6, continued

Limitation	Cause
3. Maximum permissible angle of attack in flight and during performance of any aircraft maneuvers, $+28^{\circ}$ by УУА-1 indicator (stall occurs when $+33^{\circ}$ angle of attack, as read by УУА-1 indicator, is exceeded). **WARNING**. It is forbidden to exceed the $+15^{\circ}$ angle of attack, as read by the УУА-1 indicator, in flight with the load variants mentioned in Table 7A due to the small amount of g-load stability margin	Stall safety margin of angle of attack
4. Maximum unstick ground speed, 360 km/h for tyres 800 x 200, model 41, and 370 km/h for tyres, model 42A	Tyre strength
5. Maximum permissible airspeed for landing gear retraction and extention, 600 km/h; maximum permissible airspeed for flying with landing gear extended, 700 km/h	Ability to retract LG, stability and controllability during LG extention
6. It is forbidden to exceed minus 20° pitch angle in descent at airspeeds over 1100 km/h and Mach numbers in excess of 1.8 M	To prevent surpassing maximum IAS and/or Mach number
7. Maximum permissible airspeed for going around with BLC system operating, 360 km/h	Aircraft would sink by 25 - 30 m due to automatic disconnection of BLC system by microswitch as flaps are being pressed by Q-force into retracted position at higher airspeeds
8. It is forbidden to extend landing gear and flaps or to fly with landing gear and flaps extended when carrying eight ФАБ-100 bombs, or three drop tanks, or four С-24 rockets, or two ЗБ-500 tanks, or two ФАБ-500 bombs, or four ФАБ-250 bombs, or two УБ-32 and two УБ-16-57 pods (two guided missiles), or two УБ-16-57 pods (two ФАБ-100 bombs) and two С-24 rockets (or two ФАБ-250 bombs) when fuel remainder is 700 to 1100 L. In emergency situations, when it becomes necessary to land immediately with above indicated fuel remainder, jettison external stores from outboard stations over safe place before extending LG, then land in usual way	Insufficient margin of g-load stability
9. Rated landing weight for using concrete, unpaved or snow-covered runway, 6800 kgf, BLC system being used by all means. This landing weight is obtained when aircraft: (a) has no external loads, fuel remainder not exceeding 700 L; (b) carries two missiles, or two УБ-16-57 pods, or two ОФАБ-100 bombs, or carries no combat stores but has empty drop tanks attached, fuel remainder being 500 L. **Note**. This fuel remainder ensures performance of a tight-visual-circuit go-around maneuver and landing, the flight endurance being about 6 min.	

Table 6, continued

Limitation	Cause
WARNINGS: 1. All other, heavier external loads shall be jettisoned before coming in to land. 2. The fuel remainder must be at least 600 L before instrument approach to land under bad weather conditions, in order to ensure performance of a two-180°-turns or tight-circuit go-around maneuver. 3. The rated landing weight with the BLC system not used is 6500 kgf. This weight is obtained when the aircraft carries no external loads and the fuel remainder is 400 L	
10. Landing of overloaded aircraft (whose weight, however, should not exceed 7300 kgf) is allowed in the following exceptional cases: (a) when carrying two guided missiles, or two loaded УБ-16-57 pods, or two ОФАБ-100 bombs and empty drop tanks, fuel remainder not exceeding 800 L; (b) when carrying two empty УБ-32 pods and two missiles or two ОФАБ-100 bombs, or two loaded УБ-16-57 pods; when carrying four guided missiles or four loaded УБ-16-57 pods; or two missiles and two loaded УБ-16-57 pods (two ОФАБ-100 bombs); or four ОФАБ-100 bombs, or two C-24 rockets, or two ОФАБ-250 bombs, or two loaded УБ-32 pods, fuel remainder not exceeding 600 L. Landings with weights in excess of 6800 kgf shall be made with employment of BLC system and drag chute by all means. Notes: 1. The number of landings with the weight exceeding 6800 kgf must not exceed 3% of the total number of landings. 2. After landing with the weight exceeding 6800 kgf, the landing gear shall be expected and subsequently checked for retraction/extention. 3. In the case of landing with four empty УБ-16-57 pods or with only two empty УБ-32 pods, the fuel remainder with which landing is permissible can be increased by 350 L as compared to the above figures	Landing gear strength
11. Takeoff and/or landing with one bomb of up to 250-kg caliber or C-24 rocket unsymmetrically racked on inboard station, may be accomplished if crosswind component (directed from the side opposite to that on which the external load is attached) does not exceed 8 m/s	Ability of roll counteraction
12. Ground speed of main LG touchdown must not exceed 330 km/h	LG wheel strength
13. Maximum permissible drag chute deployment speed, 320 km/h	Strength of drag chute attachment elements

Table 6, continued

Limitation	Cause
14. Ground speed of initial brake application, when drag chute is not used in landing roll, must not exceed 330 km/h	
Powerplant (in flight)	
15. Maximum low-pressure (LP) rotor speed must not exceed: (a) 101.5% at first, partial and minimum reheat settings as well as at full throttle non-reheat setting; (b) 103.5% at second (emergency) reheat setting	Compressor and turbine strength
16. Maximum high-pressure (HP) rotor speed, not over 107.5%	Compressor and turbine strength
17. Maximum permissible jet-pipe temperature: (a) not over 770°C at full throttle setting; (b) not over 830°C at reheat and second reheat power settings	Turbine strength
18. Minimum permissible oil pressure: (a) at least 1 kgf/cm^2 at idle setting; (b) at least 3 kgf/cm^2 (warning light OIL (МАСЛО) must not burn) at LP rotor speed of more than 88 - 90%. When negative g-load is applied, at all altitudes, oil pressure may drop to zero for short time (not over 17 s) with illumination of OIL light in the meantime	
19. Engine run at FULL REHEAT and SECOND REHEAT at airspeeds in excess of 1000 km/h at low and medium altitudes is allowed as long as fuel amount in tanks is at least 800 L	Ensuring continuous fuel feed into engine
20. Negative g-loads may be developed for not longer than: (a) 15 s at non-reheat engine settings; (b) 5 s at reheat settings; (c) 3 s at second reheat setting	Amount of fuel available in negative g-load tank unit
21. Flight with g-loads approximating zero (±0.2 g) should not last for longer than 1 - 2 s. **WARNING.** Negative or near-zero g-load flight is allowed provided the tanks contain at least 500 L of fuel	Ensuring continuous fuel feed into engine
22. Repeated application of negative or near-zero g-load is allowed only after at least 30-s flying at positive g-load	To let fuel refill negative g-load tank unit
23. Engine run in flight is allowed at all sustained and transient power settings at airspeed of not less than 400 km/h (on takeoff, during approach to land and in going around the airspeed is not limited), limitations being as follows:	
(a) reheat shall be cancelled after takeoff when speed is not less than 600 km/h;	To ensure flight safety

Table 6, continued

Limitation	Cause
(b) selection of reheat is allowed: (i) at any altitude, when it is selected from full throttle power setting, at airspeed of not less than 500 km/h; (ii) at altitude of or below 15,000 m, when engine is being accelerated, at airspeed of not less than 500 km/h; (iii) at altitudes above 15,000 m, when engine is being accelerated, at airspeed of not less than 600 km/h;	To ensure reliable ignition of afterburner
(c) it is allowed to accelerate engine to full throttle power and to throttle it down from reheat or full throttle setting to any required setting, at altitudes above 15,000 m, when airspeed is not less than 600 km/h;	Ensuring stable run of powerplant
(d) at altitudes above 18,000 m, engine run is allowed at reheat settings; and it is permissible to cancel reheat by moving throttle lever to FULL THROTTLE at airspeed of not less than 500 km/h. Note. The engine may be run at minimum reheat power when the altitude is less than 17,000 m.	Ensuring stable functioning of afterburner, preventing its flameout
WARNING. Until further notice it is forbidden to fly above 18,000 m	To ensure stable run of powerplant
24. Maximum time of engine continuous run at second reheat setting is not over 3 min. Repeated selection of this setting is allowed after at least 30-s interval	Turbine strength
Life-Saving and Life-Support Equipment	
25. Safe abandoning of aircraft is ensured under the following flight conditions:	
(a) during takeoff run and landing roll, at airspeeds of not less than 130 km/h;	Ensuring conditions for normal operation of parachute system elements
(b) in level flight, at airspeeds: (i) not more than 500 km/h, without any limitations as to height over ground relief; (ii) 500 to 1150 km/h, at height of not less than 30 m over ground relief; (iii) 1150 to 1200 km/h, at flight altitude of not less than 1000 m;	Providing time for operation of parachute system elements; minding strength of ejection equipment
(c) during aircraft descent, at altitude equal in magnitude to vertical velocity multiplied by four (without taking into account the time required for adopting decision and preparing for ejection);	Providing time for operation of parachute system elements
(d) depending on employed type of pilot's outfit: (i) with pressure helmet on (visor being closed) and partial-pressure suit on, at any ejection airspeed up to maximum allowable ejection airspeeds;	Effect of airstream on pilot

Table 6, continued

Limitation	Cause
(ii) with crash helmet on, light filter lowered and oxygen mask employed, up to airspeed of 900 km/h; (iii) with crash helmet on, light filter raised and oxygen mask removed or with pressure helmet on and visor opened, up to airspeed of 700 km/h. WARNING. Should it become necessary to abandon the aircraft in flight, take all measures before ejection so that the airspeed would not exceed the above limitations	
26. It is permissible to jettison canopy at airspeeds of 400 to 700 km/h in straight flight at altitudes below 5000 m	Ensuring conditions for canopy to clear fin safely
27. Flight with canopy jettisoned may be performed under the following conditions: (a) up to airspeed of 900 km/h, when wearing ЗШ-3М crash helmet with light filter lowered, oxygen mask being used; (b) up to airspeed of 1150 km/h, when wearing partial-pressure suit and pressure helmet with visor closed	Effect of airstream on pilot
28. All flights, irrespective of airspeed and altitude, shall be performed with use of oxygen equipment. Depending on type of flying mission, the following kinds of high-altitude outfit shall be used: (a) at altitudes below 11,000 m: crash helmet with oxygen mask on, without partial-pressure suit; but wear of g-suit is mandatory in all flights involving g-loads in excess of 4 g; (b) at altitudes between 11,000 and 14,000 m: crash helmet with oxygen mask and partial-pressure suit on (by all means); (c) at altitudes above 14,000 m and also under combat conditions where mass-destruction weapons and chaff clouds may be employed: pressure helmet and partial-pressure suit by all means	To ensure normal oxygen supply for pilot in flight, protect his lungs from oxygen overpressure effect (should cabin get depressurized), reduce effect of g-loads on pilot's body, protect him against radiological and bacteriological warfare agents and smoke in cabin, to permit flying through chaff clouds and to ensure safe ejection
29. Flights over water shall be made with use of sea survival equipment. WARNING. It is allowed to use only the life belt, type АСП-74, with the ГШ-6 pressure helmet	To ensure survival after abandoning aircraft over water
30. Pressure helmet visor may be opened (removed) or oxygen mask may be removed in flight on completion of mission, at altitude of not more than 4000 m and airspeed not in excess of 700 km/h	Ensuring normal oxygen supply and safe ejection

Aircraft Systems

31. It is allowed to fly with AFCS engaged in LEVELLING mode, for stabilization of heading and altitude, at altitudes not lower than 100 m over ground relief	Accuracy of altitude hold

Table 6, continued

Limitation	Cause
32. It is forbidden to engage AFCS in LEVELLING mode for training purposes when pitch angle is more than +50° at altitudes below 13,000 m, or more than +20° at altitudes above 13,000 m. WARNING. In aircraft equipped with the CAY-23ECH AFCS, when the pitch angle becomes positive after the zero bank has been established, or after the aircraft has automatically climbed from the preset limit altitude, disengage the AFCS to recover the aircraft in level flight manually	To ensure stable run of engine due to negative and near-zero g-loads

Section Three

HANDLING INSTRUCTIONS

1. The aircraft maneuvering airspeed is 450 km/h when the all-up weight is more than 9200 kgf, and 400 km/h when the $G < 9200$ kgf, at all altitudes.

2. The aircraft takeoff weights with all external load variants are grouped as specified in Table 7. Takeoff may be performed:

(a) from any kind of runway, when carrying external loads indicated in Group I;

(b) from a concrete runway only, when carrying external loads indicated in Group II.

Table 7

No.	Outboard station (No. 3)	Inboard station (No. 1)	Inboard station (No. 2)	Outboard station (No. 4)	All-up weight before engine starting, with full fuel fill (kgf)	Group No.
	No Ventral External Stores					
1	-	-	-	-	8620	I
2	-	P-3C missile (or P-3P, P-13M missile, ОФАБ-100 bomb, УБ-16-57 pod)	P-3C missile (or P-3P, P-13M missile, ОФАБ-100 bomb, УБ-16-57 pod)	-	8880	
3	P-3C missile (or P-3P, P-13M missile, ОФАБ-100 bomb)	-	-	P-3C missile (or P-3P, P-13M missile, ОФАБ-100 bomb)	8880	II
4	-	УБ-32 pod	УБ-32 pod	-	9100	
5	P-13M missile (or P-3C, P-3P missile, УБ-16-57 pod, ОФАБ-100 bomb)	УБ-16-57 pod	УБ-16-57 pod	P-13M missile (or P-3C, P-3P missile, УБ-16-57 pod, ОФАБ-100 bomb)	9150	
6	ОФАБ-100 bomb (or P-13M, P-3C, P-3P missile)	ОФАБ-100 bomb	ОФАБ-100 bomb	ОФАБ-100 bomb (or P-13M, P-3C, P-3P missile)	9150	
7	ОФАБ-100 bomb	P-13M (or P-3C, P-3P) missile	P-13M (or P-3C, P-3P) missile	ОФАБ-100 bomb	9150	

Table 7, continued

No.	Outboard station (No. 3)	Inboard station (No. 1)	Inboard station (No. 2)	Outboard station (No. 4)	All-up weight before engine starting, with full fuel fill (kgf)	Group No.
8	P-3P missile	P-3P missile	P-3P missile	P-3P missile	9150	II
9	P-13M (or P-3P, P-3C) missile	P-3C (or P-13M) missile	P-3C (or P-13M) missile	P-13M (or P-3P, P-3C) missile	9150	
10	-	C-24 rocket (or ФАБ-250 bomb)	C-24 rocket (or ФАБ-250 bomb)	-	9200	
11	P-13M missile (or P-3C, P-3P missile, УБ-16-57 pod, ОФАБ-100 bomb)	УБ-32 pod	УБ-32 pod	P-13M missile (or P-3C, P-3P missile, УБ-16-57 pod, ОФАБ-100 bomb)	9350	
12	-	ЗБ-500 incendiary tank	ЗБ-500 incendiary tank	-	9450	
13	ОФАБ-100 bomb (or P-3C, P-13M, P-3P missile)	C-24 rocket (or ФАБ-250 bomb)	C-24 rocket (or ФАБ-250 bomb)	ОФАБ-100 bomb (or P-3C, P-13M, P-3P missile)	9470	
14	490-L drop tank	-	-	490-L drop tank	9500	
15	P-13M missile (or P-3C, P-3P missile, ОФАБ-100 bomb)	ЗБ-500 incendiary tank	ЗБ-500 incendiary tank	P-13M missile (or P-3C, P-3P missile, ОФАБ-100 bomb)	9600	
16	-	ФАБ-500 bomb	ФАБ-500 bomb	-	9700	
17	ФАБ-250 bomb (or C-24 rocket)	ФАБ-250 bomb (or C-24 rocket)	ФАБ-250 bomb (or C-24 rocket)	ФАБ-250 bomb (or C-24 rocket)	9720	
18	-	Four ОФАБ-100 bombs	Four ОФАБ-100 bombs	-	9780	
19	490-L drop tank	P-13M missile (or P-3C, P-3P missile, УБ-16-57 pod, ОФАБ-100 bomb)	P-13M missile (or P-3C, P-3P missile, УБ-16-57 pod, ОФАБ-100 bomb)	490-L drop tank	9780	

Notes: 1. It is allowed to fly with the 490-L drop tank attached, when carrying the external store variants mentioned in Items 1 through 11 of the table. Then the all-up weight before engine starting gets increased by 450 kgf as against the weight indicated in the table.
It is also possible to use the variant of carrying three 490-L drop tanks, when the fuel specific gravity does not exceed 0.8 kgf/L.

2. It is allowed to fly with the 800-L drop tank attached, when carrying the external store variants mentioned in Items 1 through 4 of the table. Then the aircraft pre-starting all-up weight gets increased by 700 kgf as compared to the one specified in the table.
3. To prevent no-effect depressions of the firing (launch/release) button in flight, the УБ-16-57 rocket pods shall be racked to the inboard stations only (i.e. Nos 1 and 2) when only two УБ-16-57 pods are carried or when they are attached in combination with other kinds of external stores (except the variants: four УБ-16-57 pods, or two УБ-32 pods and two УБ-16-57 pods mentioned in Items 5 and 11 of the table).
4. Practice bombs of the 50-kg caliber can be used for training purposes, instead of the ОФАБ-100 bombs; they shall be racked in the variants specified for the ОФАБ-100 bombs.

Table 7a

No.	Outboard station (No. 3)	Inboard station (No. 1)	Ventral station	Inboard station (No. 2)	Outboard station (No. 4)	All-up weight before engine starting, with full fuel fill (kgf)	Group No.
1	УБ-16-57 pod	УБ-32 pod	800-L drop tank	УБ-32 pod	УБ-16-57 pod	10,010	II
2	-	ЗБ-500 incendiary tank	800-L drop tank	ЗБ-500 incendiary tank	-	10,060	
3	490-L drop tank	-	800-L drop tank	-	490-L drop tank	10,190	
4	-	Four ОФАБ-100 bombs	490-L drop tank	Four ОФАБ-100 bombs	-	10,250	
5	-	ФАБ-500 bomb	800-L drop tank	ФАБ-500 bomb	-	10,370	
6	С-24 rocket	С-24 rocket	800-L drop tank	С-24 rocket	С-24 rocket	10,390	
7	490-L drop tank	Р-13М missile	800-L drop tank	Р-13М missile	490-L drop tank	10,470	
8	ОФАБ-250 bomb	ОФАБ-250 bomb	800-L drop tank	ОФАБ-250 bomb	ОФАБ-250 bomb	10,470	

Note. It is permissible to carry the external load variants mentioned in lines 7 and 8 when the fuel density is not higher than 0.8 kgf/L.

When the aircraft is using a concrete runway and JATO units for takeoff, its weight must not exceed 9100 kgf whatever the variant of external loads (see Table 7).

When the aircraft is using any other type of runway (except the PSP one) and JATO units for takeoff, it must carry either no external loads or two missiles only.

3. The aircraft takeoff and landing characteristics (i.e. the liftoff and landing speeds, takeoff run and landing roll lengths) as well as the JATO unit switch-on time and airspeed are presented in the charts and nomograms of Figs 8 through 14 versus the aircraft all-up weight, engine power setting on takeoff, braking means used in landing roll, and atmosphere conditions.

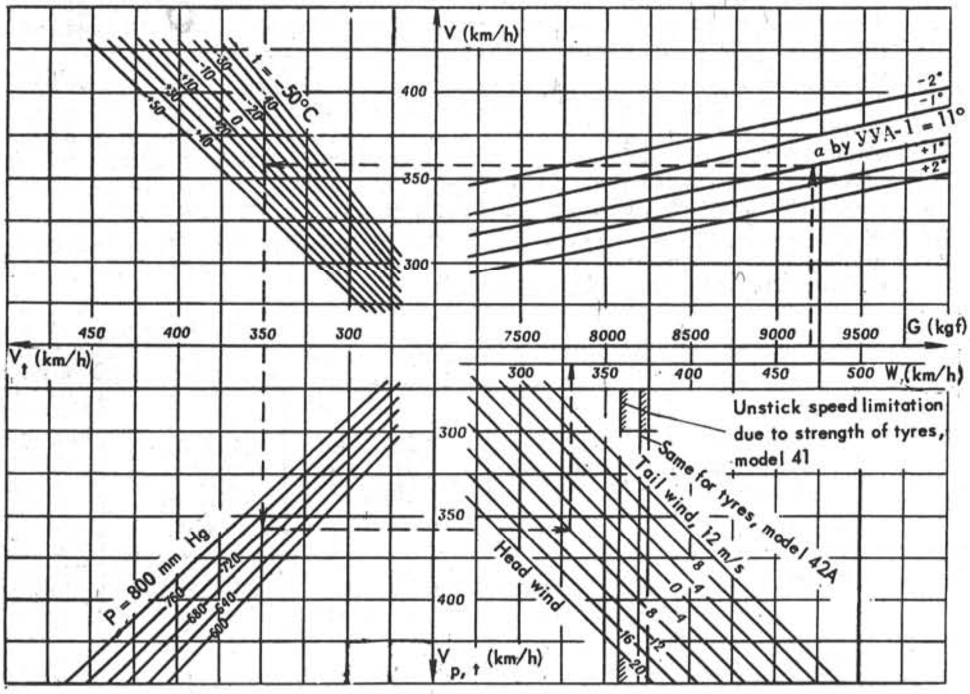


FIG. 8. UNSTICK SPEED VS AIRCRAFT TAKEOFF WEIGHT, ANGLE OF ATTACK, ATMOSPHERE CONDITIONS AND WIND VECTOR

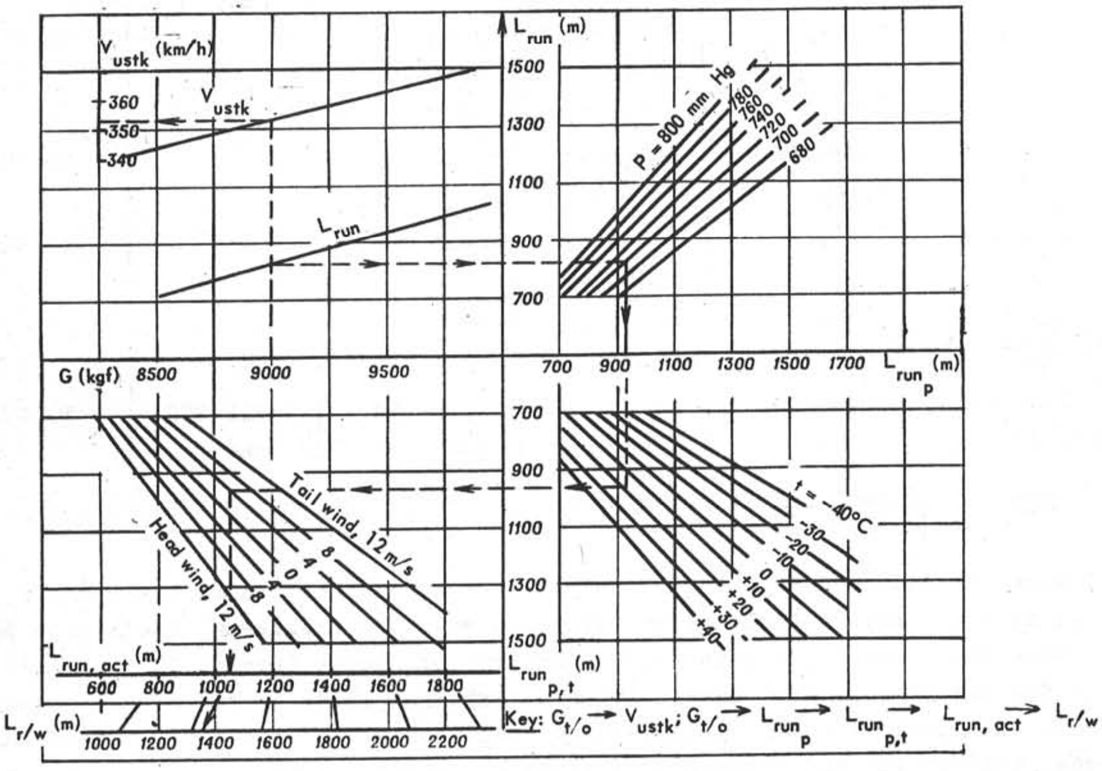


FIG. 9. TAKEOFF RUN LENGTH AND REQUIRED RUNWAY LENGTH VS AIRCRAFT TAKEOFF WEIGHT, ATMOSPHERE CONDITIONS AND WIND VECTOR, ENGINE RUNNING AT FULL REHEAT + SECOND REHEAT ($\delta_{flp} = 25°$)

Note. L_{run} is increased by 10-15° when full reheat power is used, and by 20–25% when full throttle power is used

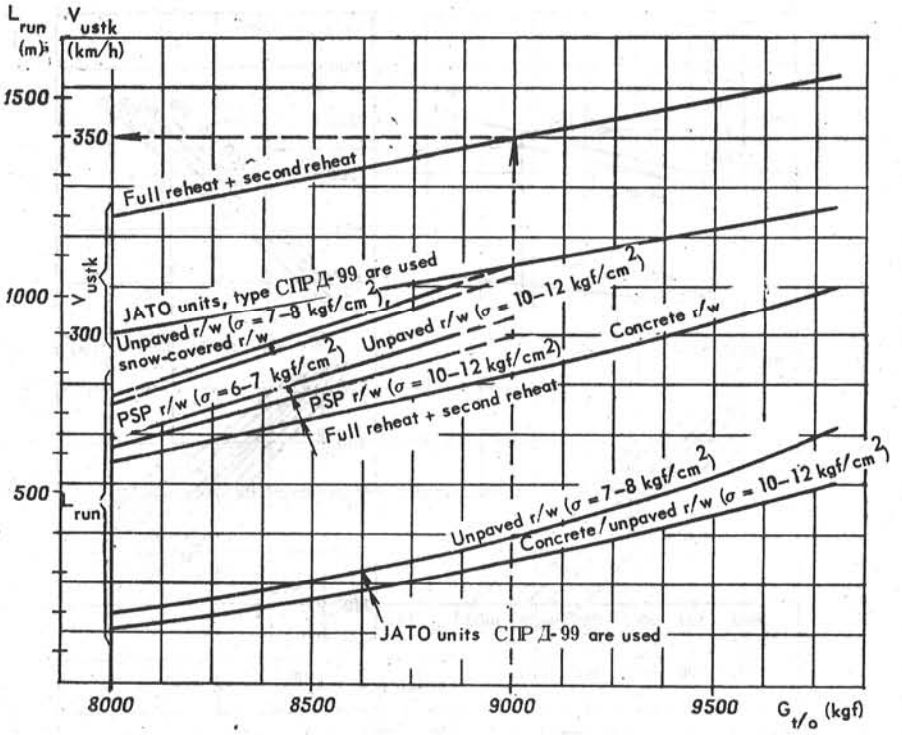


FIG. 10. UNSTICK SPEED AND TAKEOFF RUN LENGTH VS AIRCRAFT TAKEOFF WEIGHT UNDER STANDARD ATMOSPHERE CONDITIONS

Notes: 1. Takeoff run length is increased by 10–15% when minimum reheat power is used.

2. When narrow (21 to 24 m wide) PSP runways are used, narrow unpaved runways or narrow unpaved runways with paved ends, or narrow concrete runways are employed, takeoff run length becomes increased by 10–15% due to growth in unstick speed

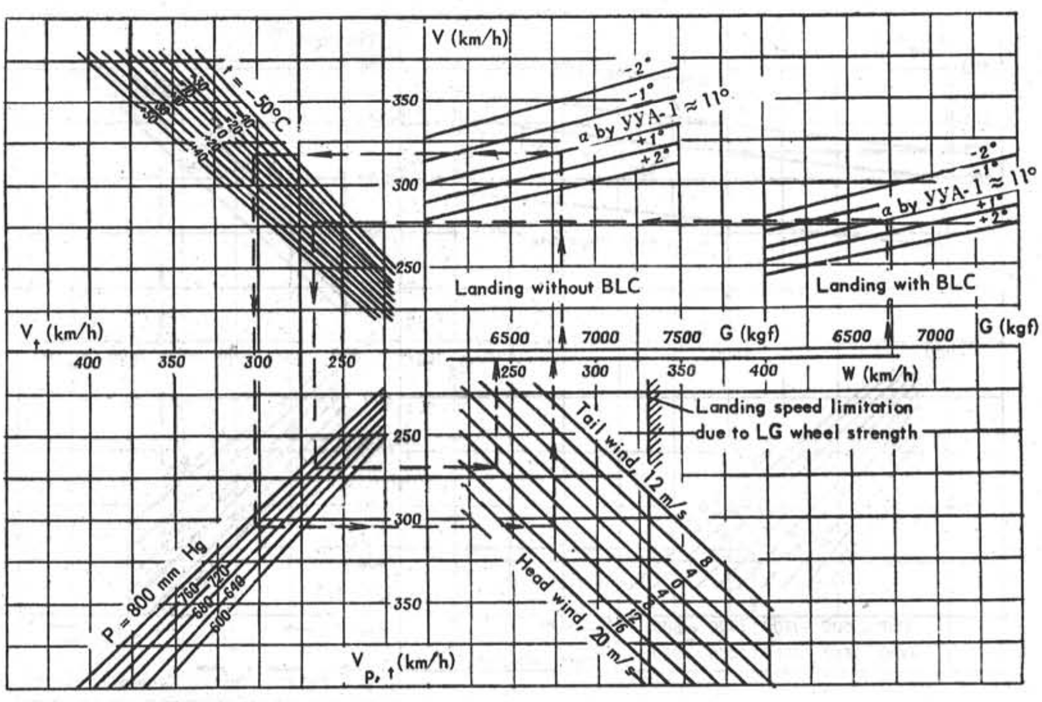


FIG. 11. VARIATION OF TOUCHDOWN GROUND SPEED WITH LANDING WEIGHT, ANGLE OF ATTACK, WING CONFIGURATION, ATMOSPHERE CONDITIONS AND WIND VECTOR

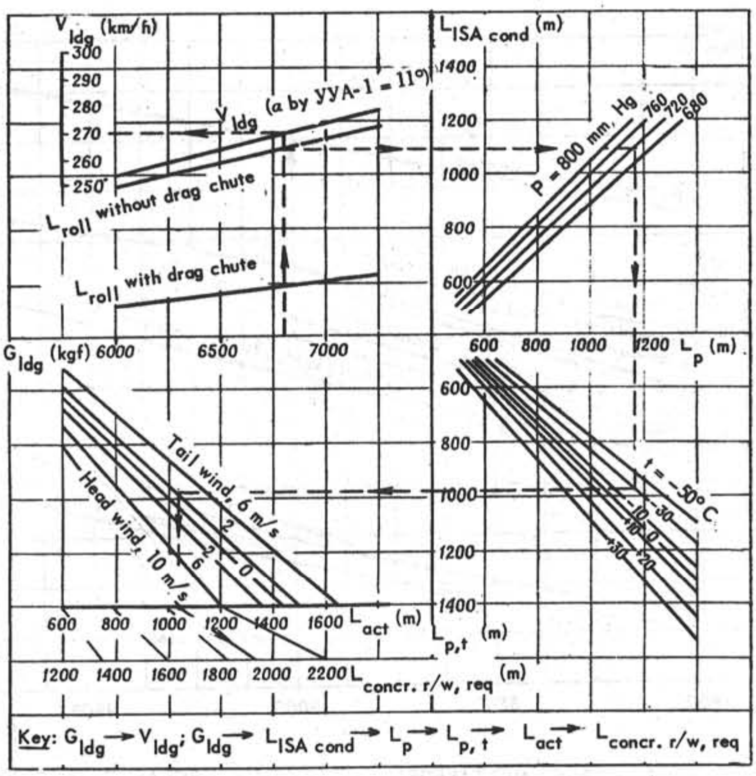


FIG. 12. VARIATION OF LANDING ROLL LENGTH AND REQUIRED LENGTH OF CONCRETE RUNWAY WITH AIRCRAFT WEIGHT, ATMOSPHERE CONDITIONS AND WIND VECTOR, BLC SYSTEM BEING EMPLOYED (DRAG CHUTE BEING DEPLOYED DURING LANDING ROLL, OR OTHERWISE)

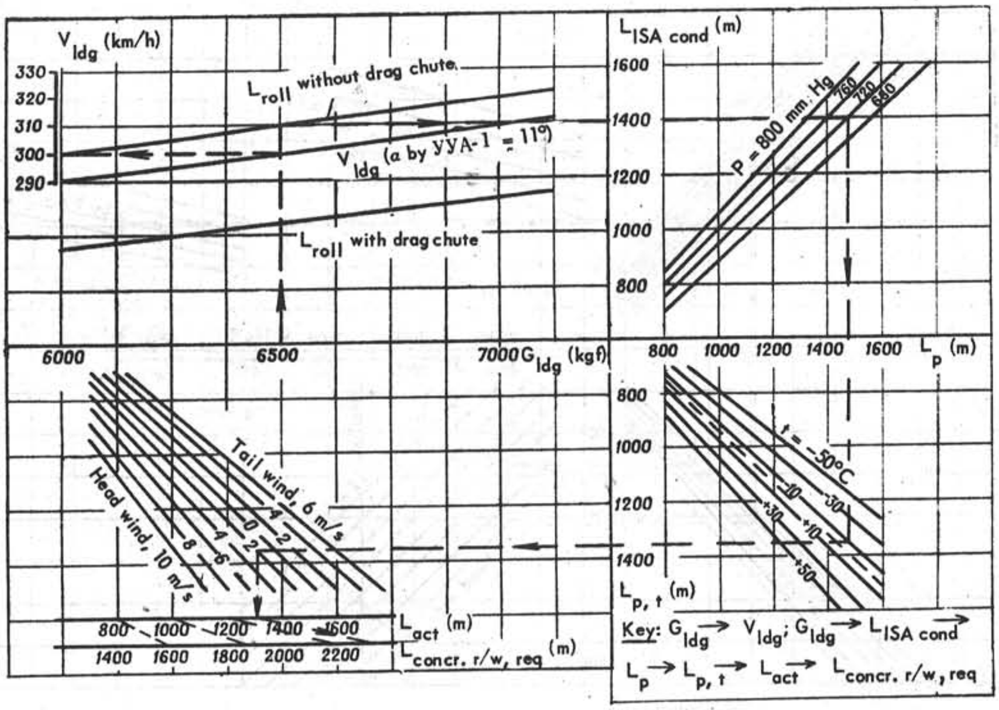


FIG. 13. VARIATION OF LANDING ROLL LENGTH AND REQUIRED LENGTH OF CONCRETE RUNWAY WITH AIRCRAFT WEIGHT, ATMOSPHERE CONDITIONS AND WIND VECTOR, BLC SYSTEM BEING NOT USED (DRAG CHUTE BEING DEPLOYED DURING LANDING ROLL, OR OTHERWISE)

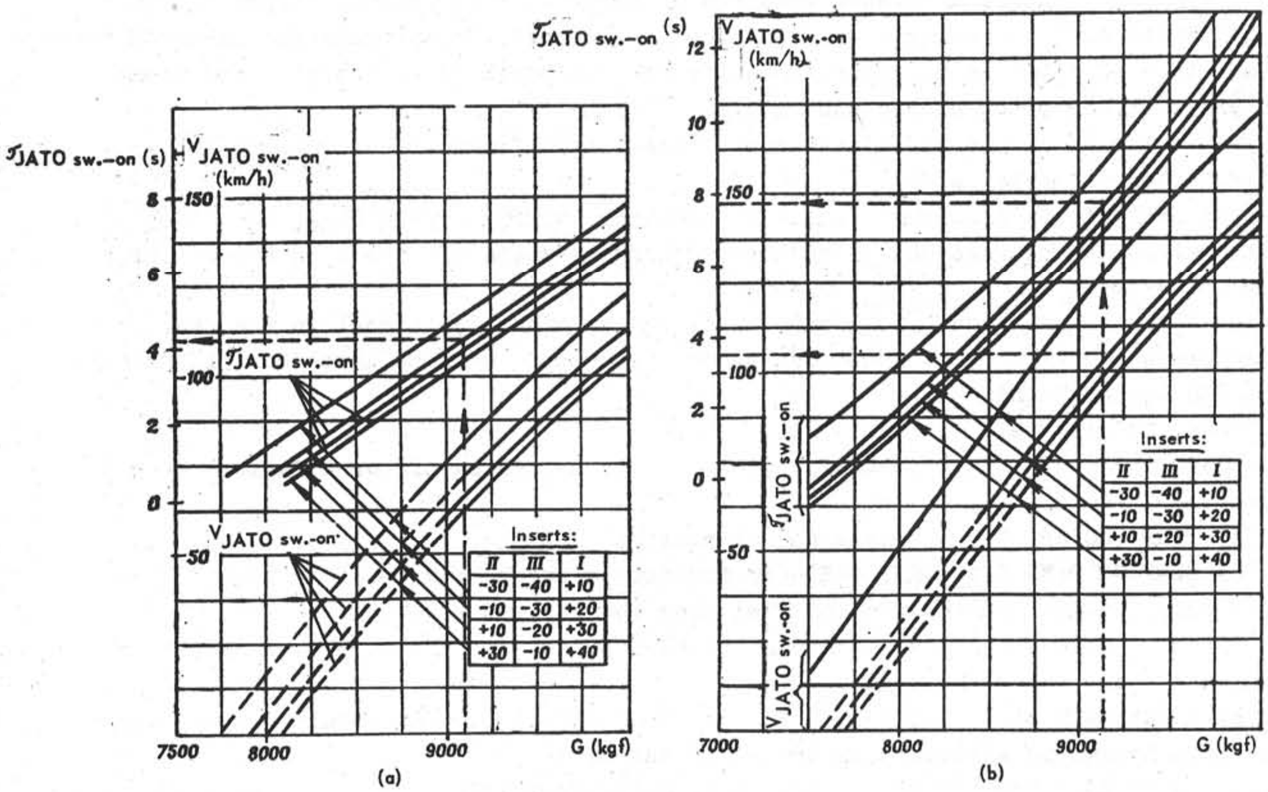


FIG. 14. JATO UNIT SWITCH-ON SPEED (TIME) DURING TAKEOFF RUN VS AIRCRAFT WEIGHT, TYPE OF INSERTS BEING USED, AND AMBIENT AIR TEMPERATURE

(a) concrete and unpaved runways with soil strength of 10–12 kgf/cm^2;

(b) unpaved runway with soil strength of 7–8 kgf/cm^2

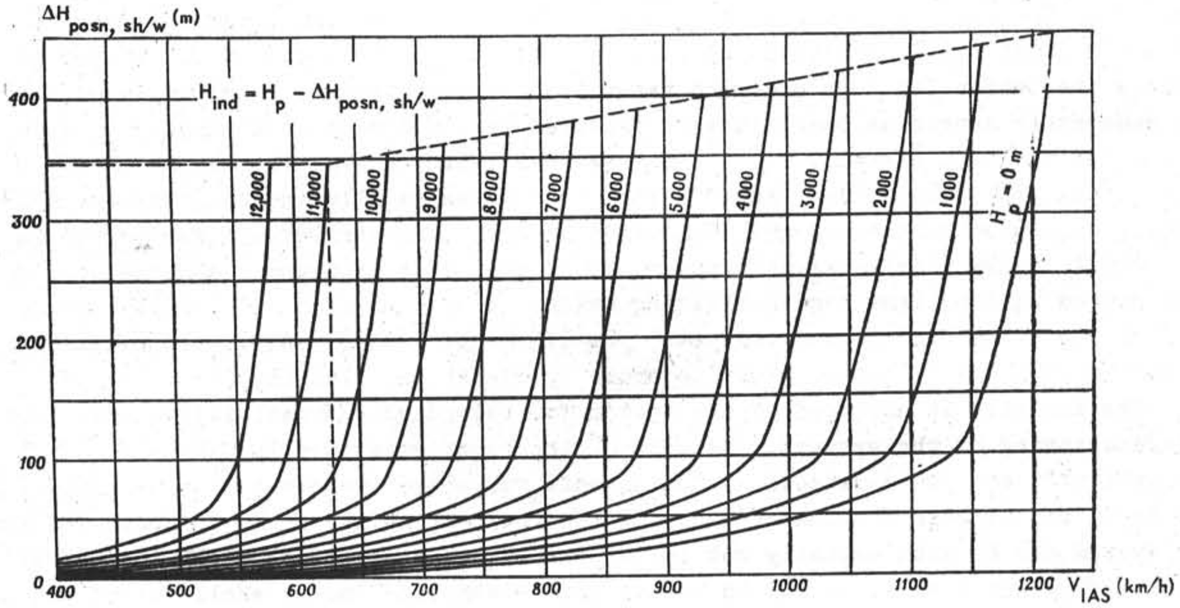


FIG. 15. VARIATION OF TOTAL (POSITION AND SHOCK-WAVE) ERROR CORRECTIONS WITH INDICATED AIRSPEED AND PRESSURE ALTITUDE (FOR AIRCRAFT EQUIPPED WITH ПВД-18-5М PITOT-STATIC TUBE)

4. While the aircraft is being flown at low altitudes and high indicated airspeeds (at $M < 1$), the pressure altimeter readings disagree with the actual flight altitude (the indicated altitude being lower than the actual one). To maintain the required pressure altitude (H_p), it is necessary to allow for the total (i.e. position and shock-wave) error of the pitot-static tube (ΔH_{posn}, sh/w).

The variation of the pitot-static tube total error corrections with flight altitude and speed is shown in Fig. 15.

5. A centralized dangerous conditions warning system, type СОРЦ-1, is employed in the aircraft so as to warn the pilot about dangerous modes of operation (or failures) of various systems.

The light signals that would come on in the warning light panel in the case of a failure or dangerous mode of functioning of some system, will be doubled by flickering of the КСЦ button light.

Those signals are:

(a) DC GEN. OFF (ГЕНЕР. = ВЫКЛ.) (to indicate switching-off or a failure of the DC generator);

(b) FIRE (ПОЖАР) (to indicate an engine fire);

(c) SERVICE TANK (РАСХОДН. БАК) (to indicate a pressure drop downstream of the booster pump, or full consumption of fuel from the service tank);

(d) 450 L FUEL REMAINING (ОСТАЛОСЬ 450 Л) (to indicate that the fuel amount in the fuselage internal tanks is about 450 L);

(e) WATCH MAIN SYST. PRES. (СЛЕДИ ДАВЛ. ОСН. СИСТ.) (to indicate a pressure drop in the main hydraulic system below 160 - 175 kgf/cm^2);

(f) WATCH BSTR SYST. PRES. (СЛЕДИ ДАВЛ. БУСТ. СИСТ.) (to indicate a pressure drop in the booster hydraulic system below 160 - 175 kgf/cm^2);

(g) LOCK CANOPY! (ЗАПРИ ФОНАРЬ) (to indicate that the locks of the collapsible canopy are open and that the cabin is not pressure-sealed; in this case the LOCK CANOPY! lamp flickers in the cabin);

(h) OIL (МАСЛО) (to indicate a drop in the oil pressure below 1.3 kgf/cm^2, or to warn that there are chips in the oil).

Once the СОРЦ system button light operates, the pilot has to determine the dangerous condition being indicated, referring to the respective light signal that will come on in the light panel, and he shall take measures to ensure security of flying, then depress the button light in order to reset it for providing the possibility of indicating some other dangerous conditions or failures in the systems (if any).

After the СОРЦ system button light has been switched off, the signal in the light panel continues to burn (say, the OIL light continues to illuminate) until the corresponding dangerous conditions are eliminated or until the aircraft is deenergized.

Should a new warning signal appear, or if the previous signal is repeated, the СОРЦ system button light begins flashing again.

As the light signal goes off (say, the OIL light extinguishes), the pilot has to press the СОРЦ system button light in order to cancel its flashing.

The aircraft is equipped with a system for recording abnormal flight conditions and functioning of the systems. The type of the recorder system is САРПП-12Г. It becomes automatically cut in on takeoff as the takeoff run speed reaches the value of 60 to 180 km/h, and it gets disconnected during landing roll as the speed is about 100 km/h. The system can be also manually cut in/cut out by means of the RECORDER (САМОПИСЕЦ) switch. The switch shall be cut in before engine starting and it shall be cut out after the engine rotors come to a standstill.

The system ensures continuous recording of the following parameters:

(a) flight indicated pressure altitude;

(b) indicated airspeed;
(c) normal (vertical) g-load;
(d) longitudinal g-load;
(e) engine rpm;
(f) stabilizer deflection angle.

Besides, the САРПП recorder records the following single command signals:
(a) pressure drop in the main hydraulic system;
(b) pressure drop in the booster hydraulic system;
(c) engagement of the AFCS;
(d) selection of the full throttle and reheat engine power settings;
(e) pushing of the firing (launch/release) button;
(f) reaching of the α_{crit} (α_{stl}) critical (stall) angle of attack;
(g) the ПАУ-473 unit changeover from the photographic camera mode to the camera gun mode.

INSTRUCTIONS ON HANDLING AND TESTING AIRCRAFT MAIN SYSTEMS AND EQUIPMENT

Handling Powerplant

The engine can be started on the ground either from ground electrical power sources or from the internal batteries.

The engine cold cranking (to drain off the jet pipe or to stop afterflaming therein) shall be made after the HP rotor has come to rest. To accomplish cold cranking, press the GROUND STARTING (ЗАПУСК НА ЗЕМЛЕ) button for 2 or 3 s with the throttle lever set at SHUT-OFF (СТОП), the ENGINE STARTING UNITS (АГРЕГАТ. ЗАПУСКА), FULL THROTTLE, REHEAT (ФОРС. МАКС.) and FIRE-FTG EQPT (ПОЖАР ОБОРУД.) circuit breakers being cut in and the ENGINE START - COLD CRANKING (ЗАПУСК ДВИГАТЕЛЯ - ХОЛОДНАЯ ПРОКРУТКА) switch being in the COLD CRANKING position.

To provide time for the starting system units to cool down, begin a repeated engine starting attempt not earlier than in 2 min since the beginning of the previous attempt.

In case of urgent necessity it is permitted to begin another engine starting cycle right after the rotors come to rest.

After five consecutive engine starting attempts or cold cranking cycles, an interval is needed to cool down the starter-generator; the length of the interval should be at least 30 min, or approximately 15 min if the unit is being cooled with compressed air.

The duration of continuous engine run in flight at the second (emergency) reheat power setting must not exceed 3 min. The engine run at other power settings is not limited. The engine rotation speed shall be increased or reduced by smooth movements of the throttle lever at a rate of not less than 1.5 to 2 s.

Under steady flight conditions and at steady engine power settings as well as during changes of the engine run, airspeed and flight altitude, check the LP and HP rotor rpm, jet-pipe temperature, oil pressure and position of the air intake cone, referring to the respective indicators and signal lights.

The oil pressure is monitored by reference to the OIL light and by a pressure gauge located on the instrument board.

The OIL light illuminates as soon as the electrical power is turned on in the aircraft, the engine being dead; it also burns in the process of engine starting (before the idle setting is reached) if the oil pressure is below 1.3 kgf/cm^2 as read by the pressure gauge. If the OIL light comes on at an oil pressure of above 1.3 kgf/cm^2, this will testify to chips in the oil.

The position of the jet nozzle flaps is monitored by reference to the JET NOZZLE OPEN (СТВОРКИ РС ОТКРЫТЫ) light; it can also be checked indirectly, by the jet-pipe temperature value and by difference between the LP and HP rotor rpm as the engine is running at the full throttle non-reheat setting and at reheat settings.

The position of the air intake cone depends on the engine speed, airspeed and flight altitude. As the rpm are reduced and/or the airspeed is increased, the cone is extending, and vice versa. The cone position is monitored by reference to the cone position indicator as well as by the CONE EXT'D (КОНУС ВЫПУЩЕН) light in the panel on the instrument board.

In separate cases the cone may be in the fully retracted position during the aircraft acceleration up to 1.4 M. The CONE EXT'D light will not illuminate in this case.

The air intake electrohydraulic control system is provided with manual control, apart from automatic one. To select manual control over the air intake cone, the pilot has to manipulate the setting knob on the cone position indicator so as to match the broad pointer with the narrow one, and to set the cone control mode switch to the MAN. (РУЧН.) position; then the cone will start moving to assume the positions assigned by the indicator broad pointer.

The derumble door (anti-surge shutter) control system is also operated either manually or automatically.

The JET NOZZLE OPEN light comes on, as the engine is being throttled down, at the HP rotor rpm of less than 58 - 61% and at reheat power settings. It extinguishes, as the throttle lever is being advanced, at the HP rotor rpm of more than 65 - 68% or as reheat is cancelled.

When the jet nozzle control system functions normally, the jet-pipe temperature should be higher than 450°C and the LP rotor speed should not exceed that of the HP rotor by more than 8% at the full throttle non-reheat setting and at reheat settings.

Select reheat power settings by moving the throttle lever to the desired power position, after the engine has gained the maximum rotation speed.

WARNING. Select reheat on takeoff by setting the throttle lever first to FULL REHEAT; then the desired reheat power may be selected, after it has been ensured that the reheat is definitely on and functions normally.

Note. It is allowed to select the full reheat power by setting the throttle to FULL REHEAT from any original engine setting at an airspeed of not less than 500 km/h at altitudes below 15,000 m, and at an airspeed of not less than 600 km/h at an altitude of or above 15,000 m.

To reduce the takeoff run length, to shorten the time of aircraft acceleration after the landing gear is retracted, or to augment the rate of climb at altitudes below 4000 m, the second (emergency) power setting may be used. To select it, turn on the SECOND REHEAT (ЧРЕЗВ. ФОРСАЖ) switch and set the throttle at FULL REHEAT (or set the throttle at this position first, then turn on the switch).

Note. The second reheat power may cut out automatically (or fail to cut in) at altitudes between 2500 and 4000 m (depending on the airspeed).

As the afterburner is turned on, the FIRST REHEAT signal light comes on in the light panel; as the second reheat power is turned on, the SECOND REHEAT light comes on in addition to the above light.

Afterburner ignition is evidenced by a jerk forward, notable thrust increase and by the appropriate light signals. Turning-on of the afterburner entails a short-time drop of the jet-pipe temperature by up to 20°C, a short-time increase of the LP rotor speed up to 106.5%, then a drop of the LP and HP rotor speed, to recover subsequently the values specified for the given engine setting.

Selection of second reheat power is monitored by a thrust increment, increase of the LP rotor rpm to 102 - 103.5% and by the appropriate light signals.

Note. Turning-on/turning-off of reheat settings may be accompanied by two or three jerks.

As the engine is running at the full reheat or second reheat power setting, the Mach number growing, the HP rotor rpm will grow; they may increase up to 107.5% (and then they will become constant again); afterwards, the LP rotor rpm will start decreasing. The value of the LP rotor rpm decrease is not limited.

If the afterburner fails to ignite or if the afterburner flameout occurs in flight, the jet-pipe temperature drops below 450°C, and the LP rotor speed exceeds that of the HP rotor by more than 8 - 12%. In this case shift the throttle lever to the FULL THROTTLE (МАКСИМАЛ) position in flight, and select reheat repeatedly only after the maximum rpm have been regained. Prior to turning on the afterburner under such conditions, increase the airspeed by 30 to 50 km/h; for more reliable catch-up of the afterburner, select reheat another time not earlier than in 4 s after the previous attempt.

To cancel the second reheat power, either retard the throttle lever behind the FULL REHEAT setting or cut out the SECOND REHEAT switch; this done, the SECOND REHEAT light will go off.

The process of the afterburner cut-out involves a short-time LP rotor overspeed to not more than 106.5% and reduction of the HP rotor rpm; then the LP and HP rotors will restore their steady rotation speed corresponding to the given power setting. The FIRST REHEAT light will go off.

While descending from high altitudes, the engine running at the IDLE setting, make sure that the engine is not dead and that its run is steady. To this end, smoothly advance the throttle lever to FULL THROTTLE when at an altitude of 5000 to 7000 m; as the engine is accelerating to the full throttle power, make sure it runs steadily.

While checking the engine acceleration from the idle speed to the full throttle power (the throttle lever being advanced at a rate of 1.5 - 2 s), the pilot shall note the time of the engine gaining maximum speed since the moment when the throttle lever was advanced from the IDLE position; if that time is more than 10 s, the engine being checked at altitudes between 5000 and 7000 m, so it means that the engine mass-flow acceleration controller (altitude compensator) system is faulty. Then mind, should it become necessary to go round again, that the time of the engine acceleration at the ground level may be as long as 18 to 20 s.

Handling Fuel System

In flight, the fuel consumption and operation of the fuel system shall be checked by reference to the fuel gauge and appropriate signal lights. The sequence of fuel consumption light signals, when functioning of the fuel system is normal, is given in Table 8. The given consumption sequence is accomplished automatically.

The WG DROP TKS EMPTY (ВЫРАБОТКА КР. БАКОВ) light is located in the light panel on the instrument board; the rest of the lights monitoring fuel consumption are located in the light panel on the right-hand console.

THE 450 L FUEL REMAINING and SERVICE TANK signal lights are of red colour, the rest of the lights are green. The lights indicating fuel consumption from groups of tanks first flicker, then illuminate continuously.

Fuel consumption from the wing fuel cells can be monitored indirectly, by the fuel amount remaining at the moment when the NO. 1 TK GP EMPTY (1 ГР. БАКОВ) signal light comes on. Illumination of the NO. 1 TK GP EMPTY light at a time when the fuel remainder is 1300 - 1600 L testifies to the fact that fuel has not been consumed from the wing fuel cells. The actually consumable remainder will in this case be 700 - 1000 L.

To avoid causing damage to the transfer pump of the first tank group, switch off the NO. 1 TK GP PUMP (НАСОС 1 ГР. БАКОВ) circuit breaker after steady illumination of the NO. 1 TK GP EMPTY light.

When coming in to land with a fuel remainder of less than 200 L, switch on the NO. 1 TK GP PUMP circuit breaker in order to transfer fuel that may happen to remain in the first tank group, into the service tank. Then this circuit breaker shall be switched off only after landing.

Before flight with drop tanks, check the WG DROP TKS EMPTY and VENTRAL DROP TK EMPTY (ВЫРАБ. ПОДВ. БАКА) signal lights during engine run-up on the ground.

Table 8

Monitored tank group	Fuel remainder by reference to gauge (L)			Signal light coming on
	Ventral drop tank carried	Wing drop tanks carried	Three drop tanks carried	
Wing drop tanks	-	2700 - 2500	3200 - 3000	WG DROP TKS EMPTY
Ventral drop tank	2700 - 2500	-	-	VENTRAL DROP TK EMPTY
First tank group	-	-	700 - 1000	NO. 1 TK GP EMPTY
Emergency fuel reserve	-	-	400 - 550	450 L FUEL REMAINING
Third tank group	-	-	250 - 350	NO. 3 TK GP EMPTY

Handling Life-Saving and Life-Support Equipment

Handling Emergency Escape Equipment

The emergency escape equipment provides a means for the pilot to escape in an emergency situation in flight; the equipment comprises the ejection seat and canopy emergency jettison system.

To prevent accidental operation of the emergency escape equipment mechanisms during ground checks of the cabin equipment, ground safety pins shall be fitted in the first-stage stabilizing parachute rod gun and in the canopy jettison gun actuating handle. The ground safety pins shall be removed by the aircraft technician after the engine test, before lowering of the collapsible canopy.

Prior to climbing into the cabin, make sure that all the ejection seat and canopy jettison handles are set in the initial positions and properly locked (fixed).

When once the canopy is closed, ensure that its locks are securely fastened, referring to the position of the canopy normal (operational) control lever, protrusion of the locking rods, and also to the appropriate warning light.

Before performing takeoff or landing, be sure to lock the shoulder restraint straps; during flight the shoulder restraint straps may be loosened. To avoid injury during ejection, use the waist restraint handle to tightly fasten the waist restraint belt before taxiing out to line up.

The procedure for using the emergency escape equipment during ejection and actions to be taken by the pilot after ejection are set forth in section "Bail-Out Procedures".

Handling Oxygen Equipment and Pilot's Outfit

The pilot must use only his own individual set of flying outfit that has been chosen to fit his size and has been adjusted with the help of the unit medical officer and high-altitude outfit technician (mechanic).

Prior to flying with the high-altitude outfit on, the pilot must inquire the high-altitude outfit maintenance technician (mechanic) about the condition of the outfit, check the inhalation and exhalation valves for air-tightness and the radio communication rig for functioning. It is forbidden to use a high-altitude outfit that has been found faulty.

Note. On aircraft equipped with an ejection seat incorporating a radio beacon, type KOMAR, before the flight it is required to check the presence of the radio beacon power supply unit in the pocket of the pilot's outfit (flying clothing), provided the power supply unit is kept in this pocket.

Put on the oxygen mask or close the visor of the pressure helmet when still on the ground, before taxiing. Shift the helmet ventilation control knob to the ON position and do not switch it off throughout the flight, while the oxygen mask is on or the pressure helmet visor is closed.

In flight, check periodically the amount of oxygen in the system, referring to the pressure gauge, as well as the flow of oxygen being supplied by the economizer (oxygen regulator), referring to the oxygen flow indicator blinker segments that should come together during inhalation and move apart during exhalation. When the pressure in the oxygen system drops to 30 kgf/cm^2, descend to a safe altitude (4000 m).

In the case of abnormal functioning of the oxygen equipment (say, oxygen deficiency and/or great resistance to inhalation are felt, or if the pilot feels unwell), immediately switch on the emergency oxygen supply, setting the red lever to the ON position; then closely watch the amount of oxygen remaining in the system, because the rate of oxygen consumption is now doubled or trebled.

Notes: 1. At cabin altitudes of below 2000 m, if the air dilution valve lever is in the MIXT. (СМЕСЬ) position, no oxygen will be supplied for breathing and the blinker segments of the oxygen flow indicator will not respond to breathing.

2. With the pressure helmet ventilation system engaged, the blinker segments may not respond to inhalation/exhalation even at cabin altitudes above 2000 m. To make certain that the oxygen equipment is in good condition, make two or three deep inhalations and exhalations, or shift the air dilution valve control lever to the "100% O_2" position; in the latter case, the indicator blinker segments should come together during inhalation and move apart during exhalation.

In flight, check the extent of heating of the pressure helmet visor glass and if necessary, use the pressure helmet fast heating button.

When a ventilated outfit is used in flight, adjust the rate of the ventilation air flow through the outfit as required.

WARNING. It is prohibited to use the АСЖ-58 or АСЖ-58Б life jacket with the ГШ-6 pressure helmet.

Prior to putting on the АСЖ-58 life jacket, in order to reduce swelling of its bladders at high altitude, thoroughly evacuate remaining air from the bladders by folding (or rolling up) the jacket, the valves of the inflation pipe mouthpieces being open; then close the valves.

If the АСЖ-58 life jacket gets swollen in flight, bleed air from its bladders by depressing the inflation pipe mouthpieces for a short time.

Prior to putting on the АСЖ-58Б life jacket, make certain that the valve of the LH mouthpiece (of the main bladder) is closed, the valve of the RH mouthpiece (of the reserve bladder) is open and the altitude (vent) valve is safetied with a pin.

The schematic diagram of the KKO-5 set of oxygen equipment is shown in Fig. 16.

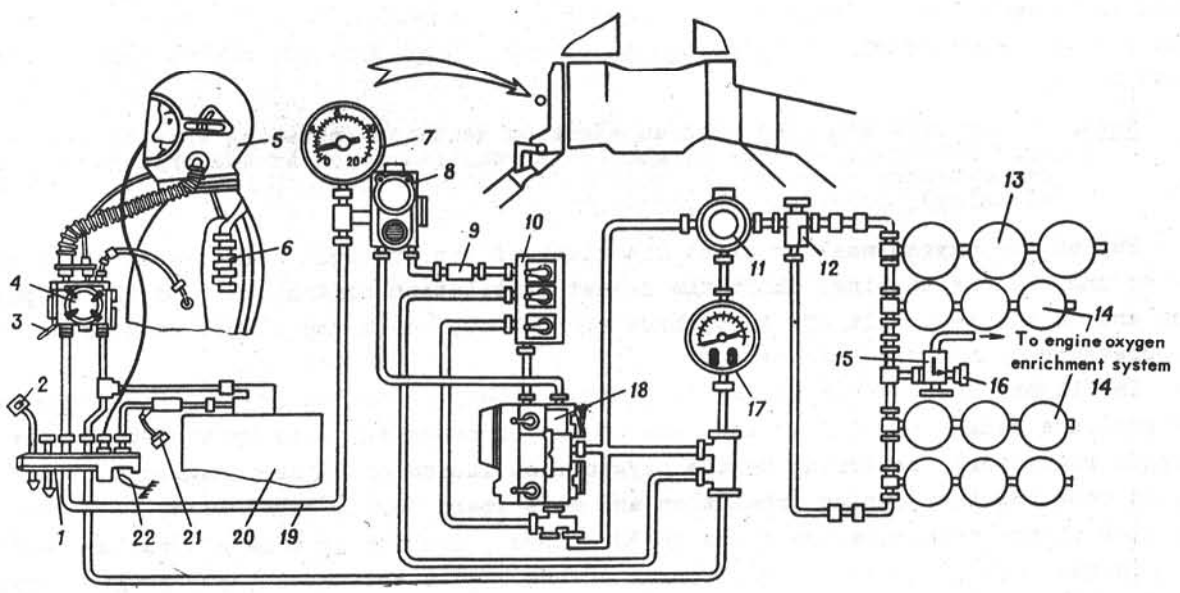


FIG. 16. SCHEMATIC DIAGRAM OF KKO-5 SET OF OXYGEN EQUIPMENT

1 – OPK-11A quick-release common connector (quick disconnect assembly); 2 – anti-g device hose; 3 – КП-52М oxygen regulator quick-release connector emergency opening handle; 4 – oxygen regulator КП-52М; 5 – pressure helmet; 6 – partial-pressure suit BKK-6; 7 – pressure gauge, type M-2000; 8 – helmet ventilation device, type ВУШ-6; 9 – union with orifice for helmet ventilation device line; 10 – remote control panel ДУ-7; 11 – oxygen reducing valve KP-26A; 12 – KB-2MC oxygen supply valve; 13 – oxygen bottle (4-L capacity); 14 – ball-shaped oxygen bottles; 15 – KB-2MC oxygen supply valve for single-point charging; 16 – supply union; 17 – oxygen flow indicator, type ИК-52; 18 – РПК-52 oxygen supply regulator; 19 – oxygen hoses КШ-52; 20 – parachute-packed oxygen set КП-27М; 21 – КП-27М oxygen set emergency setting-on handle; 22 – OPK-11A quick-release common connector emergency disconnect cable

Handling Cabin Pressurization

All flights, irrespective of altitude, must be performed with the cabin sealed and pressurization switched on.

After lowering the collapsible canopy in position, push the canopy lock control handle all the way forward and fit it into the retaining slot.

The collapsible canopy operational control locks being closed, pressurize the cabin by pushing the pressurization cock lever all the way forward and up, after which check the canopy operational control locks for proper closing, making sure that the lock pivots have entered the holes in the canopy-carrying underframe, the lock control handle fits into the retaining slot, and the blinking indicator lamp on the port side has gone out.

The canopy shall be opened only after the aircraft has come to rest on the parking site.

Canopy emergency jettison is accomplished by operating the respective handle located in front of the pilot, on the starboard side of the cabin.

Cabin temperature is maintained automatically; for this, the COLD-AUTO-HOT (ХОЛОД.-АВТОМ.-ГОРЯЧ.) selector switch should be set to AUTO.

In case the automatic equipment fails, cabin temperature may be controlled manually, by setting the selector switch to COLD or HOT. The time of mixer shutters shifting from the COLD to HOT position and vice versa will not exceed 30 s.

When flights are performed at altitudes of less than 3000 m under positive air temperatures and high air humidity conditions (the relative humidity amounting to 70% or more), mist or haze is likely to appear in the cabin. To prevent mist formation, proceed as follows:

(a) preparatory to taxiing out, set the cabin heat selector switch for 25 to 30 s to COLD and then for 10 to 15 s to HOT, after which set the selector switch to the neutral position;

(b) after taking off and climbing to an altitude of 3000 m, set the cabin heat selector switch to AUTO;

(c) before performing landing approach, set the cabin heat selector switch (when flying at an altitude of 3000 m) for 10 to 15 s to HOT, after which set it to the neutral position;

(d) when mist appears in the cabin during flight, set the cabin heat selector switch for 10 to 15 s to HOT and then set it to the neutral position. The mist should vanish in 1 to 2 min, after which set the selector switch to AUTO.

If mist persists or the smell of smoke is sensed in the cabin, proceed in accordance with the instructions given in Items 331 and 332.

Prior to taking off under subzero ambient air temperatures, it is recommended to set the cabin heat selector switch to HOT; after the aircraft becomes airborne, set the selector switch to AUTO.

If misting of the canopy glass panels occurs in flight, set the cabin heat selector switch to HOT. Should misting persist, increase the engine rpm.

Cabin air pressure is maintained automatically, depending on the altitude of flight. When climbing, with the cabin pressure control system functioning normally, the differential pressure should not exceed 0.05 kgf/cm^2 (as read by the УВПД-20) up to an altitude of 2000 m; starting from an altitude of 2000 m, the differential pressure gradually increases, until it reaches 0.27 to 0.33 kgf/cm^2 at an altitude of 9000 to 12,000 m; at higher altitudes a constant differential pressure is maintained.

If the cabin pressurization cock lever is in the correct position, but there is no overpressure in the cabin at altitudes above 2000 m, it is forbidden to continue the mission.

Note. If the differential pressure control system functions normally, the maximum cabin altitude (as read by the УВПД-20 cabin altitude and differential pressure indicator) at the aircraft service ceiling should not exceed 7000 m.

In the case of a failure of the cabin pressure control system, the differential pressure at altitudes above 9000 - 12,000 m may be either below the normal value or maintained by the cabin safety valve within 0.32 to 0.35 kgf/cm^2 at all altitudes.

In the course of flight, check the differential pressure in the cabin at regular intervals by watching the УВПД-20 cabin altitude and differential pressure indicator.

Before entering a zone contaminated with radiological or biological warfare agents, or a chaff cloud, change over to pure oxygen by setting the air dilution valve lever to "100% O_2" and switch off the cabin pressurization system by shifting the cabin air supply valve lever to CLSD (ЗАКР.).

When flying at altitudes above 11,000 m, 30 to 90 s after the cabin pressurization system is switched off, the differential pressure decreases, the cabin altitude increasing accordingly. As soon as the cabin altitude becomes higher than 11,000 m, continuous oxygen supply should engage automatically, overpressure building up in the partial-pressure suit and in the pressure helmet (oxygen mask). Under these conditions, immediately descend to an altitude below 10,000 m; then continuous oxygen supply will no longer come to the partial-pressure suit and to the breathing line. Further flight with pressurization disengaged shall be performed at altitudes not above 10,000 m.

Use defroster when symptoms of windshield icing show up.

After leaving the contaminated area, switch on cabin pressurization again and proceed with the mission while breathing pure oxygen. A rapid cabin pressure increase following the engagement of cabin pressurization is likely to result in ear-ache. To slow down the rate of pressure increase, set the cabin heat selector switch to COLD before switching on the cabin pressurization system. After the differential pressure in the cabin rises to the normal value, set the cabin heat selector switch to AUTO.

Keep breathing pure oxygen until the aircraft lands and taxies in.

Handling Hydraulic and Pneumatic Systems

The aircraft hydraulic system includes two self-contained systems, i.e. the main and booster ones, which ensure higher reliability and fail-safe operation of the hydraulic equipment. The booster hydraulic system incorporates pumping unit НП-27Т which is switched on automatically as soon as the pressure in the booster hydraulic system drops below 160 - 175 kgf/cm^2 and it is switched off when the pressure in the system rises in excess of 195 kgf/cm^2.

The main hydraulic system performs the following functions:

(a) retraction and extension of the landing gear;
(b) retraction and extension of the wing flaps;
(c) control of the air brakes;
(d) control of the jet nozzle flaps;
(e) operation of one chamber in the stabilizer two-chamber booster;
(f) automatic braking of the wheels during landing gear retraction;
(g) retraction and extension of the air intake cone;
(h) control of the derumble doors;
(i) control of the electronic equipment bay cooling system.

Besides, the main hydraulic system ensures operation of the aileron boosters in case the booster system fails.

The booster hydraulic system ensures operation of one chamber in the stabilizer two-chamber booster and two aileron boosters.

Functioning of the hydraulic system can be checked by reference to the respective pressure gauge and to signal lights.

When pressure in the hydraulic systems drops to 160 - 175 kgf/cm^2, the WATCH BSTR SYST. PRES. (СЛЕДИ ДАВЛ. БУСТ. СИСТ.) and WATCH MAIN SYST. PRES. signals flash up in the light panel; the signals would go out as soon as the pressure rises in excess of 195 kgf/cm^2.

The serviceability of the НП-27Т pumping unit can be checked by reference to the booster system pressure gauge.

The aircraft pneumatic system is composed of two individual systems, i.e. the main and emergency ones.

The main system is designed for braking the landing gear wheels, jettisoning the JATO units, sealing the cabin canopy, controlling the drag chute nacelle doors and jettisoning the drag chute as well as for controlling the anti-icing system, liquid cooling system and pressurizing the radar units.

The emergency pneumatic system is intended for emergency extension of the landing gear and emergency braking of the main LG wheels.

The compressed air used in the system is stored in air bottles at a pressure of 110 to 130 kgf/cm^2.

Pressure in the systems is checked by reference to a two-pointer pressure gauge installed on the cabin starboard side.

The pressure in the main wheel braking system during operation of the brake application lever is monitored by the two-pointer pressure gauge. The brake pressure connot be monitored when the emergency system is being used for braking the LG wheels.

Handling POLYOT-ОИ System

Handling РСБН-6С Equipment

The РСБН-6С airborne equipment, used in conjunction with other elements of the POLYOT-ОИ system as well as with ground rho-theta beacons, type РСБН-4Н (or РСБН-2Н), localizer and glide path transmitters, type ПРМГ-4М, is intended as an aid in short-range navigation and landing (runway) approach under bad weather conditions by day and at night.

The РСБН airborne equipment operating range is limited by the optical range. The equipment can aid in solving the following problems:

(a) continuous aircraft coordinate indication (i.e. indication of the azimuth and distance from a ground navigational radio beacon) as well as of the beacon relative bearing;

(b) flight TO or FROM the beacon, or orbiting flight within the beacon coverage zone;

(c) homing to a landing airdrome equipped with a navigational radio beacon; indicating the aircraft azimuth, beacon relative bearing and distance to the beacon;

(d) letdown to the beacon (on an assigned azimuth) along a cloud penetration glide path;

(e) bringing the aircraft into a precalculated initial point of the prelanding maneuver, using a precalculated (and put down into the knee-pad) azimuth and distance to that point;

(f) runway approach with reference to the localizer and glide path transmitter beams when the equipment is used in the LANDING (APPROACH) mode, with indication of the distance remaining to the runway threshold; the LANDING mode should be selected when the aircraft azimuth differs from the runway approach azimuth by not more than $\pm 10^{\circ}$, in the range of distances to the navigational beacon from 19 to 40 km, provided the aircraft present heading differs from the runway approach heading by not more than 90°;

(g) runway landing approach with reference to signals of the РСБН beacon, indicating the beacon relative bearing (aircraft azimuth) and distance to the beacon;

(h) bringing the aircraft to a navigational radio beacon (hence, to the landing airdrome) with the use of the azimuth selector, should the airborne compass system fail.

WARNING. Carry out flights and all calculations involving employment of the РСБН system, using the true heading for the purpose, the magnetic declination of the departure (or destination) airdrome being set in the declination setter.

Functioning of the РСБН equipment is monitored and the equipment is controlled with the help of the control panel located on the left-hand console, as well as by means of appropriate indicators, switches and circuit breakers.

For normal operation of the РСБН equipment, the following circuit breakers should be turned on: ARC(APK); RAD. ALT., MKR REC. (PB, MPП); РСБН; ДА-200 COMB. INSTR.; SIG. OF VERT. GYRO OF FDS, AFCS, RDR (ДА-200, СИГНАЛ. ГИРОД. КСИ, САУ, РЛС); VERT. GYRO OF FDS, AFCS, RDR; GYRO HOR. SIG. (ГИРОД. КСИ, САУ, РЛС, СИГНАЛ. АГД); GYRO HOR. (АГД) and AFCS (САУ), the compass system being slaved and the magnetic declination of the flying area being set in by the declination setter.

Mounted on the control panel are the following elements:

(a) channel selectors NAVIGATION (НАВИГАЦИЯ) and LANDING (ПОСАДКА) used for setting the required channel numbers of the РСБН navigational beacons, ПРМГ localizers and glide path transmitters; the numbers are seen in the holes provided in the panel face board;

(b) pilot lamps UPDATE: AZIMUTH and DISTANCE (КОРРЕКЦИЯ: АЗИМУТ, ДАЛЬНОСТЬ) whose extinction testifies to the fact that the respective update signal has ceased to come from the navigational radio beacon;

(c) selectors AZIMUTH INITIAL SETTING (НАЧАЛЬН. УСТ. АЗИМУТ.) and DISTANCE INIT. SETTING (НАЧАЛЬН. УСТ. ДАЛЬН.) used for initial setting or updating of azimuth and distance values before flight or in flight in the dead reckoning mode (radio correction (update) being not available) on overflying check points whose coordinates are known, should the indicated coordinates happen to differ from the actual ones.

Installed on the left-hand console, near the РСБН equipment control panel, are the following elements:

(a) IDENT. (ОПОЗН.) button, to turn on the aircraft individual identification signal (when depressed); then the aircraft will be identified on the screen of the РСБН ground equipment:

(b) A, D CHECK (КОНТРОЛЬ А, Д) button, to turn on the РСБН airborne equipment built-in monitor (as the button is depressed, the following test values should be indicated: the 291.5-km distance by the ППД-type distance indicator and the 177° aircraft azimuth by the НПП-type combined course indicator).

Installed on the instrument board are:

(a) НПП-type combined course indicator (CCI) and КПП-type flight director indicator (FDI);

(b) ППД-type distance indicator;

(c) UPDATE (СУММ. КОРР.) pilot lamp, to indicate availability of the azimuth and distance update signals being picked up from a navigational beacon; 1.5 min since termination of picking-up of an azimuth or distance update signal the UPDATE lamp will die out;

(d) NAVIG. - LETDOWN - LDG (НАВИГ. - ПРОБИВ. - ПОС.) switch, to select the desired mode of the РСБН equipment operation;

(e) magnetic declination setter;

(f) heading slaving button.

The CCI can indicate the following (Fig. 17):

(a) aircraft present azimuth from the navigational beacon, to be read off the tail (which is thickened and provided with a circle) of the relative bearing pointer, against the movable scale; the pointer tail is sometimes called the "azimuth end" of the pointer;

(b) aircraft present heading, to be read off the lubber line (upper fixed) index, against the movable scale of the instrument;

(c) navigational beacon relative bearing (or homing beacon relative bearing, when the pointer is connected to the radio compass), to be read off the tip (thin end) of the relative bearing pointer, against the fixed scale;

(d) aircraft set (assigned) course, to be introduced by the SET COURSE (SC) course setting knob against the present heading scale;

(e) position of the localizer course and glide path beams with respect to the aircraft (when the РСБН equipment is operating in the LANDING mode, the failure warning flags closing their windows); this is indicated by the vertical (localizer course) position bar and horizontal (i.e. glide path) position bar;

(f) serviceability of the РСБН equipment in the LANDING MODE; this is monitored by the localizer (L) and glide path (G) channel failure warning flags closing their windows.

The course setting dial is provided with indices to designate commencement of the downwind, base leg and final turns (marked "2, 3 and 4", respectively) of the wide rectangular pattern.

The FDI can indicate the following (Fig. 18):

(a) present bank and pitch angles;

(b) assigned track position with respect to the aircraft (when the РСБН equipment is used in the NAVIGATION mode in order to maintain a constant azimuth in flying TO or FROM the beacon); this is indicated by the vertically-disposed, localizer course/assigned track position pointer (bar);

(c) position of the assigned flight path with respect to the aircraft (when the РСБН equipment is operating in the LETDOWN mode, or when it is used in the LANDING mode, the CCI failure warning flags closing their windows); this is indicated by the horizontally-disposed, glide path/assigned altitude position pointer (bar) as well as by the vertically-disposed, localizer course/assigned track position pointer (bar);

(d) command control signals in the roll and pitch channels (when the РСБН equipment is functioning in the LANDING mode, the FDI pitch (P) and roll (R) channel failure warning flags disappear from view); the signals are displayed by the vertical (roll) and horizontal (i.e. pitch) command control pointers when the command (i.e. semiautomatic) control mode or automatic control mode is selected;

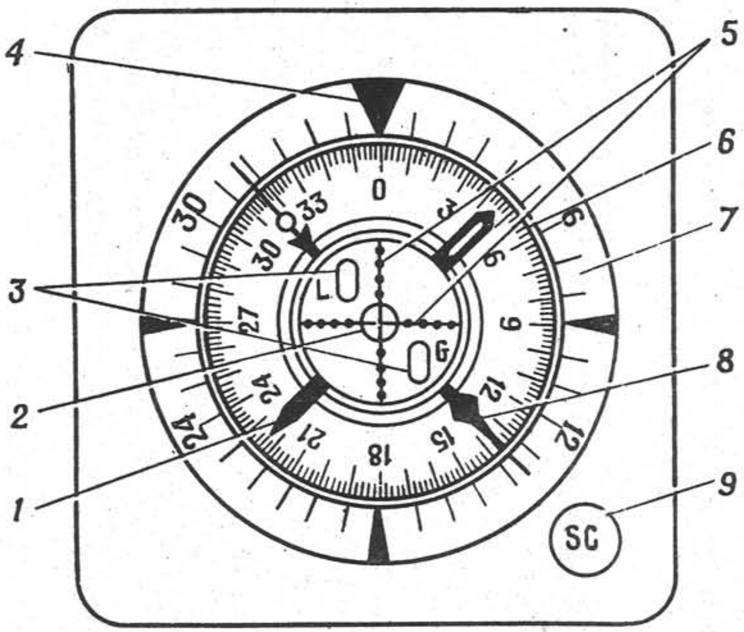


FIG. 17. COMBINED COURSE INDICATOR (CCI)
1 – set course (broad) pointer; 2 – aircraft simulated position (circle); 3 – localizer (L) and glide path (G) channel failure warning flags; 4 – lubber line index; 5– localizer and glide path position bars; 6 – magnetic heading (MC) scale; 7 – aircraft azimuth and beacon relative bearing scale; 8 – azimuth and relative bearing (narrow) pointer; 9 – SET COURSE (SC) course setting knob

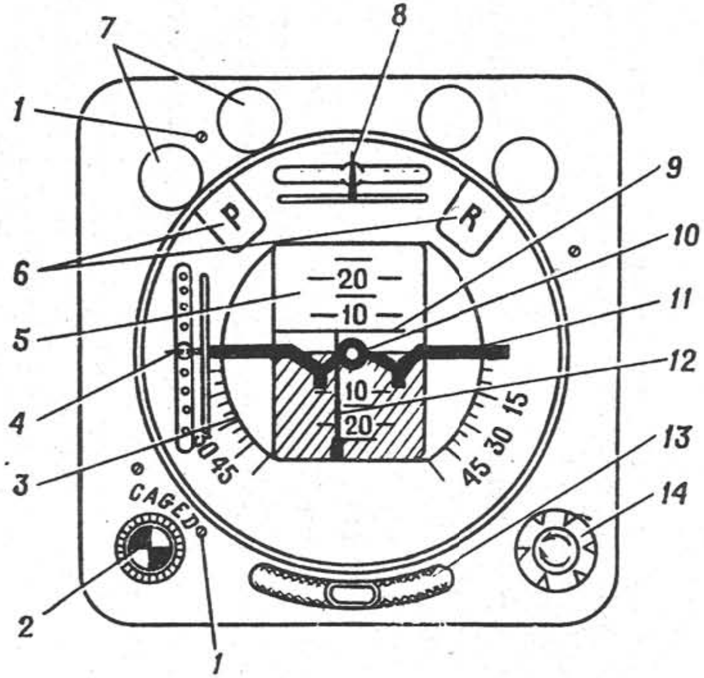


FIG. 18. FLIGHT DIRECTOR INDICATOR (FDI)

1 – adjustment screw for command control and position pointers (bars); 2 – CAGED button light; 3 – bank angle scale; 4 – glide path /assigned altitude position pointer (bar); 5 – pitch angle tape scale; 6 – pitch (P) and roll (R) channel failure warning flags; 7 – red illumination lamps; 8 – localizer course/ /assigned track position pointer (bar); 9 and 12 – command control pointers; 10 – aircraft simulated position (central circle); 11 – outline (miniature) aircraft; 13 – slip indicator; 14 – zero-pitch setting knob

(e) engagement and serviceability of the command control and automatic control modes during landing approach, as monitored by the pitch (P) and roll (R) channel failure warning flags disappearing from view.

The PCБH - ARC (APK) switch is located on the left-hand console; it is intended to connect the relative bearing pointer either to the PCБH equipment or to the radio compass.

Before flying with the use of the PCБH equipment, ensure that the destination airdrome pressure has been set in by the pressure setter located in the forward equipment bay (the set pressure value shall be reported to the pilot by the aircraft technician).

Handling Automatic Flight Control System САУ-23ЕСН

The AFCS performs the following functions:

(a) damping of oscillations and stabilization of the aircraft attitude;

(b) stabilization of the flight pressure altitude in the LEVELLING mode;

(c) levelling-off of the aircraft;

(d) climbing of the aircraft from the preset limit altitude (only when the landing gear is up) once a signal to this effect is obtained from the PB-УМ radio altimeter;

(e) runway approach in the automatic or semiautomatic (command) control mode, by signals obtained via the PCБH equipment functioning in the LANDING mode.

The AFCS control elements are installed on the control panel (which is mounted on the left-hand console) as well as on the instrument board, right-hand console vertical panel and on the control stick.

Located on the vertical panel of the right-hand console are the following elements:

(a) circuit breaker AFCS (САУ), to switch on the AFCS power supply; this circuit breaker may be turned on only when the ДА-200 COMB. INSTR.; SIG. OF VERT. GYRO OF FDS, AFCS, RDR circuit breaker, GYRO HOR. and FDS (КСИ) circuit breakers as well as the VERT. GYRO OF FDS, AFCS, RDR; GYRO HOR. SIG and AILERON BOOSTER (БУСТЕР ЭЛЕРОНА) switches are turned on;

(b) AFCS, PITCH (САУ, ТАНГАЖ) switch that can be used in order to disengage the AFCS pitch channel when the system is functioning in the STABILIZATION mode (both of the AFCS channels are engaged when the system is used in the LEVELLING mode or in the mode of automatic climb from limit altitude, irrespective of the position of the AFCS, PITCH switch).

Mounted on the control stick are:

(a) LEVELLING ON (ВКЛ. ПРИВ. ГОРИЗ.) button, to engage the LEVELLING mode;

(b) A/P OFF (ВЫКЛ. АП) red button, to disengage all the AFCS automatic modes of operation.

Located on the AFCS control panel are the following elements:

(a) button lights LANDING: AUTO CTL and COMD CTL (ПОСАДКА: АВТОМ, ДИРЕКТ.) intended to engage and monitor the AFCS run in the respective modes of operation (i.e. in automatic control and command control) during runway approach;

(b) OFF (ОТКЛ.) button intended to disengage the automatic and command control modes of runway approach;

(c) STAB. (СТАБИЛ.) button light, to engage and monitor the AFCS run in the STABILIZATION mode;

(d) LEVEL. (ПРИВЕД.) green light, to monitor the AFCS run in the LEVELLING mode;

(e) PRESET (LIMIT) ALT. (ОПАС. ВЫС,) switch intended to turn on power supply of the unit controlling automatic climb from limit altitude.

Mounted on the instrument board is a red light labelled PRESET (LIMIT) ALT. (ОПАСНАЯ ВЫСОТА); the light is intended to warn the pilot that the aircraft has descended below the limit height set in by the radio altimeter limit altitude setter.

WARNING. Prolonged (5 to 10-s) alternating and near-zero g-loads are applied to the aircraft equipped with the AFCS after it has climbed automatically from the limit altitude and levelled off after climb. To except development of alternating g-loads, disengage the AFCS once the aircraft has climbed automatically from the limit altitude, and recover it in level flight manually.
For the same reason it is not recommended to use the LEVELLING mode for recovering the aircraft in level flight after climb.

While coming in to land, engage the automatic or command control mode after switching over the РСБН equipment to the LANDING mode, at a distance of 17 to 21 km to the runway and at an altitude of 600 - 700 m.

WARNING. It is forbidden to engage the above-mentioned control modes at altitudes below 450 m (for safety reasons) or above 1000 m (due to difficulty of intercepting the glide path).

When at a distance of 21 to 40 km to the runway, engage the command control or automatic control mode after bringing the aircraft in line with the runway in the manual control mode in order to avoid a prolonged process of intercepting the localizer beam.

It is mandatory to disengage the automatic flight control system by means of the red button installed on the control stick, in the following cases:

(a) inadvertent entry into a spin or inertia rotation;
(b) fire occurred;
(c) engine flameout (or if the engine is shut down);
(d) failure of any hydraulic system;
(e) before switching off the aileron boosters;
(f) failure of the DC generators;
(g) failure of the АРУ controller automatic elements;
(h) before caging the gyro horizon;
(i) at the end of landing roll (to promote the AFCS operational reliability).

As the red A/P OFF button located on the control stick is depressed, the automatic modes of the AFCS operation get disengaged.

The AFCS is prepared for engagement by switching-on of the AFCS circuit breaker, the flight direction (compass) system, gyro horizon and aileron boosters being on and normal operating pressure being available in the hydraulic system.

The STABILIZATION mode is selected by means of depression of the STAB. button light 1 or 2 min after switching-on of the AFCS circuit breaker. When depressed, the button light should come on to indicate that the AFCS has got engaged.

In flight, before engaging the AFCS in the STABILIZATION mode, trim up the aircraft and neutralize the stick forces by manipulating the pilot's trim accordingly.

When the STABILIZATION mode has been selected and the control stick has been relieved of stick forces, the AFCS would stabilize the aircraft attitude that was by the moment of relieving the stick forces.

Notes: 1. If the aircraft bank is more than 6° by the moment the stick forces are relieved, the AFCS will stabilize the aircraft preset bank and pitch angles; if the bank is less than 6°, the AFCS will stabilize the aircraft heading, the preset pitch angle and a zero bank angle.

2. The AFCS would stabilize the preset bank, pitch angle and heading, provided the pilot applies no forces to the control stick. A force of 1.7 - 1.9 kgf applied to the control stick in the longitudinal direction, or of 1.0 - 1.2 kgf in the lateral direction, discontinues the aircraft attitude stabilization in the respective channel.

When engaged in the STABILIZATION mode, the AFCS provides stabilization of the preset aircraft attitude in steady level flight accurate to ±1°; and it stabilizes the preset attitude accurate to ±3° when the aircraft is performing climb, descent, acceleration, deceleration, spirals or banked turns.

With the AFCS engaged in the STABILIZATION mode, control of the aircraft does not differ from that with the AFCS not engaged, except the fact that the stick forces and travels required to build up identic roll rates or g-loads are somewhat higher.

Flying with the AFCS engaged in the STABILIZATION mode, the pilot can change the pitch angle (say, in order to maintain the airspeed in ascent or descent, or to maintain the altitude during aircraft acceleration or deceleration) by deflecting the TRIM (ТРИММЕР. ЭФФЕКТ) thumb switch for a short time.

With the AFCS engaged in the STABILIZATION mode, it is permissible to take off, land and execute any simple or advanced maneuver, except the spin. While performing maneuvers with the AFCS engaged in the STABILIZATION mode, mind that the AFCS would not hold heading when the pitch angle exceeds ±40°, and that at pitch angles of ±80 - 100° the AFCS would not stabilize bank either.

To take off with the AFCS engaged in the STABILIZATION mode, the pilot has to switch it on when in the line-up position (before starting takeoff run); after landing with the AFCS STABILIZATION mode engaged, the pilot has to switch off the mode during landing roll. The STABILIZATION mode should be OFF during taxiing.

Flying under bad weather conditions, before entering clouds, do not fail to check for correctness of the AFCS functioning in the STABILIZATION mode by referring to the gyro horizon and ДА-200 combined instrument, comparing their readings to the aircraft actual attitude.

The LEVELLING mode of the AFCS is engaged once the pilot has lost spatial orientation, in order to automatically recover the aircraft in straight-and-level flight. It is also recommended to use this mode of operation in prolonged straight-and-level flight at a steady airspeed in order to hold the heading and altitude (especially in flying through clouds and at night).

The LEVELLING mode is engaged by depressing of the LEVELLING ON button located on the control stick; engagement of this mode shall be checked by all means by illumination of the LEVEL. light.

It should be remembered here that when forces in excess of 1.7 - 1.9 kgf or 1.0 - 1.2 kgf are applied to the control stick in the longitudinal or lateral direction, respectively, the LEVEL. light will extinguish to indicate that the pilot is overriding, and automatic recovery in level flight is discontinued.

<u>WARNING</u>. When the LEVELLING mode is on, the pilot's trim actuator cannot be controlled by the thumb switch located on the control stick.

In en-route flight, it is allowed to select the LEVELLING mode of operation at a constant airspeed at altitudes that are not less than 100 m above the terrain features, provided the aircraft has intercepted the desired heading and reached the assigned altitude.

In steady-airspeed flight at altitudes of up to 10,000 m the AFCS, operating in the LEVELLING mode, will ensure stabilization of the pressure altitude accurately within ±50 m. At altitudes exceeding 10,000 m,the altitude stabilization error increases and may reach ±150 - 200 m. If the aircraft fails to assume the level flight attitude in flight at altitudes above 10,000 m in response to engagement of the LEVELLING mode, after the aircraft has entered the pitch angle zone of -2 to +10° and continues to climb or descend, it is recommended to switch off the AFCS.

With the AFCS LEVELLING mode engaged, the override can be performed by reference to the position of the control stick; this method of override aircraft control is rather unusual and difficult. Due to this fact, it is not recommended to use the LEVELLING mode in flight involving maneuvers.

Do as follows to use the AFCS for restoration of spatial orientation:

(a) depress the LEVELLING ON button on the control stick;

(b) remove the forces from the stick and make certain that the LEVEL. light is burning;

(c) place and fix rudder in the neutral position;

(d) cancel reheat (if it was on);

(e) during aircraft recovery in level flight,watch the airspeed, altitude and angle of attack (by the УУА-1 indicator); change the engine settings in compliance with the angle of attack, airspeed and altitude. If required, extend the air brakes;

(f) if the aircraft fails to get levelled with regard to bank (which may happen when the aircraft is in an exactly inverted attitude), shift the control stick for a short time to the right or to the left through approximately 1/5 of its full travel, then remove the forces from the stick again.

As the LEVELLING mode is engaged at altitudes 3000 to 5000 m and airspeeds of 450 - 550 km/h, the aircraft may arrive for a short time (not longer than 1.0 - 1.5 s) at angles of attack which correspond to the red-and-black sector readings of the УУА-1 indicator.

WARNING. Bear in mind that no automatic levelling will be attained if the LEVEL. light does not illuminate or it goes off during use of the LEVELLING mode.

To determine the minimum safe altitude for automatic levelling, it is good to remember the following rule: safe automatic levelling of the aircraft will be ensured when the aircraft altitude (in meters) at the time of the LEVELLING mode engagement is not less than a ten-fold value of the rate of descent.

For more exact determination of the loss of altitude during automatic levelling of the aircraft one has to refer to the nomogram of Fig. 19.

The time required for bringing the aircraft from the inverted attitude to the zero bank attitude does not exceed 6 s both at subsonic and supersonic airspeeds. When the aircraft is being levelled from bank attitudes of less than 180°, the levelling time is reduced.

When the aircraft is being levelled from a pitch-up attitude, the following is likely to occur: the fuel consumption pilot lamps of some tank groups may illuminate, the low fuel pilot lamp may illuminate, and the СОРЦ warning indicator button light may start blinking at the same time; besides, the oil pressure may drop to zero for a short time.

With the help of the БОВ-21 unit the AFCS is also used for automatic climbing of the aircraft from a dangerously low altitude (preselected by means of the ПСВ-УМ radio-altimeter limit altitude selector) at a pitch angle of 15 - 17° and for subsequent placing of the aircraft in a level attitude.

The aircraft can be automatically and safely brought in a climb from the preselected limit altitude if the bank angle does exceed 30^{o} by that time, the flight path is inclined at an angle of not more than 8^{o} to the ground surface and the rate of descent is not in excess of 40 m/s. Then the aircraft will "sink" through not more than 150 m since the instant the mode of automatic climb from limit altitude has been engaged.

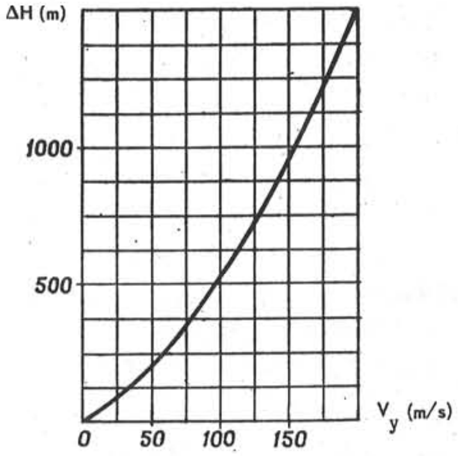


FIG. 19. LOSS OF ALTITUDE IN AIRCRAFT AUTOMATIC LEVELLING VS RATE OF DESCENT AT INSTANT OF AFCS ENGAGEMENT IN LEVELLING MODE

Proceed as follows to prepare the mode of climb from limit altitude for operation in flight:

(a) check the radio altimeter for being switched on;

(b) on the limit altitude selector, set in an altitude which is 50 m less than the assigned absolute altitude (height) of flying over the ground relief;

(c) turn on the PRESET (LIMIT) ALT. switch.

Notes: 1. The mode of climb from limit altitude will be automatically switched on only on condition that the AFCS is engaged in the STABILIZATION or LEVELLING mode.

2. If the PRESET (LIMIT) ALT. switch is turned on before takeoff, the БОВ-21 unit will start functioning 30 - 80 s after retraction of the landing gear; if the БОВ-21 unit is switched on in flight after the landing gear has been retracted, it will start functioning 30 - 80 s after the PRESET (LIMIT) ALT. switch is turned on.

Then in flight, as the aircraft descends to an absolute altitude (height) over the ground relief that has been set on the ПСВ-УМ radio-altimeter limit altitude selector, the AFCS will automatically change over to the mode of climb from limit altitude in response to the "dangerously low altitude" signal produced by the limit altitude selector unit of the РВ-УМ radio altimeter; the LEVEL. light will illuminate.

After the AFCS has switched over to the climb from limit altitude mode, the aircraft will be brought to a zero bank attitude while beginning to ascend with a g-load of not more than 3.5 g, the flight path inclination angle being 8^{o}, to leave the danger altitude zone.

In 1.5 s since the moment when the aircraft has left the danger altitude zone, the AFCS will start bringing the aircraft in level flight with g-loads close to zero or negative g-loads (not in excess of - 1 g); then it will stabilize the flight pressure altitude that exceeds the preset danger altitude by 60 to 250 m.

If the pilot was holding at the control stick by the time, he will feel the beginning of automatic climb from the preset danger altitude by a jerk of the control stick as well as by an intensive increase of positive g-loads and aircraft reversal to climbing.

To except development of stall warning buffeting (that is likely to occur when the aircraft has been descending at a high vertical velocity and at an airspeed of about 600 km/h), it is required to open the throttle to obtain the maximum engine rpm as soon as the climb from limit altitude mode has been engaged.

In order to ensure aircraft automatic climb from the preset limit altitude in the entire range of operating flight airspeeds, the following rates of descent should not be exceeded:

(a) when the aircraft carries no external loads, or when four АПУ launchers are attached and two guided missiles are carried: 15 m/s when the altitude preselected by means of the limit altitude selector is 50 m, 25 m/s when it is 100 - 150 m, and 40 m/s when it is 200 - 400 m;

(b) when the aircraft carries four АПУ launchers, two missiles and a full 800-L ventral drop tank: 10 m/s when the altitude preselected by means of the limit altitude selector is 50 m, 15 m/s when it is 100 - 150 m and 25 m/s when it is 200 - 400 m.

The mode of automatic climb from danger altitude is disengaged when the PRESET (LIMIT) ALT. switch is turned off or when the A/P OFF button is pushed (on the control stick); the mode is also disengaged automatically as soon as the landing gear is extended.

Disengagement of the AFCS is monitored by extinction of the STAB. button light and LEVEL. light.

During performance of aerobatics and conduct of dog fighting with the AFCS engaged in STABILIZATION mode, the control stick forces in the pitch channel increase substantially, thus hampering piloting of the aircraft. So provision is made in the AFCS design for disengaging the pitch channel only, by placing the AFCS, PITCH switch to the OFF position; then the roll channel stabilization will be retained.

Note. Regardless of the position of the AFCS, PITCH switch, both the roll and pitch channels get engaged as soon as the LEVELLING mode or the mode of automatic climb from limit altitude gets engaged.

Handling УУА-1 Angle-of-Attack Indicator and СУА-1 Limit Angle-of-Attack Warning Unit

Employment of the УУА-1 angle-of-attack indicator and СУА-1 limit angle-of-attack warning unit in the МиГ-21БИС aircraft permits the pilot to check the main aerodynamic parameter that determines the behaviour of the aircraft, namely the angle of attack (α), and to get informed in due time of approaching the limit angles of attack.

Angle-of-attack indicator УУА-1 shows the current angle of attack to the pilot. The scale of the УУА-1 indicator is calibrated in degrees of local angle of attack (corresponding to deflection angles of the vane of transmitter ДУА-3) with a scale increment of 1^o; the scale is numbered every 10^o. A yellow-and-black sector and a red-and-black sector (of zebra type) are marked on the indicator scale.

The yellow-and-black sector (covering the +21 to $+28^o$ angle-of-attack range) is intended to warn the pilot of approaching the limit angles of attack (affecting the flight safety). It is permitted to fly the aircraft at angles of attack corresponding to location of the pointer in the yellow-and-black sector. At these angles of attack maximum use is made of the aircraft maneuverability; yet, flying requires greater attention of the pilot in checking the angle-of-attack value.

The red-and-black sector (covering the +28 to $+35^o$ angle-of-attack range) indicates the zone of angles of attack which are dangerous for flying, because the aircraft may stall.

The $\alpha = +28^o$ angle of attack (as read by indicator УУА-1) is the maximum permissible one, assuming that a lift coefficient of $C_y \approx 0.85\ C_{y\ stall}$ corresponds to the above angle at Mach numbers of 0.85 M and higher (the C_y margin increasing at lower Mach numbers). Angles of attack exceeding $+33^o$ (as read by the indicator) correspond to the aircraft stall conditions. So, the angle-of-attack safety margin is at least 5 to 8^o.

Warning unit СУА-1 warns the pilot of approaching the maximum permissible flight conditions with regard to the angle of attack. The warning unit operates with respect to the angle-of-attack variation rate.

With the angle of attack changing at the minimum possible rate (i.e. during the aircraft deceleration in level flight, when the engine rotation speed is decreasing smoothly), warning unit СУА-1 operates at $\alpha = +26^o$. As the rate of the angle-of-attack variation increases, the warning unit will operate at lower angles of attack (in advance), and when the angle of attack is being changed at the maximum possible rate, the warning unit will operate at $\alpha = +22^o$.

Thus, at an abrupt increase of the angle of attack, when the СУА-1 warning unit operates at $\alpha = +22$ to $+23^o$, it warns the pilot of approaching the stall conditions at least 11 - 12^o before the stall angle of attack is reached.

The frequency of warning unit СУА-1 light flickering depends on how closely the limit angle of attack is being reached. At the moment when the warning unit operates, the frequency of lamp light flickering is 3 - 4 Hz. The frequency increases up to 7 - 8 Hz as the angle of attack is being further increased. The СУА-1 unit circuitry has interlocking as to the LG position; the unit is automatically switched on as the landing gear is retracted, and it gets cut out as the LG is extended.

Directions on Use of Angle-of-Attack Indicator УУА-1 and Angle-of-Attack Warning Unit СУА-1 in Flight

Readings of the УУА-1 indicator are stable over the entire range of operating altitudes and airspeeds.

During takeoff run, readings of the angle-of-attack indicator become stable at an IAS of 200 to 300 km/h, after the nosewheel clears the ground. If the recommended unstick angle of attack is maintained by the УУА-1 indicator in the course of takeoff (after lifting of the nosewheel), the aircraft unsticks at the required speed irrespective of the aircraft takeoff weight and external load variant. In takeoff, maintain an angle of attack of about 11 to 13^o, referring to the УУА-1 indicator. After the unsticking, the indicator pointer oscillations do not exceed $\pm 1^{\circ}$, and when the airspeed grows to 400 - 500 km/h, the pointer will practically stop oscillating.

In level flight at airspeeds of 500 km/h and higher, the УУА-1 indicator pointer is in an almost horizontal position.

In the aircraft accelerations and decelerations in level flight the readings of the УУА-1 indicator will remain practically constant while the aircraft is passing the transonic speed range, irrespective of the altitude or external loads, and this promotes the aircraft handling accuracy.

While the aircraft is being flown at angles of attack corresponding to the C_y of initial stall warning buffeting, the readings of indicator УУА-1 are between 16 and 18°; the СУА-1 warning unit would not operate.

To accomplish descent at the optimum airspeed corresponding to the maximum gliding distance, maintain an angle of attack of +5 to $+7^{\circ}$ by the УУА-1 indicator and make the final turn at a +7 to $+9^{\circ}$ angle of attack; to obtain the required glide speed on the leg from the final turn to the outer beacon, maintain an angle of attack of +6 to $+7^{\circ}$ irrespective of the aircraft landing weight and external loads. Here the recommended rate of descent is to be maintained by changing the engine thrust (increase it when the angle of attack increases, and vice versa).

To maintain the required glide speed as the aircraft is descending after overflying the outer beacon, the angle of attack should be so increased that before the roundout the angle of attack is 11 - 12° by the УУА-1 indicator (with the BLC system disengaged) or 9 - 10° with the BLC system engaged, irrespective of external loads.

As the BLC system is engaged, without a change in the preset flight conditions the readings of the УУА-1 indicator become less by 2 - 2.5°; this testifies to engagement and correct operation of the BLC system. To set up the recommended airspeed after the BLC system has got engaged, restore the angle of attack that was by the instant of its engagement. With the BLC system operating, the aircraft will display pitch oscillations within a range of 1 - 4.5° by the УУА-1 indicator; these oscillations are revealed by corresponding fluctuations of the angle-of-attack indicator pointer.

Monitoring of flying conditions by the angle-of-attack indicator is convenient and it promotes accuracy of handling the aircraft at any stage of flight (at any operating weight of the aircraft). If the airspeed indicator fails, maintain the above angles of attack in the process of landing, and this will ensure normal landing of the aircraft.

In the course of flying, when reaching the prestall buffeting zone (at α in excess of 16 to 18°), check the flight conditions by referring to the УУА-1 indicator. It is permitted to fly the aircraft under buffeting conditions, irrespective of the external loads being carried, up to the angles of attack at which the СУА-1 warning unit operates. When it operates, reduce the g-load or angle of attack till the lights of the СУА-1 warning unit extinguish.

When flying at an airspeed of up to 650 km/h, check the maneuver permissible limits by referring to the УУА-1 indicator and СУА-1 warning unit; when flying at airspeeds in excess of 650 km/h, refer for that purpose to the УУА-1 indicator and to the g-load indicator so that the established limitations are strictly observed.

In maneuvers with angles of attack up to 12°, sideslipping either to the left or to the right (with the slip indicator ball coming to the stop) does not practically affect the readings of the УУА-1 instrument. In maneuvers with angles of attack exceeding 12°, the readings of the УУА-1 indicator will change by up to 2 - 3°.

If the supply voltage drops from the 28.5-V value to 22 V, the УУА-1 indicator will function with large errors (underreading the angle-of-attack values); therefore, it is forbidden to use the УУА-1 indicator if the DC generator fails.

In case the DC generator fails, the СУА-1 warning unit may be used by the pilot, because it functions practically without errors; but when the unit operates, its lamps will glow continuously rather than flicker.

Handling A-23Б Radar

The pilot controls the A-23Б radar in flight and selects its modes of operation by manipulating switches and button lights located on control panels mounted on the instrument board and RH console (Fig. 20).

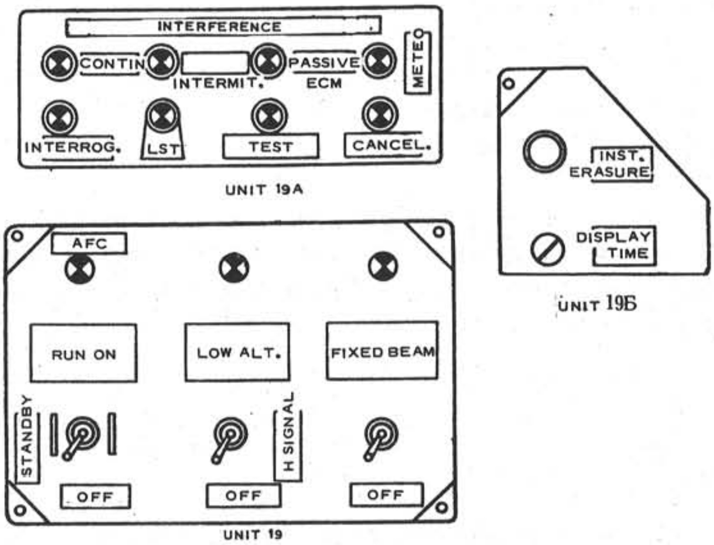


FIG. 20. CONTROL PANELS OF RADAR A-23Б

The control panel located on the right-hand console is used in the following functions:

(a) switching the radar on/off by means of the OFF - STANDBY - RUN ON (ВЫКЛ. - ПРЕДВ. - ПОЛНОЕ ВКЛ.) selector switch; as the switch is set at STANDBY, the radar is warmed up and stands by ready for run in 3.5 to 5 min; as the RUN mode is selected, the extremely high voltage (EHV) is turned ON; at this time red light AFC (АПЧ) comes on, then it goes off (if it fails to go off, the radar is unserviceable); besides, with the EHV on, the radar screen would illuminate;

(b) switching on compensation (side-lobe blanking) by means of the OFF - H SIGNAL - LOW ALT. (ВЫКЛ. - Н СИГН. - МАЛ. ВЫСОТА) selector switch; as the selector switch is set at OFF, the radar would run in the normal mode; as the switch is set at H SIGNAL, the compensation (side-lobe blanking) channel becomes engaged; and as the switch is set at LOW ALT., apart from engagement of the compensation channel, the lower line of the scanning sector becomes inclined at an angle of 1.5 to 2^{o} to the horizon plane;

(c) switching on/off the FIXED BEAM mode by means of the FIXED BEAM (ЛУЧ ЗАКРЕПЛЕН.) - OFF switch; as it is set in the FIXED BEAM position, the radar antenna is fixed in the position which is 0^{o} in azimuth and minus 1.5^{o} in elevation, with respect to the aircraft fore-and-aft axis; as this happens, the green light located above the switch will illuminate.

The control panels located on the instrument board are used in the following functions:

(a) switching on the circuitry intended to protect the radar from continuous and intermittent jamming and passive interference (electronic countermeasures, i.e. ECM) as well as from meteo interference; the protection circuits are turned on by means of button lights: CONTIN. (НЕПР.), INTERMIT. (ПРЕР.), PASSIVE ECM (ПАСС.) and METEO;

(b) switching on the interrogator for target identification by means of the INTERROG. button light;

(c) switching off the target speed-screenout circuit, for attacking low-speed targets, by means of the LST (МСЦ) button light;

(d) switching on the built-in test mode by means of the TEST (КОНТРОЛЬ) button light;

(e) cancelling any other mode of the radar operation and selection of the SCAN mode by means of the CANCEL. (СБРОС) button light;

(f) erasure of the electronic image on the radar screen once the INST. ERASURE (МГН. СТИР.) button light is depressed.

Besides, the rotatable drum, mounted on the throttle lever handle, is used for the following functions:

(a) control of the range gates (hence, the zone of lock-on as to range) during performance of target lock-on, when the GYRO - MSL (ГИРО - СС) switch is set in the MSL position (the AUTO - MAN. (АВТ. - РУЧ.) switch located on the gunsight bracket being set in the AUTO position).

CAUTION. The range gates will assume their positions in the lower part of the radar screen, and they will not be controlled from the drum on the throttle lever handle, once the AUTO - MAN. switch is placed in the MAN. position;

(b) reduction of the receiver-channel sensitivity with the CONTIN. button light depressed (i.e. in the mode of operation under continuous jamming interference); then the range gates will automatically assume the following positions: the upper one at a range of 18 km and the lower one at a range of 12 km (hence the zone of the range-finder lock-on) and the range gates will not be controlled from the drum on the throttle lever handle;

(c) manual range input into the sight, when the GYRO - MSL switch is set in the GYRO position, the AUTO - MAN. switch being placed in the MAN. position.

When the LOCK-ON - DAMP. (ЗАХВАТ - ДЕМПФ.) button located on the control stick is depressed, the radar is changed over to the NARROW SEARCH mode during performance of lock-on, and damping of the sight reticle is effected.

The screen of the radar scope is designed for the following functions:

(a) in the SCAN mode (Fig. 21):

(i) observation of target blips in the zone of $\pm 30^{\circ}$ in azimuth, 20° in elevation and up to 30 km as to range;

(ii) determining of the target range;

(iii) determining of the target azimuth;

(iv) elevation of the target relative elevation with respect to the interceptor aircraft by means of the "above" or "below" marks, in the range of the interceptor aircraft pitch angles between minus 25° and plus 8°.

Note. If the OFF - H SIGNAL - LOW ALT. switch is set in the OFF or H SIGNAL position, the "below" mark will not correspond to the target actual relative elevation when the negative pitch angles of the interceptor aircraft are in excess of minus 25°, or the "above" mark will not correspond to the target actual relative elevation when the interceptor aircraft positive pitch angles are more than plus 8°;

(v) display of the identification (IFF) mark;

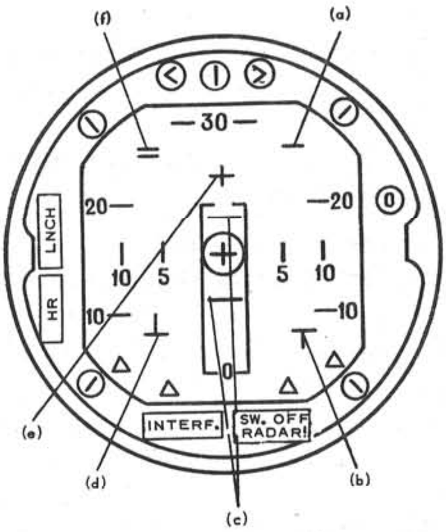


FIG. 21. VIEW OF RADAR SCREEN IN SCAN MODE
(a) – target is "foe" (interrogator is on);
(b) – target is below;
(c) – range gates;
(d) target is above;
(e) – target is at same level;
(f) – target is "friend" (interrogator is on)

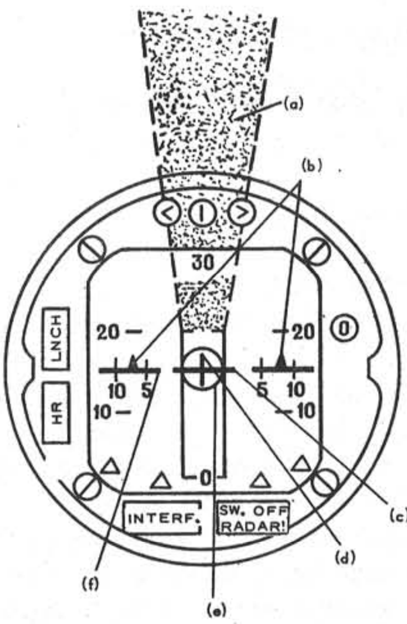


FIG. 22. VIEW OF RADAR SCREEN IN AUTOTRACKING (LOCK-ON) MODE
(a) – target azimuth lock-on zone;
(b) – range marks;
(c) – $D_{clr\ min}$ range;
(d) – aiming mark;
(e) – aiming ring;
(f) – $D_{clr\ max}$ range

(vi) gating of the selected target as to range, before it is locked on and autotracking begins;

(b) in the AUTOTRACKING mode (Fig. 22):

(i) determining of the target position with respect to the aiming point, as to azimuth and elevation;

(ii) determining of the target range in attack;

(iii) indication of the "in-range" zones for launching missiles (rockets);

(iv) determining of the range to brake off the attack.

Located on the radar scope bezel are the following light signals (see Figs 21 and 22) whose illumination corresponds to the following commands or information about the condition of systems:

(a) LNCH (ПУСК), i.e. clearance to launch missiles (rockets) as to range and g-load;

(b) ⓞ (brakeoff signal), i.e. the command to brake off the attack immediately;

(c) SW. OFF RADAR! (ВЫКЛ. СТ), i.e. the command to switch off the radar because it is unserviceable;

(d) (HR) (ГГ), i.e. HEAD READY, a signal about target lock-on by the port inboard P-3P missile (this monitor signal has been introduced for training purposes);

(e) INTERF. (ПОМЕХА), i.e. a monitor signal to indicate the radar operation under conditions of enemy interference (jamming) when in the LOCK-ON mode.

Handling Optical Sight

The МиГ-21БИС aircraft is provided with sight АСП-ПФД. The АСП-ПФД sight is designed for aiming:

(a) at aerial targets, at ranges of 600 to 2000 m when launching free rockets, 1000 to 9000 m when launching missiles, 600 to 2000 m when firing the gun, and at a fixed range of 300 m;

(b) at ground targets, at ranges of less than 2000 m when launching free rockets and firing the gun.

Besides, the optical sight ensures aimed dive bombing.

Depending on the type of combat mission being performed, the sight modes of operation are selected:

(a) by the firing - bombing (F - B) (С - Б) switch (the B position is for bombing, the F position is for all the remaining modes of the sight operation);

(b) by the GUN - RKTS (НО - РС) switch; the GUN position is for firing the gun, while the RKTS position is for launching missiles and rockets;

(c) by the AUTO - MANUAL (АВТ. - РУЧ.) switch; the AUTO position is used for introducing the range from the radar or slant-range unit, whereas the MANUAL position is intended for introducing the range from the external-base optical range-finder as well as for setting in angular corrections manually;

(d) by means of the SPAN (M) (БАЗА) - R OF RING (MILS) (R КОЛЬЦА (ТЫС.) handle:

(i) the inner scale is used for setting in the target size (in meters) for the GYRO mode, if the external-base range-finder is employed, or for setting in the radius of the range-finding diamond ring (in mils) for the MSL mode;

(ii) the outer scale located on the SPAN knob is used to set in the target size for the GYRO mode in the 300-m fixed range;

(e) by means of the GS, PF : AIR - GND (ПФ НОВ ВОЗДУХ - ЗЕМЛЯ) switch (the switch is set in the AIR position for attacking air targets, and GND position for attacking ground targets).

The optical sight ensures the following:

(a) automatic reproduction of the present range on the sight indicator in the AUTO, GYRO and MSL modes during firing at ground and air targets within a range of 600 to 2000 m;

(b) automatic present range reproduction on the sight indicator in the MSL, RKTS, AUTO and AIR modes during launching of missiles at air targets within a range of 1000 - 9000 m;

(c) operation of the solenoid limiter as the sight reticle deflects through an angle up to 7^{o};

(d) LNCH and BRAKEOFF (ВЫХОД) indication for the GYRO and MSL modes during attacks at air and ground targets;

(e) target lock-on indication (when the radar locks on the target, a green light illuminates on the left side of the range scale).

Besides, the АСП-ПФД sight is provided with an additional fixed reticle, type ПКИ. When taking aim, the pilot is able to watch the movable and fixed reticles simultaneously, or any of them. The fixed reticle is switched on by means of a special reticle illumination rheostat.

Aircraft manufactured since 1973 are provided with sight АСП-ПФД featuring an additional transparent scale; this scale facilitates target range tracking in the process of aiming. The upper part of the transparent scale corresponds to the smaller range scale.

Marked in the lower part of the transparent scale are radii of the range-finding diamond ring (in mils); the radii can be set in by turning of the throttle control lever handle (manual range introduction), with the GYRO - MSL and AUTO - MAN. switches placed in the MSL and MAN. positions, respectively, a span of 70 m being set in.

The general view of the sight, layout of its controls, and its fixed reticles are shown in Figs 23 and 24.

In firing the gun and launching free rockets at air targets, the optical sight permits taking aim under the following conditions:

(a) in the GYRO, AUTO mode of operation, while attacking non-maneuvering targets or targets that maneuver at small g-load values, when firing the gun and/or launching rockets with range input into the sight from the radar (when the sight is in this mode, absence of the target lock-on or target lock-on failure will involve automatic introduction of the 600-m fixed range into the sight, and the BREAKOFF lamp will not light up) or from the external-base optical range-finder;

(b) in the GYRO mode, when firing the gun at maneuvering targets, and with the sight operating in the 300-m fixed range mode (in this mode the target span is to be set in on the external scale by means of the SPAN knob; the damping knob is disconnected);

(c) in the MSL mode, while attacking maneuvering or non-maneuvering targets, when use is made of the main or additional fixed reticle, provided the pilot has sufficient aiming habits in conduct of traversing fire.

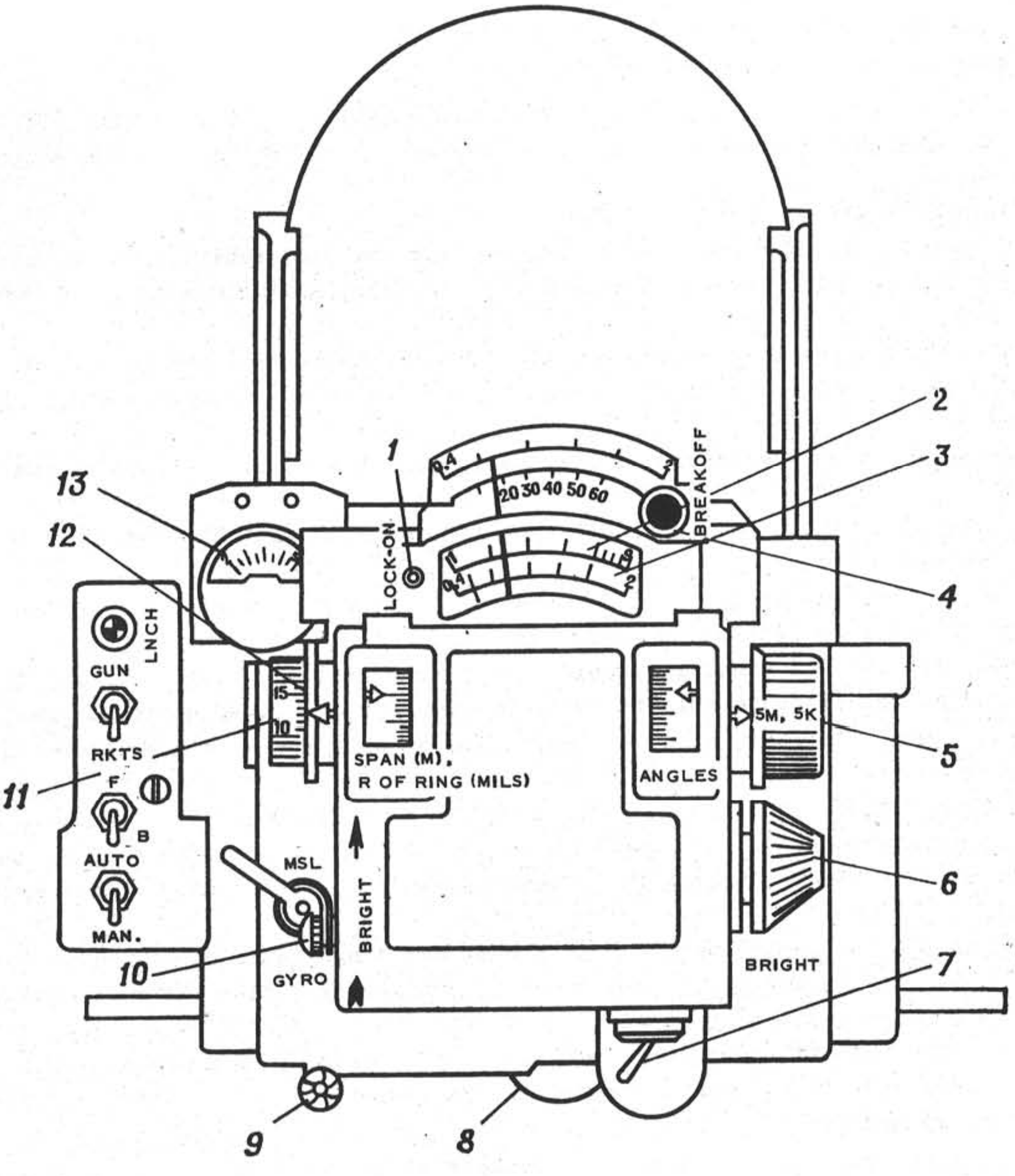


FIG. 23. LAYOUT OF SWITCHES, KNOBS, SCALES AND PILOT LAMPS ON SIGHT АСП-ПФД HEAD

1 – target radar lock-on indicator; 2 – range scale for missile launching; 3 – range scale for rocket launching and gun firing; 4 – BREAKOFF warning light; 5 – firing angular correction setting knob; 6 – movable reticle dimmer knob; 7 – movable reticle illumination filament selector switch; 8 – fixed reticle illumination fixture; 9 – fixed reticle dimmer knob; 10 – sight head scales dimmer knob; 11 – target span (or reticle ring radius) setting knob; 12 – target span additional scale (for "GUN, 300 m" mode); 13 – launch permissible range (in-range) indicator

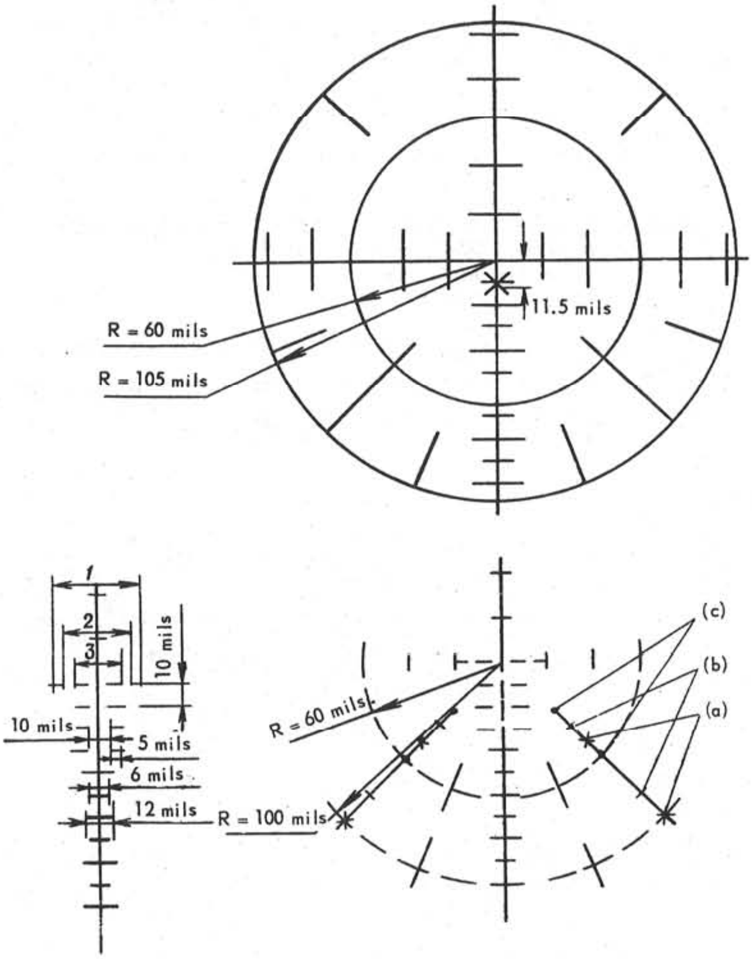


FIG. 24. SIGHT FIXED RETICLES
(at 400-m range: span 1 corresponds to Vautour wing span, span 2 to that of Phantom and span 3 to Mirage wing span)
(a) – firing zone for target speed of 900–1100 km/h;
(b) – same for target speed of 700–900 km/h;
(c) – same for target speed of 500–700 km/h

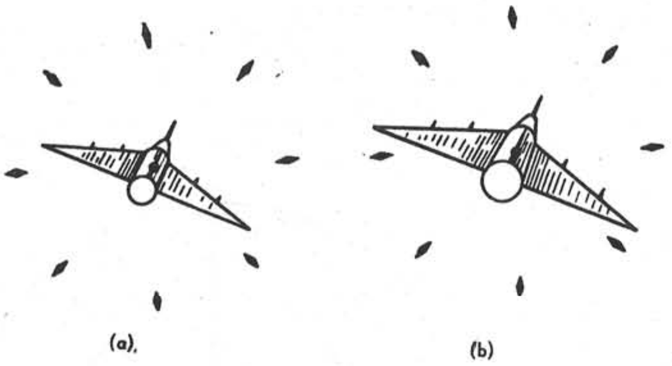


FIG. 25. POSITION OF TARGET ON SIGHT RETICLE WHEN SIGHT IS USED IN "GYRO" (300-m) FIXED RANGE MODE
(a) – at fire opening instant;
(b) – at end of firing

The aiming rules for using the sight in the GYRO mode in attacking a maneuvering target are given in Fig. 25; those for attacking a non-maneuvering target or a target maneuvering at minor g-loads are presented in Fig. 26;

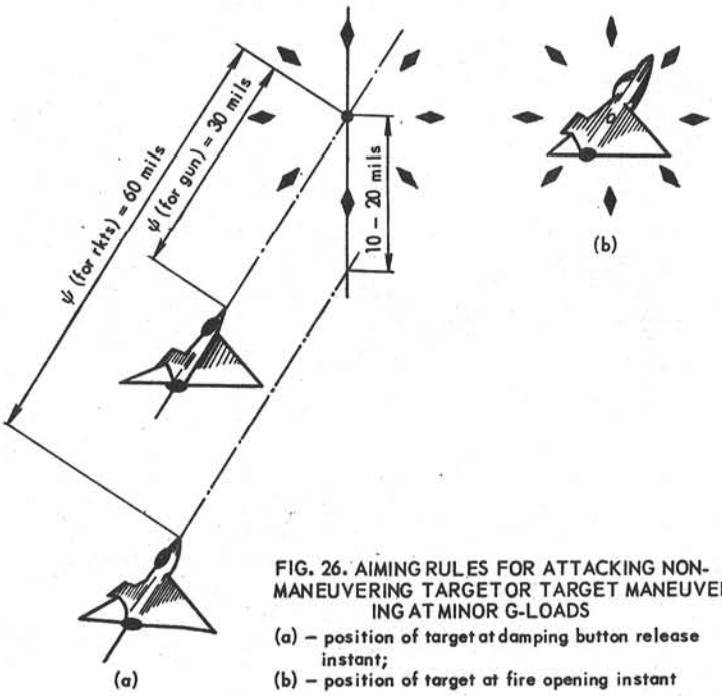


FIG. 26. AIMING RULES FOR ATTACKING NON-MANEUVERING TARGET OR TARGET MANEUVERING AT MINOR G-LOADS
(a) – position of target at damping button release instant;
(b) – position of target at fire opening instant

Traversing fire is a kind of variable-lead fire that is commenced at a greater, and ceased at a smaller, summary (total) angular correction value than the one required for the given attack conditions (or vice versa). During a burst, the target moves across the sight reticle from the maximum ($\phi_{\varepsilon_{max}}$) to the minimum ($\phi_{\varepsilon_{min}}$) total correction (or vice versa).

The maximum summary angular correction depends mainly on the airspeed and aspect of the target; in firing of the gun, it numerically equals (in mils) half the product of the target TAS (expressed in tens of km/h) by the numerator of the target aspect as viewed by the pilot (expressed in eighths of a unity).

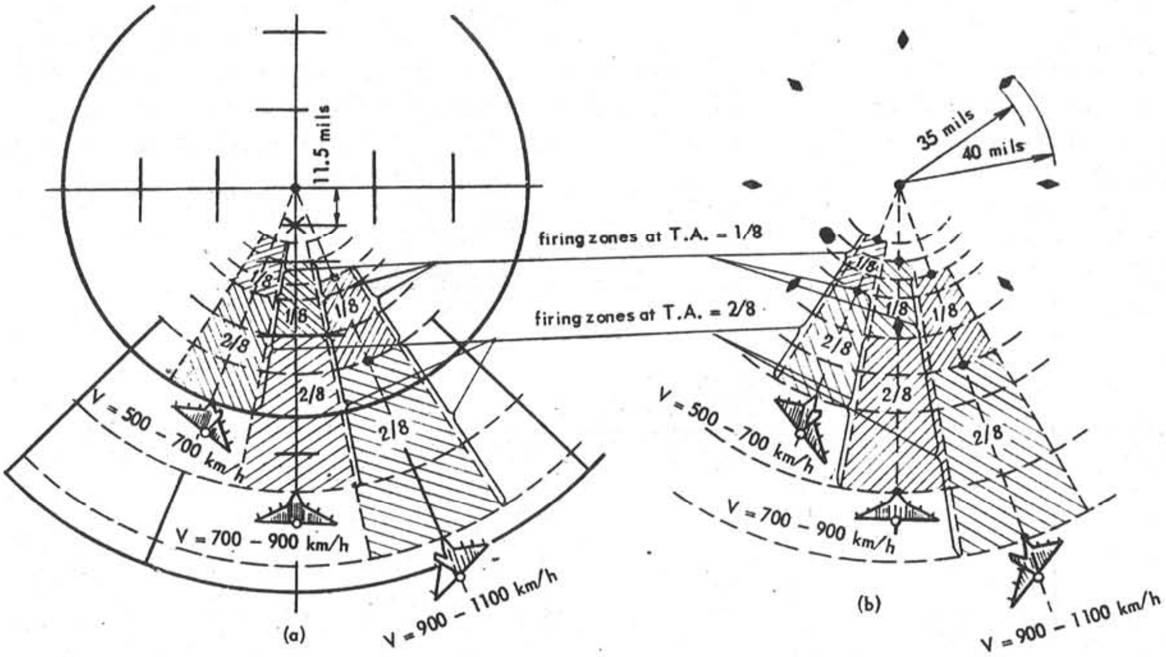


FIG. 27. AIMING RULES FOR DELIVERY OF TRAVERSING FIRE
(a) – sight АСП- ПФД additional reticle is used;
(b) – sight movable reticle is used in "MSL" mode

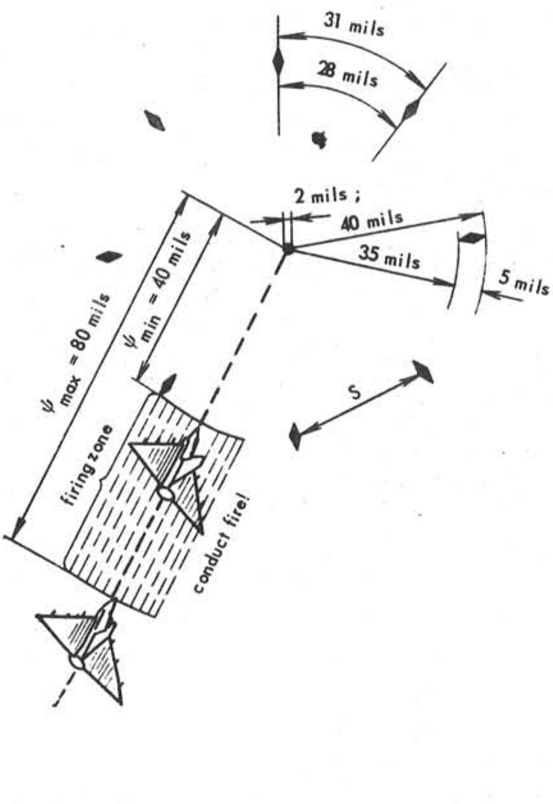


FIG. 28. EXAMPLE OF AIMING FOR DELIVERY OF TRAVERSING FIRE IN "MSL" MODE

When target visible span equals distance S between two adjacent diamonds, target range equals:
250–300 m for type Skyhawk or Mirage target;
400 m for type Phantom target and 500 m for type Vautour target.
Firing conditions: target is type Mirage, target aspect is 2/8, target speed is 700 to 900 km/h, range is 400 m

The minimum summary angular correction for a one-second burst must be twice as less as the maximum one.

For example, at a target aspect of 1/8 and target TAS equal to 600, 800 and 1000 km/h, the maximum summary firing corrections are equal to 30, 40 and 50 mils, while the minimum firing corrections are equal to 15, 20 and 25 mils, respectively.

The summary angular corrections for other airspeeds and aspects of the target are given in Table 9, the firing rules are given and illustrated in Figs 27 and 28, respectively.

Table 9

Target aspect	Target relative bearing corresponding to given aspect (deg)	Range of target relative bearings corresponding to given aspect (deg)	V_{tgt} (km/h)	$\phi_{\varepsilon_{max}}$	$\phi_{\varepsilon_{min}}$
0/8	0	0 - 3	500 - 700	15	0
			700 - 900	20	0
			900 - 1000	25	0
1/8	7	3 - 11	500 - 700	30	15
			700 - 900	40	20
			900 - 1100	50	25
2/8	15	11 - 18	500 - 700	60	30
			700 - 900	80	40
			900 - 1100	100	50

The highest target hit probability is obtained in traversing firing, when fire is delivered in bursts lasting 1.0 - 1.5 s at ranges of 400 - 200 m.

Target aspects are shown in Fig. 29.

Given in Figs 30 and 31 are examples of determining the target range during attacks.

In firing of the gun and launching of rockets at ground targets, the optical sight can solve aiming problems in the GYRO and MSL modes.

Proceed as follows to aim at a ground target in the GYRO, AUTO mode:

(a) before entering the dive or the preceding maneuver, depress the sight reticle damping button;

(b) having entered the dive, superimpose the central dot on the target and eliminate sideslipping;

(c) check to ensure that the radar range-finder has locked on the target, referring to illumination of the LOCK-ON indicator light;

(d) release the sight reticle damping button, refine the aiming and track the target (keeping the central dot on the target) for 2 - 3 s;

(e) determine the instant to open fire by reference to the LNCH light that will come on at this time, or by the range indicator scale on the sight head.

If the radar and slant-range unit are inoperative, introduce the range from the external-base range-finder, for which purpose shift the AUTO - MAN. switch to the MAN. position. Under these circumstances, determine the moment to open fire visually (by the time when the target is framed by the range-finding diamond ring, or by comparing the target visual size to the sight reticle elements) or referring to the altimeter readings and taking into account appropriate corrections.

In these modes, the external-base range-finder permits determining of target range in attacks at ground targets whose angular size at fire opening range is not less than 22 mils.

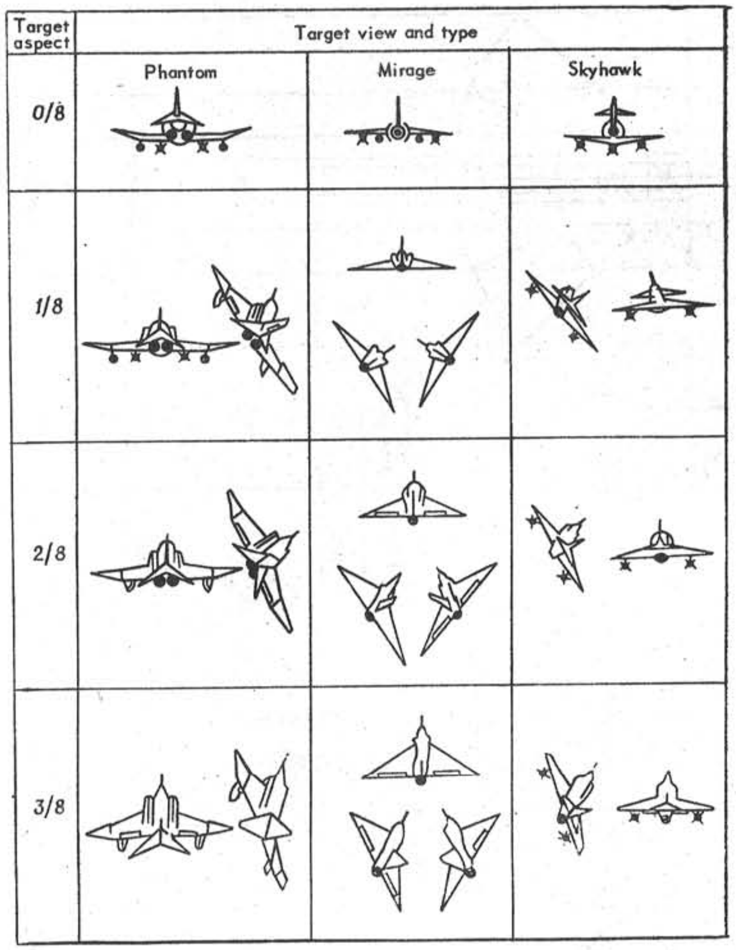
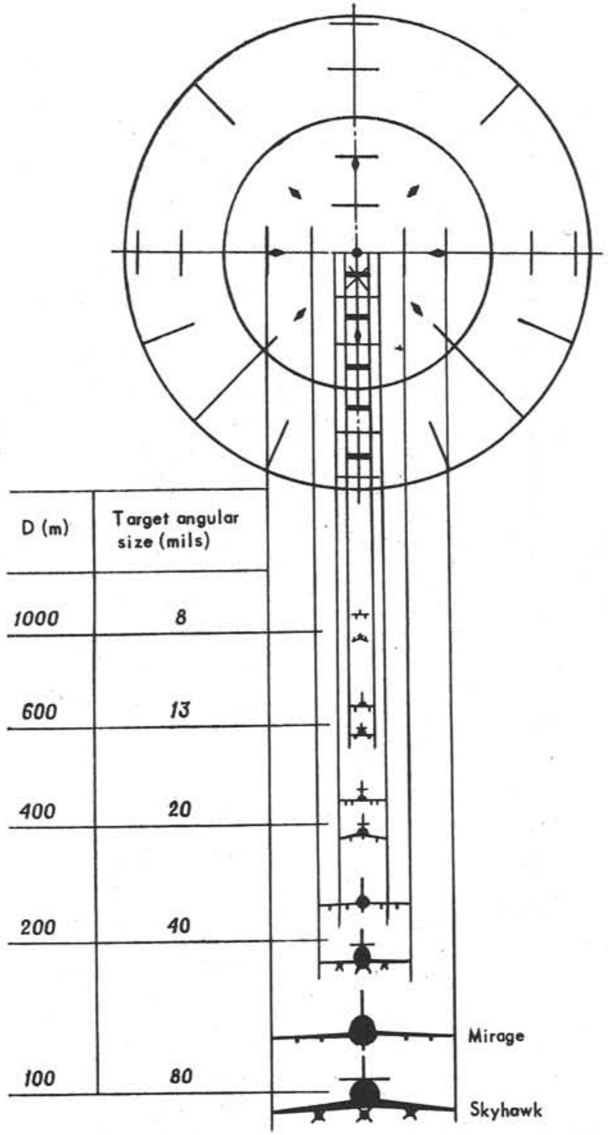
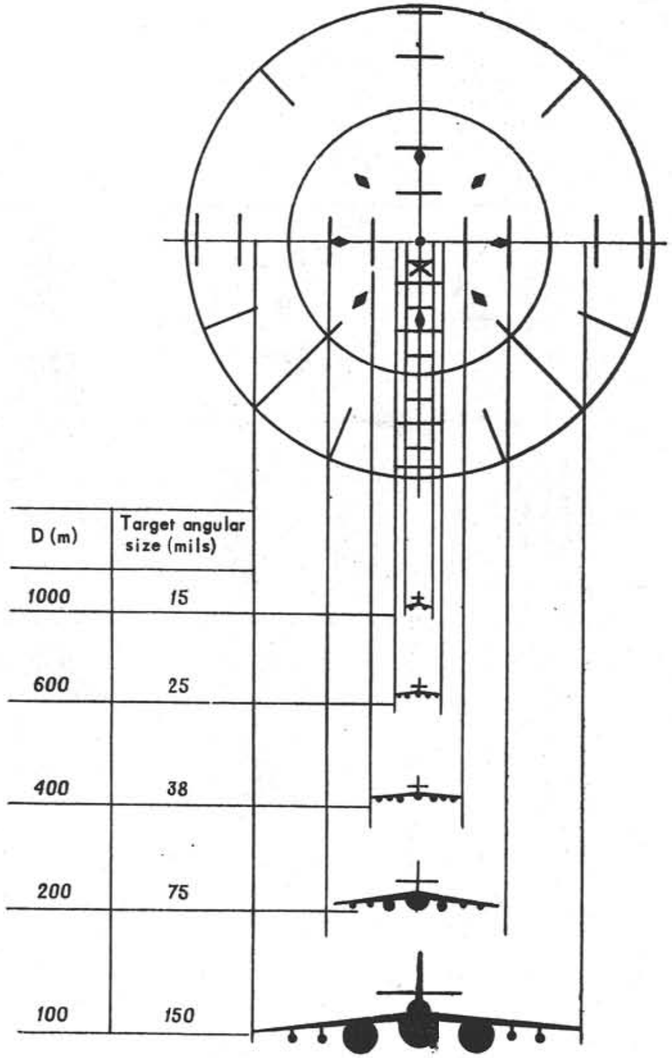


FIG. 29. TARGET ASPECTS



D (m)	Target angular size (mils)
1000	8
600	13
400	20
200	40
100	80

FIG. 30. MIRAGE AND SKYHAWK AIRCRAFT IN SIGHT RETICLES AT 1000 TO 100-m RANGES



D (m)	Target angular size (mils)
1000	15
600	25
400	38
200	75
100	150

FIG. 31. VAUTOUR AIRCRAFT IN SIGHT RETICLES AT 1000 TO 100-m RANGES

When attacking smaller-size targets, it is required to introduce the target range either automatically, from the radar or slant-range unit (when the dive angle exceeds 20°), or by eye estimation, with the help of the sight reticle elements that are used as the scale (the minimum diameter of the diamond ring is 22 mils, the diamond length is 5 mils and the central dot diameter is 2 mils).

In the MSL mode, aiming at a ground target is possible either with automatic output of constant mean angular corrections for the given kind of weapon (in the MSL, AUTO mode) or with manual introduction of precalculated total angular corrections for the given attack conditions (in the MSL, MAN. mode).

When in the MSL, AUTO mode, sufficient aiming accuracy is provided under conditions that are close to the rated ones, i.e. (when the dive angles are 30 - 35° for a TAS of 800 km/h, and 20 - 25° for a TAS of 900 km/h,)(for firing the gun and launching type C-5 rockets at a range of 1300 m)(and for launching the C-24 rockets at a range of 1700 m.)

When in the MSL, MAN. mode, it is required to introduce the total angular correction in compliance with Table 10, using the ANGLES (УГЛЫ) knob for the purpose.

When aiming in the MSL mode, do not fail to take into account the wind vector and target speed correction, assuming that it is as follows:

(a) for gun firing, the two-fold value of the summary target and wind velocity (in meters per second), or the 1.5-fold value of the same (in mils);

(b) for rocket launching, the three-fold value of the summary target and wind velocity (in m/s), or the two-fold value of the same (in mils).

Table 10

Parameter of attack	Variants of air/ground attack conditions		
	1st	2nd	3rd
Dive angle (deg)	10	20	40
Indicated dive entry altitude (m)	450	1200	2500
Dive entry TAS (km/h)	800	800	650
Firing (launching) initial range (m)	1500 (1800 for C-24 rockets)	1500 (1800 for C-24 rockets)	1600 (1900 for C-24 rockets)
Firing (launching) cessation range (m)*	At least 1000 m when firing gun, 1200 m when launching type C-5 rockets, and 1600 m when launching C-24 rockets		At least 1300 m when firing gun and launching type C-5 rockets, 1700 m when launching C-24 rockets
Aiming angle to be introduced into sight:			
(i) for gun firing	1°0'	0°50'	0°50'
(ii) for launching rockets:			
C-5M	2°0'	1°30'	1°40'
C-5K	2°15'	1°40'	2°0'
C-24	2°50'	2°30'	2°15'

*If the firing (launching) cessation ranges are less, the aircraft may get hit by splinters of own rockets or shells during dive recovery.

It is recommended to use the MSL mode for firing at ground targets when the pilot has no habits in firing the weapons in the GYRO mode under conditions when the aiming time is extremely limited, as well as when the sight automatic system fails.

If the sight is equipped with the additional transparent range scale, use it in aiming for gun firing and rocket launching in all the sight operating modes. The radial scale of the range-finding ring can be used for introduction of the wind velocity and target speed correction during air/ground gun firing and rocket launching in the MSL, MAN. mode.

Note. The transparent scale can be used either for finding the target range or for introducing the angular correction, but it cannot be employed for both purposes at one and the same time.

Optical Sight Checking Sequence

The optical sight should be checked in the following sequence:

(a) connect ground sources of DC and AC power to the aircraft mains;

(b) switch on the storage battery, AC generator, ПО-750 inverter No. 2 and turn on the GS (ПРИЦЕЛ) switch;

(c) visually check for cleanliness of the sight reflector and light filter;

(d) set the GYRO - MSL, AIR - GND, AUTO - MAN., GUN - RKTS and B - F switches to the following positions: GYRO, AIR, MAN., GUN and F;

(e) make certain that illumination of the sight reticles changes steplessly in response to turning of the rheostats;

(f) turn the SPAN (M) - R OF RING (MILS) knob to make sure that the diameter of the reticle diamond ring changes in response to turning of the knob;

(g) check the sight reticle for normal deflection along the vertical line, for change of its ring diameter, and the range pointer for proper motion within the range of 2000 to 600 m in response to turning of the handle on the throttle lever; check also for illumination of the LNCH and BREAKOFF lights that must come on in turn;

(h) make certain that the sight reticle central dot is caused to sharply move upward, the range-finding diamond ring gets enlarged and the BREAKOFF light illuminates, when the throttle lever handle is turned in the direction of the minimum range as far as it will go (all this testifies to the fact that the sight has been changed over to the 300-m fixed range);

(i) place the AIR - GND switch in the GND position; rotate the throttle lever handle to make certain that the LNCH light illuminates when at a range of 1950 m, the BREAKOFF light illuminates at a range of 1600 m (for the case of launching type C-24 rockets), and 1200 m for the case of launching type C-5 rockets and firing the gun;

(j) shift the AIR - GND and GUN - RKTS switches to the AIR and RKTS positions, respectively, and make sure that the sight reticle moves vertically and sideways as the ДУАС angle-of-attack and sideslip detector vanes are deflected by the technician; as the GUN - RKTS switch is changed over from the GUN to RKTS position, make certain that the sight central dot moves downward;

(k) set the B - F switch in the B position and use the ANGLES knob to shift the reticle downward in order to make sure that once the B - F and RKTS - GUN switches are selected to F and GUN, respectively, the ANGLES scale would return to the zero position and the sight reticle moves upwards.

When through with the sight check, set the GYRO - MSL switch to the MSL position and place all other switches to positions required for performing the assigned mission;

cut out the GS and "ПО-750 NO. 2" switches as well as the AC generator and storage battery.

CAUTION. Take off and land with the GYRO - MSL switch in the MSL position only.

Handling Pressure Altimeter

In a round-trip flight with landing on the departure airfield, do not change the altimeter pressure scale setting corresponding to the runway pressure (QFE). Maintain the assigned flight altitude by reference to the pressure altimeter readings as computed by the chief navigator of the unit (or by the CP personnel) before the flight.

In an en-route flight with landing on another airfield, set the pressure scale of the altimeter to 760 mm of mercury after gaining the assigned altitude; proceed on course, maintaining the pressure altitude as computed by the chief navigator of the unit (or by the CP personnel).

Note. In case it is impossible to receive the computed flight altitude from the unit chief navigator (from the CP), do as follows:

(a) when flying at the maximum range airspeeds, maintain the assigned altitude by reference to the pressure altimeter in compliance with the data of the table contained in the aircraft cabin;

(b) when flying at other airspeeds, maintain the assigned altitude by the pressure altimeter, taking into account the total (position and shock-wave) correction determined from the graph given in Fig 15. It is mandatory to have the total altitude corrections, computed for the flight conditions of the given mission, on the knee-board.

Prior to landing approach obtain the transition level and the landing airfield surface pressure (QFE) from the flying control officer. On reaching the transition level, set the pressure scale of the altimeter to the landing airfield runway pressure (QFE).

Before takeoff from a high mountainous airfield which is located at 1000 m and higher above the sea level, set the pressure scale of the altimeter to 760 mm of mercury, memorize (write on the knee-board) the altitude reading, and take it as the altitude "conventional zero". After takeoff determine the flight altitude relative to the takeoff airfield by the pressure altimeter, considering the "conventional zero" as the scale zero.

Before landing on a high mountainous airfield which is located at 1000 m and higher above the sea level, obtain from the flying control officer: the transition level, the runway atmospheric pressure converted into the sea level pressure (QNH), the airfield pressure altitude (i.e. the airfield true elevation relative to the sea level with allowance for the altimeter measurement-method and temperature error) and put it down on the knee-board.

On reaching the transition level given by the flying control officer, set the pressure scale of the altimeter to the runway pressure converted into the sea level pressure (QNH). Further in the flight, determine the flight altitude above the landing airfield by the pressure altimeter, considering the airfield pressure altitude as the altitude zero.

Note. When flying in the airfield local area above the transition level (except for the case of landing on the takeoff airfield), read the flight altitude by the altimeter set to 760 mm of mercury.

Handling СПО-10 Radar Illumination Warning System

When the aircraft is illuminated by airborne or ground radars operating in the frequency band to which the СПО-10 system is adjusted, corresponding warning lights would illuminate on the СПО-10 indicator to designate the sector (direction) from which radar irradiation comes to the aircraft; at the same time, a sound signal is fed into the pilot's headphones. It should be borne in mind that if the ground-controlled approach system is in operation on the given airdrome, the СПО-10 radar illumination warning system will operate in all the four channels on the ground and in flight at the distance of up to 20 - 25 km from the airdrome.

When a radar illuminating the aircraft operates in the SCAN mode, the lights on the СПО-10 system indicator will illuminate, and the sound signals will be produced, concurrently with the scanning cycle of the illuminating radar. The direction from which radar irradiation comes to the aircraft is determined like this:

(a) when the upper left or upper right light is burning, the illuminating radar is ahead and to the left or ahead and to the right of the aircraft, respectively, at a target aspect of 1/4 to 3/4 (i.e. at "11 to 10 o'clock" or "1 to 2 o'clock");

(b) when both upper lights are on, the illuminating radar is straight ahead of the aircraft, i.e. at a target aspect of 0/4 (at "12 o'clock");

(c) when the upper and lower right or the upper and lower left lights are burning, the illuminating radar is abeam to the right or abeam to the left of the aircraft, i.e. at a target aspect of 4/4 (at "3 o'clock" or "9 o'clock", respectively);

(d) when the lower right or lower left light is on, the illuminating radar is behind and to the right or behind and to the left of the aircraft, respectively, at a target aspect of 1/4 to 3/4 (i.e. at "5 to 4 o'clock" or "7 to 8 o'clock");

(e) when both lower lights are on, the illuminating radar is dead astern, i.e. at the target aspect of 0/4 (at "6 o'clock").

While the enemy interceptor is closing upon the aircraft, the frequency of the СПО-10 equipment operation increases from one operating cycle per illumination cycle to three operating cycles per illumination cycle.

Once the illuminating radar has changed over from the SCAN to the LOCK-ON mode, the frequency of sound signal sharply grows and the corresponding lights start flickering.

When the range between the enemy interceptor and your aircraft becomes as small as 5 to 2 km (depending on the irradiation power of the illuminating radar), the СПО-10 equipment will operate in all the four channels (all the lights burning).

The pilot should determine the avasive maneuver in order to disrupt the enemy attack, taking into account the altitude, airspeed and tactical situation at hand.

To check the СПО-10 system for serviceability, the pilot has to depress the test button on the СПО-10 equipment indicator, his own aircraft radar operating at this time. One or several signal lights should come on in response to that action.

Towing Aircraft

The aircraft shall be towed about the airfield only with the collapsible canopy closed. The towing speed shall not exceed 15 km/h on concrete runways and 10 km/h on unpaved ground.

In the process of the aircraft towing, the pilot (or the technician) must be in the cabin, ready to apply the brakes to the aircraft wheels (especially at the instant when the towing vehicle stops moving). At night the aircraft shall be towed with the navigation lights on.

Section Four

CHECKING READINESS OF AIRCRAFT AND ITS SYSTEMS FOR FLIGHT

1. Prior to flight the pilot shall hear the technician's report on the aircraft readiness for the flight in accordance with the mission; in his report the technician should mention the amount of fuel held in the tanks, charging of the respective systems with oxygen and alcohol, loading of the gun, suspension of missiles, bombs and JATO units as well as the latest maintenance operations performed on the aircraft.

Note. Before flying with the employment of the РСБН equipment, inquire the technician about the pressure value set on the ЗДВ-30 pressure setter; before taking off with the aid of JATO units, ascertain the set in value of JATO units automatic start.

The report over, order the technician to adjust the pedals to fit your tall and adjust the parachute harness (the pilot should know the numbers to which the waist and leg loops are set).

INSPECTION OF AIRCRAFT

2. Make a visual inspection to ascertain that:

(a) the blanking and slip covers are removed from the pitot-static tubes and angle-of-attack detector vanes; make sure the screw clamp is removed from the rudder;

(b) the air intake cone is in the proper condition and position (the cone should be retracted and locked); check for condition and position of the derumble doors;

(c) there are no foreign objects in the intake duct; see that the air intake duct skin is free of damage;

(d) the wheel tyres are normally deflected (there should be no flat where the tyre contacts the pavement);

(e) the airframe, landing gear and radome and antenna fairings are in proper condition;

(f) no leakage of oil, hydraulic fluid, or fuel shows up;

(g) the proper drop tank(s) is (are) attached;

(h) the external stores and the ammunition allowance correspond to the flight mission; see that the ground safety pins are installed, when using missiles (make sure the external loads are free of external damage);

(i) the main landing gear wheels are securely chocked.

3. Directly before climbing into the cabin, order the technician to remove the ground safety pins, exclusive of the safety pins installed into the first stabilizing parachute rod gun bolt and canopy jettison lever.

VISUAL INSPECTION OF CABIN

4. Before entering the cabin, the pilot, while taking appropriate precautions, should ascertain that:

(a) the cabin contains no foreign objects.

WARNING. It is not allowed to place slip covers, pads or any other objects into the seat pan, except the standard cushion that is part of the seat set;

(b) ground safety pins are installed into the first stabilizing parachute rod gun bolt and into the canopy jettison lever;

(c) the canopy jettison interlock cable is attached to the collapsible canopy and to the KM-1M seat ejection gun assembly;

(d) the bowden cables of the soft foot grips are put into the special flaps on the instrument board;

(e) the belt restraint strap is loosened through 150 - 180 mm, approximately;

(f) the firing (launch/release) button trigger on the control stick is set in the guarded position;

(g) the BAT., EXT. PWR SUP. (АККУМ. БОРТ. АЭРОД.) switch is turned off, all switches and circuit breakers on the instrument board, left-hand and right-hand front and horizontal consoles are turned off, whereas the No. 1 BUSBAR (ШИНА № 1) and No. 2 BUSBAR circuit breakers are turned on;

(h) all circuit breakers, including the No. 3 BUSBAR circuit breaker, on the right-hand rear electric panel (under the cover glass) are turned on;

(i) switches on the УК-2М amplifier are set to the PRES. HELM. (ГШ) and MIKE (М) positions when the pilot is wearing the ГШ-4 pressure helmet, and to the OXY. MASK (КМ) and THR. MIKE (Л) positions when the pilot is wearing an oxygen mask or type ГШ-6 pressure helmet;

(j) the head of the АД-6Е automatic pressure controller and its safety valve are set to MIN. when the pilot is wearing the ВКК-3М partial-pressure suit or ППК-1 g-suit, or to MAX. when he is wearing the ВКК-6 (ВКК-4) pressure suit;

(k) the cabin thermostat knob is set to 16°C in summer and to 20°C in winter;

(l) the index of the pressure helmet heating rheostat knob is set in the position (according to the inscription) corresponding to the desired cabin temperature in flight;

(m) the oxygen pressure in the engine oxygen feed (enrichment) system is within 9 to 10.5 kgf/cm^2;

(n) the oxygen pressure in the pilot's oxygen supply system is within the range of 130 to 150 kgf/cm^2;

(o) the landing gear control valve lever is set in the neutral position and locked with a latch;

(p) the fuel gauge pointer indicates the amount of usable fuel contained in the tanks, i.e. 2750 L when the tanks are filled to capacity, no drop tanks being attached, or 3250 L when carrying a 490-L ventral drop tank, or 3500 L when carrying the 800-L ventral drop tank, or 3750 L when two wing drop tanks are attached, or 4200 L when three drop tanks are attached (i.e. two wing drop tanks of 490 L each, and a 490-L ventral drop tank);

(q) the pressure in the main and emergency air systems is within the range of 110 to 130 kgf/cm^2;

(r) the pedals are adjusted to fit the legs;

(s) the JATO START and JATO JETT. (ПУСК УСКОР., СБРОС УСКОР.) circuit breakers are OFF; the JATO START and JATO JETT. buttons are covered with protective caps.

INSPECTING CABIN AND EQUIPMENT AFTER TAKING SEAT

5. After taking seat in the cabin the pilot should perform the following operations (either independently or with the technician's assistance):

(a) connect the snap hook of the survival kit to the flight clothing (pilot's outfit).

Note. On aircraft carrying an ejection seat provided with type KOMAR radio beacon, connect the latter to the power supply unit cable plug connector if the power supply unit is arranged in the pilot's outfit (flying clothes);

(b) put on the parachute harness, making sure that the latter fits tightly;

(c) when wearing life jacket АСЖ-58, bring out the jacket inflation pipe mouthpieces from under the shoulder restraint straps of the harness;

(d) connect the hose of the partial-pressure suit tensioner bladders to the КП-52М oxygen regulator;

(e) put the pressure helmet tensioner clamp and the tape holding the pressure helmet (oxygen mask) corrugated hose onto the buckle of the left leg loop, before locking it;

(f) close the parachute harness release;

(g) connect the suit ventilation and g-suit hoses to the upper block of the quick release common connector;

(h) connect the pressure helmet (oxygen mask) hoses to the КП-52М oxygen regulator, never allowing compression or twisting of the exhalation valve back-pressure hose;

(i) fasten the КП-52М oxygen regulator to the lock installed on the parachute harness left leg loop, below the larger D-ring;

(j) couple the pressure helmet heating system plug connector and the radio communication plug connector to the wire bundle on the quick-release common connector, after passing the wire bundle under the parachute harness;

(k) check operation of the waist harness restraint reel mechanism, then tighten the waist restraint strap;

(l) check operation of the shoulder harness restraint mechanism.

6. Check to see that the control elements of the aircraft equipments and systems are in the following initial positions:

(a) the air dilution valve lever on the ДУ-7 remote-control panel is in the MIXT. (СМЕСЬ) position, the emergency oxygen supply handle and the helmet ventilation control handle are in the OFF (ВЫКЛ.) position;

(b) the SUIT VENTILATION (ВЕНТИЛЯЦИЯ КОСТЮМА) valve control panel is turned clockwise as far as possible;

(c) the cabin heating selector switch is in the AUTO (АВТОМ.) position;

(d) the ENGINE START-COLD CRANKING (ЗАПУСК ДВИГАТЕЛЯ - ХОЛОДНАЯ ПРОКРУТКА) switch is in the ENGINE START position;

(e) the 2-PSN NOZZLE EMERG. CTL (АВАР. ВКЛ. 2-Х ПОЗ. СОПЛА) switch is turned off;

(f) the BLC (СПС) switch is ON;

(g) the АРУ pitch channel transmission ratio controller mode-of-operation switch is placed in the AUTO position and locked;

(h) the required navigation and landing channel numbers are selected on the РСБН equipment control panel;

(i) the РСБН-ARC switch is adjusted in the required position;

(j) the PRESET (LIMIT) ALT. switch located on the AFCS control panel is set in the proper position as required by the flight mission;

(k) the derumble door control switch is locked in the ANTI-SURGE SHUTTERS: AUTO (СТВОРКИ, АВТОМАТ.) position; the cone mode-of-operation switch is in the CONE: AUTO (КОНУС, АВТОМАТ.) position;

(l) the DRAG CHUTE JETT. (СБРОС ПАРАШЮТА) button is closed with the safety cap;

(m) the ANTI-SKID UNIT (АВТОМ. ТОРМОЖ. КОЛЕС) switch is ON;

(n) the AIR RELIGHT (ЗАПУСК В ВОЗДУХЕ) circuit breaker is in the OFF position and locked;

(o) the FULL THROTTLE, REHEAT (ФОРС. МАКС.); ENGINE STARTING UNITS (АГРЕГАТ. ЗАПУСКА) and FIRE-FTG EQPT (ПОЖАР. ОБОРУД.) circuit breakers are ON;

(p) the throttle lever is in the SHUT-OFF (СТОП) position;

(q) the JATO JETT. (СБРОС УСКОРИТ.) and FIRE EXT. (ОГНЕТУШИТЕЛЬ) buttons are closed with the caps and the caps are locked;

(r) the (TAXI/LDG) LAMP (ФАРА) selector switch is in the RETR. (УБРАНО) position;

(s) the AILERON BOOSTER (БУСТЕР ЭЛЕРОНА) switch is locked in the ON position;

(t) the AFCS, PITCH (САУ, ТАНГАЖ) switch is OFF;

(u) the firing (launching) variant selector switch is adjusted to a position required for the given flight mission;

(v) the GS PF: AIR - GND (ПФ НОВ: ВОЗДУХ - ЗЕМЛЯ); MSL - NEUT.-RGM (СС - НЕЙТР. РНС); RKTS - GUN (РС - НО) and F - B (С - Б) switches are set to positions required for the given flight mission.

WARNING. Before flying with the РСБН equipment engaged in the LETDOWN mode, set the GS PF: AIR - GND switch in the AIR position;

(w) the GYRO - MSL (ГИРО - СС) lever is in the MSL position;

(x) the NAVIG. - LETDOWN - LDG switch is in the NAVIG. position;

(y) the cone position indicator pointers are in the zero position;

(z) the OUTER - INNER (ДАЛЬН. - БЛИЖН.) beacon selector is set at OUTER;

(aa) the radio compass distance counter reads as required;

(bb) the emergency LG wheel braking handle is depressed and locked in that position;

(cc) the nosewheel brake switch is in the OFF position;

(dd) the clock indicates the exact time and is prepared for flight;

(ee) the caps of the buttons: EXT. STORES EMER. JETT.: OUTBD, INBD (АВАР. СБРОС ПОДВЕСОК: ВНЕШН., ВНУТРЕН.) are closed;

(ff) the cap of the MSL, RGM EMERG. LCH (АВАР. ПУСК СС, РНС) button is closed;

(gg) the TACTICAL RLS (ТАКТИЧ. СБРОС) switch is locked in the OFF position;

(hh) the proper magnetic declination of the flying area is set on the magnetic declination setter;

(ii) the GUN (ПУШКА) switch is OFF;

(jj) the MSL, RGM, RKT LCH (ПУСК СС, РНС, РС) circuit breaker is OFF;

(kk) the PERISCOPE, AA XDCR, P-S TUBE, CLOCK (ПЕРИСКОП, ДУА, ПВД, ЧАСЫ) circuit breaker and the SIDE P-S TUBE (ПВД БОРТ.) circuit breaker are OFF;

(ll) the limit altitude selector switch on the radio altimeter limit altitude setter is in the OFF position; the СОД АТС XPONDER (СОД) switch is in the СОД АТС (СОД) position; the СОД equipment mode-of-operation selector switch is in the GUIDANCE, COARSE (НАВЕДЕНИЕ,ГРУБО) position, and the wave selector switch is adjusted to the assigned wave (frequency) number;

(mm) the pitot-static tube P-S TUBE (ПВД) selector valve lever is locked in the MAIN (РАБОЧ.) position;

(nn) the D (day), N (night) and T (twilight) (Д, Н, С) aperture indices of the radar scope camera attachment are set in positions corresponding to the time of the day;

(oo) the OFF - STANDBY - RUN ON (ВЫКЛ. - ПРЕДВ. - ПОЛНОЕ ВКЛ.) selector switch is at OFF;

(pp) the FIXED BEAM - OFF (ЛУЧ ЗАКРЕПЛЕН. - ВЫКЛ.) switch is in the OFF position;

(qq) the OFF - H SIGNAL - LOW ALT. (ВЫКЛ. - Н СИГН. - МАЛ. ВЫСОТА) selector switch is at OFF;

(rr) the ANT. - COMP. (АНТЕН. - КОМПАС) switch is set at COMP., the ARC VOLUME

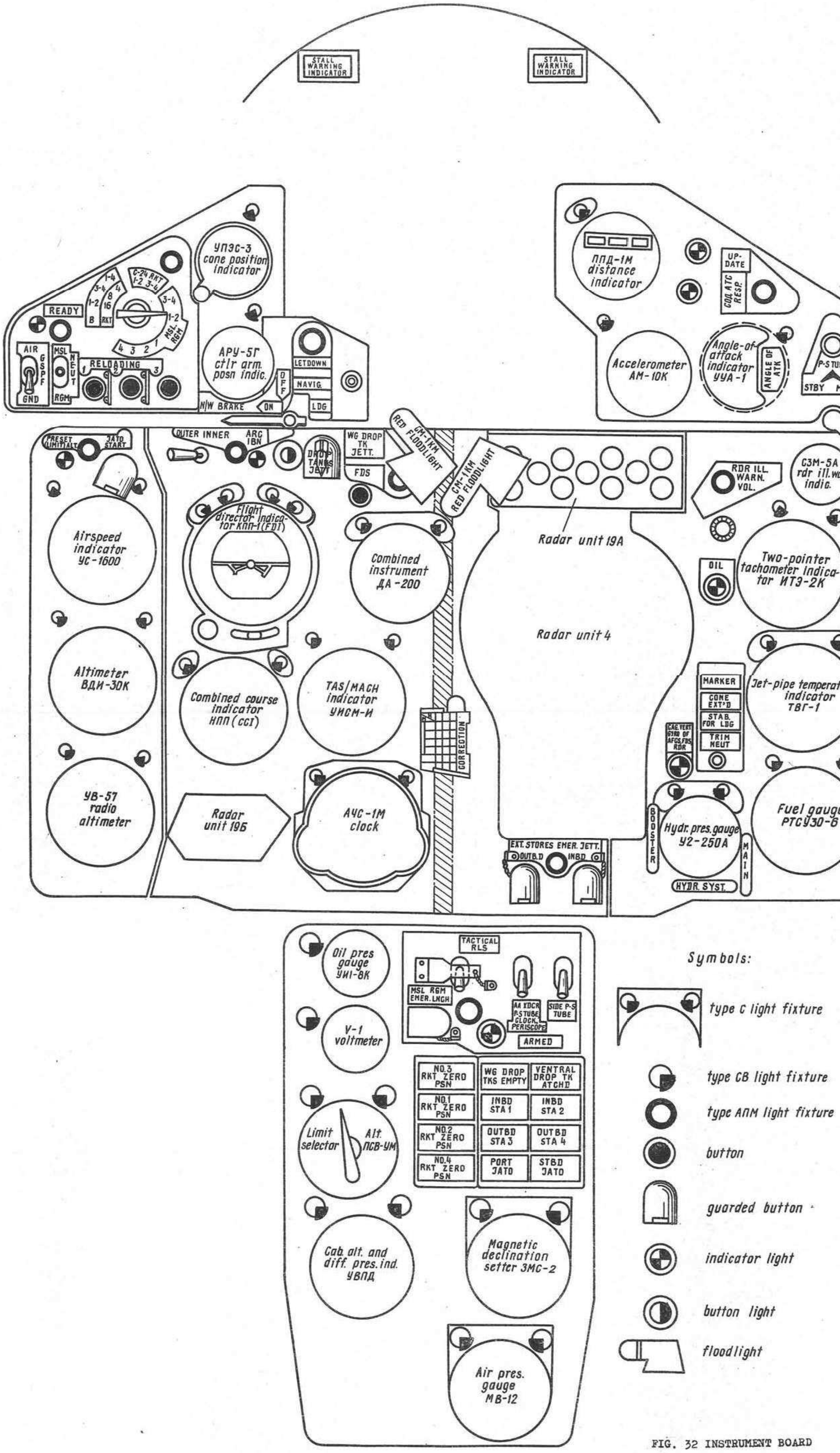


FIG. 32 INSTRUMENT BOARD

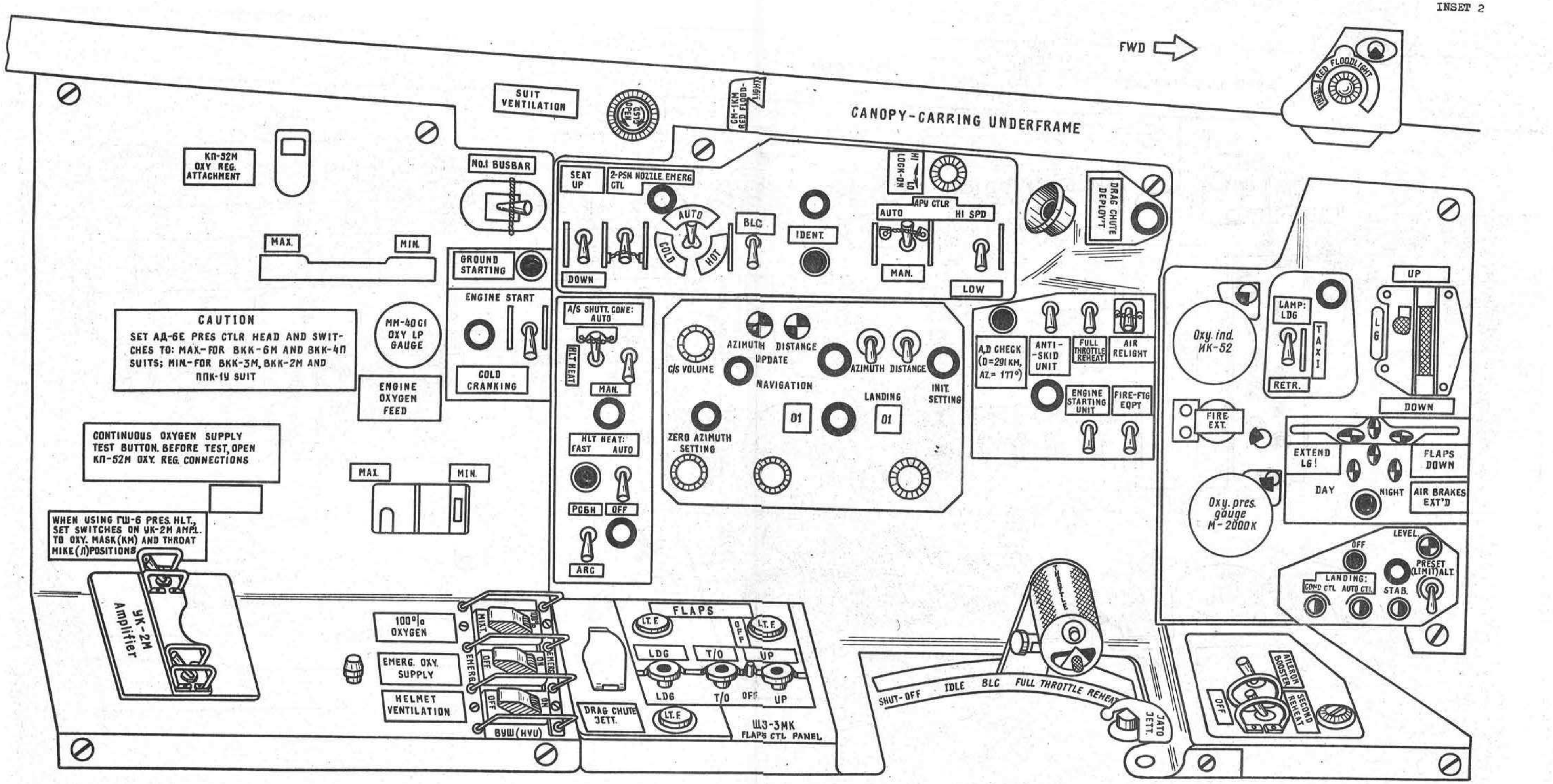


FIG. 33. LEFT-HAND CONSOLE

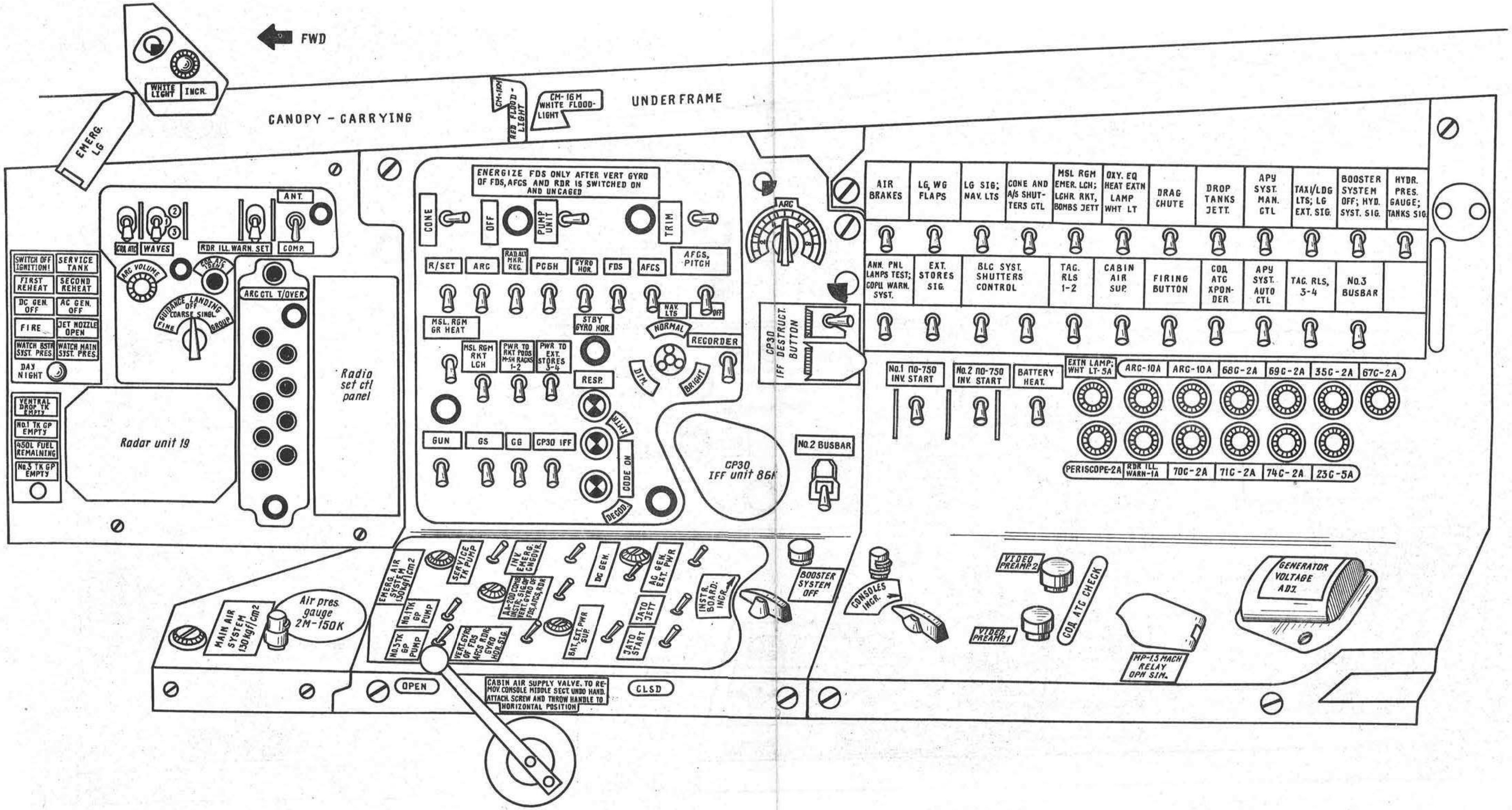


FIG. 34. RIGHT-HAND CONSOLE

(ГРОМК. АРК) knob is turned clockwise to the utmost, the radio compass wave remote-control selector is adjusted to the position corresponding to the selected inner beacon button, the button corresponding to the outer beacon of the landing airdrome is depressed, and the radio data of the pretuned homing beacons and broadcasting radio stations are written down on the radio data plate for the АРК-10 radio compass;

(ss) the RDR ILL. WARN. SET (СПО) switch is in the RDR ILL. WARN. SET position;

(tt) the DISTRESS (БЕДСТВИЕ) switch and the IFF DEST. (ВЗРЫВ) button are in the OFF positions, closed with their caps and lockwired;

(uu) the primary communication channel is selected on the control panel of the radio set, the VOLUME (РГ) control knob is turned all the way clockwise, the R/SET - COMP. (РАДИО - КОМП.) switch is in the R/SET position, and the N. SUP. (ПШ) switch is ON;

(vv) the СРЗО-2 set code selector switch is shifted to the assigned code number;

(ww) the CONE - OFF (КОНУС - ВЫКЛ.) switch is in the CONE position.

The arrangement of the circuit breakers, instruments, switches and selector switches, knobs, levers and other control elements as well as of signal lights and light panels in the cabin is shown in Figs 32 through 34.

CHECKING AIRCRAFT SYSTEMS, INSTRUMENTS, ASSEMBLIES AND EQUIPMENT BEFORE ENGINE STARTING

7. Adjust the barometric altimeter as follows:

(a) set the pointer to zero, when operating the aircraft from airfields having an elevation of less than 1000 m; in this case the pressure read off the instrument scale should not differ from that prevailing at the ground level (as reported by the weather station) by more than 2 mm Hg;

(b) set in a pressure of 760 mm Hg, when taking off airfields having an elevation of 1000 m or over; in this case the altitude read off the instrument scale should not differ by more than 50 m from the airfield pressure altitude (with regard to 760 mm Hg) reported by the weather station.

WARNING. If the difference between the pressure (altitude) reading on the instrument and the pressure (altitude) reported by the weather station is in excess of 2 mm Hg (50 m), the aircraft is not allowed to be flown; neither is it allowed to eliminate the discrepancy by unscrewing the instrument setting knob nut.

8. Check the voltage and capacity of the loaded aircraft storage batteries, for which purpose close the BAT., EXT. PWR SUP. switch, SERVICE TK PUMP (РАСХОД. НАСОС), No. 3 TK GP PUMP (НАСОС 3 ГР. БАКОВ) circuit breakers and No. 1 ПО-750 INV. START (ЗАПУСК ПО-750 No. 1), R/SET (РАЦИЯ) switches for a short time (the switches and circuit breakers are located on the cabin right-hand console). The voltmeter should read a voltage of not less than 22.5 V; the storage battery capacity by the ИСА indicator should not be less than 40 A·h.

Turn off the switches and circuit breakers in the reverse order.

9. To spare the storage battery, use only external power sources for checking the instruments and assemblies.

Give the command to the technician: "Connect external power sources!" and close the BAT., EXT. PWR SUP. switch. (Ground AC power sources shall be used by all means in serviceability checks of the radar and optical sight). The DC voltage should be 28 - 29 V with the ground power unit generator running, or 24 - 25 V with the unit generator inoperative. Turn on the AC GEN., EXT. PWR (ГЕНЕР.~ АЭРОД. ИСТ.) circuit breaker when the ground AC power source is connected.

Once the BAT., EXT. PWR SUP. switch is ON, the СОРЦ warning indicator button light starts blinking; depress the button light to switch it off.

10. After switching on the power supply, adjust the seat pan to your height by manipulating the pressure switch; ascertain that the STAB. FOR LDG light comes on in the light panel, whereas the АРУ pitch channel transmission ratio controller indicator pointer deflects to the extreme left-hand position; make sure that the VENTRAL DROP TK ATCHD (ПОДВЕСКА БАКА), INB. STA. 1, INB. STA 2 lights, etc., illuminate (in accordance with the external loads attached).

Depress the light panel lamp test button to make sure that all lights illuminate in the light panels (the No. 3 TK GP EMPTY (3 ГР. БАКОВ) and No. 1 TK GP EMPTY lights illuminate only with the No. 3 TK GP PUMP and No. 1 TK GP PUMP circuit breakers turned on, whereas the No. 1 RKT ZERO PSN (НУЛЬ. ПОЛОЖ. PC No. 1), No. 2 RKT ZERO PSN, No. 3 RKT ZERO PSN and NO. 4 RKT ZERO PSN lights illuminate depending on the external loads carried).

11. Check for serviceability of the brake system with the nosewheel brake engaged and disengaged. With the brake lever fully pressed, the pressure should be within the limits of 9 to 10 kgf/cm^2. When the pedals are fully deflected, with the brake lever pressed, the pressure in the unbraked wheel air bag should drop to zero.

12. To check the pressure helmet visor for proper heating, breathe against the facepiece 2 to 3 min after switching on the power supply, making sure the facepiece does not get misted.

Note. Fast heating of the pressure helmet visor to a temperature at which no misting takes place is allowed by periodical depression (for not more than 2 min) of the HLT FAST HEAT. (БЫСТР. ОБОГР. ГШ) button.

13. Check functioning of the oxygen equipment set at no overpressure and after application of overpressure; before executing the checkup, close the pressure helmet visor (or put on the oxygen mask) and secure the pressure helmet tensioner with the aid of the tape. (Check the system under overpressure before flying to altitudes higher than 11,000 m or before a combat flight).

Proceed as follows to check the oxygen equipment set with no overpressure applied:

(a) with the air dilution valve lever set to MIXT. (СМЕСЬ), make two or three deep inhalations and exhalations. No resistance to breathing should be offered; the blinker segments of the oxygen flow indicator should not move;

(b) set the air dilution valve lever to "100% O_2" and make two or three deep inhalations and exhalations; the oxygen flow indicator blinker segments should draw together during inhalation and move apart during exhalation; then set the air dilution valve lever to MIXT. again;

(c) shift the emergency oxygen supply lever to ON; the equipment functions properly if the face is blown continuously with a stream of oxygen; then set the lever to OFF, this should discontinue the flow of oxygen around your face;

(d) set the helmet ventilation valve lever at ON: if a continuous stream flows around your face, the helmet ventilation equipment functions normally; then shift the lever to OFF: the flow around the face should cease.

Check serviceability of the oxygen equipment at an overpressure, proceeding as follows:

(a) set the air dilution valve lever and the emergency oxygen supply lever to the "100% O_2" and ON positions, respectively;

(b) make certain, for 15 - 20 s, that there is no surge of overpressure in the pressure helmet (oxygen mask), referring to the M-2000 pressure gauge for the purpose;

(c) depress (with the technician's assistance) the manual control button of continuous oxygen supply and keep this button depressed throughout the check;

(d) after the high-rate oxygen supply is over (the pressure of the suit on the body diminishes), close the hole on the КП-52М oxygen regulator by a finger to build up an overpressure (as read by the М-2000 gauge) of up to 1000 mm of water in the pressure helmet (or up to 500 mm of water in the oxygen mask);

(e) make several inhalations and exhalations: if the pointer of the М-2000 pressure gauge deflects to the left (through 100 - 200 mm of water) at inhalation and returns to the initial position at exhalation, and the partial-pressure suit makes a tight fit with the body, causing no pain, then the oxygen equipment functions normally;

(f) release the continuous oxygen supply button and open the hole on the КП-52М oxygen regulator;

(g) shift the emergency oxygen supply lever and the air dilution valve lever to the OFF and MIXT. positions, respectively.

WARNINGS: 1. To exclude injury to the lungs, it is prohibited to check the oxygen equipment under overpressure if the pilot wears no partial-pressure suit.

2. Surge of overpressure in the pressure helmet (oxygen mask) when the hole on the КП-52М oxygen regulator is open, absence of pressure in the partial-pressure suit when there is pressure in the pressure helmet (oxygen mask) as well as impossibility of creating an overpressure of 1000 mm Hg in the pressure helmet (500 mm H_2O in the oxygen mask) when the hole on the КП-52М oxygen regulator is closed, testify to abnormal functioning of the oxygen equipment set; under these conditions it is prohibited to take the aircraft into the air.

14. To accomplish an integrated functional check of the ДА-200 combined instrument, АГД-1 gyro horizon, КСИ compass system (flight directional system, FDS), УУА-1 angle-of-attack indicator and СУА-1 angle-of-attack warning unit, do as follows:

(a) manipulate the correction knob on the gyro horizon indicator to align the pitch correction index with the zero mark of the roll scale;

(b) switch on the ДА-200 COMB. INSTR.; SIG. OF VERT. GYRO OF FDS, AFCS, RDR (ДА-200, СИГНАЛ. ГИРОД. КСИ, САУ, РЛС) circuit breaker;

(c) make sure that the warning light on the gyro horizon indicator and the CAGING OF VERT. GYRO OF FDS, AFCS, RDR (АРРЕТИР. ГИРОД. КСИ, САУ, РЛС) light are shining;

(d) turn on the VERT. GYRO OF FDS, AFCS, RDR; GYRO HOR. SIG. (ГИРОД. КСИ, САУ, РЛС, СИГНАЛ. АГД) circuit breaker and check to ensure that the warning light on the gyro horizon indicator and the CAGING OF VERT. GYRO OF FDS, AFCS, RDR light will go off not later than in 15 s;

(e) turn on the FDS circuit breaker;

(f) in 1 to 1.5 min press on the left part of the instrument board central portion, making sure that the turn indicator pointer deflects to the right; when pressure is applied to the right part of the instrument board, the turn indicator pointer should deflect to the left; when the pressure is discontinued, the turn indicator pointer should return to zero;

(g) make sure that 1.5 to 2 min after the indicator warning light goes out, the gyro horizon indicator reads the aircraft ground pitch and bank angles;

(h) turn on the GYRO HOR. circuit breaker and ascertain that the gyro horizon has changed over to the main vertical gyro (this will be indicated by the light flashing up on the gyro horizon indicator for not more than 15 s); once the light goes off, the indicator should read the aircraft ground pitch and bank angles;

(i) turn off the GYRO HOR. circuit breaker and make sure that the instrument has changed over back to the additional vertical gyro (this will be accompanied by a gentle jerk of the pitch scale); after the changeover, the gyro horizon indicator should produce stable readings of the aircraft ground pitch and bank angles;

(j) depress the FDS SLAVING (СОГЛАСОВ. КСИ) button and keep it depressed until the combined course indicator scale stops moving; slaving over, the combined course indicator should read the aircraft parking heading;

(k) check the voltage in the aircraft mains: it should be 27.5 to 28.5 V; if the voltage is other than indicated above, order the technician to adjust the voltage to the above limits;

(l) order the technician to deflect the vanes of the ДУА-3 angle-of-attack transmitter all the way down; this done, the УУА-1 angle-of-attack indicator should read an angle of attack of -5 to -9^{o};

(m) with the lamp test button on the LG/flaps position indicator depressed, order the technician to slowly deflect the ДУА-3 transmitter vanes upward as far as they will go; the СУА-1 warning unit should operate when the angle of attack is within the range of +24 to $+28^{o}$ as read by the УУА-1 indicator; as the vanes are being deflected towards the upper stop, the blinking frequency of the warning lights should increase; with the transmitter vanes deflected upward as far as possible, the angle of attack by reference to the УУА-1 angle-of-attack indicator should be +31 to $+35^{o}$; in the process of checking functioning of the УУА-1 indicator and СУА-1 warning unit the technician shall check to ensure that there is no binding of the ДУА-3 transmitter vanes.

Note. If it is required to check functioning of the УУА-1 indicator and СУА-1 warning unit with supply from the aircraft storage batteries, bear in mind that at a voltage drop from 28.5 to 22 V the УУА-1 indicator readings are substantially less than the actual angles of attack. Under these conditions the lights that illuminate in response to operation of the СУА-1 warning unit might burn continuously, instead of blinking.

15. To accomplish an integrated functional check of the radio set, radio compass, РСБН equipment, РВ-УМ radio altimeter, МРП marker beacon receiver, СРЗО-2 IFF transponder and СОД-57 transponder, switch on the following circuit breakers: R/SET; ARC; RAD. ALT., MKR REC. (РВ, МРП); СРЗО IFF; РСБН and СОД АТС; turn on the No. 1 ПО-750 INV. START switch.

To check functioning of the radio set, do as follows:

(a) check for correctness of the microphone installation when wearing a pressure helmet (the microphone should be arranged at a distance of 1 - 1.5 cm from the pilot's lips);

(b) in 1.5 - 2 min after connection of the power supply, test communication with a ground radio station through the required channels; making use of the VOLUME control knob on the control panel, select the desired volume;

(c) check functioning of the noise suppressor (when the N. SUP. switch is placed in the OFF position, some noise can be heard; when it is turned on, no noise should be heard);

(d) after the check of the radio set is completed, set in the communication primary channel and turn on the noise suppressor.

Notes: 1. Radio set changeover to any communication channel will occur within not more than 4 s.

2. In case reception deteriorates during flight at great distances from the ground radio station, turn off the noise suppressor.

3. When the R/SET - COMP. switch is set to R/SET, only messages of a VHF (UHF) communication radio station will be heard in the earphones; when the switch is set to COMP., weakened messages of a VHF (UHF) communication radio station will be heard, as well as the callsigns of the homing beacon to which the radio compass has been tuned.

For testing the radio compass, proceed as follows:

(a) 3 to 5 min after switching on the power supply, set the PCБH - ARC switch in the ARC position and ascertain that the radio compass pointer on the combined course indicator points in the direction of the outer beacon, whereas the tuning meter pointer deflects from the zero position;

(b) adjust the R/SET - COMP. switch on the radio set control panel to COMP. and the function switch on the radio compass control panel to ANT.; make sure that the callsigns of the outer beacon are coming loud and clear;

(c) set the OUTER - INNER switch to INNER and ascertain that the callsigns of the inner beacon are loud and clear;

(d) place the R/SET - COMP. switch to R/SET; adjust the radio compass function switch to COMP. after which ascertain that the radio compass pointer on the heading indicator points in the direction of the inner beacon;

(e) set the OUTER - INNER switch to OUTER and make sure that the radio compass changes over to the outer beacon;

(f) if necessary, use the same procedure for testing the radio compass on other pretuned channels, provided the distance to the broadcasting radio station or to the homing beacon permits to do so.

The test over, adjust again the radio compass to pick up the outer beacon of the departure airdrome.

The test over, adjust again the radio compass to pick up the outer beacon of the departure airdrome. If the PCБH equipment is to be used in the flight, place the PCБH - ARC switch in the PCБH position.

Notes: 1. When the aircraft is positioned in a shelter, the readings of the radio compass pointer on the combined course indicator may disagree with the direction towards the picked up radio station.

2. Radio compass changeover from the outer beacon to the inner beacon frequency occurs automatically in flight, due to operation of the УАП-1 automatic switch, the landing gear being extended and the МРП-56П marker beacon receiver operating, when over the marker beacon (as soon as the marker beacon receiver operates, the radio compass is automatically changed over to the inner beacon, the ARC IBN (АРК БПРС) light flashing up).

3. The distance (slant range) to a homing radio beacon to which the radio compass is tuned, is determined by means of the distance counter that is part of the АРК-10 radio compass set.

To check the PCБH equipment for serviceability, proceed as follows: 3 to 5 min since turning-on of the power supply, having ascertained that the PCБH - ARC switch is in the PCБH position, make sure that the UPDATE: AZIMUTH, DISTANCE and UPDATE lights are shining, the relative bearing pointer points in the direction of the navigational beacon and the distance value displayed on the ППД distance indicator corresponds to the actual distance to the beacon.

The checks over, cut out the ДА-200 COMB. INSTR; SIG. OF VERT. GYRO OF FDS, AFCS, RDR circuit breaker, the VERT. GYRO OF FDS, AFCS, RDR; GYRO HOR. SIG. circuit breaker and the FDS circuit breaker.

Use the following procedure for checking the PB-УМ radio altimeter:

(a) set the limit altitude selector switch to CH (K), then to any other position, except OFF;

(b) make sure a sound signal is issued 3 to 10 s afterwards, the PRESET (LIMIT) ALT. light burning; 2 - 3 min later, the radio altimeter pointer should read zero, accurate to ±5 m;

(c) set the limit altitude selector switch to the required safe altitude of flight.

Note. When the aircraft carries wing drop tanks and other external loads, the following peculiar features of the radio altimeter operation should be taken into account:

(a) in the course of aircraft parking and taxiing, the altimeter indicator pointer may rest against the left stop (below the zero mark);

(b) after takeoff, the radio altimeter will give stable readings starting from an altitude of 10 to 15 m;

(c) when the limit altitude switch is being set to a new altitude value at altitudes of 550 to 600 m, the radio altimeter may produce erroneous readings for a short time (the altitude indicator pointer deflecting all the way to the right).

To check serviceability of the CP3O-2 IFF equipment, make certain that the XMTR. (ПЕР.), CODE ON (КОД ВКЛ.) and DECOD. (ДШ) lights come on in 2 to 3 min after turning-on of the equipment power supply. With the ground interrogator functioning, the RESP. (OTBET) neon pilot lamp should flicker at the time of the equipment responding to interrogation signals; this being the case,the equipment responder section is serviceable.

The interrogator section of the equipment shall be checked by the ground crew with the use of the special test equipment set.

Notes: 1. The CP3O-2 IFF equipment is switched on in the INTERROGATION mode, for target identification in flight, by depression of the INTERROG. (ЗАПРОС) button light on the radar control panel. Once the button light is depressed, the "below" and "above" target marks disappear from the radar screen. If the interrogated aircraft is friendly, the "friend" recognition mark will appear above the target blip.

2. The range of air-to-air identification is not less than the target aircraft detection range of the A-23Б airborne radar.

Proceed as follows to check the СОД-57 distance (ATC) transponder:

(a) shift the mode-of-operation selector switch of the СОД-57 transponder to the LANDING, SINGLE (ПОСАДКА, ОДИН) position;

(b) 2 to 3 min after energizing the СОД equipment, press, in turn, the VIDEO PREAMP. 1 and VIDEO PREAMP. 2 (ПВУ-1, ПВУ-2) buttons; in response to this, the СОД ATC RESP. (OTBET СОД) neon lamp should illuminate;

(c) depress the СОД ATC IDENT.(ОПОЗНАВ. СОД) button for a short time (0.5 to 1 s); in this case the СОД ATC RESP. lamp should illuminate and continue to burn, the lamp brightness gradually increasing.

Note. Should the СОД ATC RESP. neon lamp be burning (blinking) before any of the buttons is depressed, (which means that the СОД ATC transponder is responding to interrogation signals of some ground radars at this time), the lamp brightness should increase (blinking should cease) as soon as the buttons are depressed;

(d) shift the СОД-57 transponder mode-of-operation selector switch to the GUIDANCE, COARSE (НАВЕДЕНИЕ, ГРУБО) position.

Note. The СОД ATC IDENT. button will be depressed in flight (for a short time) in response to commands from ground radar posts; in such cases the СОД ATC RESP. pilot lamp should burn brightly for 6 to 10 s after the button is released.

16. Before flying a combat mission (or a mission to practise combat employment of the aircraft) where the optical sight will be used, check the sight for serviceability in accordance with the procedure set forth in section Handling Optical Sight.

17. The equipment tests completed, turn off all circuit breakers and switches except the R/SET circuit breaker and the No. 1 ПО-750 INV. START switch (to maintain communication with the flying control officer).

PREPARATION FOR ENGINE STARTING, ENGINE STARTING AND RUNNING UP

18. Start the engine from an external power supply source; in separate cases the aircraft storage battery may be used for the purpose, provided its capacity is not less than 40 A·h.

The same procedure is used for starting the engine from an external power source and from the aircraft battery.

19. Having obtained the permission to start the engine, give the command to the technician: "Get ready for engine starting!" After receiving the "Ready for starting" acknowledgement, check again to ascertain that:

(a) the BAT., EXT. PWR SUP. switch is turned on;

(b) the ENGINE STARTING UNITS circuit breaker, the FULL THROTTLE, REHEAT circuit breaker and the FIRE-FTG EQPT circuit breaker (located on the left-hand console) are turned on;

(c) the ENGINE START - COLD CRANKING switch on the left-hand console is set to ENGINE START;

(d) the 2-PSN NOZZLE EMERG. CTL switch is set at OFF (on the left-hand console);

(e) the CONE - OFF switch is at CONE (on the right-hand console).

Preparatory to starting the engine:

(a) check the throttle lever for ease of travel and for proper locking in the IDLE, BLC (СПС), FULL THROTTLE, MIN. REHEAT (МИНИМ. ФОРСАЖ) and FULL REHEAT positions; then set the throttle lever to SHUT-OFF;

(b) switch on the DC GEN. (ГЕНЕРАТ.=), No. 1 ПО-750 INV. START switches and the R/SET circuit breaker (thereby switching on the fuel gauge and the oil pressure gauge) and the SERVICE TK PUMP circuit breaker.

CAUTION. When starting and running up the engine or checking the aircraft systems, cooperate with the aircraft technician.

20. Give the technician the command: "Clear the engine!" and, having received the acknowledgement, shift the throttle lever to IDLE and depress the GROUND STARTING (ЗАПУСК НА ЗЕМЛЕ) button for 2 to 3 s; this action will illuminate the SWITCH OFF IGNITION! (ЗАЖИГ. ВЫКЛЮЧ.) light in the light panel. In the course of engine starting, check the jet-pipe temperature and the oil pressure.

The engine should pick up the idle rpm automatically.

21. Should the engine fail to start or in case some malfunctions are detected (e.g. the jet-pipe temperature surges with a tendency to exceed 700°C, there is no oil pressure, the engine monitoring instruments are unserviceable, an engine fire or juddering of the engine occurred, etc.), shut off the engine by moving the throttle lever to SHUT-OFF.

CAUTION. To abort the starting procedure with the SWITCH OFF IGNITION! light on, first switch off the ENGINE STARTING UNITS circuit breaker, then set the throttle at SHUT-OFF.

Notes: 1. If the engine starting process was aborted before the SWITCH OFF IGNITION! light extinguished, switch on the ENGINE STARTING UNITS circuit breaker for 40 s in order to complete the interrupted starting cycle of the engine starting panel.

2. In case of afterflaming in the jet-pipe, cold-crank the engine after the high-pressure rotor comes to a standstill.

3. It is allowed to repeat the engine starting only after the cause of the starting failure has been found and eliminated.

After the engine has accelerated to the idle rpm, the SWITCH OFF IGNITION! light should extinguish in the light panel, and the LP rotor speed should be 30 to 38%, the jet-pipe temperature not exceeding 420°C, the oil pressure should be not less than 1 kgf/cm^2 (if the pressure is in excess of 1.3 kgf/cm^2, the OIL light should not come on).

22. Having started the engine, switch on the AC GEN., EXT. PWR (ГЕНЕР.~ АЭРОД. ИСТ.) circuit breaker and wave your hand to order the technician to switch off the ground power sources, then make sure that the DC generator is connected to the aircraft mains (by extinguishing of the DC GEN. OFF light and by reference to the voltmeter that should read a voltage of 28 - 29 V); make sure that the AC generator is likewise connected to the aircraft mains (by referring to the AC GEN. OFF light which should go off).

Note. If the AC GEN. OFF lamp keeps burning, turn off the AC GEN., EXT. PWR circuit breaker and then turn it on again.

Turn on the No. 2 ПО-750 INV. START switch, No. 3 TK GP PUMP and No. 1 TK GP PUMP circuit breakers, VERT. GYRO OF FDS, AFCS, RDR; GYRO HOR. SIG. and ДА-200 COMB. INSTR.; SIG. OF VERT. GYRO OF FDS, AFCS, RDR circuit breakers (on the horizontal portion of the right-hand console); turn on the RDR ILL. WARN. SET and СОД АТС (ХРОNDER) switches (i.e. shift their levers to the upper position); switch on the TRIM; ARC; RAD, ALT. MKR REC; FDS; GYRO HOR.; CG (CAMERA GUN) (ФКП); CP30 IFF circuit breakers and turn on the RECORDER (САМОПИСЕЦ) switch (on the right-hand forward electrical panel).

23. If the engine has not been tested or warmed up by the technician, run up the engine in the following sequence:

(a) smoothly advance the throttle lever to obtain an LP rotor speed of 88 - 90%, warm up the engine at this speed for 1 min and check the oil pressure which should be 3.5 - 4.5 kgf/cm^2 (the OIL light should not burn); check operation of the DC generator (the voltmeter should read 28 to 29 V).

WARNINGS: 1. Warm up the engine with the air intake cone fully retracted (the CONE EXT'D light should not illuminate in the warning light panel and the cone position indicator pointers should be at zero).

2. If the OIL light continues to burn after the engine rotation speed has been increased, shut down the engine and find the cause;

(b) smoothly shift the throttle lever to FULL THROTTLE, keep the engine running at this power setting for 10 to 15 s, check the maximum rpm, jet-pipe temperature and oil pressure;

(c) reduce the engine speed to the idle figure;

(d) for 1.5 to 2 s, shift the throttle lever from IDLE to FULL THROTTLE; check the LP rotor overspeed and the jet-pipe overtemperature.

24. If the aircraft is being prepared for flying without the technician's assistance, should it be necessary for the pilot to test the engine at the FULL THROTTLE setting and with reheat on, tie down the aircraft at the parking ground with the aid of captive cables, then test the engine, observing the following limitations:

(a) the jet-pipe temperature at the FULL THROTTLE setting should not exceed 770°C; the same at reheat and the SECOND REHEAT settings should not be over 830°C;

(b) the maximum LP rotor speed at the FULL THROTTLE setting and at reheat settings should not exceed 101%; the same at the SECOND REHEAT setting should not exceed 103%;

(c) the time of the engine continuous run at the FULL THROTTLE setting, reheat settings and the SECOND REHEAT setting should not be over 15 s;

(d) the LP rotor overspeed during engine acceleration to FULL THROTTLE should not exceed 103%, and the jet-pipe overtemperature should not be more than 850°C for not longer than 5 s.

CAUTION. At an ambient air temperature of +2 to minus 10°C and high air humidity (e.g. mist, fog, drizzle or sleet), the technician shall check for ice formations on the sharp edges of the air intake as the engine is being started and run up. If ice formations are detected, he shall order the pilot to switch off the engine at once.

CHECKING SYSTEMS AND EQUIPMENT WITH ENGINE RUNNING

25. With the engine idling, check the following:

(a) functioning of the pilot's trim actuator; to do so, shift the thumb switch on the control stick backward and forward (the relieved control stick should follow the switch movements). The check completed, shift the switch backward until the trimming mechanism is set to neutral, which will be indicated by the TRIM NEUT. light flashing up in the light panel;

(b) functioning of the aircraft control system; for this, smoothly deflect the control stick three or four times to the extreme positions (rightward, leftward, forward, and backward); the control stick should travel smoothly, without creeping or jerks; the TRIM NEUT. light should keep burning in the light panel when the control stick is being moved all the way forward and backward; make sure that the control stick is duly loaded by the artificial feel mechanisms, and that it returns to the neutral position after being released in any extreme position; check to see that rudder can be fully displaced;

(c) functioning of the hydraulic system and hydraulic pumps, using the following procedure:

(i) check the pressure in the hydraulic systems with the control stick fixed (the pressure in the main hydraulic system should not be less than 180 kgf/cm^2, that in the booster hydraulic system should not be below 185 kgf/cm^2);

(ii) move the control stick diagonally several times at as high rate as possible (the pressure in the main hydraulic system should not drop below 175 kgf/cm^2 and that in the booster hydraulic system should not drop below 165 kgf/cm^2; during this check, the WATCH PRES. IN BSTR SYST. light may come on in the panel for a short time);

(iii) extend and retract the air brakes by manipulating the thumb switch on the throttle lever (extension of the air brakes should illuminate the AIR BRAKES EXT'D light on the LG/flaps position indicator; the light should go out as soon as the air brakes are retracted); the aircraft technician should check the air brakes for synchronous operation;

(iv) extend and retract the flaps; as the flaps are 25° down, make sure that the FLAPS DOWN (ЗАКРЫЛКИ ВЫПУЩЕНЫ) light comes on, and as they are up, the light goes out on the LG/flaps position indicator; have the aircraft technician check the flaps for extention by 45°; the check over, leave the flaps extended to the takeoff position (25°).

26. Prior to performing flight with employment of the AFCS, and also preparatory to executing flight in bad weather conditions and at night, check the AFCS for proper functioning in the following order:

(a) switch on the AFCS circuit breaker and turn on the AFCS, PITCH switch;

(b) slave the flight directional (compass) system and check the compass readings;

(c) set the control stick neutral (at the pilot's order the aircraft technician shall see to it that the ailerons and stabilizer are in the neutral position);

(d) engage the AFCS in the STABILIZATION mode and check its engagement; engagement of this mode of the AFCS must not envolve jerks of the control stick (at the pilot's order the aircraft technician shall see that the ailerons and stabilizer are in the neutral position);

(e) select the LEVELLING mode of operation and check its engagement (1.5 s afterwards, the control stick may start moving smoothly forward and/or backward); depress the AFCS OFF button and check the AFCS for disengagement; shift the control stick to the neutral position by manipulating the pilot's trim thumb switch.

27. Before flight with employment of the БОВ-21 limit altitude unit, check its functioning, proceeding as follows:

(a) ascertain that the radio altimeter is ON, set any value of limit altitude by the limit altitude setter selector switch;

(b) order the technician: "Deflect the ДУА-3 transducer vanes all the way down!" (the vanes shall be kept all the way down throughout the time of the БОВ-21 limit altitude unit check);

(c) engage the AFCS in the STABILIZATION mode, turn on the PRESET (LIMIT) ALT. switch;

(d) depress the lamp test button on the LG/flaps position indicator and keep it depressed;

(e) in 30 to 80 s after the button has been depressed, the STAB. light should extinguish on the LG/flaps position indicator and the LEVEL. light should illuminate;

(f) make sure that the control stick is moving backward;

(g) release the lamp test button on the LG/flaps position indicator (in this case the LEVEL. light should continue to burn) and see that the control stick has stopped moving;

(h) depress the A/P OFF button and order the technician to release the angle-of-attack detector vanes;

(i) set the stabilizer in the neutral position by manipulating the pilot's trim thumb switch.

WARNING. After the AFCS or limit altitude unit check has been completed, order the technician to make sure and report whether the stabilizer and ailerons are in the neutral position.

28. Before performing flight in a partial-pressure suit or a g-suit, depress the button on the АД-6Е automatic pressure control unit head (through the rubber cap), making sure that air is supplied into the bladders of the anti-g device. The suit anti-g device should apply uniform pressure on the legs and the abdomen. The pressure should diminish after the pressure on the button is somewhat decreased; after the button is released, air should be completely bled from the anti-g device.

29. After running up the engine, check the cold and hot lines of the air-conditioning system; for this, set the cabin heating switch alternately to COLD and HOT for not less than 30 s. Check by touch that cold and hot air is delivered to the canopy glass panels; this done, set the switch to AUTO.

Smoothly open the suit ventilation valve to check whether conditioned air is supplied into the ventilated suit.

30. WARNING. In the process of checking the aircraft systems and equipment the pilot should mind that the time of the engine continuous run on the ground at the idling speed should not exceed 10 min.

Section Five
FLYING

PREPARING TO TAXI OUT, TAXIING OUT

31. After running up the engine and checking the aircraft systems, order the technician: "Close the canopy!" At this command the technician shall remove the ground safety pins from the canopy jettison handle and the first stabilizing parachute rod gun bolt; the technician shall show the removed ground safety pins to the pilot, then close the canopy.

32. Having ascertained that the engine is running normally and that the instruments, assemblies and systems function properly, check the position of tne LG wheel brake emergency control lever (it should be sunk and safetied); check also that the nosewheel brake is switched off and that the flaps are lowered into the takeoff position.

Once the technician has closed the collapsible canopy, secure its locks by shifting the lock control handle all the way forward and fitting the latter into the retaining slot: then pressure-seal the cabin with the aid of the sealing valve control latch. Check the canopy operational control locks for closed position, making sure that the locking pins have entered the lugs of the canopy side locks and that they fit completely into the canopy-carrying underframe holes, that the lock control handle fits in the retaining slot; refer to the appropriate warning lights for the same purpose.

With the canopy operational control locks closed and the cabin pressure-sealed, the flickering warning light should extinguish on the cabin left side. Depress the COPЦ centralized warning indicator button light and make sure that this light has gone off.

<u>WARNING.</u> It is forbidden to open the cabin pressure-sealing valve control latch while moving the operational locks control handle forward, with applying a force to the latch, because the canopy locks may fail to close to the full extent in such a case.

Switch on the pressure helmet ventilation, close the helmet visor or put on the oxygen mask and make sure that oxygen is continuously supplied to the pressure helmet (oxygen mask).

33. After obtaining the taxi-out clearance, proceed as follows:

(a) brake the wheels; sign the technician to remove the chocks (as soon as this sign is given, prior to removing the chocks, the technician should remove the protective grids from the takeoff shutters and the safety pins from the launchers when the aircraft is carrying missiles;

(b) having ascertained (by watching the signs given by the technician) that the chocks are removed and the way ahead is clear, smoothly increase the LP rotor speed to 70 - 80% (with the aircraft held in position);

(c) throttle down the engine to the idling speed and request the technician's taxi-out clearance by raising your left hand;

(d) after the technician signs his consent, ascertain once more that the way ahead is clear of obstacles, release the brake lever and start taxiing.

As soon as the aircraft starts moving, smoothly throttle the engine to the idling speed.

34. The taxi speed should ensure safety of aircraft movement about the airfield and prevent collision with obstacles. When performing turns in the course of taxiing, avoid sharp brake application to one of the wheels. Preparatory to making a turn, decrease the taxi speed to not more than 15 km/h (when carrying no external loads), and to not more than 5 km/h when carrying external loads.

In taxiing, the aircraft retains stability and displays no tendency to inadvertent turns. The aircraft performs controlled turns in a brisk manner when taxiing. While performing maneuvers in taxiing, check for serviceability of the radio compass and flight directional system.

CAUTION. Discontinue the taxiing procedure in case the main braking system fails. To stop the aircraft, use the emergency braking system and shut down the engine, if necessary.

DAY CIRCUIT FLYING

35. Enter the runway only at the flying control officer's permission. Before taxiing onto the runway, tighten up the seat harness by means of the waist restraint handle, lock the shoulder restraint straps in the tightened position and set in the appropriate values on the radio compass distance counter.

Turn on the pitot-static tube heating and heating of the periscope if the weather conditions make icing probable.

When on the runway, taxi straight for some 10 to 15 m along the runway in order to align the nosewheel with the aircraft fore-and-aft axis and with the axis of the runway, then smoothly brake the wheels. When the aircraft comes to a stop, release the brake application lever, switch on the nosewheel brake and then again brake the LG wheels by pressing the lever.

Before starting the takeoff run, check to see that the readings of the flight and navigational instruments agree with the actual position and attitude of the aircraft on the runway (i.e. the heading, radio station relative bearing (Radsta. RB), bank, pitch, altitude, etc.). Unlatch the landing gear control valve lever and request the clearance to take off.

Concrete-Runway Takeoff

36. Take off with the flaps extended to the takeoff position and, as a rule, with minimum reheat power; when drop tanks or combat external stores are carried, full reheat power shall be used.

When the aircraft carries no external loads or two missiles only, takeoff may be performed with full throttle non-reheat power, provided the takeoff run length under the actual conditions (determined from the nomogram of Fig. 9) does not exceed 1100 m.

It is also permissible to use second reheat power for takeoff, in order to reduce the takeoff run length, obtain a higher rate of aircraft acceleration in second-segment climb as well as to increase the rate of climb up to an altitude of 4000 m. In such cases the switch controlling the engine second reheat power shall be turned on either before the request for takeoff clearance or after setting of the throttle to FULL REHEAT.

The same procedure is used for takeoff at reheat and the full throttle non-reheat engine settings. Under positive ambient air temperatures, the second reheat may get engaged with a certain delay, in the course of takeoff run.

The jet-pipe temperature remains practically constant in the process of takeoff with reheat power; during takeoff with full throttle engine power, the jet-pipe temperature may reduce in the process of takeoff run by some 20 to 30°C.

37. Having obtained the takeoff clearance, depress the buttons for starting the stopwatch and flight time counter, advance the throttle lever smoothly to the FULL THROTTLE position while keeping the aircraft against the brakes, and set the throttle lever to FULL REHEAT as soon as the LP rotor speed comes to about 100%. Having ascertained that the afterburner is ignited (which will be indicated by a peculiar kick, smooth increase of the jet-pipe temperature and ratio between the LP and HP rotor speeds), establish the required reheat setting, release the brake lever and start the takeoff run.

Notes: 1. After the throttle lever has been set to a reheat position, the FIRST REHEAT and JET NOZZLE OPEN lights will flash up in the light panel.

2. When taking off a wet runway, release the brake lever as the aircraft starts moving, and proceed to executing the takeoff run never allowing skidding. Check the afterburner for proper ignition in the course of the takeoff run.

WARNING. In case the afterburner fails to ignite (no peculiar kick is sensed, the jet-pipe temperature is below 450°C and the LP rotor speed exceeds that of the HP rotor by more than 8 to 12%), discontinue takeoff and taxi to the parking area to find the cause of the trouble.

38. When taking off at full throttle, after shifting the throttle lever to FULL THROTTLE and bringing the LP rotor speed to about 100%, release the brake lever and start the takeoff run. If the jet nozzle flaps fail to shift to the FULL THROTTLE position, when taking off at full throttle (which will be indicated by the JET NOZZLE OPEN light coming on, the jet-pipe temperature dropping below 450°C and the LP rotor speed exceeding that of the HP rotor by more than 8 to 12%), discontinue the takeoff procedure.

39. At the takeoff run start, keep the control stick in the neutral position; maintain directional control with the aid of the brakes, using the rudder as the speed increases.

Upon attaining a speed of 150 to 200 km/h, shift the control stick back through 3/4 of its full travel and keep it in this position until the beginning of nosewheel liftoff.

As soon as a speed of 250 to 270 km/h is reached, the nosewheel smoothly clears the ground. In the course of nosewheel liftoff reduce the control stick backward deflection, in a smooth manner, to establish the normal takeoff attitude. At the normal takeoff attitude the skyline will be seen at the base of the pitot-static tube and the УУА-1 indicator will read an 11 - 13° angle of attack.

40. The aircraft unstick speed will amount to 340 - 360 km/h depending on the aircraft takeoff weight when carrying various external loads (the УУА-1 indicator reading the 11 - 13° angle of attack, approximately).

41. After unsticking, proceed climbing smoothly, while retaining the pitch angle approximately equalling the liftoff pitch angle. After unsticking the aircraft retains stability and displays no tendency to balloon or stall.

42. No peculiar features are involved in the takeoff procedure when carrying the ventral drop tank and two missiles, or one missile, or two rocket pods УБ-16-57.

When taking off with the C-24 rockets, or aerial bombs, or other heavy external loads on board, nosewheel liftoff and aircraft unsticking occur at a higher speed, the takeoff run increasing.

The takeoff run length and the unstick speed vs takeoff weight and atmospheric conditions can be determined with use of nomograms presented in Figs 8 and 9.

CLIMBING TO CIRCUIT HEIGHT

43. At an altitude of 10 to 15 m, set the landing gear control valve lever at UP (УБРАНО). Do not exceed the airspeed of 600 km/h before the landing gear is fully retracted; full retraction of the landing gear will take 6 to 8 s under these conditions. At a higher speed, the time of landing gear retraction will increase; in this case the landing gear may fail to fully retract.

Having ascertained that the landing gear is fully retracted (referring to the appropriate lights in the LG/flaps position indicator and to the pressure in the hydraulic system which should increase to 210 kgf/cm^2), set the landing gear control valve in the neutral position and check extension of the intake cone, which will be indicated by the CONE EXT'D light flashing up in the light panel and by the cone position indicator.

CAUTION. If, during landing gear retraction at an increased airspeed, one of the LG retracted-position lamps is dead, set the landing gear control valve to UP, reduce the airspeed to 550 km/h and check the landing gear for retraction. The landing gear being retracted, set the landing gear control valve in the neutral position.

44. At an altitude of less than 100 m retract the flaps. Retraction of the flaps will cause a nose-down moment, which will be easily counteracted by manipulation of the control stick.

With the airspeed increasing from 390 to 600 km/h, check functioning of the АРУ pitch channel transmission ratio controller; the instrument pointer should deflect to the right, and the STAB. FOR LDG light should go off in the light panel.

WARNING. Flight at an airspeed of more than 800 km/h and altitude of less than 7000 m with the АРУ transmission ratio controller set to the larger arm may result in dangerous progressive pitching oscillations of the aircraft.

After accelerating the aircraft to an airspeed of 600 km/h, turn off the afterburner (if it was on) and proceed to performing circuit flight (with the landing gear retracted) at this speed.

Note. If, immediately upon takeoff, the aircraft is to fulfil some other mission involving climb under optimum conditions, set up the optimum climb speed by the time of reaching an altitude of 1000 m.

Visual Runway Approach with BLC System ON

45. At an altitude of 150 to 200 m bring the aircraft into a turn at a bank of 35 - 45°. When flying a tight visual circuit, make the crosswind and downwind turns fluently, at a bank of 35 to 45°.

Upon completion of the downwind turn (before performing a runway approach), check the following:

(a) turning-on of the BLC switch;

(b) pressure in the hydraulic systems;

(c) pressure in the pneumatic systems (the pressure in the main system should be not less than 90 kgf/cm^2; that in the emergency system should be not less than 110 kgf/cm^2); if the pressure in the main system is less than 70 kgf/cm^2, be ready to use the emergency braking system;

(d) engagement of the anti-skid unit and nosewheel brake;

(e) turning-off of all the switches of the armament system;

(f) setting of the firing (launch/release) button to the safetied position.

When nearing the point abeam of the runway, decrease the speed; at an airspeed of not more than 550 km/h set the landing gear control valve to DOWN (ВЫПУЩЕНО) and increase the engine rpm in order to prevent the airspeed from dropping below 500 km/h. Oppose sideslipping while extending the landing gear.

Check to see that the landing gear is extended, referring to the respective lights in the LG/flaps position indicator and making sure the pressure in the hydraulic system is again 210 kgf/cm^2. Leave the landing gear control valve lever in the DOWN position until taxiing in to the parking area.

Note. While the landing gear is being extended, the WATCH MAIN SYST. PRES. light may flash up for a short time.

46. After extending the landing gear, lock the shoulder harness and trim out the control stick,using the pilot's trim; check to see that the cone is retracted, making sure the CONE EXT'D light has gone out and the cone position indicator has produced the appropriate readings; refer to the two-pointer pressure gauge to make sure that there is no pressure in the wheel brakes.

47. Before performing the turn to the base leg, report extension of the landing gear and request the landing clearance. Enter the base leg turn after flying abeam of the outer beacon, at the beacon relative radio bearing of 250° (110°); execute it while flying level, at a bank of 35 to 45° (through an angle of 100 - 110°). While performing the base leg turn, do not allow the airspeed to drop below 500 km/h.

After recovery from the base leg turn, bring the aircraft into descent at a rate of 3 to 5 m/s, extend the flaps in the takeoff position (refer to the light in the LG/flaps position indicator to make sure that the flaps are really extended) and set up an airspeed of 450 km/h.

Extension of the flaps will cause a minor nose-up moment which is readily counteracted with the aid of the control stick.

WARNINGS: 1. If the aircraft starts banking vigorously during flap extension, immediately retract the flaps and perform a missed approach procedure if practicable, after which perform flaps-up landing approach as laid down in Para. 77.

2. If the EXTEND LG! light flashes up in the LG/flaps position indicator after extension of the flaps (the landing gear is extended partially or fails to extend altogether), go around, then extend the landing gear completely and perform landing.

48. Perform the final turn at a bank of 30 to 45°, at an airspeed of 450 km/h. Recovery from the turn should be completed at an altitude of not less than 300 m. The turn completed, establish an airspeed of 400 to 420 km/h and lower the flaps in the landing position by depressing the appropriate extension button.

Note. If the given bank limitations are exceeded in the course of the base leg turn or final turn performance, the aircraft is likely to lose speed intensively and stall.

While descending, decrease the airspeed in a smooth manner so as to overfly the outer beacon at an altitude of 200 m and an airspeed of 360 to 380 km/h. When a speed of 360 - 380 km/h is reached, make certain that the BLC system operates normally (with the BLC system operating normally, the angle of attack by the УУА-1 indicator diminishes by 2 to 2.5° as compared to the angle of attack at the same speed with the BLC system not used).

WARNINGS: 1. Every time, when checking for engagement of the BLC system, make sure that the JET NOZZLE OPEN light signal has not come on in the light panel. If this signal light comes on, immediately switch off the FULL THROTTLE, REHEAT circuit breaker and gradually increase the engine rpm to the maximum figure. Depending on the developed engine thrust, set up an engine power (not above the full throttle one) that will ensure normal landing on the runway.

2. Should the aircraft start banking vigorously at the moment when the BLC system is engaged (at an airspeed of 360 - 380 km/h), gradually increase the engine rpm to the maximum value while counteracting the bank with the help of the control stick and rudder. After reaching an airspeed of 340 - 350 km/h, bring the aircraft in level flight, then in climb, and go round again. When at an altitude of not less than 150 m, increase the airspeed to 380 - 400 km/h at the expense of lesser angle of climb, retract the flaps and then land the aircraft with the flaps lowered in the takeoff position.

49. Upon overflying the outer beacon, descend in such a way that the inner beacon would be overflown at an altitude of 60 - 80 m and airspeed of 330 - 340 km/h.

Having overflown the inner beacon, glide on a path providing for aircraft descent into a point located at a distance of 150 - 200 m to the runway threshold. Maintain an airspeed of 330 km/h down to the moment of flareout beginning.

WARNING. Before a signalling system capable of indicating normal engagement of the BLC system is installed on the aircraft, the gliding and the flareout beginning speed should be not less than 330 km/h.

The speeds of overflying the outer and inner beacons and the initial flareout speed should be increased by 10 to 15 km/h when the aircraft is coming in to land with bombs, C-24 rockets and/or some other heavy external stores on board.

Landing on Concrete Runway

50. Having ascertained that your estimation is correct and having checked the airspeed, from an altitude of 20 to 30 m shift your glance forward and to the left of the direction of aircraft descent.

From an altitude of 8 to 10 m (depending on the vertical speed of descent), pull the control stick back in a smooth manner, to reduce the angle of glide so as to bring the aircraft to the ground (discontinue the descent) at a height of about 1 m. In the course of flareout smoothly decrease the engine speed by shifting the throttle lever to the BLC gate.

WARNING. The throttle lever must not be shifted behind the BLC gate before the aircraft touches down.

As the aircraft is descending in the course of holding-off, pull the stick back smoothly at first, and then, just before the aircraft touches the ground, pull the stick more vigorously (proportionately to the aircraft rate of descent), because the aircraft develops a tendency to lower the nose intensively 1.5 to 2 s before touching the ground.

51. In the case of a normal landing profile and normal landing weight the aircraft would touch down at a speed of 260 to 280 km/h, with the control stick pulled practically all the way back.

The touchdown speed and the landing roll length, with or without the use of the drag chute, depending on the aircraft weight and the atmosphere conditions, can be determined with the help of the nomograms given in Figs 11 and 12.

When insufficient back pressure is applied to the control stick (the landing attitude being less than recommended), the aircraft will touch down at an excessive speed with resultant increase of the landing roll length.

52. After touchdown, hold the control stick in the same position as at the moment of touchdown, looking in the same direction as during holding-off.

As soon as the aircraft starts rolling steadily, shift the throttle lever to IDLE, smoothly lower the nosewheel, shift your glance forward, retract the flaps and start brake application by smoothly pressing the brake lever; increase the pressure in the wheel brake system lever as the rolling speed and distance to the end of the runway decrease. If necessary, deploy the drag chute. To shorten the landing roll, the brake lever may be fully depressed at the very beginning of brake application.

53. After completing the landing roll, disengage the nosewheel brake and the AFCS (if engaged); switch off the pitot-static tube and periscope heating, clear the runway and jettison the drag chute.

54. When landing onto a moist or ice-coated runway, press the brake lever (in a smooth manner) immediately after lowering the nosewheel, and do not fail to deploy the drag chute. If the aircraft tends to yaw during the second half of the landing roll, decrease the pressure in the brake system, depending on the remaining length of the runway (during landing roll on a runway partially coated with ice, the anti-skid unit will not prevent wheel skidding at a rolling speed of 20 to 30 km/h).

55. In exceptional cases (say, considerable overshooting in landing on a short runway) it is allowed to reduce the landing roll length by deploying the drag chute at an altitude of not more than 1 m (if the pilot has sufficient skill in landing with the BLC system).

Once the parachute canopy gets inflated, some slight jerk is felt, followed by intensive descent of the aircraft. Under these conditions landing takes place at a speed of about 250 km/h (if the aircraft landing weight is 6500 kgf).

If the drag chute fails to deploy in landing on a short runway or in landing with a considerable overshoot, reduce the landing roll length by smoothly lowering the nosewheel on the runway (during 1 - 2 s) right after touchdown, fully depressing the brake lever, retracting the flaps and shutting down the engine if required.

In case the aircraft rolls off the runway and there is an immediate danger of colliding with some obstructions, or the pilot's life is endangered in some other way, jettison the collapsible canopy and retract the landing gear.

56. Should it be necessary to perform emergency landing immediately after takeoff (upon jettisoning all external loads), the airspeeds of overflying the outer and inner beacons and the flareout initial speed should be increased by 15 to 20 km/h as compared to those specified for normal landing weights, whereas the touchdown speed will amount to 290 - 300 km/h.

Under these conditions touchdown should be accomplished in the normal landing attitude, with greater caution. After lowering the nosewheel, deploy the drag chute at a speed of not more than 320 km/h and fully depress the brake lever in a smooth manner. After the flight perform aircraft rigging and inspect the landing gear.

57. Should the brakes fail, or if a brake is abruptly applied to one of the wheels when the brake lever is actuated, proceed as follows:

(a) release the brake lever, immediately deploy the drag chute and retract the flaps;

(b) disengage the anti-skid unit and smoothly depress the brake lever to apply the brakes; increase the pressure in the wheel brake system as the rolling speed and remaining length of the runway decrease.

If the aircraft fails to be decelerated after the anti-skid unit has been disengaged (as a result of failure of the main braking system), shut off the engine after deploying the drag chute, and resort to the emergency braking system. When using the emergency brake lever, bear in mind that its initial travel is idle. Brake application should be accomplished by smoothly pulling the handle; increase the brake pressure as the aircraft is being decelerated, depending on the remaining length of the runway.

Peculiarities of Runway Approach and Landing with Flaps in Takeoff Position

58. Lower the flaps in the takeoff position on the base leg, during descent at a speed of 500 km/h (check them for extention, referring to the appropriate light in the LG/flaps position indicator) and set up an airspeed of 450 km/h.

WARNING. If the aircraft starts banking rapidly at the moment of flaps extension, retract the flaps at once, go round again (if the conditions permit it), approach and land the aircraft with the flaps up, following the directions of Para. 77.

Note. It is possible to land the aircraft when the flaps are not symmetrically extended to the takeoff position. The rolling tendency in this case should be counteracted by deflections of the ailerons and rudder. The rudder should be deflected to such an extent that before flareout, at a speed of 360 km/h, the ailerons would be deflected (opposite to the bank) through not more than half of their full deflection. Then the airspeeds of overflying the outer and inner beacons, the flareout initial speed and the touchdown speed should be increased by 20 to 30 km/h as compared to those specified for runway approach and landing with the flaps lowered in the takeoff position.

59. Perform the final turn at an airspeed of 450 km/h. After the final turn has been completed, set up an airspeed of 400 to 420 km/h. Recover from the final turn at an altitude of not less than 200 m.

If the final turn recovery altitude is 250 to 300 m and the distance to the runway threshold is 5 - 6 km, the glide path will be of normal steepness. When flying over the outer beacon at an altitude above 200 m and/or at an airspeed above 450 km/h, do not shift the throttle lever below the BLC stop, lest this may involve a sharp decrease of the airspeed and substantial loss of altitude (due to opening of the jet nozzle).

60. In the course of descent smoothly reduce the airspeed so as to overfly the outer beacon at an altitude of 200 m and airspeed of 400 to 420 km/h, and overfly the inner beacon at an altitude of 50 to 70 m and airspeed of 350 to 360 km/h.

After overflying the inner beacon, adjust the glide path so that the aircraft would be descending into a point located at a 200 - 250-m distance to the runway threshold. Set up an airspeed of 330 - 340 km/h by the beginning of flareout.

61. When at an altitude of 8 to 10 m, smoothly pull the stick back to reduce the angle of glide so as to bring the aircraft to the ground (discontinue the descent) at a height of about 1 m. In the process of flareout, as the aircraft is nearing the ground, smoothly decrease the engine speed, retarding the throttle to not below the BLC gate (which corresponds to the LP rotor rpm of 50 to 52%). The flareout over, shift the throttle lever to IDLE.

62. In the case of a normal landing profile and normal landing weight the aircraft would touch down at a speed of 280 - 300 km/h.

The touchdown speed and the landing roll length, with or without the use of the drag chute, depending on the all-up weight and the atmosphere conditions, can be determined from the nomogram of Fig. 13.

When the aircraft starts rolling steadily, smoothly lower the nosewheel on the runway, shift your glance forward and start braking the LG wheels by smoothly pressing the brake lever; increase the pressure in the wheel brake system as the rolling speed and distance to the end of the runway decrease.

If required, deploy the drag chute (at a speed of not more than 320 km/h).

When the aircraft lands at an angle of attack smaller than recommended, the touchdown speed will be too high and the length of landing roll will be increased.

63. When landing on a short runway, or when your landing estimation is erroneous (bringing about overshoot), reduce the landing roll length by smoothly lowering the nosewheel (during 1 - 2 s) right after touchdown, deploying the drag chute at a speed of not more than 320 km/h, fully depressing the brake lever and retracting the flaps.

Note. While landing on a short runway, the flaps being in the takeoff position, extend the air brakes in gliding on the final leg so as to make landing estimation easier.

Go-Around

64. Go-around with the BLC system on is possible from any altitude, down to the initial flareout altitude. However, to ensure due safety, the decision to go around should be taken at an altitude of not less than 70 m in gliding with the normal landing weight, or at an altitude of not less than 100 m in gliding with the all-up weight in excess of 6800 kgf. Having taken the decision to go around, proceed as follows:

(a) without changing the angle of glide, open the throttle to obtain full throttle engine power;

(b) as the airspeed increases, reduce the glide angle so as to bring the aircraft in level flight at an airspeed of 340 to 350 km/h, then reverse to climbing (it should be remembered that the time of aircraft acceleration, with the BLC system on, increases considerably due to reduction of the engine thrust and growth of drag with the flaps full down);

(c) once the aircraft starts climbing, retract the landing gear, then proceed to climb at a 340 to 350-km/h airspeed;

(d) when at an altitude of not less than 150 m, increase the speed up to 380 - 400 km/h by reducing the climb flight path angle, retract the flaps and repeat the runway approach.

WARNINGS: 1. The aircraft must not be accelerated to the speed of 360 km/h at a low altitude, because automatic cutoff of the BLC system takes place at this speed, entailing aircraft sinking by 25 - 30 m and lateral oscillations.

2. Watch the speed when going round again with the BLC system on.

3. Premature recovery of the aircraft from gliding may result in major loss of speed and altitude.

In the case of going around with a high all-up weight (over 6800 kgf), the aircraft gains speed very sluggishly; then it is allowed to intentionally disengage the BLC system by accelerating the aircraft to a speed of 380 - 400 km/h and retracting the flaps at an altitude of not less than 100 m.

65. In case the decision to go around is taken after some delay, increase the engine speed to maximum while proceeding with the landing, until touchdown, after which depart from the ground upon gaining the required speed.

66. Going round again with the flaps in the takeoff position is practicable from any altitude, down to the altitude of flareout beginning. Yet, it is advisable to adopt the decision to go around at an altitude of not less than 30 m in gliding with the jet nozzle closed, or not less than 150 to 180 m in gliding with the nozzle open. Then the runway will be overflown at a height of 10 to 15 m.

Having adopted the decision to go round again, proceed as follows: without changing the angle of glide, open the throttle to maximum rpm; as the airspeed increases, reduce the glide angle so as to smoothly bring the aircraft in level flight at an airspeed of 360 to 380 km/h, then reverse to climbing after reaching the 400-km/h airspeed. Once the aircraft starts climbing, retract the landing gear, and retract the flaps when the altitude is not less than 100 m.

Engine Shutdown at Parking

67. After taxiing in to the parking, switch off all loads (leaving the SERVICE TK PUMP and FULL THROTTLE, REHEAT circuit breakers closed) and shift the throttle lever to SHUT-OFF. This done, before the engine rotors come to rest, turn off the BAT., EXT., PWR SUP. switch, SERVICE TK PUMP circuit breaker and FULL THROTTLE, REHEAT circuit breaker.

FLIGHT WITH PARTIALLY FILLED FUEL TANKS

68. It is allowed to take the aircraft into the air with the fuel tanks filled partially in order to perform circuit flights, flights for practising instrument letdown and other short-duration flights as well as flights involving takeoff with heavier external loads (not to exceed the maximum permissible takeoff weight). Then the fuel fill should correspond to the flying mission, but it must not be less than 1400 - 1500 L.

The amount of fuel contained in the tanks shall be checked on the ground, before starting the engine, by turning on the No. 1 TK GP PUMP circuit breaker for 2 to 3 min. In this case the No. 1 TK GP EMPTY and 450 L FUEL REMAINING lights should not illuminate in the light panel.

In flight, the lights indicating fuel consumption from individual groups of tanks should flash up at the same fuel levels as when the system is filled to capacity. After the 450 L FUEL REMAINING light flashes up, turn on the No. 3 TK GP PUMP circuit breaker to allow transfer of any remaining amount of fuel.

The fuel system may be filled partially for not more than four times in succession, after which the system should be filled to capacity.

FLIGHT WITH DROP TANK ATTACHED

69. Flight with a ventral drop tank of the 490-L or 800-L capacity, within the range of operating altitudes, airspeeds and Mach numbers, does not differ essentially from flights where no drop tanks are carried (except some specific features that are mentioned in Subsection "Brief Information on Aircraft Stability and Controllability"). As soon as the entire amount of fuel is drawn from the drop tank, the VENTRAL DROP TK EMPTY light should flash up in the light panel.

Handling of the aircraft carrying two wing drop tanks is essentially much the same as handling of the aircraft carrying one ventral drop tank. In flight with two or three drop tanks, the aircraft experiences more persistent lateral oscillations at maximum permissible Mach numbers, and more pronounced roll reaction to rudder deflection (i.e. roll with yaw) is observed in the entire range of operating airspeeds.

When all usable fuel is consumed from the wing drop tanks, the WG DROP TKS EMPTY light comes on in the light panel.

Given in Table 8 are the sequence of illumination of signal lights indicating completion of fuel consumption from the respective tank groups, and the fuel amounts at that time as indicated by the fuel gauge.

WARNING. If the fuel-consumption signal lights come on at larger fuel amounts, or if they fail to come on at smaller fuel amounts than those specified in Table 8, it means that fuel is not being consumed from the drop tanks.

If fuel is not used up from the drop tanks, they should be jettisoned lest the aircraft might develop g-load instability (when the fuel gauge reads a fuel remainder of at least 2500 L in flight with two drop tanks, or at least 3000 L in flight with three 490-L drop tanks).

It is allowed to jettison empty or full wing drop tanks that were not modified and the 490-L ventral drop tank (containing any amount of fuel) in straight, slipless flight at an airspeed of not more than 1000 km/h and Mach number not over 1.6 M.

WARNING. When non-modified wing drop tanks are being dropped containing some unconsumed fuel, they may get turned nose-up and kick against the aircraft.

It is allowed to jettison modified wing drop tanks (containing any amount of fuel) in slipless flight at a speed of not more than 1000 km/h or Mach number not over 1.6 M, the g-load not exceeding 3 g.

The 800-L ventral drop tank may be dropped (with any amount of fuel therein) in straight-and-level flight without sideslipping, at airspeeds of 600 to 1000 km/h, the Mach number not exceeding 1.6 M.

For jettisoning the ventral drop tank, depress the respective button on the control stick. Check for dropping of the tank by watching the VENTRAL DROP TK ATCHD light that should go off in the light panel on the instrument board lower section.

The wing drop tanks are jettisoned when the WG DROP TK JETT. (СБРОС КР. БАКОВ) button is depressed on the instrument board. Check for dropping of the tanks by referring to the OUTB. STA. 3 and OUTB. STA. 4 lights which should go off in the light panel. When the drop tanks are jettisoned, check the fuel remaining on board by watching the signal lights of the No. 1 and No. 3 tank groups as well as the warning light of the emergency fuel remainder.

Note. After a full ventral drop tank has been jettisoned, the amount of fuel available on board will be either 500 L or 800 L less than the reading of the fuel gauge (depending on what tank has been dropped), or 1000 L less in case full wing drop tanks have been jettisoned.

PECULIARITIES IN TAKEOFF AND LANDING PERFORMANCE

Jet-Assisted Takeoff

70. When inspecting the aircraft and cabin before flight, the pilot, apart from fulfilling the requirements of Para. 4, should check to see that the JATO unit start electrical cables are disconnected from the aircraft, the bodies of the JATO units have no external damage, and he shall find out the airspeed of starting the JATO units which has been set in by the technician on the CCA instrument (airspeed warning unit).

After taking the seat in the cabin, when the electrical supply is ON, in addition to fulfilling the requirements of Para. 10, check to ensure that the PORT JATO and STBD JATO (УСКОРИТ. ЛЕВ., ПРАВ.) lights are shining.

Having started the engine and checked the aircraft systems, make sure that the JATO START (ПУСК УСКОР.) and JATO JETT. (СБРОС УСКОР.) circuit breakers are turned off; then order the technician to connect the JATO unit start electrical cables to the aircraft.

On lining up on the runway and obtaining the permission to take off, switch on the JATO START and JATO JETT. circuit breakers. The PORT JATO and STBD JATO lights should be shining at this time.

71. Open the throttle to obtain the maximum rpm while holding the aircraft against the brakes, set the throttle lever to FULL REHEAT, ascertain that the afterburner has really caught up, then smoothly release the wheel braking lever and as soon as the aircraft starts moving steadily (as to direction), pull the stick back through 3/4 of its travel.

The JATO units will be started automatically once the airspeed set in on the CCA airspeed warning unit is reached.

If the condition of the runway surface would not permit holding the aircraft against the brakes at full throttle, release the braking lever the moment the aircraft starts moving (taking care to prevent skidding), while carrying on opening the throttle. Turn on full reheat in the process of takeoff run and make sure it is really on.

<u>WARNING.</u> For automatic start of the JATO units, their switch-on airspeed should exceed the headwind velocity component (directed along the runway) by at least 15 km/h. If the JATO unit switch-on speed, determined from the nomogram of Fig. 14, exceeds the headwind velocity component by less than 15 km/h, the JATO units must be started manually, by means of the JATO START button which shall be depressed when the aircraft starts moving steadily as to direction.

<u>Note.</u> If the automatic JATO start system is not to be used, compute the distance (before flight) which the aircraft will cover in takeoff run by the time the speed for manual start of the JATO units is reached. A prominent mark should be placed at this distance beside the runway, and once abeam of this mark, the pilot shall push the JATO START button.

Engagement of the JATO units is sensed by a considerable growth of forward acceleration, and also a specific noise appears. With the units ON, the aircraft runs on the ground for 7 to 9 s. To set up the takeoff pitch attitude, the pilot has to apply back pressure to the stick, and the pull forces are somewhat higher than in unassisted takeoff.

The aircraft gets airborne at an airspeed of 340 - 350 km/h when the normal takeoff pitch attitude is maintained. When airborne, the aircraft is laterally and longitudinally stable.

WARNING. Jet-assisted takeoff at night is forbidden.

72. When the aircraft reverts to climbing, set the LG control valve for LG retraction.

At an altitude of not less than 20 - 25 m and airspeed of 370 - 380 km/h, make a turn at a bank of 20 - 30° towards the strip allotted for JATO release. Having performed the turn and having ascertained (by a sharp reduction of forward acceleration) that the JATO units are through with their operating cycle, jettison the units by depressing the JATO JETT. button.

If the strip allotted for JATO release is straight ahead of the runway, jettison the units on passing the established line, when the LG control valve has been set for LG retraction, the JATO units have ceased operation and the altitude of at least 25 m has been reached.

The aircraft speed by this time (when the units are being released under such conditions) is 380 to 450 km/h and the altitude is 30 to 50 m.

While releasing the JATO units, prevent sideslipping through more than 2 diameters of the slip indicator bubble. Jettison of the JATO units is monitored by extinction of the PORT JATO and STBD JATO lights.

Should the JATO units fail to get jettisoned, try it over again, making a run of the jettison strip at an altitude of 50 to 100 m and airspeed of 500 to 550 km/h. If the units have failed to release another time, build up a positive g-load of more than 1 g at the time of pushing the JATO JETT. button; but do not exceed the 750-km/h airspeed by that time.

If all attempts at releasing the JATO units have proved unsuccessful, report the fact to the flying control officer and make a decision to land with the units unreleased. Then the fuel amount at the time of landing has to be some 200 L less than the amounts specified in Items 9 and 10 of Table 6 (for account of the weight of the unit bodies).

73. Should both JATO units fail to start, abort the takeoff procedure, using all the available means in order to stop the aircraft within the runway limits.

If a decision is made to cancel takeoff before the JATO units have started functioning, retard the throttle lever off the FULL REHEAT stop so as to prevent the units from switching on automatically. Cut out the JATO START and JATO JETT. circuit breakers before clearing the runway.

Failure of one of the units to engage is sensed by a slower growth of airspeed and development of a minor yawing moment towards the dead JATO unit.

Note. Jet-assisted takeoff with only one unit functioning is practicable, provided the runway usable length permits unassisted takeoff of the same aircraft; yet, the pilot must be more cautious in such a takeoff. Counteract yaw by applying rudder, lift off the nosewheel at the same airspeed as in unassisted takeoff. Having lifted the nosewheel off the runway, maintain the normal takeoff pitch attitude, preventing the aircraft from peeling off the ground at an insufficient airspeed.

Inadvertent Start of JATO Units

74. Proceed as follows if the JATO units have started functioning inadvertently and the aircraft is on the runway:

(a) if the JATO units have got engaged before the beginning of takeoff run, abort the takeoff procedure and use the runway for letting the units complete their operating cycle while the aircraft is moving on the ground;

(b) if they have got engaged inadvertently in the process of takeoff run, continue taking off.

Peculiarities of Crosswind Takeoff and Landing

75. Crosswind takeoffs and landings are allowed provided the crosswind velocity component does not exceed 15 m/s.

A crosswind component of up to 10 m/s will have no practical effect on the takeoff procedure. The aircraft retains directional stability and displays no tendency to yaw.

In taking off with a crosswind component of or over 10 m/s, the aircraft tends to bank and yaw with the wind during takeoff run. Counteract yaw by applying the brakes at the beginning of takeoff run, then use the rudder for the purpose. Deflect the ailerons to oppose banking of the aircraft. As the aircraft picks up speed, the tendency to bank and yaw diminishes, therefore, as the speed increases, sideways pressure on the control stick as well as rudder deflection should be so decreased that by the moment the aircraft unsticks, the ailerons and rudder are deflected to angles sufficient for maintaining the direction and counteracting the aircraft tendency to bank.

Nosewheel liftoff should be accomplished in the same manner as in no-wind takeoff; unsticking should be performed at a speed by 10 to 15 km/h higher than the normal speed of unsticking. After unsticking do not allow the aircraft to bank or deviate from the takeoff direction.

After retracting the landing gear and flaps, make a smooth correction turn to the wind through the crab angle.

WARNING. It is forbidden to take off carrying one bomb of up to 250-kg caliber (or one C-24 rocket) on the lee-side inboard station when the crosswind component is stronger than 8 m/s.

76. Landing with a crosswind component of up to 10 m/s presents no difficulty. While gliding in final approach, counteract drift by crabbing alone or by crabbing combined with sideslipping.

When the crosswind component amounts to 10 - 15 m/s, the pilot should exercise greater caution in landing; in final approach, drift should be counteracted by crabbing. The gliding speed for overflying the outer and inner beacons, and for flare initiation, should be increased by 10 to 20 km/h.

By the end of holding-off gradually reduce sideslipping or the crab angle so as to ensure that two-point touchdown is accomplished without skidding or bank, with the rudder set in the neutral position.

After touchdown, smoothly lower the nosewheel in order to increase directional stability; start brake application, after which deploy the drag chute.

WARNINGS:

1. Deployment of the drag chute during landing roll will result in a jerk in the direction of the wind, which should be counteracted by applying the brakes and deflecting the ailerons. The drag chute may be deployed at a crosswind component of not more than 10 m/s.
2. If there is a crosswind component and it is required to deploy the drag chute before touchdown, land the aircraft only with the AFCS engaged in the STABILIZATION mode. If the crosswind component is stronger than 10 m/s, it is forbidden to deploy the drag chute before touchdown, because then the aircraft may touch the ground with a drift.
3. The pilot should bear in mind that when landing is accomplished in a crosswind component of up to 10 - 15 m/s, the landing roll length will increase by 20 to 30%.

Flaps-Up Landing

77. Flaps-up landing is allowed only in case the flaps fail to extend (owing to the hydraulic system failure, aircraft rolling in response to flap extension, etc.).

When performing flaps-up approach, start the base-leg turn at a radio beacon relative bearing of 240° (120°) and proceed turning through an angle of 100 to 110°, maintaining an airspeed of 500 km/h; glide on the base leg and perform the final turn at an airspeed of 470 km/h.

Having completed the final turn, establish an airspeed of 430 to 450 km/h and gradually decrease the airspeed so as to overfly the outer beacon at an altitude of 150 to 180 m and an airspeed of 430 to 440 km/h, and the inner beacon at an altitude of 40 to 60 m and an airspeed of 370 to 380 km/h.

After overflying the inner beacon, glide on a path providing for aircraft descent to a point located at a distance of 250 to 300 m from the approach end of the runway. By the moment of flareout initiation establish an airspeed of 350 to 360 km/h.

When gliding with the flaps up, the aircraft acquires much higher angles of attack, which hampers the pilot to view forward.

When the flaps are retracted, holding-off takes much longer time than that during landing with the flaps in the takeoff position. In the course of holding-off it is advisable to throttle the engine down to the idle speed when over the runway.

The landing speed with the flaps up amounts to 330 km/h when the landing weight is normal; therefore, it is practical to land with the minimum fuel remainder in this case.

After touching down and lowering the nosewheel, fully depress the braking lever, and deploy the drag chute at a speed of not more than 320 km/h.

The landing over, it is advisable to inspect the landing gear.

METHODS OF RUNWAY APPROACH WITH USE OF INSTRUMENT LANDING SYSTEMS

Runway Approach with Use of POLYOT-OИ System

78. Before flight where the POLYOT-OИ system is to be employed, do the following preparatory to taxi out:

(a) check to ensure that the PCБH-ARC, NAVIG. - LETDOWN - LDG and GS PF: AIR - GROUND switches are set in the PCБH, NAVIG. and AIR positions, respectively;

(b) adjust the set course pointer of the CCI to the runway approach heading;

(c) check the PCБH equipment for serviceability, referring to the stable output of navigational information (i.e. the azimuth and distance) and to illumination of the AZIMUTH, DISTANCE and UPDATE indicator lights;

(d) if the AFCS is to be used in flight, check to ensure that the AFCS circuit breaker is ON.

Wide Rectangular Approach

79. It is advisable to fly the wide rectangular pattern at an altitude of 600 m; then the STABILIZATION mode may be used before the automatic runway approach mode is selected.

Note. It is much easier to perform runway approach in the manual and command control modes when the AFCS is engaged in the STABILIZATION mode.

Proceed as follows after takeoff:

(a) on the intowind leg, retract the landing gear and flaps, and set up an airspeed of 600 km/h; climb at a rate of 10 to 15 m/s;

(b) when at a distance of 5 to 7 km from the navigational beacon, start the crosswind turn (through 90°) at a bank of 30°.

Having completed the turn, fly on the crosswind leg till the moment when the azimuth end (i.e. tail) of the relative bearing pointer coincides with the downwind turn commencement index (marked "2"). Then start the turn to the downwind leg; carry out the turn at a bank of 30°. The distance to the beacon by the time of downwind turn initiation should be 14 to 15 km.

When abeam of the navigational beacon (the distance to the beacon should be 12 to 14 km) report the fact to the flying control officer, reduce the speed to 550 km/h, extend the landing gear and set up an airspeed of 500 km/h.

When the tail of the relative bearing pointer comes in coincidence with the base leg turn commencement index (marked "3"), start the turn at a bank of 30°. The distance to the navigational beacon at the time to start the base leg turn should be 23 to 25 km.

Once the tail of the relative bearing pointer comes in line with the final turn commencement index (marked "4"), at a distance of 17 to 21 km to the runway, start the final turn at a bank of 30°. Place the NAVIG. - LETDOWN - LDG switch in the LDG position: the UPDATE: AZIMUTH pilot lamp will die out, the CCI failure warning flags should close their (localizer and glide path channel serviceability) windows, and the vertically- and horizontally-disposed position bars of the CCI and FDI should start functioning.

The UPDATE indicator light will die out 1.5 min since selection of the LANDING mode, whereas the UPDATE: DISTANCE light should continue to burn.

<u>Runway Approach in Command Control Mode</u>

80. When the CCI localizer channel failure warning flag closes its window, the tail of the relative bearing pointer coinciding with the final turn commencement index (the relative bearing pointer deflecting from the set course pointer by 10 to 12°), depress the COMD CTL button light, check for disappearance of the R(K) roll channel failure warning flag on the FDI and bring the aircraft in line with the runway, making the final turn at a bank of 30°. Handle the aircraft in the process of the final turn so that the relative bearing pointer matches the set course pointer by the time the airplane is brought onto the landing course; 30° before intercepting the (landing) runway approach course, revert to handling the aircraft by the command control pointers, keeping them within the limits of the simulated aircraft position (central) circle.

<u>Note</u>. The pilot will bring the aircraft on the landing course too early if he starts handling the plane by the command control pointers since the very beginning of the final turn.

Deflection of the command control pointers shows the direction in which the pilot has to alter the bank value or the pitch angle value (altitude), i.e. it shows the pilot the direction in which he has to deflect the control stick so as to intercept the assigned flight path in the best way.

When on the runway approach course (on the final leg), set the PCБH-ARC switch to ARC in order to use the radio compass for monitoring the runway approach accuracy; lower the flaps to the takeoff position and set up an airspeed of 450 km/h.

Check for accuracy of runway approach by referring to the CCI and FDI position bars, altimeter, radio compass and other flying and navigational instruments. The localizer position bars of the CCI and FDI will move from the leftmost or rightmost position towards the indicator center as the aircraft is intercepting the localizer beam; and once the airplane has intercepted the beam, they will settle within the limits of the simulated aircraft position circle.

When the airplane crosses the glide path transmitter beam center line (at a distance of 12 to 14 km), follow the appropriate command pointer of the FDI to commence descent (the glide path position bars of the CCI and FDI should smoothly move down into the limits of the simulated aircraft position circle); then handle the plane so that the command control pointers are kept within the limits of the central circle.

When at a distance of 8 to 10 km (at an altitude of 400 to 500 m), push the flaps landing-position extension button and start smoothly reducing the speed so that it would reach the 360 to 380-km/h value by the time the aircraft is at a distance of 5 to 6 km to the runway (at an altitude of 250 to 300 m).

On reaching the 360 to 380-km/h airspeed, check to ensure that the BLC system is functioning normally (when it is operating normally, the angle of attack by the УУА-1 indicator diminishes by 2 to 2.5^{o} as compared to the angle of attack that was at the same speed before engagement of the BLC system).

While descending on the glide path, check the altitude and distance to the runway, which should comply with the figures given in Table 11.

Table 11

H(m)	600	400	200	100	50
D(km)	12 - 14	8 - 9	4	2	1

Notes: 1. Should the glide path channel failure warning flag disappear from its window, (the P(T) pitch channel failure warning flag appearing in view on the FDI), the horizontally-disposed command control pointer of the FDI will be commanding the pilot to maintain the altitude he had by the time of the malfunction. Then do not follow the directions of the horizontally-disposed command control pointer, but rather follow the recommended distance and altitude values of Table 11 for checking the descent regime.

2. The following simplified rule may be used for checking the correctness of the glide path descent regime: the flight altitude (in hundreds of meters) should correspond to half the distance to the runway threshold (in kilometers).

Overfly the outer homing beacon at an airspeed of 360 to 380 km/h and the inner beacon at a speed of 330 - 340 km/h.

When at an altitude of 50 - 60 m (near the inner homing beacon), depress the OFF (ОТКЛ.) button on the AFCS control panel, check visually for accuracy of the approach direction and undershoot/overshoot estimation, and carry out landing.

81. Coming in to land with the flaps down in the takeoff position (hence, without use of the BLC system), start reducing the airspeed smoothly when at a distance of 5 to 6 km to the runway (at an altitude of 250 to 300 m) so as to set up an airspeed of 400 - 420 km/h by the time when the altitude is 200 m (i.e. by the time of overflying the outer homing beacon). Overfly the inner beacon at a 360- to 380-km/h airspeed.

Runway Approach in Automatic Control Mode

82. When the CCI localizer channel failure warning flag closes its window, the tail of the relative bearing pointer coinciding with the final turn commencement index (the relative bearing pointer deflecting from the set course pointer by 10 to 12^{o}), enter the final turn, and perform the turn with reference to the relative bearing pointer and set course pointer; 30^{o} before intercepting the runway approach course, depress the COMD CTL button light and check for disappearance of the R(K)

roll channel failure warning flag on the FDI. Set the command control pointers within the limits of the simulated aircraft position (central) circle, then depress the AUTO CTL button light.

Notes: 1. Relieve the stick forces, using the pilot's trim for the purpose, before selecting the automatic approach control mode; do not apply pressure to the stick once automatic control is ON (the AUTO CTL light shining).

2. If automatic control is selected at the very beginning of the final turn performance, the airplane will be automatically recovered from the turn some 18 to 20° before intercepting the runway direction, and it will carry on flight at that angle to the runway center line, completing interception of the localizer beam at a distance of 6 to 8 km to the runway.

3. It is permissible to engage the automatic control mode without preliminary selection of the command control mode, but then, after pushing the AUTO CTL button light, discontinue manipulating the control stick only when the command control pointers have settled within the limits of the central circle, otherwise the plane may start banking vigorously.

4. If the pilot is too late to carry out the final turn, automatic interception of the localizer beam will be completed somewhat later, when the aircraft is near the outer beacon already.

Once the automatic control mode has been engaged, the aircraft will automatically intercept the localizer beam (with a certain readjustment) at a distance of 10 to 12 km to the runway, and the system will begin to stabilize the flight altitude that was at the time when the AUTO CTL button light was pushed.

Set the PCБH-ARC switch in the ARC position upon interception of the runway approach course.

Before intercepting the glide path transmitter beam (at a distance of 14 and 15 km to the runway threshold), make sure that the P(T) pitch channel failure warning flag has disappeared from view on the FDI.

At a distance of 12 to 14 km to the runway, as the aircraft is crossing the center line of the glide path transmitter beam, the airplane will automatically intercept the glide path transmitter beam and begin to descend at a rate of 5 to 8 m/s; the horizontally-disposed (glide path) position bar of the CCI may deflect downward of the aircraft simulated position circle as far as the fourth dot while the plane is beginning the descent.

Lower the flaps and approach to land (with or without the use of the BLC system) in the automatic control mode at the same airspeeds as in the command control mode.

WARNING. Throughout the landing approach in automatic control, be sure to timely adjust the run of the engine in accordance with the variation of the flying conditions and after lowering of the flaps, never allowing the loss of speed.

When at an altitude of 50 to 60 m, depress the OFF button on the AFCS control panel, check visually for accuracy of the approach direction and overshoot/undershoot estimation, and carry out landing.

The command control pointers should be within the limits of the central circle in the process of automatic runway approach, the AFCS operating normally; check the progress of runway approach, referring to the position bars of the FDI and CCI, ARC, altimeter and other flying and navigational instruments as well as to appropriate signals.

In the process of descent along the glide path, check for correct maintenance of the required altitude and distance in accordance with Table 11.

<u>WARNING</u>. Should the glide path channel failure warning flag disappear from its window (the FDI pitch channel failure warning flag appearing in view), the aircraft will automatically revert to level flying at an altitude at which the failure occurred; then the horizontally-disposed command control pointer will stay within the limits of the central circle. In this case follow the directions of Para. 83 to continue approach and land the aircraft, or use the radio compass for the purpose.

Should the localizer channel failure warning flag disappear from its window (the FDI roll channel failure warning appearing in view), the automatic approach mode will get disengaged (the AUTO CTL button light going out) and the aircraft will continue flying with the course and pitch angle that it had by the moment the malfunction occurred.

If the localizer channel failure warning flag has closed its window in the CCI, engage the automatic approach control mode another time, by pushing the AUTO CTL button light again; if this button light fails to illuminate in response to pushing, press the OFF button located on the AFCS control panel,and carry on the landing approach by the position bars or by the radio compass.

If the window of the CCI localizer channel failure warning flag is open, depress the OFF button on the AFCS control panel and carry on the landing approach by the radio compass.

<u>Runway Approach by CCI Position Bars</u>

83. When the CCI localizer channel failure warning flag closes its window, the tail of the relative bearing pointer matching the final turn commencement index in the instrument, bring the aircraft into the final turn at a bank of 30°. In the process of the turn, match the circle at the relative bearing pointer tail with the localizer (vertically-disposed) position bar; so handle the plane in the course of the turn that before the localizer position bar enters the limits of the aircraft simulated position circle, this bar would be matched all the time with the circle of the relative bearing pointer tail (Fig. 35).

Upon intercepting the runway approach course, set the PCBH-ARC switch to the ARC position, lower the flaps to the takeoff position and make a correction turn to obtain the zero relative bearing (RB = 0°). Should the localizer position bar begin to deflect to the left (right) in the process of the final approach, reduce (increase) the heading by 3 to 5° and maintain the new heading until the bar starts moving to the central (i.e. the aircraft simulated position) circle of the CCI. When the bar enters the limits of the circle, diminish the landing (runway) approach course correction to obtain such a heading that the localizer position bar is kept within the limits of the aircraft simulated position circle.

<u>Note</u>. Fly on the final leg before intercepting the glide path transmitter beam, at an altitude of 600 m.

Going to intercept the glide path transmitter beam (at a distance of 14 - 15 km to the runway), check to ensure that the glide path channel failure warning flag has closed its window in the CCI. As the glide path (horizontally-disposed) position bar is approaching the aircraft simulated position circle (at a distance of 12 to 14 km to the runway), smoothly bring the airplane into descent at a rate of 5 to 8 m/s; carry on flying while keeping both CCI position bars within the limits of the central circle.

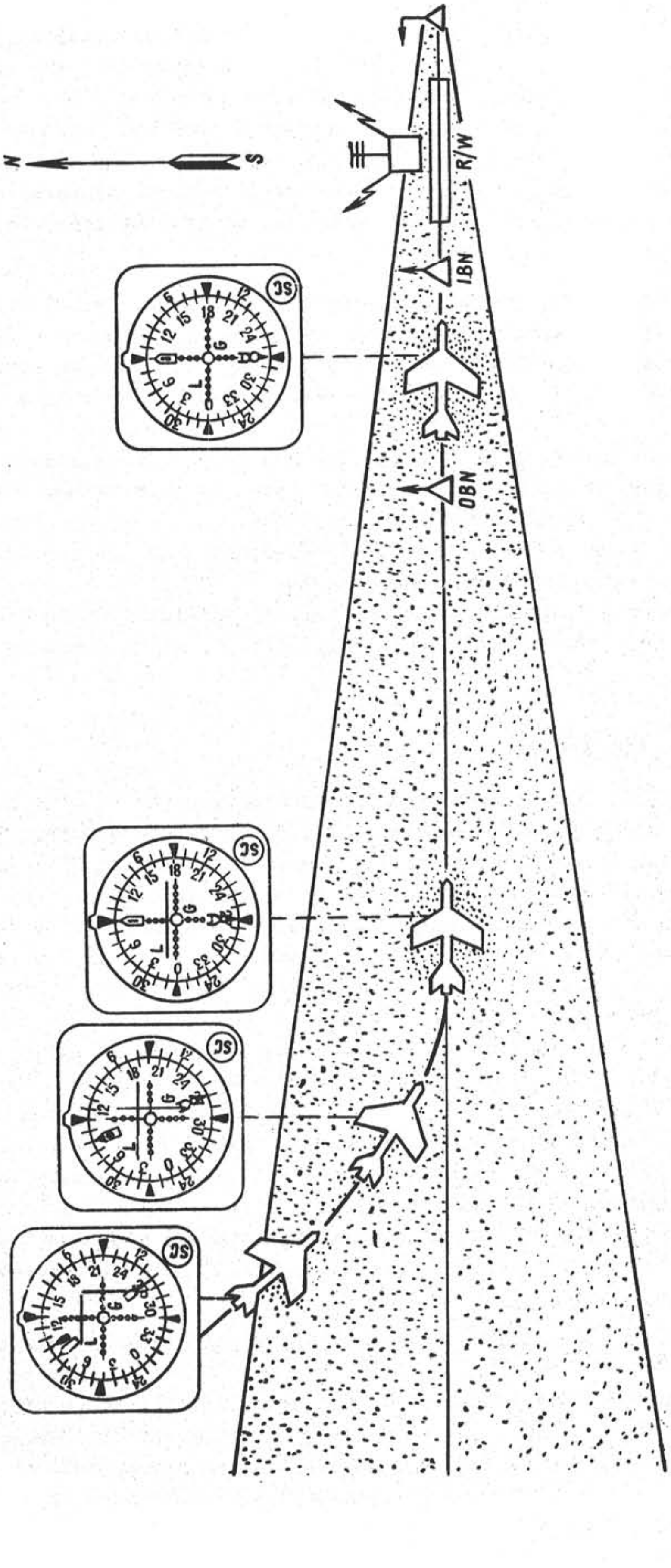


FIG. 35. RUNWAY APPROACH BY CCI POSITION BARS

Should the glide slope position bar begin to deflect down (or up) in the process of gliding upon the aircraft interception of the glide path transmitter beam, then increase (or reduce) the rate of descent by 2 to 3 m/s and maintain the new descent rate value till the bar starts moving towards the central circle. Once the glide path position bar has come into the limits of the aircraft simulated position circle, smoothly diminish the descent rate correction to obtain such a value of the descent rate that the glide path position bar is kept within the limits of the circle.

Further on, perform landing approach, with or without use of the BLC system, at the same airspeeds as those maintained in the command control mode of approach. In the process of the approach, check for accuracy of keeping the required flight direction, referring to the radio compass, and check the progress of the descent along the glide path by referring to the figures recommended in Table 11.

When at a height of 100 m, check visually for correctness of the runway approach and overshoot/undershoot estimation, then carry out landing.

Two-180°-Turns Approach

84. After overflying the navigational beacon, start the downwind turn when at a distance of 5 to 7 km from the beacon. Make the turn at a bank of 30°.

The turn completed, introduce the crab angle into the heading (if required). While approaching the position abeam of the navigational beacon, set up an airspeed of 550 km/h. When abeam of the beacon, clock the time and report passing abeam of the navigational beacon to the flying control officer.

When the 23- to 25-km distance is reached, begin the final turn to the zero relative bearing (RB = 0°) at a bank of 30°.

Having completed the turn to RB = 0°, extend the landing gear and lower the flaps to the takeoff position while flying on a 30-s level leg; set up an airspeed of 450 km/h and place the NAVIG. - LETDOWN - LDG switch in the LDG position.

Once the localizer channel failure warning flag has closed its window in the CCI, set the PCБH - ARC switch to ARC, intercept the runway approach course, proceeding in the automatic, command control or manual control mode, and carry out runway approach as laid down in Paras 48 and 49.

Approach from Estimated Line

85. After fulfilling the mission, contact the flight control (and GCA) center, report your altitude and proceed flying to the letdown initiation line on the assigned course, maintaining the optimum-range airspeed.

Upon approaching the estimated line, make a correction turn to intercept the assigned course (at the command from the control center) and send the aircraft into descent, maintaining the assigned flight conditions. In the course of descent, timely respond to the commands from the control center to correct your heading and vertical speed.

Note. The direction of descent (heading) is assigned so as to bring the aircraft to an altitude of 2000 m (or to some other altitude specified for the given airfield) to a point where the turn to the runway approach heading is to be started. The rate of descent is assigned by the control center crew. For training purposes, descent to an altitude of 2000 m should be accomplished at an airspeed of 550 km/h and vertical velocity of 40 m/s.

At an altitude of 2000 m bring the airplane into level flight and then (at the command from the control center or upon reaching the assigned aircraft azimuth and distance to the navigational beacon) perform a (correction) turn to RB = 0° at a bank of 30°.

Note. Going on a mission, the pilot shall put down (into the knee-pad) the aircraft azimuths and distances to the navigational beacon at the estimated points of commencing turns to hit the landing airdrome runway approach course, or he shall receive those data over the radio from the flying control officer before coming in to land.

While proceeding on the final leg at RB = 0°, extend the landing gear on a 30-s level flight leg, establish an airspeed of 500 km/h, set the NAVIG - LETDOWN - LDG switch in the LDG position and bring the aircraft into descent at a rate of 15 m/s.

After the localizer channel failure warning flag closes its window in the CCI, set the PCБH - ARC switch in the ARC position, make a correction turn to RB = 0° and intercept the localizer beam. Upon reaching the 1000-m altitude, set up a vertical speed of 10 m/s; revert to level flying when at an altitude of 600 m, lower the flaps into the takeoff position, establish an airspeed of 450 km/h and carry out landing approach in the automatic, command control or manual control mode.

Straight-In Approach

86. Climb to the assigned flight level and fly until hitting the runway approach heading, at an airspeed of 600 km/h.

With the course setter adjusted to the assigned letdown azimuth, turn the aircraft to match the tail of the relative bearing pointer with the lubber line (fixed) index of the CCI; choose such a heading in the process of climb that the aircraft azimuth would stay the same. Use the vertically-disposed position bar of the FDI for checking the correctness of flying along the assigned track (keep the bar in the center of the aircraft simulated position circle). When some 200 to 300 m remain before climbing to the assigned flight level, commence a turn to RB = 0°, reduce the rate of climb so as to reach the assigned flight level by the time of completing the turn. This done, set the course setter pointer to RB = 0° (aligning this pointer with the thin end (tip) of the relative bearing pointer) and proceed to the navigational beacon.

The moment the navigational beacon is overflown (which is monitored by the relative bearing pointer turning through 180° and by reversal of the ППД instrument distance count), set the course setter pointer to a precalculated azimuth of flight off the navigational beacon. Then turn the aircraft so as to match the tail of the relative bearing pointer with the lubber line (fixed) index of the CCI; then keep this azimuth constant as long as reaching the precalculated initial distance of turning to intercept the runway approach course.

Note. The flying control officer shall advise the pilot the azimuth of flight off the navigational beacon and the distance to begin the turn to intercept the runway approach course; they will be given in the landing instructions.

On reaching the assigned distance, start turning to RB = 0° at a bank of 30°; lose 200 m of altitude in the first half of the turn, then set the course setter pointer to the runway approach course.

The turn to RB = 0° completed, extend the landing gear on a 30-s level flight leg, set up an airspeed of 500 km/h and send the aircraft in descent; at altitudes above 2000 m descend at a rate of 40 m/s. When at a distance of not more than 40 km, place the NAVIG. - LETDOWN - LDG switch in the LDG position.

Further actions are similar to those in landing from an estimated line.

Go-Around

87. Proceed as follows after taking the decision to go round:

(a) if the runway approach has been performed in the automatic or command control mode, disengage the respective mode of operation by depressing the OFF button on the AFCS control panel;

(b) retract the landing gear and flaps while flying on the intowind leg, send the plane into climb at a rate of 10 to 15 km/h; set up an airspeed of 600 km/h in the process of climb; place the NAVIG. - LETDOWN - LDG switch in the NAVIG. position and the PCБH - ARC switch in the PCБH position;

(c) when at a distance of 5 to 7 km to the navigational beacon, enter a turn at a bank of 30° so as to fly a wide rectangular pattern or perform landing approach by two 180° turns.

Runway Approach with Use of Radio Compass

Approach from Estimated Line

88. After fulfilling the mission, contact the flight control (and GCA) center, report your altitude and proceed flying to the letdown initiation line on the assigned course, maintaining the optimum-range airspeed.

Upon approaching the estimated line, make a correction turn to intercept the assigned course (at the command from the control center) and bring the aircraft into descent at the predetermined rate. In the course of descent, do not fail to respond to the commands from the control center to correct your heading and vertical speed.

Note. The direction of descent (heading) is assigned so as to bring the aircraft to an altitude of 2000 m (or to the altitude specified for the given airfield) to a point where the turn to the landing heading is to be started. The rate of descent is assigned by the control center crew. For training purposes, descent to an altitude of 2000 m should be accomplished at an airspeed of 550 km/h and vertical velocity of 40 m/s.

At an altitude of 2000 m bring the aircraft into level flight and then (at the command from the control center) perform a (correction) turn to the landing heading at a bank of 30°. To hit the landing course with due accuracy, vary the aircraft bank (not exceeding the 60° value); to check the approach accuracy, fulfil the control center commands and request for radio bearings.

While proceeding on the landing heading (on a 30-s level flight leg), extend the landing gear and lower the flaps in the takeoff position, establish an airspeed of 500 km/h and bring the aircraft into descent.

The vertical speed of descent on the landing heading should be as follows:

(a) 15 m/s, from an altitude of 2000 to 1000 m;

(b) 10 m/s, from an altitude of 1000 to 600 m;

(c) 5 to 7 m/s, from an altitude of 600 m to 200 m.

Establish an airspeed of 450 km/h at an altitude of 600 m.

If the landing approach is being executed on a glide path corresponding to the equisignal beam of the glide slope transmitter, perform descent (depending on the distance to the runway) so that the altitude (in hundreds of metres) equals half the distance to the runway (in kilometers). At an altitude of 300 to 400 m lower the flaps in the landing position and start gradually decreasing the airspeed so as to overfly the outer beacon at an altitude of 200 m and airspeed of 360 - 380 km/h.

If the landing approach is being accomplished on a glide path accepted for the ОСП two-beacon system, perform further descent (depending on the distance to the runway) so as to bring the aircraft to an altitude of 200 m at a distance of 6 to 8 km from the runway. After descending to an altitude of 200 m, bring the aircraft into level flight, depress the button to extend the flaps into the landing position, smoothly decrease the airspeed (in level flight) to 360 - 380 km/h and keep flying at this airspeed until overflying the outer beacon.

On attaining the speed of 360 - 380 km/h, make sure that the BLC system functions normally (when the system operates normally, the angle of attack (by the УУА-1 indicator) gets reduced through 2 - 2.5° as compared to the angle-of-attack value indicated at the same airspeed before the BLC system starts functioning).

When over the outer beacon, with the radio compass changing over automatically from the outer beacon to the inner beacon frequency, make a correction turn to the landing heading, and then to RB = 0°. Establish (or maintain) a vertical speed of 3 to 5 m/s and hold the RB = 0°; approach the inner beacon at an altitude of 60 to 80 m and airspeed of 330 to 340 km/h.

After overflying the inner beacon, check the approach direction and landing estimation visually, and perform landing. As the aircraft overflies the outer and inner beacons, the marker beacon receiver will issue the appropriate light and sound signals.

Note. If the radio compass fails to change over to the inner beacon automatically, switch it over manually, by setting the OUTER - INNER switch to INNER.

89. Coming in to land with the flaps extended into the takeoff position (when the BLC system is not used), set up an airspeed of 400 - 420 km/h after descending to the 200-m altitude and maintain that speed as far as the outer beacon. Overfly the inner beacon at an altitude of 50 - 70 m and airspeed of 360 - 380 km/h.

Straight-In Approach

90. Climb to the assigned flight level and proceed to the point of hitting the landing heading at an airspeed of 600 km/h. When 200 to 300 m remain before the aircraft has climbed to the assigned flight level, start turning to RB = 0° while reducing the vertical velocity, so as to set up the assigned cruising altitude by the time of completing the turn. Then proceed to the homing beacon.

The moment the outer beacon is overflown, the radio compass reading will change from 0 to 180°, and the marker beacon receiver will produce appropriate light and sound signals (at $H \leqslant 2000$ m). Having overflown the outer beacon, start the stopwatch, make a correction turn to the assigned heading (through the turn-away angle) and proceed on this heading for the estimated time, after which make a turn to the landing heading at a bank of 30°.

In the course of the turn, descend by 200 m and change the bank (never exceeding the bank angle of 60°) to hit the landing heading with due accuracy.

After intercepting the landing heading (on a 30-s level flight leg), decrease the airspeed, extend the landing gear, lower the flaps into the takeoff position, establish an airspeed of 500 km/h and bring the aircraft into descent.

At altitudes above 2000 m, descend at a vertical speed of 40 m/s.

Further actions are similar to those in landing from an estimated line.

91. Should it prove impossible to perform landing immediately after penetrating through clouds (owing to an excessive airspeed, wrong approach to the runway, etc.), go around and request the clearance for a visual approach beneath the clouds (depending on the weather conditions and the relief) or for instrument approach in the clouds (or beneath the clouds) by two reverse 180° turns or by the wide or tight rectangular pattern.

Two-180°-Turns Approach

92. When going around for performing landing approach by two 180° turns, increase the engine speed to maximum; start the stopwatch the moment the aircraft overflies the inner beacon, make a correction turn to the landing heading and begin to climb. While climbing, retract the landing gear and flaps, establish an airspeed of 600 km/h; climb at a vertical speed of 10 to 15 m/s.

One minute after overflying the inner beacon (or 1 min 30 s after overflying the outer beacon), perform a turn at a bank of 30° to the downwind leg. After making the turn, introduce the angle of crab (if necessary). When approaching the point abeam of the outer beacon, establish an airspeed of 550 km/h. When abeam of the outer beacon, clock the time; 1 min 30 s after passing the outer beacon, in level flight, perform a turn to the landing heading at a bank of 30°.

During the second half of the turn vary the bank to ensure precise interception of the landing heading.

After hitting the landing heading, extend the landing gear and lower the flaps in the takeoff position while flying level for 30 s, and establish an airspeed of 450 km/h (an airspeed of 500 km/h when proceeding at an altitude of over 600 m), after which bring the aircraft into descent at an assigned vertical speed depending on the distance to the runway and altitude of flight. Further, proceed in the same manner as when performing approach from an estimated line.

Wide Rectangular Pattern

93. For going around to make a wide rectangular pattern approach, proceed in the same way as during two-180°-turns approach.

Retract the landing gear and flaps while the aircraft is gaining altitude, set up a speed of 600 km/h and climb to the assigned altitude at a rate of 10 - 15 m/s. Make all turns in the pattern at a bank of 30°.

On expiry of the rated time (i.e. 1 min since overflying the inner beacon), commence the crosswind turn through 90°.

At RB = 240° (120°) start the turn to the downwind leg. While proceeding on this leg, reduce the speed by the time of approaching the point abeam of the outer beacon, report passing of the outer beacon over the radio, extend the landing gear and set up an airspeed of 500 km/h.

At RB = 240° (120°) or 45 - 60 s after passing abeam of the outer beacon, start the base leg turn through 90°. Lose 200 m of altitude if the circuit height was 1000 m.

At RB = 285 to 290° (75 - 80°) start the final turn. Vary the bank in the second half of the turn for precise interception of the runway direction.

On completing the final turn, lower the flaps into the takeoff position, set an airspeed of 450 km/h and start descent at a rate of 5 m/s, depending on the distance to the runway and present altitude. Further, proceed as while performing approach from an estimated line.

94. If the fuel remaining is scarce or time is limited, it is advisable to execute a tight rectangular pattern approach. The crosswind turn should be started then immediately after adoption of the decision to go around, and the downwind turn 30 s after completion of the former (when the airspeed is 600 km/h) or 40 s after completion of the same, when the airspeed is 500 km/h (with the LG down). The further procedure is similar to flying a wide rectangular pattern.

FLYING IN BAD WEATHER

95. It is allowed to fly in bad weather only on condition that airdromes are available near the flying area, which are equipped with electronic landing systems.

96. Instrument approach with the use of landing systems can be executed either from an estimated line, or by the straight-in method, or making two 180° turns, or flying a wide (or tight) rectangular pattern.

When getting ready for flight in bad weather conditions, pay special attention to serviceability of the gyro horizon, AFCS, compass system, PCБH equipment, radio compass, radio set, radio altimeter, ДА-200 combined instrument as well as other flight and navigational instruments.

Besides, perform the following checks:

(a) check the anti-icing system to make sure it is filled with appropriate fluid;

(b) check serviceability of the main and stand-by pitot-static tubes heating, for which purpose turn on the PERISCOPE, AA XDCR, P-S TUBE, CLOCK and SIDE P-S TUBE circuit breakers and order the aircraft technician to check operation of the heating elements by touch.

<u>WARNING.</u> Keep the pitot-static tube heating system energized on the ground for not longer than 2 min; the check over, turn off the above circuit breakers;

(c) check to see that the course selector is set to the landing heading;

(d) make sure the altitude limit switch is set in a position corresponding to the safe altitude of instrument flight or landing approach.

After starting the engine, switch on the flight and navigational instruments and the radio aids required for performing the flight, and run up the engine. Preparatory to taxiing out, slave the compass system and, having ascertained that the systems and equipment are serviceable, the instruments producing correct readings, proceed to taxiing out.

97. Prior to entering the runway, switch on the heaters of the main and stand-by pitot-static tubes and that of the periscope. After lining up for takeoff, make sure that the flight and navigational instruments produce readings which agree with the position of the aircraft on the runway (the relative bearing, azimuth and distance from the beacon, heading, bank, pitch, altitude, etc.).

Having obtained the takeoff clearance, start the stopwatch and flying time counter.

After takeoff, retract the landing gear and flaps. Before entering the clouds, check the readings of the gyro horizon and ДА-200 combined instrument; compare their readings with the actual aircraft attitude. Assess the readings of the main flight and navigational instruments (variation of the airspeed, altitude, rate of climb; the jet-pipe temperature, rpm, oil and hydraulic pressure) and change over to instrument flying.

98. It is recommended to carry out upward penetration at full throttle power, while maintaining a true airspeed of 850 to 870 km/h which should be established upon gaining an altitude of 1000 m. Adequately trained pilots are allowed to penetrate the clouds also at reheat power (if necessary), the true airspeed amounting to 900 - 950 km/h.

Note. The former figures in the recommended climb speeds correspond to flying with the drop tank, the latter ones relate to carrying no drop tank.

When performing flight involving cloud penetration for training purposes, with a view to practising straight-in approach, upward penetration should be accomplished at full throttle power at an indicated airspeed of 600 km/h which should be established at an altitude of 1000 m.

In the clouds, pay major attention to maintaining the flight conditions; check the pitch angle by referring to the readings of the FDI, airspeed indicator and ДА-200 combined instrument; check the bank (sideslipping) by reference to the FDI, ДА-200 combined instrument and to changes in the heading.

99. When practising straight-in approach, after emerging from clouds or still in the clouds, 200 - 300 m below the assigned flight level, bring the aircraft into a turn at a bank of 30°, simultaneously decreasing the rate of climb. Perform the turn so as to place the aircraft in the direction of the navigational or outer homing beacon at the assigned flight level, the airspeed amounting to 600 km/h. Check recovery from the turn by reference to the radio compass and by requesting for radio bearings.

Proceed to the beacon (outer beacon) during straight-in approach or after fulfilling the mission, either at the assigned flight level or at an altitude which is 200 to 300 m above the cloud top, having requested the flying controller for landing instructions.

Note. The flying conditions during upward cloud penetration with subsequent straight-in approach, exclusive of the letdown on final, may vary depending on the stationing conditions of the unit and peculiarities of flying in the given airfield area.

Having obtained approach clearance, perform the operations prescribed in section "Handling Pressure Altimeter" and set the course selector to the landing heading. Then, come in to land by the POLYOT-OИ system; if it is not practicable, use the radio compass and gouund direction-finder, also, follow the commands of the GCA talk-down controller.

FLIGHT IN ICING CONDITIONS

100. During flight in clouds at a temperature of or below +5°C, ice formations are likely to occur on the aircraft.

The conditions and area of intensive icing are determined by the meteorological service, the data obtained being checked by a weather reconnaissance aircraft.

Training flights are not allowed in intensive icing conditions.

Taxiing and takeoff (if required) under intensive icing conditions on the ground should be accomplished without preliminary engine run-up.

Perform level flight through an intensive-icing area at an indicated airspeed of not less than 700 km/h or at a true airspeed of not less than 800 km/h. Descend and climb in flying conditions providing for the minimum time of flight in the icing area.

If ice is building up on the aircraft and cabin canopy during upward penetration, come out of clouds and switch on the anti-icing system in level flight. Switch on the system in pulses of 6 to 8 s at intervals of 10 to 15 s.

To remove ice, increase the airspeed (if practicable) to an indicated airspeed of 700 km/h at medium altitudes, or to a true airspeed of 800 - 900 km/h at high altitudes.

If the icing area is below 1000 m, it is advisable to approach either from an estimated line or in the straight-in method; then the landing gear should be extended at a distance of 10 km to the outer beacon.

If icing occurs during downward cloud penetration, switch on the anti-icing system at an altitude of 1000 m, without changing the flying regime.

101. If the engine develops some trouble in flight (vibration, abnormal noises, etc.), immediately leave the icing area and land on the nearest airfield.

102. After every flight in an icing area, the pilot should order the aircraft technician to thoroughly inspect the air intake and blades of the compressor first stage.

NIGHT FLYING

103. While preparing the cabin interior lighting, take it into account that the best illumination is ensured (with the least number and intensity of light spots on the canopy) when the main illumination system light fixtures are used in conjunction with the red floodlight ones.

Sufficient illumination of the cabin is provided by the main illumination system functioning alone, as well as by the emergency system functioning alone.

Preparing Cabin Equipment for Night Flying

104. Prior to taking seat in the cabin at night, order the technician to switch on the cabin illumination; check to make sure that the LG SIG., NAV. LTS (СИГНАЛ. ШАССИ, АНО); TAXI/LDG LAMPS, LG EXT. SIG (ФАРЫ, ВНЕШН. СИГНАЛ. ШАССИ) and OXY. EQ. HEAT., EXTN LAMP, WHT LT (ОБОГРЕВ ККО, ПЕРЕН. ЛАМПА, БЕЛ. СВЕТ) circuit breakers on the right-hand rear electrical board are turned on.

105. After taking seat in the cabin, apart from making routine checks and preparations of the equipment for flying, check and prepare the aircraft lighting equipment, proceeding as follows:

(a) adjust the red floodlight fixtures in the required positions;

(b) turn on the No. 1 ПО-750 INV. START switch located on the right-hand console vertical panel;

(c) use the RED FLOODLIGHT (ЗАЛИВАЮЩИЙ КР. СВЕТ) dimmer rheostat to adjust the minimum level of red lighting of the instrument board and cabin sides;

(d) manipulate the INSTR. BOARD: INCR. (ПРИБОРНАЯ ДОСКА: ЯРЧЕ) and CONSOLES: INCR. (ПУЛЬТЫ: ЯРЧЕ) dimmer knobs to set in the required level of illumination of the instruments and trans-illuminated inscription plates on the instrument board and cabin sides;

(e) manipulate the WHITE LIGHT (БЕЛЫЙ СВЕТ) dimmer knob to test the white light fixture;

(f) close the iris shutters of the pilot lamps as well as shutters of the warning lights in the light panels and in the LG/flaps position indicator, to obtain the desired brightness;

(g) switch on the navigation lights and order the technician to check for condition and functioning of the navigation lights and landing gear external indication lights; set in the desired brightness of the navigation lights;

(h) check thoroughly the sight reflector and the cabin glazing for cleanliness;

(i) test the taxi/landing lights for extending and retracting properly, for properly illuminating the ground by their taxiing and landing filaments, then retract the lights.

Starting and Taxiing Out

106. Engine starting and run-up should be accomplished in the same sequence as in the daytime.

Before taxiing out, slave the compass system and switch on the taxi/landing lights in the taxiing duty.

Having obtained the taxi clearance, brake the wheels and blink the navigation lights, thereby giving the technician the command to remove the wheel chocks. Having ascertained that the technician has gestured his clearance for taxiing out and that the way ahead is free of obstructions, start taxiing. (Switch over the duties of the taxi/landing lights to indicate that taxiing is commenced).

The taxiing technique is the same as in the daytime; however, the pilot should exercise greater caution due to poor visibility and orientation conditions. If necessary, the landing light duty may be switched on (for not longer than 5 min).

Before entering the runway, turn on the heaters of the main and stand-by pitot tubes and of the periscope.

Takeoff

107. After taxiing onto the runway and positioning the aircraft in alignment with the runway center line, proceed as follows:

(a) retract the taxi/landing lights;

(b) check for proper lighting of the instrument board, cabin sides and consoles;

(c) ascertain once more that the readings of the flight and navigational instruments agree with the aircraft position on the runway.

108. The takeoff procedure at night is the same as in the daytime. Maintain the direction of the run by referring to the runway lights. On a clear night, the amount of nosewheel liftoff during the second half of the takeoff run should be checked against the skyline and the runway lights; on a dark night, check the amount of nosewheel liftoff against the runway lights only (before the aircraft unsticks in the normal pitch attitude, the angle of attack should be 11 - 13° by the УУА-1 indicator).

Before unsticking, shift your glance to the runway lights on the left side of the runway. Upon unsticking, accelerate the aircraft, never allowing any bank or sideslip, while gradually climbing off the ground and retaining (approximately) the pitch angle established at unsticking. While climbing off the ground, handle the aircraft by referring to the runway lights, to the FDI and to the airspeed indicator.

At an altitude of 15 to 20 m, set the landing gear control valve to LG retraction. After the landing gear and flaps have been retracted, change over to instrument flying.

109. On a dark night, if the aircraft unsticks at the end of the runway, no lights being provided beyond the runway boundary (e.g. when taking off in the direction of a sea, lake, etc.), change over to instrument flying immediately after unsticking, never allowing the aircraft to bank or sideslip; maintain the pitch angle established at the moment of unsticking.

Peculiarities of Night Flying

110. Aircraft flying on a clear night does not essentially differ from aircraft flying in the daytime, yet, when checking the aircraft attitude on a clear night, pay major attention to the flight instruments rather than to visual checkout.

When the natural horizon is not visible or on a dark night, fly the aircraft solely on instruments.

When flying in bad weather at night, perform climbing, upward cloud penetration, flight in clouds and above the clouds at an assigned cruising level, initial approach to the landing airfield, descent and approach with the use of the РСБН system, straight-in approach, approach from an estimated line and by two reverse turns, wide and tight rectangular-pattern approach, in much the same way as in the daytime under instrument meteorological conditions.

The peculiarities of night IMC flight are:

(a) presence of navigation light reflection, resulting in frequent variations of illumination, owing to uneven cloud density;

(b) presence of jet reflection when the engine is running at reheat power settings;

(c) presence of landing light reflection in haze and precipitation under the clouds.

The unusual visual perception of the surroundings diverts the pilot's attention from the instruments, which hampers the handling of the aircraft.

If the navigation light reflection becomes too intensive, decrease the brightness of the navigation lights.

In the presence of haze or precipitation, perform landing on a runway illuminated by floodlights, without extending the taxi/landing lights.

When performing bad weather night flight, fly on the instruments until the outer beacon is overflown, even in adequate visibility.

Planning of a visual circuit approach pattern and the sequence of flight are the same as in the daytime. Start the base leg turn somewhat later, at RB = 240° (120°), perform it through an angle of 110 to 120°. When correcting the landing approach during the final turn, do not increase the bank in excess of 45°. Recovery from the turn should be terminated before overflying the outer beacon, at an altitude of not less than 300 m.

Runway Approach and Landing

111. The techniques used for landing estimation and landing proper at night, when landing the aircraft on a floodlighted runway, with the landing lights switched on or off, are essentially the same as in the daytime. The speeds of glide and flareout beginning should be increased by 10 km/h over the daytime speed values.

After overflying the outer beacon, extend and switch on the landing lights (at an altitude of not less than 100 m).

On overflying the inner beacon the aircraft should descend to the floodlighted point located at a distance of 150 to 200 m from the approach end of the runway. After terminating the landing roll, switch on the taxi light duty and switch off the heaters of the pitot-static tubes and periscope.

Landing at night with the flaps in the takeoff position is similar to that performed by day.

Landing on Runway Not Illuminated by Searchlights

112. Landing on the runway not illuminated by searchlights is a complicated procedure calling for greater caution and skill on the part of the pilot in determining the flareout initiation altitude.

After overflying the outer beacon, at an altitude of not less than 100 m switch on the landing lights. Upon overflying the inner beacon the aircraft should descend to the flareout point represented by the runway threshold lights.

The landing lights permit viewing the ground from an altitude of 60 - 80 m.

At an altitude of 20 to 30 m shift your glance to the ground lit by the landing lights and concentrate your attention on determining the flareout initiation altitude.

At an altitude of 8 to 10 m deflect the control stick backward, in a smooth manner, to start the flareout procedure so as to bring the aircraft to the ground (terminate the descent) at a height of not more than 1 m. In the course of subsequent alighting, establish an appropriate landing attitude, so as to ensure two-point touchdown free of pancaking.

The landing roll completed, switch on the taxi light duty, switch off the pitot-static tube and periscope heaters, and taxi to the parking.

Peculiarities of Night Flights with Use of Narrow Runway

Takeoff

113. Position the aircraft in alignment with the runway center line with the taxi light duty on.

The taxi light duty will aid the pilot in maintaining the direction of the run along the center line.

114. Perform takeoff at somewhat lower pitch angles so as to secure a better view of the narrow "gate" in the runway lead-out lights, since it is very difficult to ensure proper directional control by reference to the runway edge lights.

At the moment of unsticking practically no runway lights are visible.

As soon as the aircraft becomes airborne, change over to instrument flying, since it is difficult to determine the spatial attitude of the aircraft owing to the presence of light reflection. Retract the taxi/landing lights after setting the landing gear control valve to UP.

Runway Approach and Landing

115. The airfield lights visibility distance does not exceed 14 - 16 km usually; the runway lights are seen at this distance as a continuous line. Groups of lights of different designations and colours can be distinguished from a distance of not more than 6 - 10 km.

The coded neon light beacon (pundit) can be seen from a distance of 50 - 60 km, depending on the flight altitude and air transparency. When the aircraft is flying a wide rectangular pattern, the pundit is visible from any point of the route. The runway lights can be identified from a distance of not more than 6 to 10 km.

When flying is being performed over a terrain where light sources are numerous, refer to the pundit for identifying the runway, since the runway lights fail to stand out against the background in this case.

116. To secure an adequate view of the runway, perform the final approach glide at a higher airspeed, increasing it by 10 km/h as compared to the speeds to be

maintained after the final turn, while over the outer and inner beacons, beginning the flareout and touching down by daytime with the use of a narrow runway. Fly over the outer beacon at an altitude of 200 m and the inner beacon at an altitude of 50 m (when the beacons are located at distances of 4 and 1 km to the runway threshold, respectively).

To maintain the required direction after overflying the outer beacon and to determine the drift angle with the required accuracy, the pilot should refer to the beam of a searchlight positioned for this purpose on the runway center line near the inner beacon.

WARNING. When there is no searchlight whose beam is directed strictly along the runway center line, it is very difficult to land on a narrow runway, especially in presence of cross wind.

117. Land the aircraft with the taxi/landing lights switched on in the landing duty, which is essential for illumination of the runway center line during landing roll; it is difficult to keep the direction of landing roll while the center line is not visible.

LOCAL FLYING

Aerobatics

118. The aircraft is capable of performing all kinds of elementary and advanced maneuvers. This section deals with maneuvering (aerobatics) flights performed either without external loads or with external loads which are conventionally divided into the following four groups:

(a) group I, the aircraft carrying either no external loads, or a 490-L ventral drop tank, or two missiles;

(b) group II, the aircraft carrying four missiles (with the ventral drop tank attached or otherwise) or two C-24 rockets;

(c) group III, the aircraft carrying two missiles and two C-24 rockets, or carrying four УБ-16-57 pods;

(d) group IV, the aircraft carrying two УБ-32 pods and two УБ-16-57 pods.

WARNING. It is forbidden to execute aerobatics when other variants of external stores are attached.

119. Before performing upward maneuvers, trim the aircraft at an airspeed close to the maneuver entry speed or at an airspeed by 100 to 150 km/h below the maneuver entry speed; tighten and lock the safety harness. It is not recommended to use the pilot's trim in the process of aerobatics.

The minimum radius of any maneuver will be obtained when the latter is being performed with g-loads approaching the maximum permissible values or with angles of attack of about 28° by the УУА-1 indicator, but not exceeding the maximum operating g-loads given in Table 12.

120. When performing separate ascending maneuvers with reheat engine power, it is recommended to turn on the afterburner 5 to 6 s before entering the ascending portion of the maneuver, and to turn it off (if required) after passing the uppermost point of the maneuver at an airspeed of 500 to 550 km/h.

For quick aircraft acceleration during performance of maneuvers in close succession, the engine power should be increased on the descent portion of a previous maneuver (rather than in level flight) to make up for the considerable engine acceleration time, afterburner ignition time and time to accelerate the aircraft to the required speed.

121. Execution of vertical maneuvers at Mach numbers in excess of 1 M requires greater stick deflections and higher pull forces (e.g. at an altitude of 4000 m it is required to pull the control stick practically all the way back in order to build up a g-load in excess of 5 g).

122. If the speed of performing the ascending portion of maneuver has proved to fall below the required values, the pilot should handle the aircraft controls in an especially precise and coordinated manner, never allowing the angle of attack to exceed the +28° value by the УУА-1 indicator.

If such speed reduction has occurred in an inverted attitude of the aircraft, fix the control stick in a position close to neutral, without deflecting it sideways or pushing rudder; then the aircraft will lower the nose of itself and begin to descend. When the speed is increased up to 450 km/h, carry out a half-roll (with the ailerons alone), and when it is 500 km/h, bring the aircraft in level flight.

123. Flying the aircraft at subsonic airspeeds and high angles of attack involves slight buffeting whose intensity does not practically change down to development of wing-to-wing rocking. When rocking starts, immediately reduce the g-load and angle of attack until it ceases.

124. For ensuring correct functioning of the УУА-1 angle-of-attack indicator and preventing the aircraft from stalling in case the indicator fails during performance of maneuvers at buffeting angles of attack, the g-loads must not exceed the values given in Table 12 at all altitudes, when the fuel remainder is 2100 L or less.

Table 12

n_y	2 g	2.5 g	3 g	4.5 g	5.5 g	6.5 g
V_{IAS} (km/h)	400	450	500	600	700	750

Note. Given in Table 12 are the values of permissible g-loads for various indicated airspeeds, which should be observed during performance of maneuvers in the buffeting zone (if the angle-of-attack indicator is unused) when the aircraft carries guided missiles and has the fuel remainder of not more than 2100 L.

125. In the transonic speed zone it is permissible to perform unsteady maneuvers and various aerobatic stunts (a loop, half-loop, chandelle and wingover) when the aircraft carries external stores permitting creation of maximum g-loads in excess of 5 g, provided the spontaneous growth of g-loads (tuck-in) is counteracted in due time by decreasing of the control stick backward deflection at a Mach number of 0.9 to 0.87 M.

126. When performing descent maneuvers, the pilot must bear in mind that an error made in execution of the maneuver (e.g. a too high maneuver entry speed, excessively high engine power, too low maneuver entry altitude, prolonged maneuver entry and/or performance of the maneuver with a g-load that is less than the recommended one) may not always be corrected due to lack of altitude.

In case of such an error, immediately set the throttle lever to IDLE while extending the air brakes and pulling the stick to build up the maximum permissible g-load.

127. When flying or executing maneuvers at high airspeeds, mind the unstable readings zone of the airspeed indicator (the so-called "discontinuity zone"). The airspeed ranges associated with the unstable readings zone, depending on the flight altitude, are given in Table 4.

128. For checking the spatial attitude of the aircraft while performing aerobatic maneuvers (especially in poor visibility of the natural horizon), make use of the flight director indicator.

Banked Turn

129. Banked turns may be performed both at reheat and non-reheat power settings (including SECOND REHEAT) within the entire operating altitude and airspeed range.

The left and right banked turns are executed in the same manner.

Before entering a banked turn, establish the desired airspeed and then deflect the control stick and rudder in a coordinated manner to bring the aircraft into the maneuver, simultaneously increasing the engine thrust to the required value.

Check the banked turn parameters by reference to the FDI (natural horizon), vertical speed indicator, airspeed indicator and altimeter. Maintain the preset airspeed by changing the angle of bank and g-load or by varying the engine power.

Recovery from the turn should be executed by coordinated displacement of the control stick and rudder with simultaneous decrease of the engine thrust, so as to commence level flight without altering the airspeed.

130. Unsteady turns at a bank of over 60° and an airspeed corresponding to a Mach number in excess of 1.2M, and at altitudes of over 10,000 m, are performed with the control stick pulled fully back. The resulting g-load will amount to 3 - 4 g, no buffet occurring.

Unsteady banked turns may be performed at subsonic airspeeds within the buffet zone, never exceeding the g-load values presented in Table 12 or the $+28^{\circ}$ angle of attack by the УУА-1 indicator.

131. In executing sustained turns at bank angles in excess of 65 to 70° ($n_y > 2.5$ g), check the preset turn conditions, referring to the normal g-load.

The variation of g-loads in a steady banked turn vs airspeed, engine power setting and altitude is given in Fig. 36.

External loads have no essential effect on the banked turn techniques.

Chandelle

132. The chandelle may be performed at FULL THROTTLE and reheat power settings.

Preparatory to entering the maneuver, establish the required engine power setting, accelerate the aircraft to the assigned airspeed and then deflect the control stick in a smooth manner backward and in the direction of the maneuver, simultaneously applying minor pressure on the respective pedal to bring the aircraft into climbing along a spiral at an initial bank of 10 to 15°, so as to build up a g-load of 4.0 to 4.5 g for 3 to 4 s. Do not exceed a bank of 65 to 70° after covering two thirds of the maneuver path.

As the airspeed decreases, reduce the g-load in due time so as not to exceed the permissible 28° angles of attack by the УУА-1 indicator or g-load values presented in Table 12 for the given airspeed.

After the aircraft turns through 110 to 120°, gradually decrease the bank and pitch angles by coordinated deflection of the control stick (along the diagonal, forward) and pedals so as to bring the aircraft into level flight upon completion of the 180° turn, at an airspeed of not less than 400 km/h.

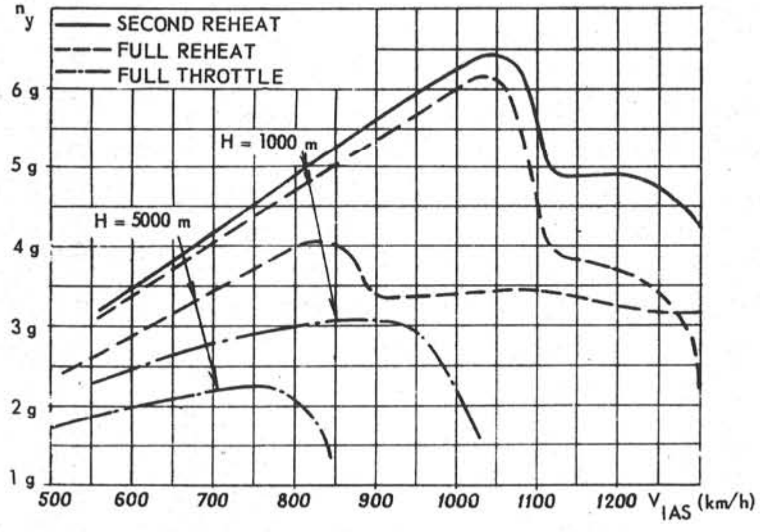


FIG. 36. VARIATION OF G-LOAD IN STEADY BANKED TURN WITH ALTITUDE, AIRSPEED AND ENGINE SETTING (EXTERNAL LOAD GROUP I, G = 7500 kgf)

$$n_{y\ req} = n_{y\ b.\ turn} \frac{7500}{G_{all\text{-}up\ (kgf)}}$$

For executing the chandelle at n_y = 3.5 to 4 g, the entry speed should amount to not less than 1000 km/h with the engine running at FULL THROTTLE, and to not less than 800 km/h when the engine is operated at FULL REHEAT or SECOND REHEAT.

133. The altitude gained during the maneuver will depend primarily on the flying technique and on the angle of bank. When the aircraft is brought into the maneuver from an altitude of not more than 1000 m and airspeed of 800 to 1000 km/h, the altitude gain will amount to 2000 - 5000 m, depending on the entry speed, g-load, engine power setting and external stores carried. The smaller values of altitude gain correspond to higher g-loads, lower entry speeds and heavier external stores.

134. If the chandelle is to be performed within a minimum time, irrespective of the altitude to be gained, establish a bank of 15 to 45° while bringing the aircraft into climb and perform the first half of an oblique loop in an energetic manner, so as to recover the aircraft from the bank as soon as its nose approaches the horizon.

Entry into such a chandelle may be performed at the same altitudes, airspeeds and engine power settings as entry into the loop.

Wingover

135. The wingover may be effected, depending on the engine power settings, within the altitude and speed ranges indicated in Fig. 37.

The altitude loss per maneuver as well as recovery speeds, when entering the maneuver from minimum permissible altitudes and flying the aircraft within the buffet zone at g-loads and angles of attack close to the permissible values, are given in Fig. 38.

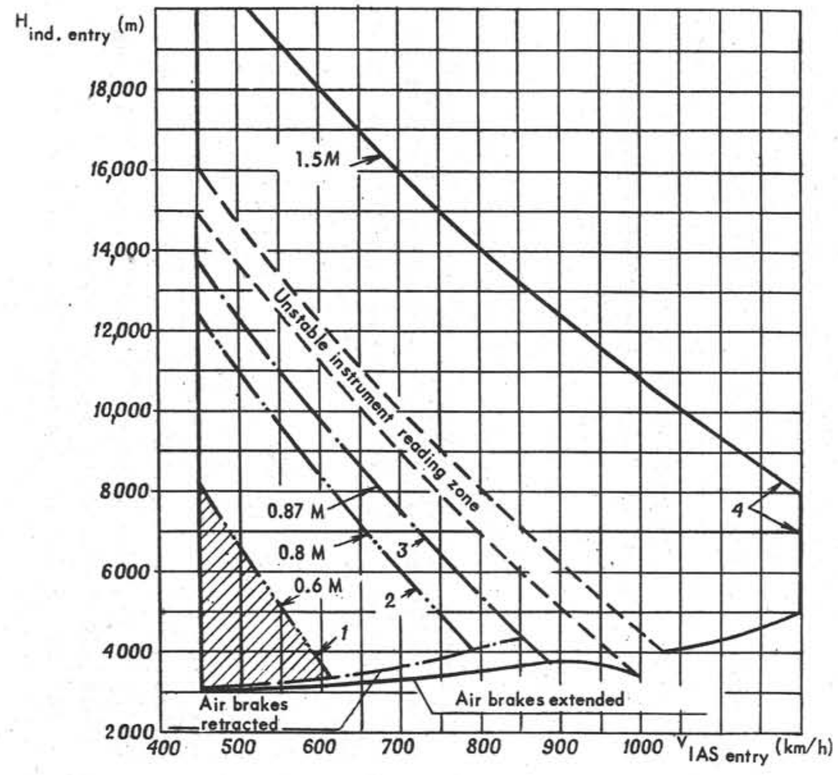


FIG. 37. WINGOVER EXECUTION AREA

1 – maximum IAS of wingover entry, air brakes retracted, engine running at FULL REHEAT (aircraft carrying external loads of any group); 2 – maximum IAS of wingover entry, air brakes retracted, engine running at FULL THROTTLE (aircraft carrying external loads of any group); 3 – maximum IAS of wingover entry with air brakes retracted (aircraft carrying external loads of any group, and with air brakes extended when aircraft carries external stores having $n_{y\ max} \leqslant 5$ g limitation, engine running at IDLE); 4 – maximum IAS of wingover entry, air brakes extended, engine running at IDLE (aircraft carrying no external loads or missiles only)

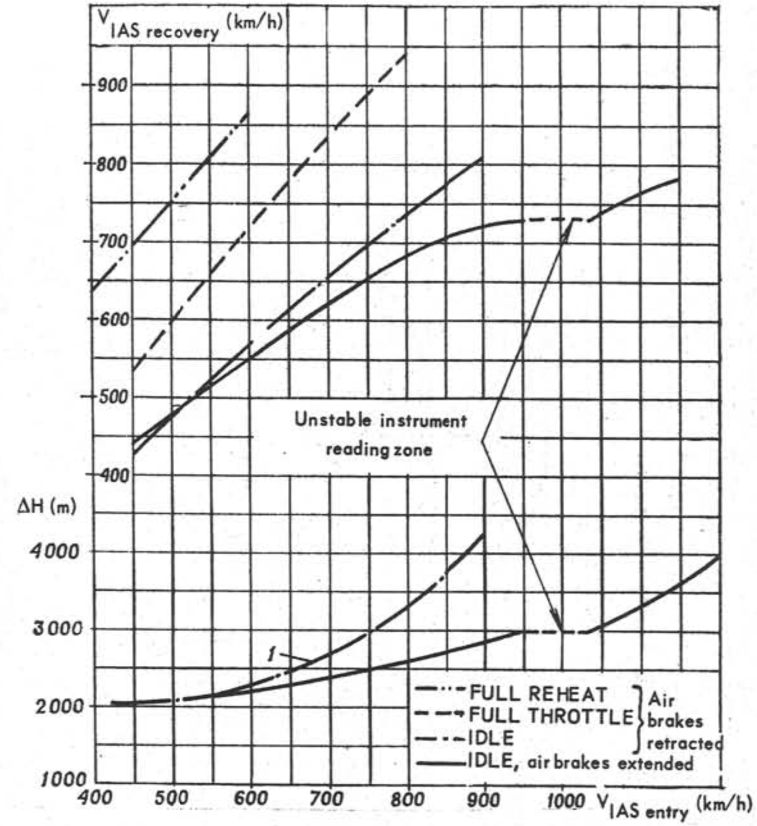


FIG. 38. LOSS OF ALTITUDE IN WINGOVER (ΔH) AND WINGOVER RECOVERY IAS VS AIRSPEED, IN CASE OF ENTRY AT MINIMUM PERMISSIBLE ALTITUDES (AIRCRAFT CARRYING EXTERNAL LOADS OF ANY GROUP MENTIONED IN PARA. 118)

1 – altitude loss in wingover (aircraft carrying external stores of any group, engine running at FULL REHEAT, FULL THROTTLE and IDLE, air brakes retracted)

Initially, the maneuver should be practised from altitudes of 5000 to 6000 m with entry speeds amounting to 500 - 600 km/h.

136. Preparatory to entering the maneuver, establish the assigned airspeed and altitude while in level flight, smoothly apply back pressure on the stick to assume a pitch-up angle of 10 to 15°, and then deflect the control stick and pedals in a coördinated manner during 3 to 4 s to assume the wheels-up attitude (make a half-roll); then establish the required engine power setting.

Without hesitating in the inverted position, smoothly displace the control stick backward so as to pull a g-load (during 3 to 4 s) corresponding to the buffet conditions. Perform the maneuver with a g-load associated with a 26 - 28° angle of attack, never exceeding the g-loads permissible for the given external stores. In this case the altitude loss will be minimum.

If the 28° angle of attack (by the УУА-1 indicator) or g-load values presented in Table 12 are exceeded during the maneuver, the aircraft nose starts wandering, which is accompanied by waggling (rocking from wing to wing). In this case relieve back pressure on the stick without any delay, to reduce the angle of attack (or g-load) to the value specified for the particular speed.

Extension of the air brakes prior to entry into the maneuver at an airspeed of 500 to 600 km/h will not practically affect the loss of altitude per maneuver; extension of the air brakes at an entry speed of 700 to 800 km/h will reduce the altitude loss by 300 to 400 m.

137. When entering the maneuver at high indicated airspeeds (over 700 km/h) and minimum permissible altitudes, with the engine running at FULL THROTTLE (with $M \leqslant 0.8$) or at FULL REHEAT (with $M \leqslant 0.6$), immediately upon rolling through an angle of 180°, pull a g-load close to the permissible one (during 3 to 4 s) and maintain this g-load throughout the maneuver, never exceeding $n_{y\,max}^{op}$ or $\alpha = 28°$. Then the safe recovery altitude will be guaranteed and the aircraft will be prevented from entering the transonic zone (the Mach number not exceeding 0.87 to 0.9 M).

When the wingover is being performed at full throttle power (the entry Mach number being about 0.8 M) or at full reheat power (the entry Mach number being about 0.6 M), the pilot's delay in approaching the maximum permissible (for the given conditions) g-load immediately after rolling the aircraft about the longitudinal axis through 180° will result in a rapid increase of airspeed and a considerable loss of altitude; it is also likely to bring the aircraft into the transonic zone.

As soon as the aircraft enters the transonic zone, shift the throttle lever to IDLE, simultaneously extending the air brakes and applying back pressure on the stick to establish the maximum permissible g-load.

Entry into the maneuver at a supersonic airspeed should be accomplished only with the air brakes extended. While the aircraft is rolling through 180°, shift the throttle lever to IDLE, extend the air brakes and apply full back pressure on the stick as soon as the half-roll is completed. Under these conditions, the aircraft is decelerated in the course of wingover execution, the transonic zone being passed at dive angles of 60 to 70°. While passing the zone of Mach numbers of 0.87 to 0.9 M, timely relieve the pull force on the stick in order to counteract the g-load growth. After passing the transonic zone, increase g-load to the maximum permissible value, never exceeding the 28° angle of attack by the УУА-1 indicator.

Entry into the wingover at higher altitudes and higher supersonic airspeed will involve a greater altitude loss. When entry is accomplished at an altitude of 18,000 m and airspeed of 550 to 600 km/h, the altitude loss will be 10,000 - 11,000 m.

Nesterov Loop

138. The Nesterov loop may be performed at FULL THROTTLE and reheat power settings, within the altitude and airspeed ranges specified in Fig. 39 in order to ensure that the airspeed in the uppermost point of the maneuver is not less than 400 km/h.

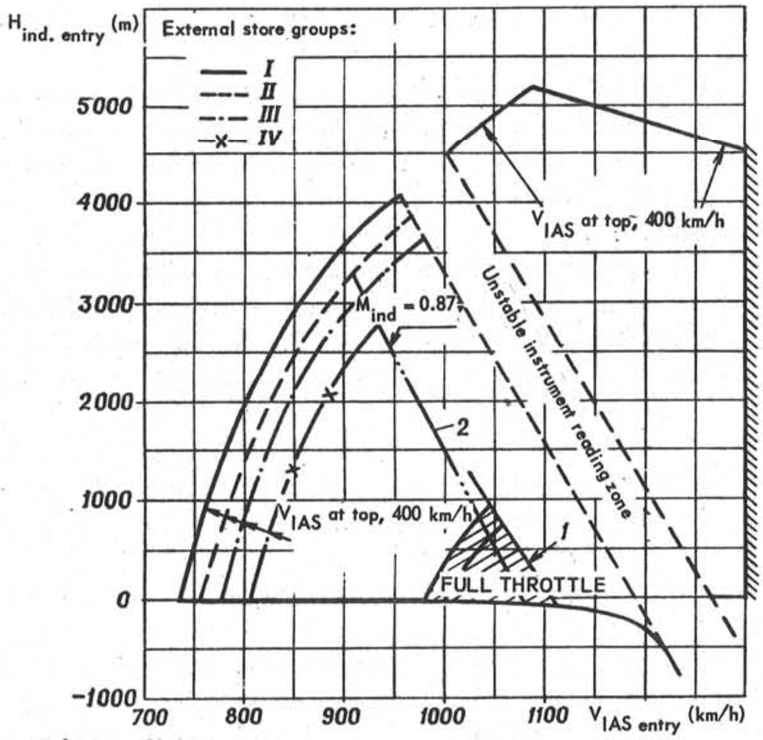


FIG. 39. NESTEROV LOOP AND HALF-LOOP EXECUTION AREA, ENGINE RUNNING AT FULL AND SECOND REHEAT
1 – maximum level flight IAS, engine running at FULL THROTTLE; 2 – maximum maneuver entry speed, aircraft carrying external stores having $n_{y\ max}^{op} \leqslant 5$ g

During initial practising of the maneuver, the aircraft carrying either no external loads or carrying two missiles, entry into the loop should be performed with the engine running at FULL REHEAT, the airspeed amounting to 900 km/h, the altitude being equal to 2000 m; with the engine running at FULL THROTTLE, entry should be accomplished at an airspeed of 1050 km/h and an altitude of 500 m.

139. Preparatory to entering the maneuver, establish the assigned airspeed and bring the aircraft into climb, applying a g-load of 4.5 to 5.5 g during 3 to 4 s, never exceeding the maximum permissible g-load for the given external load variant.

The rate of control stick backward displacement on the ascending portion of the trajectory should provide for retaining of the permissible g-load (i.e. 4.5 to 5.5 g) until reaching the 22 - 24° angles of attack by the УУА-1 indicator; then, these angles of attack should be maintained till approaching the uppermost point of the loop.

In the uppermost point the angle of attack should be 20 to 22° by the УУА-1 indicator, the airspeed should not be less than 400 km/h, with g-load equal to 1.5 - 2 g.

After passing the upper point of the maneuver, with the aircraft nose dropping below the horizon, smoothly increase the angle of attack to 26 - 28° by the УУА-1 indicator; the airspeed increasing to 500 - 550 km/h, establish the required engine power setting and proceed handling the aircraft in the same manner as when performing a wingover.

When entering the maneuver at Mach numbers exceeding 0.9 M, relieve back pressure on the stick in order to counteract the spontaneous growth of g-load while decelerating the aircraft at M = 0.87 - 0.9, after which establish g-load (or angle of attack) corresponding to the normal looping conditions of the maneuver ascending portion.

140. Slow (disproportionate) backward displacement of the control stick on the ascending portion of the loop is likely to result in airspeed drop below 400 km/h. In this case, fix the control stick and pedals in the neutral position. After the aircraft nose drops below the horizon, the airspeed increasing to 450 km/h, proceed executing the descending portion of the maneuver, provided the altitude is more than 2500 m.

The altitude gain on the ascending portion of the loop amounts to 2000 - 5000 m (depending on the altitude and airspeed of entry, and on the engine power setting).

If the altitude in the uppermost point of the maneuver is less than 2200 to 2500 m, terminate the maneuver by performing a half-loop (after the aircraft nose drops below the horizon and the airspeed grows to 450 km/h).

Half-Loop

141. The half-loop may be performed at reheat and full throttle engine power, within the altitude and airspeed ranges specified in Fig. 39.

At the initial stage of practising maneuvering flights on an aircraft without external loads or carrying two missiles, it is desirable that entry into the maneuver be accomplished at FULL REHEAT, the airspeed amounting to 900 km/h, the altitude being equal to 2000 m; with the engine running at FULL THROTTLE, the entry speed and altitude should be 1050 km/h and 500 m, respectively.

142. The ascending phase of the half-loop shall be executed in the same manner as the first half of the loop.

As soon as the aircraft reaches the upper point of the half-loop (with the airspeed amounting to not less than 400 km/h), deflect the control stick (forward, along the diagonal) and the pedals in a smooth and coordinated manner to roll the aircraft through 180° (perform a half-roll). The control surfaces should be displaced at a rate and to a degree providing for completion of the half-roll during 3 to 4 s.

As soon as the aircraft reverts to level flight, prevent further rolling, after which establish the required engine power setting.

If the airspeed in the upper point of the half-loop is below 400 km/h, set the stick and rudder neutral and fix them there; when the aircraft lowers the nose below the horizon, and after the airspeed increases to 450 km/h, perform a half-roll or complete the maneuver by performing the descending portion of a loop in case the altitude in the upper point of the maneuver is in excess of 2500 m.

The altitude gain per half-loop, depending on the entry altitude and airspeed as well as on the g-load and engine power setting, will amount to 2000 - 4500 m.

Oblique Loop

143. Enter the oblique loop at altitudes and airspeeds recommended for initiation of the Nesterov loop.

Before entering the oblique loop, pick out a reference point and establish the assigned airspeed; bank the aircraft to an angle of 15 - 45° and enter the oblique loop with this bank (by the FDI), using the same procedure as when entering the loop. Check the inclination of the oblique loop plane by reference to the FDI; refer to the natural horizon to check the inclination of the oblique loop plane at the beginning of entry, near the uppermost point of the maneuver and prior to recovery from the oblique loop.

The FDI provides for checking the initial angle of bank in the upper and lower portions of the oblique loop, both at positive and negative angles of pitch not exceeding $\vartheta = 90 - \gamma$, where γ is the angle of bank at which the aircraft enters the maneuver.

On the ascending and descending portions of the oblique loop, at pitch angles close to $90 - \gamma$, the FDI miniature airplane starts rolling in the same manner as during the normal loop, to indicate increase of the bank; the lesser the inclination of the oblique loop plane relative to the vertical, the greater the rate of roll of the miniature airplane.

After the roll ceases on the ascending portion of the maneuver, the miniature airplane indicates the aircraft bank in the inverted attitude; after the aircraft stops rolling on the descending portion of the maneuver, the miniature airplane indicates the angle of bank in the normal attitude.

With the miniature airplane rolling, give major attention to the control stick which should be kept in the neutral position (with respect to lateral control).

After the aircraft is brought into level flight, eliminate the bank.

Initially, the oblique loop should be practised at a bank of not more than 20°.

Dive

144. Diving should be made at angles of up to 60°. Entry into the dive should be accomplished, depending on the angle of dive, from a turn or wingover.

In dive from an altitude of 4000 m, the entry speeds amounting to 500 - 600 km/h, the engine running at IDLE and the air brakes being retracted, the airspeed increment per 1000 m of altitude loss will be as follows:

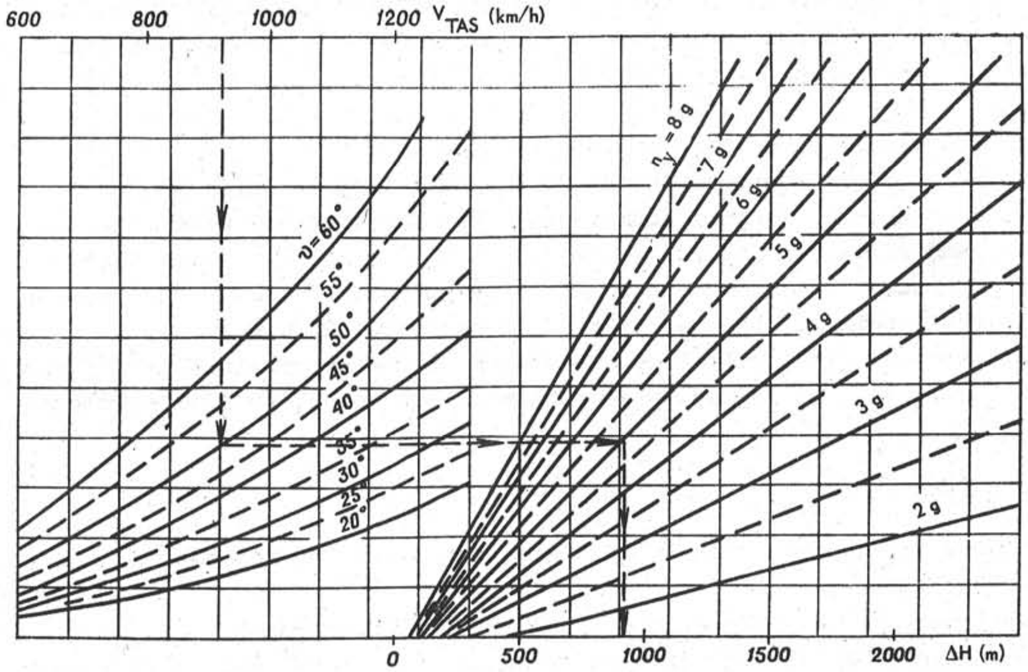


FIG. 40. ALTITUDE LOSS IN RECOVERING FROM DIVE (ΔH) VS RECOVERY INITIAL AIRSPEED, DIVE ANGLE AND G-LOAD (AIRCRAFT CARRYING EXTERNAL LOADS OF ANY GROUP)

(a) 70 to 130 km/h, at dive angles of 30 to 45°;

(b) 130 to 180 km/h, at dive angles of 45 to 60°.

The loss of altitude during recovery from dive will depend on the angle of dive, airspeed and g-load. The altitude loss during recovery from dive vs the angle of dive, initial recovery airspeed and g-load during recovery, is presented in Fig. 40.

The aircraft retains adequate stability and controllability when diving both with and without external loads.

Zoom

145. The zoom may be executed within the entire operational altitude range, at FULL THROTTLE and at reheat settings, with the entry speed not exceeding the maximum permissible value.

Depending on the altitude, entry speed and engine power setting, the zooming angle may be up to 80°. It should be borne in mind that when the maneuver is executed at angles of over 50 to 60°, the entry speed should not be less than 700 km/h, the engine running at FULL REHEAT; when the maneuver is accomplished at FULL THROTTLE, the entry speed should be at least 900 km/h.

146. After accelerating the aircraft to the assigned speed, apply back pressure on the stick in a smooth manner (to pull a g-load of 3.5 to 5.5 g, but not exceeding the g-load limitation for the given external store variant) to establish the required angle of zoom. Refer to the FDI to make sure the required angle of zoom is maintained and to ascertain that the aircraft is not banking. The recovery speed vs the angle of zoom and the engine power setting is presented in Fig. 41. It is recommended to recover from the maneuver by making a turn or two half-rolls in succession.

For recovery by making a turn, do as follows: upon reaching a speed of not below the specified value, deflect the control stick and rudder in a coordinated manner to bring the aircraft into a turn, subsequently lowering the nose to the horizon and recovering from the turn.

To recover the aircraft from zoom by making two successive half-rolls, do as follows: upon reaching a speed which is not below the specified value, roll the aircraft through 180° and pull the control stick back to vigorously lower the aircraft nose to the horizon, subsequently rolling through another 180°.

With the angle of zoom exceeding 45°, zoom recovery should be accomplished by making two half-rolls.

The altitude gain per zoom will depend on the speed and altitude of entry, angle of zoom, engine power setting and external loads being carried.

The characteristics of limit zooms are shown in Figs 41 - 43.

Zoom-and-Roll

147. Entry into the maneuver should be executed at the same altitudes and airspeeds as entry into the zoom (Para. 145).

For executing the maneuver in the course of initial training, start zooming from an altitude of 1000 to 2000 m at an airspeed of not less than 900 km/h, the engine running at FULL THROTTLE.

148. After accelerating the aircraft to the assigned airspeed, enter the zoom as recommended in Para. 136. Upon attaining the initial zoom recovery speed which is not below the recommended value (Fig. 41), deflect the control stick and rudder in a coordinated manner to roll the aircraft through 180°, after which pull the control stick

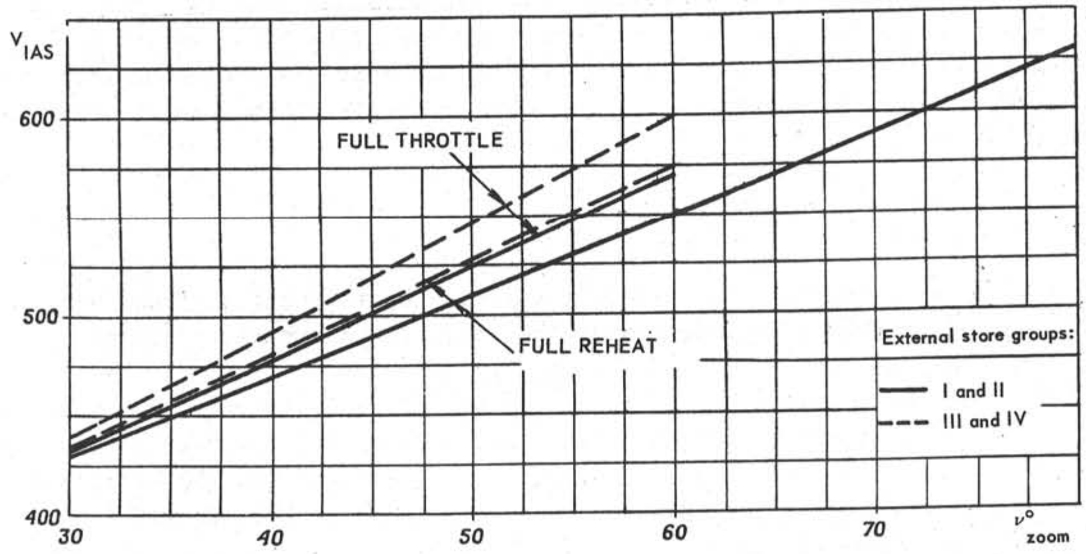


FIG. 41. ZOOM RECOVERY INITIAL AIRSPEED VS ZOOM ANGLE AND ENGINE POWER SETTING

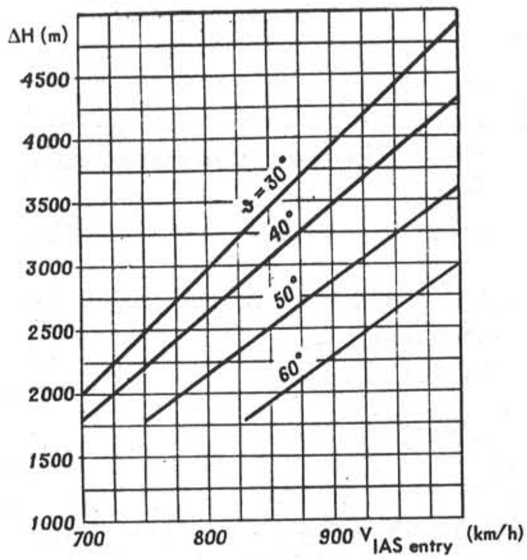


FIG. 42. ALTITUDE GAIN IN ZOOM, ENGINE RUNNING AT FULL THROTTLE (AIRCRAFT CARRYING EXTERNAL STORES OF ANY GROUP MENTIONED IN PARA. 118)

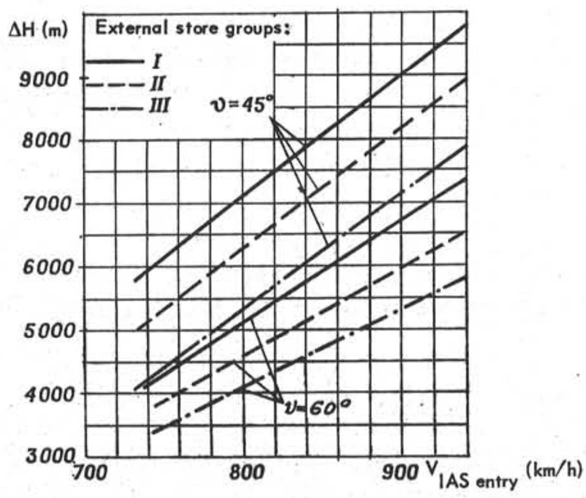


FIG. 43. ALTITUDE GAIN IN ZOOM, ENGINE RUNNING AT FULL AND SECOND REHEAT

back to energetically bring the aircraft nose to the horizon. Further execution of the descending portion of the maneuver does not differ in technique from execution of the descending portion of a loop.

Execution of the descending portion of the maneuver is allowed provided the altitude at the upper point of the maneuver is not less than the minimum altitude amount recommended for making a wingover (at the given airspeed). If the altitude at the maneuver upper point is less than the minimum value recommended for wingover performance at the given airspeed, terminate the maneuver by performing the second half-roll when the aircraft lowers its nose below the horizon line.

Roll

149. It is permissible to perform snap and slow horizontal, ascending and descending controllable rolls at an airspeed of not less than 550 km/h.

150. For performing a controllable snap roll during initial training, establish an airspeed of 600 to 700 km/h in level flight, assume and maintain a nose-up attitude of 10 to 15°, after which shift the control stick (diagonally forward) and the pedals in a coordinated manner, to cause the aircraft to roll. By the time the aircraft is approaching the wings-level attitude, set the controls for recovery, so as to cease rolling at zero bank. The snap roll will be accomplished during 6 to 8 s.

To perform a controllable snap roll at airspeeds in excess of 700 km/h, bring the aircraft to a nose-up angle of 15 to 20°, depending on the airspeed(the higher the speed, the larger the angle). In other respects, the roll performance technique does not differ from that employed for roll execution at airspeeds of 600 to 700 km/h.

151. A slow controllable roll will be accomplished for 10 to 12 s. One portion of the maneuver is performed at positive angles of attack, whereas the other portion is executed at negative angles; as a result, the pilot will experience alternating g-loads.

To perform a slow roll in level flight, set up an airspeed of 700 to 800 km/h, pitch up the aircraft to 15 - 20° and maintain this attitude; then shift the control stick smoothly in the desired direction, to cause the aircraft to roll. While performing the roll, use the control stick and rudder to keep the aircraft nose from lowering. As the aircraft approaches the level flight attitude, set the controls for recovery; after rolling ceases, neutralize the control surfaces.

152. Double (multiple) rolls are two or more rolls executed in close succession. It is allowed to perform controllable snap and slow double (multiple) horizontal and ascending rolls.

The speed of entry into a double horizontal roll at medium altitudes should be not less than 600 km/h. Double (multiple) rolls are executed in the same manner as single rolls.

Spiral Dive

153. Spiral dive shall be performed at a bank of 45° and airspeed of 500 to 550 km/h, the engine running at IDLE. When the maneuver is started at an altitude of 5000 m, the aircraft will lose 1500 to 1600 m of altitude in one spiral turn.

With the landing gear and flaps extended, spiral dive should be executed at an increased engine speed and an airspeed of 450 km/h, the rate of descent being not more than 25 - 30 m/s.

Preparatory to entering the spiral dive, bring the aircraft into glide at an airspeed of 500 to 550 km/h,then enter the spiral dive by coordinated manipulations of the stick and rudder.

Decrease or increase the airspeed in the course of spiralling by appropriate variations of the pitching attitude (bringing the aircraft nose up or down, respectively).

Recover from the spiral dive by coordinated deflections of the stick and rudder with simultaneous increase of the engine speed when recovering the aircraft from the glide (descent) pitch angle.

In the process of spiral dive, the aircraft is stable and it has no tendency to go into an ever steeper spiral dive.

When recovering the aircraft from a steep spiral dive with a pitch-down attitude of over 30°, first eliminate the bank, then pull the aircraft out of dive.

FLIGHT FOR MAXIMUM IAS AND MACH NUMBER

154. For flying the aircraft at maximum Mach numbers, its acceleration should be accomplished at FULL REHEAT. The aircraft acceleration to maximum Mach numbers for training purposes (when carrying no external loads or with missiles attached) should be performed in compliance with the following schedule:

(a) take off at FULL REHEAT; turn off the afterburner upon attaining an airspeed of 600 km/h;

(b) climb to an altitude of 1000 m with acceleration to a true airspeed of 870 km/h, then climb to 10,000 m at the constant true airspeed;

(c) perform level flight at the 10,000-m altitude at an airspeed of 530 km/h until departing from the airfield to a distance of 130 to 150 km;

(d) turn towards the airfield; select FULL REHEAT by the end of the turn;

(e) accelerate the aircraft while descending by about 300 m (to compensate for the pitot-static tube total position and shock-wave errors) until exceeding the sonic speed; then accelerate the aircraft to an indicated airspeed of 1200 km/h at a constant altitude of 10,000 m;

(f) climb to an altitude of 11,500 m at a constant indicated airspeed of 1200 km/h;

(g) accelerate the aircraft at a constant altitude of 11,500 m to M = 2.05 or to a fuel remainder of at least 700 L (in fair weather by day) or 800 L (in bad weather by day and in fair weather at night), or 900 L (in bad weather at night), the distance to the airfield being not more than 100 km.

As the Mach number increases in the course of the aircraft acceleration, the HP rotor speed grows, and it may rise to 107.5% at $M > 1.8$; during the further aircraft acceleration, the HP rotor speed will remain constant, whereas the LP rotor speed will start decreasing.

If the HP rotor fails to pick up the maximum speed in the course of the aircraft acceleration, with the LP rotor speed starting to decrease from M = 1.5, discontinue accelerating the aircraft (acceleration will be less intensive).

While accelerating the aircraft, check the position of the air intake cone.

The acceleration procedure completed, turn off the afterburner and shift the throttle to IDLE. While making a turn towards the airfield, reduce the airspeed to 550 km/h and descend to the assigned altitude or to the circuit height at a constant airspeed of 500 to 550 km/h, the engine set at IDLE.

Note. When the aircraft is accelerated on a route or a profile differing from that recommended in the Instructions, return to the airfield from a distance exceeding 100 km at an altitude of 11,000 m and airspeed of 510 km/h until the distance to the airfield decreases to 90 km. In this case, increase the amount of fuel remaining by the moment the aircraft acceleration is terminated by 100 L per 50 km of distance to be covered additionally. At a distance of 90 km from the airfield bring the aircraft in descent and proceed descending at an airspeed of 500 to 550 km/h with the engine running at IDLE.

FLIGHT FOR SERVICE CEILING AND ZOOM ALTITUDE

155. Fly for the service ceiling for training purposes either without external loads or carrying two missiles; proceed until reaching the 1200-km/h IAS in much the same way as in flying for accelerating the aircraft as set forth in Para. 154.

Having attained an IAS of 1200 km/h, bring the aircraft into climb and proceed climbing at a constant airspeed of 1200 km/h until a Mach number of 1.80 to 1.85 is reached.

Perform further climbing at a constant Mach number of 1.80 to 1.85 up to V_y = 3 - 5 m/s or until the amount of fuel drops to the values specified in Para. 154 (g), when the distance to the airfield does not exceed 120 km/h.

Note. The specified amounts of fuel provide for descent from the service ceiling at a distance of not more than 120 km, landing approach from an estimated line, missed approach procedure by two reverse 180° turns or by flying a wide rectangular pattern, and subsequent climb to 2000 m for ejection (in case landing proves to be impracticable after the missed approach).

In case the distance to the airfield is over 120 km, increase the fuel remainder by 100 L per 50 km of the additional distance to be covered.

Having completed climbing, cancel reheat and throttle the engine down to IDLE, turn the aircraft towards the airfield while beginning to descend at an airspeed of 500 - 550 km/h.

If the distance to the airfield is more than 120 km, descend to an altitude of 11,000 m and fly towards the airfield at this altitude and an airspeed of 510 km/h. When the distance to the airfield decreases to 90 km, bring the aircraft into descent and proceed descending at an airspeed of 500 to 550 km/h with the engine idling.

156. The service ceiling for an aircraft carrying two missiles and climbing at FULL THROTTLE at a true airspeed of 870 km/h, is 12,000 m (under the standard atmosphere conditions, at an average weight of the aircraft) and 11,000 m with four missiles.

The service ceiling for an aircraft carrying two missiles and climbing at FULL REHEAT (under the standard temperature conditions) is 17,500 m, the fuel remainder at the ceiling altitude amounting to 700 L.

157. When flying for the service ceiling with four missiles attached, the aircraft can reach the ceiling only when it carries a drop tank, owing to higher rates of fuel consumption; the tank should be dropped when empty.

158. To reach altitudes in excess of the service ceiling, the method of zooming is employed, entry into the zoom being accomplished at an altitude of 15,500 to 16,000 m and airspeed corresponding to 1.9 M. Entry into the zoom should be made by increasing the pitch-up angle through 10 - 15° from the initial, steady climb value, with a g-load equal to 1.5 - 2.0 g. Upon gaining an airspeed of 500 to 530 km/h, cancel reheat and apply forward pressure on the stick to recover the aircraft from the zoom so that the airspeed would not be less than 400 km/h. When the aircraft is being recovered from the zoom, the g-load should be 0.3 to 0.4 g.

Notes: 1. Check reheat cancellation by referring to the FIRST REHEAT light, which should die out, since no peculiar kick will be sensed at the zoom altitude as the afterburner is turned off.

2. If the afterburner fails to run steadily at the zoom altitude (which is indicated by fluctuations of the engine speed and jet-pipe temperature), cancel reheat.

WARNING. Engine rotor overspeeding is likely to occur at the zoom altitude if the engine is run at reheat settings or if the airspeed is less than 450 km/h.

Should this occur (the LP rotor rpm exceeding 101.5% for longer than 5 s), proceed as follows:

(a) cancel reheat, moving the throttle lever to the FULL THROTTLE position, if the engine was running at reheat power;
(b) shut down the engine, moving the throttle lever to the SHUT-OFF stop, if the engine was running at full throttle power.

At the zoom altitude smooth correction turns can be performed. Energetic maneuvering will result in fast airspeed and altitude loss.

CAUTION. While the zoom altitude is being gained, surging of the power plant may occur, with resultant engine flameout. Engine relight should be accomplished as recommended in Paras 292 through 294.

EXTREME-LOW FLYING

159. No barometric altimeter or radio altimeter can be used for maintaining the preset altitude over the relief or over obstacles within the range of 20 to 100 m, since the barometric altimeter makes no allowance for changes in the relief, whereas the radio altimeter reads an ever-changing height above the terrain overflown by the aircraft at the moment.

It is possible to maintain the extreme-low altitude by visual reference; however, this will hamper observation of the airspace, even in the forward hemisphere, as well as aircraft navigation and target search.

At altitudes of 20 to 100 m the coverage of the airborne radio set is 20 to 25 km, and that of the radio compass (when radio beacon ПАР-8С is employed) is 100 to 110 km.

Neither ground radar surveillance nor aircraft identification (in passive or active modes of operation) is possible during flight at an altitude of 20 to 100 m, practically since the time of takeoff.

160. To ensure due safety and facilitate flying at extreme-low altitudes (20 to 100 m) and high airspeeds, it is most convenient to maintain the preset altitude over the terrain and obstacles with the aid of the optical sight functioning in the MSL mode.

The use of the sight at the above altitudes is also possible when visual determination of the altitude is hardly practicable (when flying over snow-covered or water surfaces), or when the flight visibility is 3 - 5 km and the natural horizon is not seen.

To hold the preset altitude of flight (20 to 100 m) and to preclude collision with the ground or obstacles, the pilot should keep the sight reticle center point (deflected manually downwards through an angle determined by reference to the nomogram presented in Fig. 44, depending on the aircraft weight and indicated airspeed) skipping over the ground surface at a distance of 1 to 5 km ahead of the aircraft (depending on the altitude to be maintained).

The nomogram of Fig. 44 is so arranged that once an angle determined from the nomogram is set in the sight, the reticle central dot will be deflected through 20 mils down of the airspeed vector, provided the assigned airspeed is maintained.

161. If some elevation or obstacle is detected ahead of the aircraft, pull the stick back to raise the reticle central dot to the top of the obstacle (or elevation). After overflying the obstacle, deflect the control stick in an appropriate manner to lower the central dot again and keep it skipping over the ground surface 1 to 5 km ahead of the aircraft.

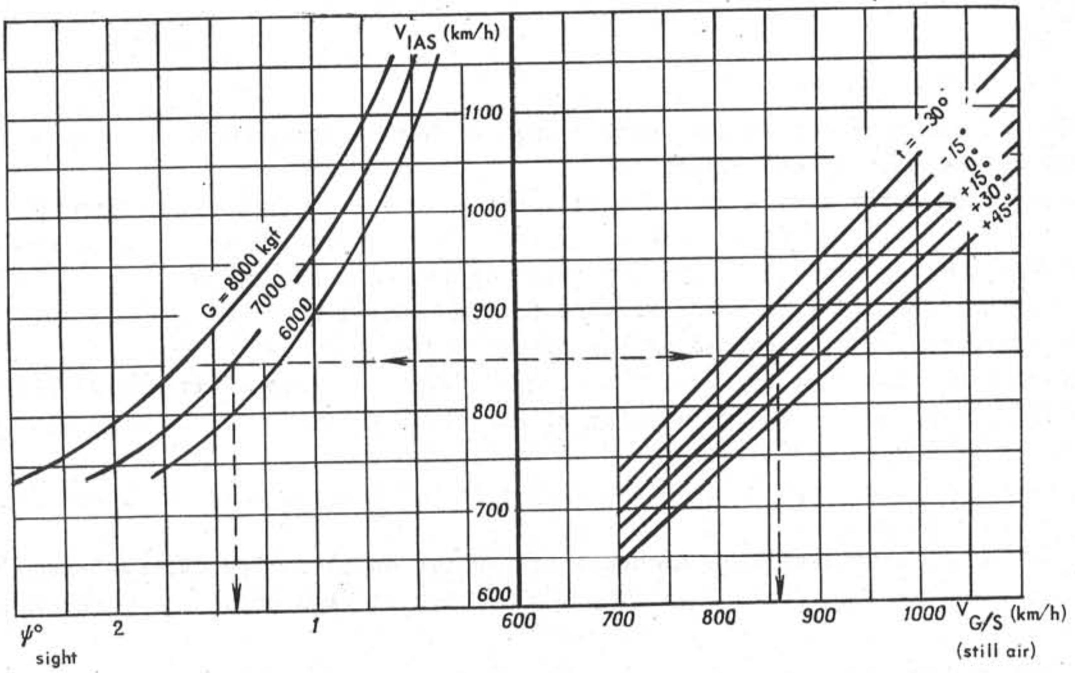


FIG. 44. NOMOGRAM TO DETERMINE REQUIRED SIGHT SETTING ANGLE FOR MAINTAINING EXTREME-LOW ALTITUDE, VS AIRSPEED AND ALL-UP WEIGHT

To ensure safety, the pilot must not reduce the airspeed below the preset value corresponding to the sight reticle angle determined by reference to the nomogram of Fig. 44, since this would result in decrease of the flight altitude.

Preparatory to performing a turn, climb a little so as to prevent altitude loss during entry into the turn and its execution. After completing the turn, descend to the assigned altitude again.

AIRCRAFT BEHAVIOUR IN DANGEROUS FLIGHT CONDITIONS

Spin

Normal Spin

162. The aircraft may be sent into a spin either intentionally or as a result of a blunder on the part of the pilot.

Inadvertent entry into a spin occurs under normal g-loads corresponding to stall angles of attack. In all cases spin is preceded by dropping of the wing in the direction of the pushed rudder or in the direction opposite to sideslip.

If the control stick is moved forward to the neutral position (with the ailerons and rudder neutral) in the course of the aircraft deceleration in straight flight after onset of rocking from wing to wing, the aircraft will go into a dive while gaining speed. Rudder deflection during rocking of the aircraft from wing to wing will send the latter into a spin in the direction of the pushed rudder.

The aircraft will lose some 1500 - 2000 m in stall and subsequent recovery from dive into level flight.

163. When an excessive back pressure is applied on the stick during banked turns, chandelles and other maneuvers involving application of high normal g-loads, stalling proceeds more vigorously at subsonic airspeeds.

If the control stick is not set neutral immediately after onset of stall, during 3 - 4 s, the aircraft will start oscillating briskly and unsteadily about its three axes, with high lateral g-loads and rudder forces.

164. The most frequent blunder on the part of the pilot that may cause going into a normal spin during performance of vertical and three-dimensional maneuvers, is excessive pull of the stick with exceeding of the permissible angles of attack by the УУА-1 indicator and pushing of rudder at the same time (hence creating sideslip).

Setting of the control surfaces in the neutral position immediately after onset of stall will effectively restore the normal flight conditions and prevent the aircraft from going into a spin.

In recovering from stall or spin, never shift the control stick all the way forward, since in some cases in the presence of considerable sideslipping the aircraft may enter inverted spin.

165. The aircraft would not enter spin at a supersonic flight speed. With the stick pulled fully back and rudder pushed through 10 - 12° aside (as limited by the rudder forces), the ailerons being neutral, the aircraft performs rolls (at a rate of 5 - 6 s per turn) while reducing the airspeed.

No change in the rolling conditions is observed at the time when the aircraft is passing through the sonic speed, but harsh rolling oscillations occur at the time when the aircraft reaches 0.93 M and is decelerating further. Once the controls are set neutral, rolling ceases and the aircraft enters a dive.

166. The normal spin features high instability, vigorous oscillations in roll, pitch and yaw, unsteady rotation involving inadvertent changes of direction.

The rate of descent, when spinning is performed from an altitude of 10,000 to 12,000 m, equals 100 to 120 m/s; when spinning is started at an altitude of 16,000 - 18,000 m, the rate of descent amounts to 200 - 250 m/s.

The right spin is not steady, especially within the initial 8 to 10 s, when the aircraft makes abrupt alternating turns through 1/2 to 2/3 turn (the aircraft movements resembling those of a falling leaf). Under these conditions the pilot experiences considerable lateral g-loads and heavy pedal beats.

The left spin proceeds in a somewhat more quiet manner. Immediately upon stalling, the aircraft is likely to make up to 1.5 turns of a steady left spin. Lateral g-loads and rudder forces are somewhat smaller than those involved in a right spin.

167. Minor deflections of the ailerons (up to 1/5 - 1/4 of the stick travel) will have no notable effect on the spin entry or performance conditions.

Deflection of the ailerons to 1/3 of the total stick travel and more, will slightly alter the character of the normal spin regimes.

When the ailerons are deflected into the spin, both the left and right normal spins proceed in the oscillatory manner, without any prevailing sense of rotation. The aircraft oscillations in roll and yaw become ever more vigorous and sharp, and the lateral g-load variations grow considerably, same as the rudder force kicks (beats).

When the ailerons are deflected against the spin, rolling and pitching oscillations become considerably larger, both in left and right normal spins. In the course of a left normal spin, the aircraft may be even turned upside-down.

168. Aircraft recovery from the normal spin shall be accomplished by simultaneous setting of the stick and rudder in a neutral position; then the delay in spin recovery will not exceed one turn (i.e. 4 - 5 s).

In most cases the aircraft recovers from the spin without any delay. The loss of altitude in spin recovery amounts to 2000 - 2800 m when the recovery is started at an altitude of 5000 - 8000 m.

Inverted Spin

169. The aircraft may be sent into an inverted spin intentionally, from an inverted attitude, by shifting of the stick forward beyond the neutral position and pushing of the rudder to the side of the desired spin.

The aircraft may enter an inverted spin as a result of complete forward deflection of the control stick during recovery from a normal spin, as well as in the cases when the ailerons are deflected considerably (through more than 1/2 of the stick total travel) against the spin in the course of a left normal spin. The aircraft always spins in the direction of the deflected rudder when in an inverted spin.

The aircraft will be recovered from the inverted spin by setting of the stick and rudder in the neutral position. The delay in recovery from the inverted spin will amount to 4 - 6 s.

The aircraft will lose some 3000 - 4000 m of altitude to recover from inverted spin when the recovery is started at an altitude of 8000 - 9000 m.

Influence of Deployed Drag Chute on Spin and Recovery Conditions

170. In order to recover the aircraft from any spin conditions, use may be made of the drag chute. Type ПТ-21У or ПТ-21УК drag chute system operates reliably and discontinues the aircraft rotation very quickly under any spin conditions, provided the drag chute is deployed at indicated airspeeds not in excess of 300 to 320 km/h.

Deployment of the drag chute at indicated airspeeds higher than 320 km/h results in practically instantaneous destruction of the chute canopy and produces no effect on the spinning conditions.

When the drag chute is deployed under normal spin conditions, after a peculiar jerk, in 2 - 3 s the aircraft stops rotating and enters descent accompanied by oscillations in roll, yaw and pitch; these oscillations might produce a false impression that the aircraft has failed to recover from the spin. If rudder is not neutral in this case, the aircraft will roll in the direction of rudder deflection.

As soon as the drag chute is jettisoned, the airspeed starts rapidly increasing. When the airspeed increases to 450 km/h, start smooth recovery from dive into level flight, at an angle of attack not exceeding 15°.

Note. It must be remembered that with the engine running at full throttle power, jettisoning of the drag chute will involve an intensive increase of the airspeed (at a rate of about 20 km/h per s).

Pilot's Actions in Inadvertent Stall and Spin

171. In all cases of unintentional wing stall, immediately push the control stick forward to the neutral position (with the rudder and ailerons neutral) and disengage the AFCS.

If the aircraft develops a spin after stall, fix the control stick and rudder in the neutral position.

When rotation discontinues and the aircraft enters a dive, keep the control surfaces in the neutral position until the airspeed increases to not less than 450 km/h (then the angle of attack should not be more than 15° by the УУА-1 indicator). As soon as this speed is reached, start gradually recovering from dive, taking care that the angle of attack by reference to the УУА-1 indicator does not exceed +20°.

172. While recovering the aircraft from spin with the use of the standard drag chute, do as follows:

(a) at an airspeed of not more than 300 - 320 km/h depress button DRAG CHUTE DEPLOY'T (ВЫПУСК ПАРАШЮТА), shift the control stick and rudder to the neutral position and fix them there;

(b) after the peculiar jerk, when the aircraft stops rotating and enters descent, jettison the drag chute; do not change the neutral position of the stick and rudder before the airspeed increases to 450 km/h (the angle of attack should be maintained at values not exceeding 15° by the УУА-1 indicator);

(c) once the airspeed becomes 450 km/h, start gradual recovery from dive, avoiding an increase of the angle of attack above +20° by the УУА-1 indicator (or an increase of the normal g-loads beyond the values permissible for the given indicated airspeed).

WARNINGS: 1. It is advisable to employ the drag chute as an auxiliary (emergency) means of recovering the aircraft from spin.

2. It is not recommended to use the drag chute for recovering from spin at altitudes above 11,000 m.

Do not alter the throttle position before the aircraft is recovered from spin (both when the engine is running steadily and when it runs a flameout).

On completing spin recovery, check the engine controllability, increasing the rpm to the maximum figure by smoothly opening the throttle.

Should the engine run a flameout, blow it through by setting the throttle to SHUT-OFF for at least 2 s; then set up a reliable engine relight airspeed and relight the engine.

Inertia Rotation of Aircraft

173. The aircraft is most likely to experience dangerous inertia rotation at supersonic airspeeds, when performing maneuvers involving continuous rolling (for more than 4 to 6 s) due to almost full deflection of the ailerons with simultaneous forward displacement of the control stick and application of near-zero ($\pm$0.2 g) or minor negative vertical g-loads. Deflection of the rudder in the direction of the roll will promote the onset of inertia rotation.

At subsonic airspeeds the aircraft may enter inertia rotation when maneuvering involves vigorous rolling at a rate of more than 90 deg/s in the direction opposite to pushed rudder (say, if the pilot makes an attempt to discontinue aircraft rolling at an angular velocity of more than 90 deg/s by pushing rudder). In this case, most favourable conditions for aircraft entry into inertia rotation are created by deflection of the control stick diagonally forward and in the direction of rolling. The aircraft will enter the inertia rotation more readily when the pilot strives to counteract an increase of negative g-loads by applying back pressure on the stick.

Onset of inertia rotation is also promoted by lack of directional trim, causing sideslip.

Deflection of the ailerons in opposition to the direction of rolling or setting them in the neutral position for counteracting the developed inertia rotation, can discontinue rolling only when the ailerons are highly effective (at high subsonic airspeeds at low and medium altitudes). Operation of the ailerons in the above manner at supersonic airspeeds will be of no avail.

It is not permissible to deflect rudder against the aircraft roll for counteracting the developed inertia rotation, since this may reverse the sideslip, as a result of which the aircraft may start rolling in the opposite direction.

In all cases, elimination of sideslip by setting of the rudder neutral will aid in the aircraft recovery from inertia rotation.

174. To prevent onset of inertia rotation at subsonic airspeeds, the pilot, in performing harsh maneuvers, must not permit continuous (for more than 3 to 4 s) aircraft rolling at a rate of more than 90 deg/s. Neither should the pilot apply forward pressure on the stick, nor impose near-zero or minor negative vertical g-loads, when the aircraft is rolling at an angular velocity of about 90 deg/s.

When flying at a supersonic airspeed, with the aircraft rolling continuously and with the ailerons almost fully deflected, avoid applying near-zero or minor negative normal g-loads.

175. The symptoms of inertia rotation onset are as follows:

(a) intensive growth of sideslip and lateral g-loads;

(b) intensive increase of the positive or negative g-load, or onset of an alternating vertical g-load, failing to agree with the stabilizer deflection;

(c) continuous increase of the roll rate with the ailerons kept at one and the same deflection angle.

Actions to be taken:

(a) disengage the AFCS immediately;

(b) switch off the afterburner if it is ON;

(c) immediately set and fix (squeeze) the control stick and rudder in the neutral position.

WARNING. As the aircraft rotation progresses, do not allow rudder to depart off the neutral position. Here the rudder forces may be as high as 60 kgf;

(d) after the aircraft stops rolling, bring it into level flight, check the engine run and the aircraft controllability;

(e) discontinue the mission and proceed to the airfield.

FLIGHTS WITH USE OF PSP, UNPAVED AND SNOW-COVERED RUNWAYS, AND UNPAVED RUNWAYS WITH PAVED ENDS

176. It is allowed to use unpaved runways, and those with paved ends, provided the soil strength is not less than 7 kgf/cm^2 and the upper layer of soil is not excessively wet (there are no waterpools and/or mud on the runway surface).

Snow-covered runways may be used after soft snow has been cleared off and the runway surface has been hardened by rollers, the snow layer not exceeding 15 cm in thickness and its density being at least 0.5 g/cm^3.

Flying with the use of unpaved, snow-covered and PSP runways can be conducted provided the crosswind component is not higher than 10 m/s.

The takeoff run and landing roll distances as well as the distance to the end of the runway should be checked with the aid of marks put at distances of 500 and 1000 m to the runway ends.

Taxiing

177. The run-on force sufficient to move the aircraft from rest is obtained at engine rpm of 70 - 80%, depending on the soil or snow conditions. Taxi with the nosewheel brake disengaged and with the anti-skid unit engaged, at a speed of not more than 30 km/h.

As turns are made in taxiing, the braked wheel will make a deeper tread in the soil. So, taxi with increased radii of turns (at least 15 m) to spare the airfield surface; do not halt the aircraft and prevent bogging of wheels down the soil or snow.

When the soil strength is less than 10 kgf/cm^2, or when using snow-covered strips of 10 to 15-cm thickness, taxi at a speed of 25 - 30 km/h and perform turns at increased radii, without speed reduction (taxiing is unsteady when performed at a lower speed, and the aircraft yaws due to bogging of the wheels down the soil or snow).

Stop the aircraft in the line-up position by gradually reducing the engine power, without brake application, lest the nosewheel may bog down the soil or snow.

WARNING. When taxiing out in a formation, take measures to prevent dust or mud from getting into the engine air intakes.

Taxi on a PSP runway or taxiway in the same manner as on unpaved strips (the run-on LP rotor rpm are 70 - 80%). In turning, avoid harsh evolutions, so as not to damage the braked wheel tyre against steel plates.

If the PSP surface is wet and muddy, the aircraft is likely to skid during turns and braking.

Should the aircraft roll onto the ground out of the PSP runway or taxiway, reduce the taxi speed by throttling down the engine, avoiding vigorous brake application, and taxi onto the PSP strip (runway or taxiway), proceeding at an angle of 20 to 30° to the strip center line.

Takeoff

178. Take off, using an unpaved, PSP or snow-covered runway with full reheat engine power, with the flaps lowered in the takeoff position and the nosewheel brake disengaged.

Before takeoff, brake the wheels by fully depressing the braking lever; smoothly open the throttle, shifting the lever to the FULL THROTTLE position, and as the LP rotor picks up about 100% rpm, select FULL REHEAT.

The aircraft can be held against the brakes on a dry unpaved or PSP runway till the maximum rpm are reached; on a hardened snow-covered runway or on a wet or mud-covered PSP runway the aircraft can be held in place before the 70 - 85% LP rotor rpm are reached.

If the runway condition cannot ensure holding the aircraft in place at FULL THROTTLE, smoothly release the braking lever as soon as the machine starts moving (preventing skidding of the wheels) while increasing the engine rpm to the maximum value; having ascertained that the engine is running at FULL THROTTLE, turn on the reheat unit (afterburner). Check to ensure that reheat is really engaged in the process of takeoff run.

As the speed becomes 100 - 150 km/h, pull the stick back through approximately 2/3 of its full travel range. Keep the stick in that position as long as the beginning of the nosewheel liftoff. Then, as the nosewheel leaves the ground, set up the required takeoff pitch attitude by smooth deflection of the control stick.

When taking off a runway whose soil strength is less than 10 kgf/cm^2, pull the stick all the way back at an airspeed of 100 to 150 km/h and keep it in this position until the beginning of nosewheel liftoff.

The nosewheel liftoff initial speed is somewhat higher, in using of unpaved or snow-covered runways, than in the case of using concrete runways; this speed grows as the soil strength diminishes or the snow layer thickens.

Once the nosewheel begins to peel off the ground, smoothly deflect the control stick so as to establish the required takeoff pitch attitude.

Counteract turning and yawing tendencies in the first half of the takeoff run by applying the LG wheel brakes; use rudder for the same purpose when the speed grows sufficiently. There is no need to counteract longitudinal oscillations of the aircraft on takeoff run occurring as a result of the uneven surface and unequal strength of the runway.

In the course of takeoff run on an unpaved runway with paved ends, the aircraft slightly sinks its nose (nods) at the time of entry onto the unpaved runway section; but this would not hamper performance of further takeoff run.

Landing

179. Before coming in, check to ensure that the nosewheel brake is engaged.

At the time of touching down upon an unpaved runway, the aircraft tends to lower the nose vigorously, especially when the ground is soft or the snow layer is thick; so, prevent the nosewheel from kicking harshly against the ground after touchdown.

When the nosewheel is on the ground, brake the wheels in a smooth manner, and deploy the drag chute if required.

Use the wheel brakes to reduce the landing roll distance, depending on the situation (e.g. intensity of aircraft braking by the soil of the runway, execution of the landing with an overshoot or undershoot, etc.).

Jettison the drag chute at a speed of 40 - 50 km/h by the end of landing roll, and discontinue braking of the wheels. Taxi out of the runway, never allowing the aircraft to halt, in order to prevent bogging of the wheels down the soil or forming of deep treads; also it is advisable to taxi out of the runway at the end of the latter, so as to prevent forming of cross treads on the usable length of the runway.

Use of the drag chute is mandatory in landing roll over a hard snow-covered runway (the landing roll distance without use of the drag chute would be as great as 1700 m).

Landing on the PSP runway and roll over this runway are just ordinary procedures, but the drag chute shall be used by all means in landing on a wet or muddy PSP runway, so as to except the cases of tyre damage should skidding develop in the second half of the landing roll. Jettison the drag chute before the aircraft comes to rest, because taxiing with the drag chute trailing behind may damage the latter against steel plates.

In the course of landing roll over an unpaved runway with paved ends, the aircraft deceleration grows perceptibly at the time when the aircraft enters the unpaved runway section.

PECULIARITIES OF USING NARROW RUNWAYS

180. It is allowed to operate the aircraft from narrow PSP runways, 21 m wide, constructed from plates placed on a bedding of soil, provided the soil strength is over 6 kgf/cm^2 and the runway surface is dry.

Flights from narrow PSP runways may be performed only by pilots who have been trained in approach and landing on a 21-m wide strip marked on a concrete runway, and who have practised landing on a dry PSP runway placed onto soil having a high strength (of more than 10 kgf/cm^2). Flights with the use of a narrow PSP runway should be performed at a crosswind component of not over 8 m/s.

<u>Takeoff</u>

181. Preparatory to takeoff, position the aircraft along the center line of the runway so that its longitudinal axis and nosewheel are aligned with the takeoff direction.

Takeoff shall be performed at FULL REHEAT, with the flaps extended into the takeoff position.

Prior to takeoff, brake the wheels by fully depressing the brake lever.

During takeoff run, pay major attention to maintaining the direction in strict alignment with the runway center line. Use the brakes for directional control with due care, never applying the brakes in an abrupt manner for counteracting the deviations, since this may cause the aircraft to yaw with resultant rolling off the runway, especially in the presence of cross wind.

Before nosewheel liftoff, maintain directional control by reference to the center line drawn on the runway; after nosewheel liftoff, refer to the center line and to the side marks (limiters).

To provide better observation of the narrow runway ahead, perform takeoff at lesser takeoff angles; as a result, the unstick speed will increase by 10 to 20 km/h.

<u>WARNING.</u> When operating the aircraft from a narrow PSP runway, never sit low in the cabin, since this will result in a restricted forward view.

182. Abrupt and incoordinated operation of the brakes and rudder during takeoff run, or failure to maintain the direction of the run relative to the runway center line, is likely to result in aircraft rolling off the runway and onto the unpaved surface. Return to the PSP runway is difficult and unsafe, since use of the brakes for changing the direction of movement will entail abrupt dashing of the aircraft in either direction. Therefore, whenever the aircraft rolls onto the unpaved surface in the course of the first half of takeoff run, discontinue the takeoff procedure; if the aircraft rolls onto the unpaved surface during the second half of the run, proceed running on the soil, parallel to the runway center line.

Landing

183. An adequately marked narrow PSP runway is visible from a distance of 8 to 10 km, provided the visibility is good enough.

Gliding in final approach should be performed along a normal path, at an airspeed by 10 to 15 km/h greater than that prescribed for landing on a runway of the normal width; this will ensure better view of the runway up to the moment of touchdown. When gliding is accomplished at a lower airspeed, the narrow PSP runway will not be visible owing to an increased angle of pitch during flareout and holding-off.

While gliding, finalize the landing approach by making minor correction turns during final approach.

Cross wind makes landing approach more difficult and calls for timely measures for counteracting drift.

184. To ensure proper touchdown, establish a pitch angle somewhat below the normal one (at a touchdown speed 15 to 20 km/h greater than that used on a runway of the normal width) to land the aircraft on the runway center line and to ensure ease of directional control at the beginning of landing roll.

After touchdown, smoothly lower the aircraft nose so as to have an adequate view of the runway, and start brake application by smoothly depressing the brake lever. Deploy the drag chute at a speed of not more than 320 km/h. Maintain directional control in the course of landing roll by applying rudder and the brakes.

WARNINGS: 1. It is not allowed to deploy the drag chute in case the crosswind component exceeds 8 m/s.

2. Should the aircraft roll off the PSP runway, terminate the landing roll on the soil, parallel to the runway.

185. Takeoffs from and landings on a narrow PSP runway laid over an excessively wet soil bedding, are allowed in emergency cases only. During aircraft movement on such a runway, mud is forced out of perforations in the plates, materially reducing the effectiveness of the brakes and maneuvering abilities of the aircraft, which hampers directional control during takeoff run and landing roll and is likely to result in aircraft rolling off the runway. Besides, mud that gets onto structural elements of the aircraft may disable those elements.

The aircraft positioned on a moist PSP runway (or on a hard snow-covered runway) is held by the brakes up to the LP rotor speed of 70 to 85%; therefore, engine acceleration to FULL THROTTLE, ignition of the afterburner and checking of the afterburner ignition have to be accomplished in the course of takeoff run; this considerably complicates the procedure of taking off a narrow PSP runway.

PECULIARITIES OF FLYING UNDER HIGH AMBIENT TEMPERATURES AND LOW ATMOSPHERIC PRESSURE

186. When performing flights in hot climate conditions (at high temperatures) or operating the aircraft from high-level airfields, due consideration should be given to substantial deterioration of the aircraft takeoff and landing characteristics.

Estimation of the takeoff run (landing roll), required length of the runway and unsticking (landing) speed, depending on the ambient air temperature, atmospheric pressure (airfield elevation), and takeoff (landing) weight as well as on the speed and direction of the wind, should be performed by reference to the nomograms presented in Figs 8 through 13.

When assessing the possibility of takeoff (landing), take into account the unstick (touchdown) speed, apart from considering the runway length, so as not to exceed the limitations with respect to the LG wheels. Under the known weather conditions the nomograms permit determination of the takeoff (landing) weight for the given air temperature and pressure.

It is desirable that flights in hot climate conditions be performed with the use of a ventilated suit.

It is not recommended to perform flights at low altitudes when wearing the partial-pressure suit and pressure helmet, owing to low efficiency of the cabin air-conditioning system in high temperature conditions.

187. When inspecting the aircraft under high ambient temperatures, pay special attention to the points where leakage of oil, hydraulic fluid and/or fuel may occur owing to thermal expansion of fluids; besides, check the condition of the tyres (no bulges or cord separation is allowed).

When performing ground checks, keep the electrical and radio equipment units energized for as short a time as it is possible, since overheating of the units is likely to cause more failures and malfunctions.

Starting and Running Up Engine, Taxiing Out

188. Start the engine in the usual manner, taking care to complete the ground checks and engine run-up in the shortest time possible.

When the aircraft is operated on high-level airfields, the idle speed should correspond to the barometric height of the airfield.

After engine starting, perform takeoff without any delay, to avoid overheating of the pilot owing to low efficiency of the cabin air-conditioning system on the ground.

In taxiing, use the wheel brakes sparingly, to avoid overheating.

Takeoff

189. Take off at FULL or SECOND REHEAT only.

While performing takeoff run, at a speed of 150 to 200 km/h apply full back pressure on the stick and keep it in this position until nosewheel liftoff. After the nosewheel clears the ground, keep running at a pitch angle which is somewhat below the normal one, since premature establishment of the takeoff pitch angle will result in delayed aircraft acceleration.

After the aircraft attains a speed of 280 to 300 km/h (when carrying no external stores) or a speed of 300 to 320 km/h (when carrying heavier external stores), build up the normal pitch angle. Unsticking occurs at a speed of 340 to 370 km/h, depending on the aircraft takeoff weight.

WARNING. When taking the decision to abort takeoff, bear in mind that the braking distance will increase as compared to that under the normal conditions.

At high ambient air temperatures, especially on a high-level airfield, the takeoff distance will increase and the climb performance will deteriorate owing to the slower aircraft acceleration on takeoff.

When the aircraft commences second-segment climb, set the LG control valve for retraction at a height of 10 - 15 m, and retract the flaps at an altitude of not below 100 m.

Landing

190. When performing landing approach, it is necessary to make allowance for the increase of the holding-off distance and the touchdown speed. Therefore, use of the BLC system is mandatory; on overflying the inner beacon, establish such a glide path that the aircraft would descend into a point located at a distance of 250 to 300 m from the threshold (i.e. 100 m farther than under the normal conditions); and the drag chute must be deployed during landing roll.

The wheel brakes should be used depending on the actual conditions (the length of the runway, accuracy of estimation, etc.), bearing in mind that excessive brake application will result in wheel overheating.

Peculiarities of Aerobatics

191. When the Nesterov loop (or half-loop) and wingover are to be performed over high mountainous ground, the minimum indicated altitude and the minimum entry speed should be determined with the use of nomograms presented in Figs 37 and 39.

If the altimeter pressure subscale is set to the barometric pressure on the airfield level (QFE) the nomograms should be used in the usual way.

If the altimeter pressure subscale is set to 760 mm Hg (when high-elevation airfields are used), the minimum entry altitude thus found should be increased by the airfield pressure altitude value.

Section Six

AIR NAVIGATION

PRELIMINARY AND PREFLIGHT PREPARATION

192. In the course of preliminary preparation the pilot should prepare the map for flying with the use of the PCБH equipment and radio compass, or radio compass alone; it is practical to select prominent (key) reference points, lay out routes between such reference points and the landing airdrome, and calculate the azimuth and distance of the route intermediate (turning) points from navigational radio beacons. (To facilitate position finding and to simplify correction of the PCБH system indications, distinctive landmarks and locations of electronic navigational facilities should be used as the key reference points).

Visual orientation is made easier if the pilot determines (at regular intervals) the aircraft approximate position on the map and then predicts the reference point that may be expected within view.

Depending on navigational and tactical situations, the aircraft can be brought to a ground target either with direction from the ground or by dead-reckoning from a distinctive reference point located at a 2- to 3-min flying-time distance to the target.

Having studied the flight route and the electronic navigational facilities to be used in flight (or transfer, ferry flight), brief the ground personnel on the following:

(a) variant of fuel fill;

(b) radio data of the homing beacons to tune the radio compass to, and the radio compass tuning procedure;

(c) radio data and tuning procedure of the airborne radio set.

Enter the following into the flight calculation table (knee-pad):

(a) flight route, with indication of the course and elapsed time on every leg;

(b) callsigns and runway directions of alternate airdromes;

(c) azimuths and distances of the route intermediate (turning) points, key reference points and estimated initial points of turning to final;

(d) procedure of using airway and airdrome beacons, channel numbers (frequencies) of the navigational beacons, localizers and glide path transmitters to be used in flight;

(e) callsigns and frequencies of homing beacons, procedures of using them in flight;

(f) callsigns of PCБH system beacons;

(g) callsigns of control centers (direction centers), radio traffic procedures;

(h) magnetic declination of alternate airdromes (if required).

193. In the course of preflight preparation the pilot should:

(a) verify the meteorological situation, finalize the flight calculations and (if necessary) the fuel fill variant;

(b) have the ground crew report tuning of the radio compass properly, or check personally that the radio compass picks the operating homing beacons that are to be used in flight, thus indicating that its channels have been tuned to the proper beacon frequencies (ensure that the beacon callsigns and frequencies are put down on the radio data plate and that the radio set tuning procedure is such as required by the flying mission);

(c) inquire the technician about the pressure value set in by the ЗДВ-30 barometric pressure setter;

(d) adjust the aircraft clock to read the exact time.

CROSS-COUNTRY FLIGHT

194. Prior to taxiing out, check to ensure the following:

(a) the GS PF: AIR - GND and PCБH - ARC switches are in the AIR and PCБH positions, respectively;

(b) the UPDATE light is shining (if the lamp is dead, make sure that the NAVIG. - LETDOWN - LDG switch is set at NAVIG. and that the proper channels of the navigational and landing (i.e. localizer/glide path transmitter) beacons have been selected);

(c) the magnetic declination setter has been adjusted to the magnetic declination of the flying area.

Make certain that the PCБH equipment is serviceable, referring to a stable display of the aircraft azimuth from the beacon, beacon relative bearing and distance to the beacon.

195. Preparatory to take off, set the course setter pointer to the azimuth of the first RIP (route intermediate point). After takeoff and retraction of the landing gear and flaps, turn the aircraft to align the set course pointer with the lubber line (fixed) index of the CCI. Should the tail of the relative bearing pointer fail to align with the set course pointer after the aircraft has completed the turn to the required heading, turn the airplane aside in the direction opposite to deflection of the relative bearing pointer tail, through a value equal to the mismatch between the set course pointer and the tail of the RB pointer, but not more than through 30 - 40°. Maintain this new heading until the RB pointer tail approaches the set course pointer, then start turning the aircraft to the required heading in a smooth manner, so as to match both pointers together by the end of the correction turn.

Once the tail of the relative bearing pointer coincides with the set course pointer, fly along the required azimuth line, also referring to the vertically-disposed position bar of the FDI (the bar should be kept in the limits of the aircraft simulated position circle). If the FDI vertically-disposed position bar deflects to the left (right) in the process of flight, reduce (increase) the heading by 3 to 5° and fly with the new heading until the bar begins to move to the center of the FDI aircraft simulated position circle.

When the vertically-disposed bar enters the limits of the circle, start gradually reducing the heading correction; choose such a heading that the bar is kept within the limits of the circle.

After overflying the RIP, in the process of a turn, set the course setter pointer to the new required heading. Check overflying the new RIP by the elapsed time as well as by comparing the precalculated azimuth and distance values with the actual ones.

Should the UPDATE indicator light go out, the PCБH equipment will pass over to coordinate dead-reckoning. Knowing the true coordinates of the key reference points (i.e. their azimuth and distance from the beacon), the pilot may compare those to the readings of the CCI and distance indicator at the time of overflying the check points, and he may introduce corrections by manipulating the INITIAL SETTING: AZIMUTH and DISTANCE switches.

Having overflown the last RIP, set the course setter pointer to the return course, then turn the aircraft to RB = 0°. Should the RB pointer fail to align with the set course pointer after the aircraft has completed the turn to RB = 0°, turn the airplane aside in the direction opposite to deflection of the set course pointer, through a value equal to the mismatch between the two pointers; maintain this new heading until the RB pointer approaches the set course pointer, then start smoothly reducing the heading correction so as to match both pointers together by the end of the correction turn.

Once the RB pointer coincides with the set course pointer, fly along the required azimuth line, also referring to the vertically-disposed position bar of the FDI.

196. When approaching the landing airdrome, depending on the flying altitude (and in compliance with the recommendations of Table 13), select the LETDOWN mode (if required) by placing the NAVIG. - LETDOWN - LDG switch in the LETDOWN position.

Table 13

D (km)	130	100	80	60	40	20
H (m)	10,000	8000	6000	4500	3000	600

As the horizontally-disposed position bar of the FDI approaches the aircraft simulated position circle, begin descent in a smooth manner; in the course of descent, keep the FDI position bars within the limits of the aircraft simulated position circles (Fig. 45). When at a distance of 20 to 22 km to the beacon, revert to level flying (at an altitude of 600 m) and adjust the set course pointer to read the runway approach course. If the mismatch between the RB pointer and the set course pointer does not exceed 10°, place the NAVIG. - LETDOWN - LDG switch in the LDG position, extend the landing gear and intercept the localizer beam in the automatic, command control or manual control mode.

If the angle of mismatch between the RB pointer and set course pointer exceeds 10°, home to the navigational radio beacon; at the time of overflying the navigational beacon, make a correction turn to hit the runway approach heading and fly with this heading. When at a distance of 5 to 7 km to the runway, enter a turn at a bank of 30° and either make a wide rectangular pattern approach or two-180°-turns approach.

Note. On airdromes surrounded by a complicated ground relief, where it is difficult to execute a prelanding maneuver at a height of 600 m, the altitude and distance of completing letdown and reverting to level flight will be determined by the Standing Flying Procedures of the given airdrome.

Using APK-10 Radio-Compass Distance Counter in Flight

197. In cross-country (en-route) flights with employment of a homing radio beacon located on the takeoff and landing airfield, set zero readings on the distance counter before taking off or after overflying the homing beacon (used as the route initial point).

Then, during the entire flight along any closed route lying within the coverage zone of the landing-airfield homing beacon, the distance counter will read the shortest distance to the homing beacon along a straight line, at any moment of the flight, without the wind drift allowance.

198. For straight-line transfer or ferry flight from one airfield to another, before taking off, depress the radio compass button corresponding to the frequency of the landing-airfield homing station and set the distance counter scale against the straight-line distance to this airfield.

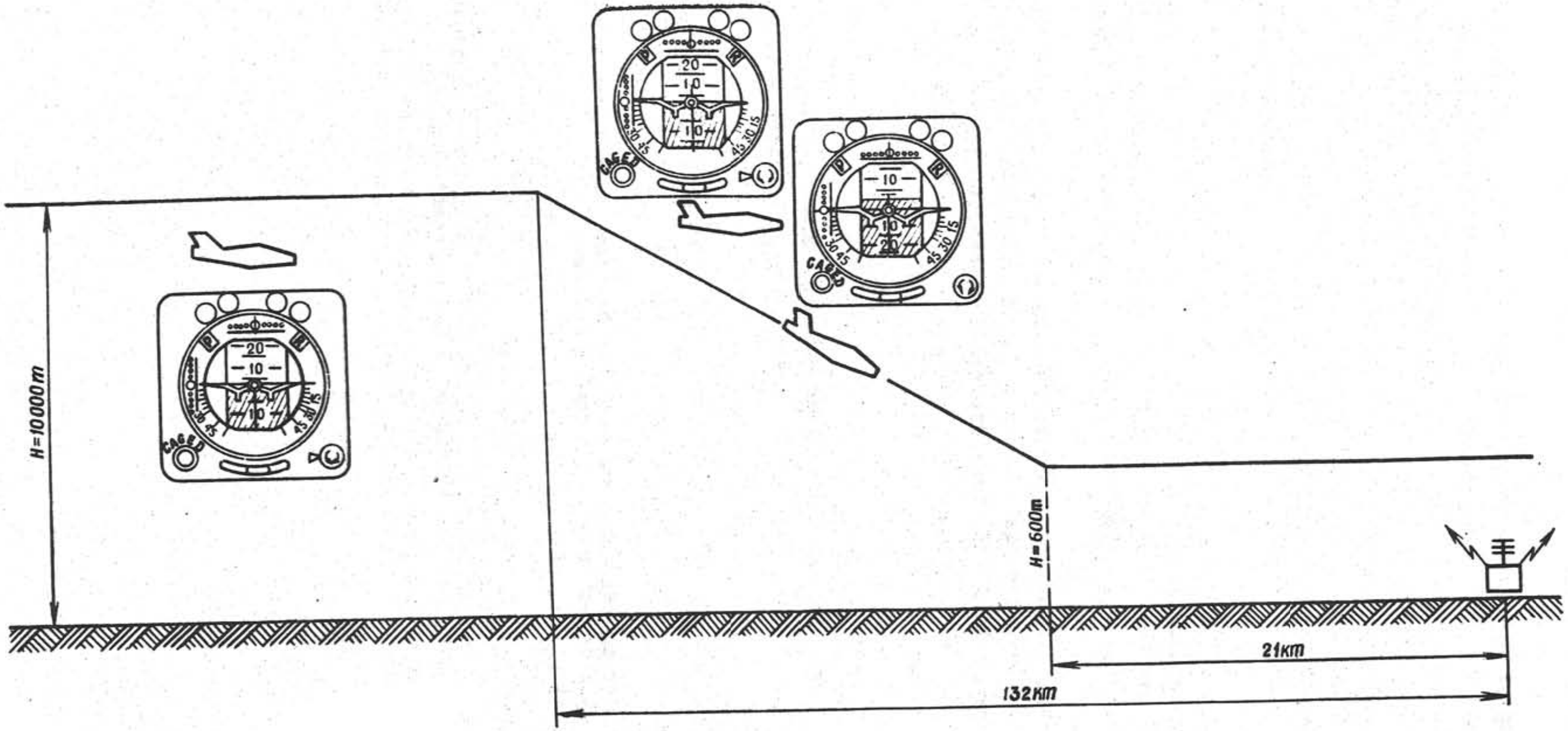


FIG. 45. APPROACH TO NAVIGATIONAL RADIO BEACON IN LETDOWN MODE

In flight, the distance counter will read distances to the beacon of the landing airfield.

199. Before taking off, in cross-country flight in which several homing beacons (NDB) will be used, tune the radio compass to the frequency of a homing beacon located at the route intermediate (turning) point, and set the distance counter to read the total length of the route running through all the homing beacons positioned at the route turning points (from the homing beacon at the route initial point to the beacon at the route terminal point).

In flight, overflying every intermediate homing beacon (NDB) located at a route intermediate (turning) point, change over to the frequency of a homing beacon of the subsequent route turning point.

The distance counter will indicate, throughout the flight, the distance to the homing beacon of the route terminal point.

When over intermediate homing beacons, it is allowed to update the readings of the distance counter with reference to the known remaining distance to the homing beacon of the route terminal point.

200. In cross-country flight in which several homing stations are to be used, it may be more convenient to read the distance to the next intermediate point on the route (RIP). To this end, before taking off, tune the radio compass to the beacon frequency of the first RIP and set in the distance to this beacon on the distance counter.

On overflying the first route turning (intermediate) point, change over to the frequency of the next RIP homing beacon and set the distance counter to read the distance to this NDB.

For cross-country flight in which distances between homing beacons exceed 1000 km, before taking off, set the distance counter to read L = 999 km, where L is the distance between the beacons (km).

Notes: 1. On leaving the coverage zone of a homing beacon (which is up to 180 km when at an altitude of 1000 m and up to 350 km at an altitude of 10,000 m), bear in mind that readings of the distance counter may become wrong.

2. If broadcasting stations are used for beacons, readings of the distance counter will be correct at greater distances.

3. To increase reliability of the distance counter indications, update its readings every 20 - 30 min, using information obtained from ground radars, control posts, referring to landmarks for the purpose, because the distance counter makes no allowance for wind. When introducing corrections, do not pass over numerals 0 or 9 in every digit, in order to exclude upsetting the readings in the adjacent digits.

4. In determining distances to homing beacons, the distance counter is accurate within 5% of track made good, not considering wind drift.

Section Seven
COMBAT EMPLOYMENT

201. The flight performance of and armament carried by the aircraft allow it to intercept aerial targets from the rear hemisphere within a wide range of altitudes and airspeeds, to attack ground targets, to conduct fighter-to-fighter combat and visual air reconnaissance.

Good knowledge of the aircraft capabilities, its armament and equipment as well as strict adherence to the assigned flight regime and to the specified sequence of handling the cabin equipment, will make for successful execution of the combat mission.

REGIMES OF FLYING FOR TARGET INTERCEPTION

202. In interception of aerial targets the engine may be run at various power settings (reheat, non-reheat and combined), depending on the target airspeed and altitude as well as on the ground radar detection range and distance to the intercept line. Under these conditions, combinations of engine power settings and the sequence of their employment may vary within a wide range.

To obtain the maximum mean airspeed on the flight path within the minimum time available for execution of the mission, use is made of reheat power settings (the entire flight, from takeoff to the end of the attack being performed at reheat power).

In all other cases non-reheat or combined power settings are used.

203. The flight program is transmitted over the radio from the direction center by R/T.

204. The flight program involving engine operation at reheat power, the aircraft carrying two or four missiles for attacking a high-altitude target, is executed at FULL REHEAT from takeoff to termination of the attack; the program consists of the following phases:

(a) takeoff and climb to an altitude of 10,000 m at a true airspeed of 950 km/h;

(b) aircraft acceleration with a loss of about 300 m of altitude by the altimeter, till exceeding the sonic speed; then, further acceleration at a constant altitude of 10,000 m, till reaching 1200 km/h IAS;

(c) climb at a constant indicated airspeed of 1200 km/h to 1.9 M;

(d) further climb at a constant Mach number of 1.9 M till the end of the turn.

Note. The indicated airspeed and Mach number must be maintained even at the expense of altitude loss;

(e) climb to the attack altitude by zooming after termination of the turn, the Mach number decreasing to 1.7 - 1.75 M, at $n_{y\ entry} = 1.5 - 2.0$ g and $n_{y\ recov} = 0.3 - 0.4$ g;

(f) taking aim, closing on the target to the permissible launching range, and launch of the missiles.

205. Depending on the target altitude and airspeed, departure from the specified program, for attaining the altitude of attack, should be effected as follows:

(a) if the attack altitude is less than 10,000 m, attain the assigned altitude of target attack, then accelerate the plane to the assigned airspeed (referring to the УИСМ-И indicator);

(b) if the attack altitude is 10,000 m or over, accelerate the aircraft to the assigned airspeed (by the УИСМ-И indicator) at an altitude of 10,000 m, then climb to the attack altitude at this airspeed.

At altitudes over 3000 m, perform the attack with a step-down separation of 500 to 3000 m with respect to the target (a vertical separation of 1000 to 1500 m is considered the most favourable); if the target is flying at an altitude of less than 3000 m, the step-down should be 300 - 500 m.

206. A combined flight program comprises the following phases:

(a) takeoff at FULL REHEAT, with subsequent climb to an altitude of 9500 - 10,000 m at FULL THROTTLE at V_{TAS} = 850 to 870 km/h;

(b) flight to the target at an altitude of 9500 - 10,000 m at an indicated airspeed of 530 km/h.

When intercepting high-altitude targets, turn on the afterburner at the direction center command and proceed to executing the aircraft acceleration and climb in accordance with the reheat-power program.

When intercepting targets flying at altitudes of less than 10,000 m, descend (on the direction center command) at V_{TAS} = 950 to 1000 km/h with the engine set at IDLE. When flying at altitudes of less than 3500 m in bad weather conditions and at night, adhere to the rates of descent set forth in Table 14. Maintain the airspeed on the flight path by varying the engine settings.

Table 14

H (m)	3500 - 2000	2000 - 1000	1000 - 600
V_y (m/s)	40	15	10

When descending in the daytime in VMC, you may exceed the descent rates specified in Table 14, provided flight safety is ensured.

Having reached the assigned altitude, set up the assigned airspeed, using the reheat settings if required.

207. If the attack is completed at great distances from the airfield, cruise back at an altitude of 11,000 m at an IAS of 510 km/h.

FLYING WITH USE OF A-23Б RADAR

208. In an air target interception flight, the pilot's handling of the radar set falls into four subsequent stages:

(a) switching on the radar and checking it for normal functioning by means of the built-in monitoring system;

(b) target detection and identification;

(c) flying the aircraft to the initial position for target lock-on;

(d) target lock-on, aiming, rocket launching (or simulation of rocket launching) and breakaway.

209. Before taxiing the aircraft out of the parking place, turn on the radar by shifting the OFF - STANDBY - RUN ON selector switch to the STANDBY position.

In 3.5 to 5 min after the switch has been shifted to the STANDBY position, check the radar for normal operation with the aid of the built-in monitoring system; the sequence of the check is as follows:

(a) press the TEST button light; as soon as it is done, the radar will automatically be changed over to the antenna equivalent in the RUN ON mode, the TEST button light will illuminate, the AFC lamp will illuminate and then extinguish (if the AFC lamp is burning constantly, the radar is unserviceable), and the LNCH lamp will illuminate, too; once in a scanning cycle (approximately 3 s) a target blip will appear on the radar screen, with the "up" and "down" marks being within the azimuth lock-on zone limits ($\pm5^{o}$) and approximately at an 8-km range (this blip may also appear at 1.5-km, 16-km and 24-km ranges);

(b) superimpose the range gates on the target blip located at the 8-km range, and press the LOCK-ON button; as this button is pressed, the LNCH lamp extinguishes and the (O) lamp starts blinking (up to the lock-on moment); after lock-on is accomplished, the radar starts operating in the autotracking mode, and an aiming blip appears on the indicator screen; this blip moves first in the right-hand upward direction, then in the left-hand downward direction and stops in the center of the screen; this is followed by illumination of the green FIXED BEAM lamp and of the lamp positioned above the OFF - H SIGNAL - LOW ALT. switch;

(c) if the aircraft carries P-3P missiles, it is required, in the autotracking mode, to shift the launch variant switch to the stations on which the P-3P missiles are suspended (if missiles of different types are suspended, set the MSL - NEUT. - RGM switch to the RGM position); listen to the sound signals produced by the missiles; the volume of the sound signals can be adjusted by means of the LOCK-ON: HI-LO knob.

Note. The sound signal produced by the heads of the missiles should cease before the aiming blip disappears from the radar screen;

(d) in 5 to 7 s after the aiming blip has reached the center of the screen, the FIXED BEAM and TEST lamps as well as the lamp positioned over the OFF - H SIGNAL - LOW ALT. switch should extinguish; the CANCEL. (RESET) button light should illuminate for 6 - 8 s and extinguish; this will testify to the fact that monitoring is completed and the radar is ready for operation.

Note. If required, the pilot may abort radar monitoring at any stage by pressing the CANCEL. button light.

210. After the interceptor has been brought into the rear hemisphere of the target and the appropriate command is issued by the direction center, shift the OFF - STANDBY - RUN ON switch to the RUN ON position; as soon as it is done, the AFC lamp will come on and extinguish.

Proceed to target search on the radar screen and control the aircraft as to course and altitude.

Upon detecting the target blip, identify the target nationality by pressing the INTERROG. button light. As soon as it is done, the "up" and "down" marks disappear and the following is observed on the radar screen: if the aircraft is friendly, an identification blip appears over the target blip, both blips being parallel and similar in shape; if the aircraft belongs to the enemy, only the target blip is displayed on the screen; after the target has been identified, switch off the interrogation mode by pressing the CANCEL button light.

211. Watching the screen, maneuver the aircraft in heading so as to bring the target blip into the azimuth lock-on zone ($\pm5^{o}$); rotate the throttle handgrip in the backward direction to turn on and superimpose the range gates on the blip, then accomplish target lock-on by pressing the LOCK-ON button on the control stick, keeping it in the pressed state for 3 to 6 s.

Notes: 1. Target lock-on can be accomplished when the screen displays both the "up" and "down" marks or only the "up" or "down" mark.

2. Superimpose the range gates so that the target blip is closer to the upper range gate. Observance of this condition will place the target blip in the range lock-on zone when the target is being locked on during the closure process.

At the target lock-on moment the radar screen displays an aiming blip ("birdie") with the present target range marks and missile permissible launch zones. The center of the aiming blip complies with the position of the locked-on target with regard to the angular coordinates, whereas the range marks, moving towards the center in the process of closure, will indicate the present target range.

If the first target lock-on attempt has failed, release the LOCK-ON button, verify the position of the target blip in the lock-on zone and press the LOCK-ON button again.

212. After lock-on is completed, in the process of target closure, maneuver the aircraft so as to take aim, registering the center of the aiming blip with the center of the aiming ring on the screen ($\pm1.5^{\circ}$ with regard to the angular coordinates), and listen to the sound signal in the earphones (this signal is produced by the missile heads as the target is locked on).

Besides, as the target is locked on by the head of the P-3P port inner missile, the HR (head ready) signal lamp will light up on the scope bezel.

After illumination of the LNCH light has become steady (the range marks on the aiming blip have entered the permissible launch zone), launch the missiles (or simulate missile launching) as recommended in Paras 237 and 238.

After heat-seeking missiles have been launched, the aircraft should break away; after launching the P-3P missiles, smoothly track the target, taking care to keep the center of the aiming blip within the limits of the screen until the target is destroyed or until the (0) (breakoff) command is received.

As soon as the (0) command signal lights up, immediately break away.

After the mission is completed, switch off the radar by shifting the OFF - STANDBY - RUN ON switch to OFF, or to STANDBY if the attack should be repeated.

Employing Radar in Passive ECM Conditions

213. The A-23B radar permits interception of chaff-dispensing aircraft up to the target aspects of 3/4 under the conditions when chaff is dispensed in the rear hemisphere continuously or intermittently.

When chaff is dispensed and the radar is running in the target detection mode, a bright spot appears on the radar screen; this spot has a shape of a trail that follows the target. When chaff is dispensed continuously, the target blip gets lost in the bright area produced under the action of the chaff. In case of intermittent passive jamming, the target blip can be distinguished in the head of the trail at separate moments.

214. After an interference bright area appears on the radar screen, do the following to accomplish target lock-on:

(a) press the PASSIVE ECM button light (to switch on the circuit used to protect the radar from passive ECM);

(b) superimpose the range gates on the head of the trail (on the upper limit of the bright spot);

(c) press the LOCK-ON button.

Target lock-on can be also accomplished without pressing of the PASSIVE ECM button light, since the circuit of protection from passive ECM gets engaged automatically when the radar changes over to the autotracking mode.

215. If chaff is being dispensed by the target aircraft when the radar has changed over to the autotracking mode, the PASSIVE ECM button light illuminates to indicate that the radar circuit of protection from passive ECM has been automatically switched on, and the radar continues to track the target. The actions of the pilot do not differ from those when the target is attacked under no-interference conditions.

In case of disruption of the target autotracking mode during the attack, make certain that passive ECM are responsible for that, as displayed on the radar screen; then switch on the radar circuit of protection from passive ECM and accomplish target lock-on.

When attacking a chaff-dispensing aircraft, it is preferable to launch heat-seeking missiles.

All other operations (i.e. starting of the radar, checking its readiness, target identification, aiming, missile launching, breakaway) under the conditions of passive ECM shall be carried out in the same way as when there is no interference.

Notes: 1. Targets that fly at airspeeds of less than 300 km/h and that do not dispense chaff are attacked with the LST (low-speed target) button light switched on (i.e., with the closure-speed screenout circuit switched off). If attempts are made to lock on a low-speed target without preliminary depression of the LST button light, the PASSIVE ECM button light illuminates and target lock-on is cancelled (the A-23Б radar does not provide autotracking of chaff-dispensing aircraft flying at a speed of less than 300 km/h). The PASSIVE ECM button light may also illuminate in the case of cloud or ground clutter lock-on; in such cases press the CANCEL. button light and accomplish a repeated lock-on.

2. Low-speed targets that dispense chaff, flying at airspeeds lower than 300 km/h, should be attacked under the visual contact conditions, the radar being used in the target detection mode only, to facilitate search and for range-finding by the radar screen; when in visual contact, use the optical sight.

3. When the radar is used jointly with the optical sight operating in the GYRO mode, no radar protection from passive ECM is provided. Frame the target manually and fire with a 600-m fixed range introduced in the sight.

216. If target interception is being performed under weather interference conditions (weather interference is displayed on the screen as very bright spots that prevent finding the target blip against their background), turn on the radar weather-interference protection circuit by pressing the METEO button light. This done, the light spot brightness gets reduced considerably, and it becomes possible to discriminate the target blip from the weather spots.

Further, proceed as mentioned in Paras 214 and 215.

Employing Radar in Jamming Conditions

217. If the target is jamming the A-23Б radar, the latter running in the autotracking mode, the INTERF. signal lights up on the scope bezel.

If the permissible launch zones and the range marks can be seen on the radar screen after illumination of the INTERF. signal, the radar running in the autotracking mode, the attack procedure does not essentially differ from the normal procedure, except the breakoff time determination, because the (O) (BREAKOFF) command signal produced by the radar cannot ensure safety of breakaway from the attack under jamming conditions due to gross errors in target range determination. Therefore, regardless of the kind of jamming, take additional measures ensuring safe breakoff:

(a) when in visual contact with the target, determine the target range by means of the additional fixed reticle of the sight, using it as the scale in compliance with the data given in Table 15; then the initial breakoff range must be 1000 to 1200 m for attacks with missiles P-13M, P-3C and P-3P;

(b) when the target is invisible, begin to break off the attack when advised by the control post (or FDC).

In combat flights under jamming conditions, break off the attack as follows:

(a) turn away immediately after launching heat-seeking missiles, without any limitations as to the breakoff maneuver;

(b) after launching radar-guided missiles, if the target is visually observed, turn away immediately after missile shootoff, proceeding in such a way that the target relative bearing would not exceed 30° before the missiles hit (or miss) the target; if the target is not visible, break away immediately on launching the missiles, but never exceeding the 30° bank.

If the permissible launch (in-range) zones cannot be seen on the radar screen after illumination of the INTERF. signal, the radar running in the autotracking mode, the pilot can only obtain the present target range information over the radio from the CP or FDC. After lock-on is accomplished, use the normal procedure for aiming as to angles. Determine the permissible launch range by the optical sight indicator (it will be produced with approximation, depending on the flight altitude, making no closing-speed allowance for missiles P-3P); when in-range according to the information obtained from the CP (FDC), launch missiles of any type. Also, the effective (permissible) launch ranges may be memorized (or put down on the knee-pad); the data contained in Table 15 are of use in this respect.

Table 15

Parameter	Aircraft type			
	Phantom, Mirage IIIG	Jaguar	B-52	Ил-14
Wing span (approx.) (m)	12	9	56	31
Linear sizes (in mils) at ranges (in m):				
300	40	30	-	103
600	20	14	90	51
1000	12	9	56	31
1200	10	-	45	26
1500	-	6	40	20
2500	5	-	20	12
3000	-	3	19	10
5000	-	-	10	6

When in visual contact with the target, determine the range by means of the optical sight additional fixed reticle in compliance with the data of Table 15 and Figs 30, 31.

The crews of control posts (and fighter direction centers) must be specially briefed on the measures to ensure interceptor safe breakoff, before they control training flights for interception of aerial targets where target aircraft will be jamming the interceptors' radars.

If the INTERF. signal lights up on the radar scope bezel after the radar has locked on the target, report the presence of jamming to the control post and if the target is not spotted visually, request the ground crew to advise the time to begin breakoff. If the target is visible, use the sight additional reticle for determining the moment to start breakaway.

If the INTERF. signal lights up for a short time and dies out, cancel the auto-tracking, then attempt another lock-on.

218. If the target aircraft is jamming the interceptor's radar operating in the detection mode, the pilot's actions in locking on the target will vary in accordance with the kind of jamming employed by the target aircraft.

If it proves impossible to lock on such a target, use the information obtained from the CP to spot the target visually, then attack it with the use of the optical sight.

Given below are five variants of jamming and actions of the pilot to be taken against every jamming variant, provided the fighter is guided by a ground CP or fighter guidance center.

Variant 1. Continuous noise jamming of high power: the width of the noise jamming bright area on the indicator exceeds the azimuth lock-on zone, and the target blip is not visible against the jam background (Fig. 46). In this case, after reaching the third guidance stage and discovering that jamming is displayed on the screen in the form of noise bright areas, transmit the coded command: "The target is covered by jam, transmit target range every 2 to 3 km" to the guidance center. Besides, check the target range with the use of the range indicator displaying the range to the target by data received from the ground command post.

If the middle of the noise bright area does not coincide with the center of the azimuth lock-on zone, make a correction turn towards the bright area so as to align the middle of the latter with the center of the azimuth lock-on zone.

If the jamming pattern is very wide or diffuse, so that it is difficult to distinguish its center, press the CONTIN. button light and rotate the throttle lever grip to narrow this pattern to a width that is convenient for piloting the aircraft; then align the pattern middle with the center of the lock-on zone.

Note. As the CONTIN. button light is pressed, the lock-on zone of the range finder is fixed for a range of 18 to 12 km; turning of the throttle lever grip will not displace the range gates, but it will reduce the sensitivity of the radar receivers.

Further, fly the aircraft in such a direction as to keep the middle of the bright area in the center of the azimuth lock-on zone. Narrow the width of the bright area to 5 - 6 mm so that it does not protrude beyond the borders of the azimuth lock-on zone. Push the LOCK-ON button.

If the lock-on of the source of jamming is steady, do as mentioned in Para. 217.

If you fail to lock on the target in two scanning cycles, release the LOCK-ON button, verify the alignment of the centers of the bright area and the lock-on zone, somewhat reduce the degree of sensitivity-down, trying to lock on the jamming aircraft.

Figs 47, 48 and 49 illustrate the views of the radar screen at the normal, insufficient and excessive degrees of sensitivity-down of the radar receivers (in cases of insufficient sensitivity reduction, lock-ons by the antenna side lobes are likely to occur).

If resetting occurs after the target is locked on, and jamming again appears in the scanning mode, repeat lock-on of the jamming aircraft.

Variant 2. Intermittent noise jamming of high power: the noise interference pattern on the radar screen is wider than the azimuth lock-on zone, but the target blip is seen in the intervals between jamming cycles.

Upon detecting the target blip in the intervals between noise jamming, attack the target in the following way:

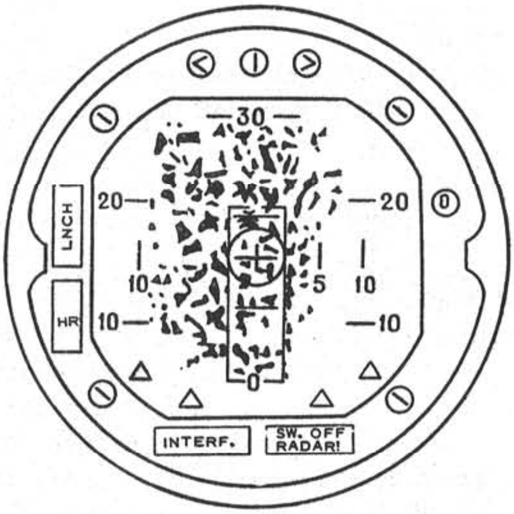


FIG. 46. RADAR PICTURE UNDER HIGH-POWER NOISE JAMMING (EXAMPLE)

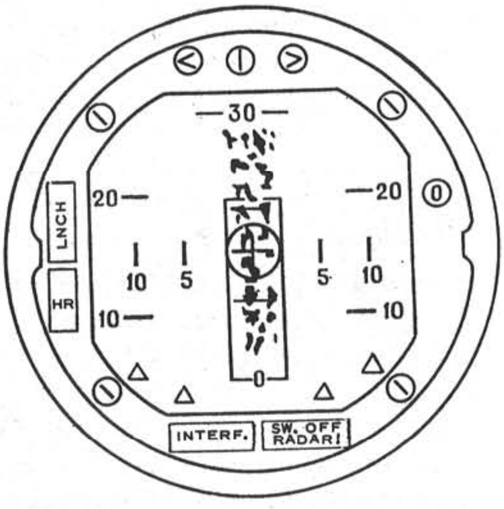


FIG. 47. RADAR PICTURE WITH PROPER SENSITIVITY REDUCTION

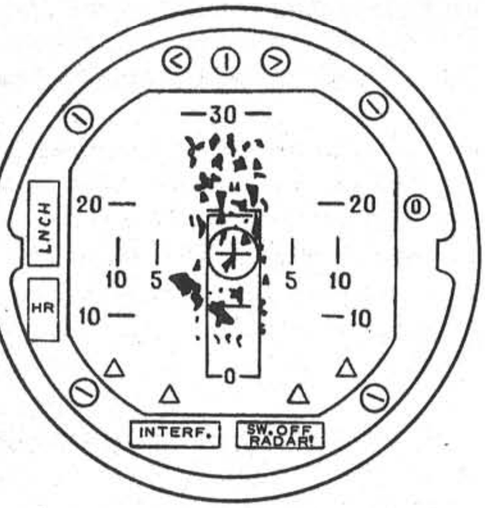


FIG. 48. RADAR PICTURE WITH INSUFFICIENT SENSITIVITY REDUCTION

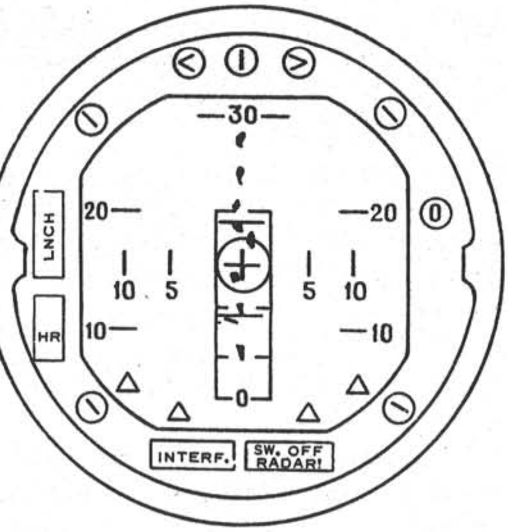


FIG. 49. RADAR PICTURE WITH EXCESSIVE SENSITIVITY REDUCTION

(a) make heading corrections to introduce the target blip into the azimuth lock-on zone ($\pm 5^{\circ}$) and simultaneously change the pitch angle in the direction of the visible "up" or "down" mark, until both the "up" and "down" marks become visible;

(b) rotate the throttle lever handgrip to superimpose the range gates so that the target blip is closer to the upper gate;

(c) depress the INTERMIT. button light;

(d) depress the LOCK-ON button (the latter operation should be only carried out when both the "up" and "down" marks are visible. The actions of the pilot after the target is locked on steadily, are similar to those described in Para. 217. If cancellation occurs after the target is locked on, and jamming is observed in the radar lock-on mode, proceed in compliance with the kind of jamming so as to ensure a repeated lock-on of the jamming aircraft.

V a r i a n t 3. Intermittent or continuous noise jamming of low power: the bright area displayed on the screen is a vertical noise track with a width of 5 - 6 mm (not exceeding the width of the azimuth lock-on zone). Then attack the jamming aircraft in this way:

(a) adjust the heading so as to align the middle of the noise track with the center of the azimuth lock-on zone;

(b) if the target blip is visible against the jammed background, adjust the heading so as to bring the target blip into the azimuth lock-on zone and superimpose the range gates so that the target blip is closer to the upper gate;

(c) if the target blip is not visible, set the gates to a range corresponding to the target range (according to the data received from the control post) and press the LOCK-ON button; if no lock-on is obtained, release the button, adjust the alignment of the middle of the noise track with the center of the lock-on zone, verify the position of the range gates and then press the LOCK-ON button again; carry on those operations until lock-on gets steady.

Note. If by the moment the middle of the noise track is aligned with the center of the lock-on zone, the noise track becomes wider than the azimuth lock-on zone, depress the INTERMIT. button light, narrow the noise track to 5 - 6 mm and push the LOCK-ON button;

(d) if lock-on of the jamming aircraft is immediately followed by illumination of the INTERF. signal, proceed as mentioned in Para. 217.

(e) if the INTERF. signal does not illuminate right after lock-on, make certain that the target range on the radar screen and its variation in the process of closure with the target, correspond to the data obtained from the control post; if they coincide, take aim and launch missiles, adhering to the ordinary procedure; if the target range data differ by more than 2 to 3 km, do as mentioned in Para. 217.

V a r i a n t 4. Multiple repeater jamming of high power: several horizontal strips appear on the screen, and the length of these strips (including the strip that is the nearest in range) exceeds the azimuth lock-on zone (Fig. 50).

Then attack the jamming aircraft in the following way:

(a) press the CONTIN. button light;

(b) rotate the throttle lever handgrip to reduce the horizontal size of the strips to 5 - 6 mm;

(c) adjust the heading to bring the jam strips on zero azimuth; when the nearest of them enters the range-finder lock-on zone, depress the LOCK-ON button;

(d) if the target is locked on immediately (before the second strip enters the range-finder lock-on zone), do as mentioned in Para. 217;

(e) if target lock-on is accomplished after two or more strips have entered the range-finder lock-on zone, act as recommended in Item (e) of Variant 3.

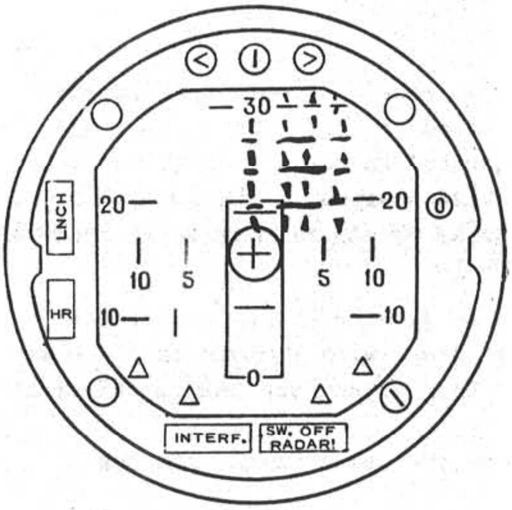


FIG. 50. RADAR PICTURE UNDER MULTIPLE REPEATER JAMMING

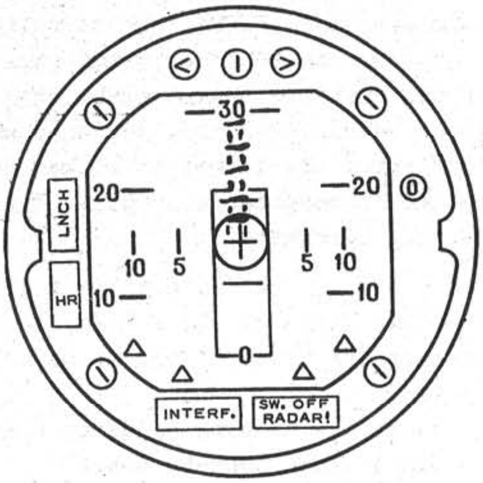


FIG. 51. RADAR PICTURE UNDER MULTIPLE REPEATER JAMMING OF LOW POWER

V a r i a n t 5. Multiple repeater jamming of low power: blips appearing on the screen form a vertical column. The horizontal size of the blips is approximately equal to the target blip and it does not exceed the width of the azimuth lock-on zone (Fig. 51).

When several blips, positioned one over the other, are detected on the radar screen, attack the jamming aircraft in the following way:

(a) adjust the heading to bring the blips on zero azimuth;

(b) rotate the throttle lever handgrip to place the upper range gate on the nearest jam blip (that is, the lowermost one);

(c) push the LOCK-ON button;

(d) if lock-on takes place immediately (before the second blip enters the range-finder lock-on zone), proceed as mentioned in Para. 217.

If you fail to accomplish an immediate lock-on, then, in the process of target closure, shift the range-finder zone so that only the first blip is located within this zone.

Note. With the LOCK-ON button depressed, take care to prevent the second blip from entering the range-finder lock-on zone.

Peculiarities of Radar Use at Low Altitudes

219. The A-23Б radar can ensure interception of aerial targets flying at altitudes of not less than 1000 m, with a step-down of 300 to 500 m with regard to the target aircraft. Interception at low altitudes has some peculiarities and requires certain skill on the part of the pilot.

220. After the pilot has taken the decision to attack a target that flies at an altitude below 2000 to 3000 m (or if he is ordered to attack such a target by the CP or FDC), he should shift the OFF - H SIGNAL - LOW ALT. switch to LOW ALT. As soon as

it is done, a protection channel gets switched on to protect the radar from ground clutter, and the antenna scan zone (in elevation) is set to an angle by 1.5 to 2° above the horizon; the scanning zone remains gyrostabilized in bank within the limits of ±70° and in pitch within the limits of +30 to minus 25°.

221. Switch over the radar to RUN when the command is issued by the CP (or FDC) and proceed to target search. Take into account the following peculiarities of the radar functioning at low altitudes:

(a) lifting of the scan zone above the horizon demands that the interceptor should fly by 300 - 500 m below the target, otherwise the target may not be detected, since it would not get into the scan zone;

(b) ground clutter makes it difficult to distinguish the target blip against its background;

(c) the target detection range diminishes with reduction of the flying altitude, especially when the target altitude is about 1000 m; the detection range is limited by the size of bright areas in the upper portion of the screen;

(d) during interception of a target flying at an altitude of 1000 m, bright areas appear on the screen from ranges of 10 - 13 km; and when the target is flying at an altitude of 800 m, the screen brightens up from ranges of 7 to 10 km; target discrimination in the brightened upper portion of the screen is rather difficult;

(e) separate clutter blips may appear in the lower portion of the screen that is void of continuous bright areas; the target blip can be distinguished amongst those blips as a more stable blip, from one sweep cycle to another;

(f) in interception of targets flying at altitudes of 2000 to 3000 m, no bright clutter areas are visible on the screen, and the target detection range is practically the same as in interception of medium-altitude targets.

222. When locking on a target flying at an altitude below 2000 - 3000 m, take into account the following:

(a) the range gates should be so superimposed over the target blip that the upper gate would not enter the band of bright areas in the upper portion of the screen and that the target blip would be closer to the upper range gate at the gate superimposing moment;

(b) in normal target lock-on, the aiming blip appears at the level of the aiming ring or above it, whereas the range marks are positioned at the range that corresponds to the actual target range;

(c) in false lock-on (clutter lock-on), the aiming blip moves as a rule to the screen bottom, and the range marks are positioned closer to the center of the "birdie"; the PASSIVE ECM button light may also illuminate (due to operation of the closure-speed screenout circuit); then depress the CANCEL. button light, verify the position of the target on the screen and repeat lock-on;

(d) in normal target lock-on, in the process of autotracking, the system may pass over to tracking of ground clutter: the "birdie" will move downward, and the PASSIVE ECM button light may illuminate (then push the CANCEL. button light, as in the case of false lock-on, and repeat the lock-on procedure);

(e) passing over to ground clutter tracking is most likely to occur when the interceptor flies at the altitude of the target, and above the latter in particular; therefore, keep the "birdie" somewhat above the aiming ring until reaching the permissible launch range, and verify the aiming just before launching the missiles.

223. Perform other operations (i.e. switching on the radar, checking it for normal functioning by means of the built-in monitoring system, identifying the nationality of the target aircraft) in the same way as during interception of medium- and high-altitude targets.

Note. Set the OFF - H SIGNAL - LOW ALT. switch to H SIGNAL when intercepting a target at an altitudes of 3000 to 10,000 m.

Interception of Maneuvering Target

224. Interception of a maneuvering aerial target is a rather difficult task; it requires certain pilot's habits and skills in handling of the radar.

On detecting the target on the radar screen, vigorously maneuver your aircraft to bring the target into the lock-on zone (to increase the lock-on probability, so fly the aircraft as to obtain the minimum azimuth displacement rate of the target blip). Superimpose the range gates on the target and accomplish lock-on (the probable target lock-on zone in autotracking covers $\pm 5^{\circ}$ in azimuth and the entire range of the scan zone in elevation). After lock-on is accomplished, keep the aiming blip in position, preventing its movement off the screen aiming ring.

When in range, launch the P-13M missiles, adhering to the launch conditions laid down in Paras 237, 238 and Table 16.

MANEUVERING AIR COMBAT

225. The МиГ-21БИС aircraft can be used for performing a maneuvering air-to-air combat (dogfight) at all service altitudes and airspeeds[x)].

Before air combat flights the pilot has to perfectly master execution of advanced maneuvers at medium and low altitudes, including unsteady turns at full throttle engine power and at reheat power, under the maximum permissible operating (service) g-loads.

The pilot must know the peculiarities of the aircraft behaviour when g-loads are developed at high angles of attack, as well as flying technique peculiarities under conditions which are close to stall.

All air combat flights shall be performed with obligatory use of the anti-g suit.

226. Prior to an air combat with a real enemy, the pilot must:

(a) check whether the positions of the circuit breakers, armament and sight selector switches correspond to the desired variant of firing and the weapon to be employed; if necessary, reload the gun;

(b) tighten up the oxygen mask, increase the rate of oxygen flow, make sure that the helmet ventilation in ON; turn on the emergency oxygen supply if necessary, and loosen the seat harness to facilitate look-out.

227. In attacking the target with gun firing in a maneuvering air combat, it is recommended to take aim with the optical sight in the GYRO mode, the 300-m fixed (constant) range being introduced into the sight.

When using the sight in this mode, set the AUTO - MAN. switch to MAN. and rotate the throttle lever handgrip all the way backward (the BREAKOFF light should come on in this case).

On detecting the target and recognizing its type, set the appropriate span on the sight outer scale; at a range of 400 to 500 m superimpose the central dot of the sight reticle on the target; the moment the target is framed by the range-finding ring, start firing, keeping the central pip on the target during the burst (the positions of the target on the sight reticle at the beginning and end of firing are shown in Fig. 25).

In that mode, aiming at a target maneuvering at a g-load of up to 3 g presents no particular difficulties (aiming is possible also under g-loads of up to 5 - 6 g, the

x) Under combat conditions, to improve the forward view, remove the СШ-45 gunsight camera if it was installed in the cabin.

reticle still remains in the field of view); the best precision in firing is achieved within the range of 250 to 350 m.

If sharp oscillations of the sight reticle are observed during the attack, do not open fire (otherwise the shells will fly behind the target), but continue tracking the target until the reticle stops oscillating.

When aiming for gun firing in a maneuvering air combat in the MSL (FIXED) mode, close upon the target with the total angular correction introduced beforehand, keeping the target in the lower (right-hand when attacking from the left side, and left-hand when attacking from the right-side) part of the reticle or sight reflector, so that the reticle center is on the extension of the target longitudinal axis (Figs 27 and 28), otherwise the available g-load of the attacking aircraft may turn out to be insufficient for placing the weapon axis forward through the total angular correction.

On reaching a range of the order of 400 m, estimate the target airspeed and aspect, and select the firing zone accordingly (i.e. determine the $\psi\Sigma_{,\ max}$ and $\psi\Sigma_{,\ min}$). Having adjusted the laying, decrease the rate of turn of the own aircraft, and at the moment when the target enters the firing zone (arrives at the point corresponding to the $\psi\Sigma_{,\ max}$), open fire; cease fire at the moment when the target leaves the firing zone (when it passes the point on the sight reticle corresponding to the $\psi\Sigma_{,\ min}$).

If the target is not shot down, finalize the attack conditions (the aspect and airspeed of the target) and, if the possibility exists, open fire at point $\psi\Sigma_{,\ min}$ to be ceased at point $\psi\Sigma_{,\ max}$, having repeated the aiming procedure by increasing the angular rate of the aircraft.

228. The rules for determining the $\psi\Sigma_{,\ max}$ and $\psi\Sigma_{,\ min}$ are set forth in subsection "Handling Optical Sight", while the values of $\psi\Sigma_{,\ max}$ and $\psi\Sigma_{,\ min}$ for three ranges of target airspeeds and aspects are given in Table 9. The firing zones for various target airspeeds and aspects are shown in Fig. 27. Deliver fire in short bursts. Mind that all the ГШ-23 gun ammunition can be spent in a 4-s burst of fire.

229. During an air combat the pilot must make the best use of the aircraft high performance and actively strive to gain tactical superiority over the enemy at all stages of the combat.

During an air combat the pilot must watch the enemy actions and check the airspeed, altitude, angles of attack, Mach number and g-load. Periodically he must check the fuel remainder, minding that an air combat at reheat settings near the ground considerably reduces the flight endurance.

The air brakes may be used in an air combat; during subsequent aircraft acceleration, check to see that they are retracted.

FLIGHTS WITH EMPLOYMENT OF ARMAMENT SYSTEMS

Checking and Preparing Armament Systems. Safety Precautions

230. Before flight in which the aircraft armament is to be employed, the pilot shall hear the technician's report on the variant of armament prepared for the flight, the amount and kind of the ammunition and availability of film in the camera gun and sight camera. Prior to inspecting the aircraft, make sure that there is nobody in the cabin and the switches and circuit breakers of the armament systems are off (except for the circuit breakers arranged on the vertical panel of the right-hand console, under the glass cover).

While inspecting the aircraft, the pilot must:

(a) make sure that the armament variant corresponds to the mission to be performed; see that the external stores are free of damage;

(b) before flying for launching missiles, check to see that there are safety pins in the launchers.

Note. When only one bomb is taken for the mission, make certain that a dummy bomb is suspended from the opposite bomb rack.

231. After taking the seat in the cabin, proceed as follows:

(a) make sure that the trigger of the firing button is in the safe position;

(b) make certain that all the circuit breakers arranged on the starboard side (under the glass cover) are cut in;

(c) check for cleanliness of the cabin glazing, reflector and light filter of the sight;

(d) before a missile and/or rocket launching mission, ascertain that the TACTICAL RLS switch is turned OFF;

(e) make sure that upon connection of an external power source the warning lights confirm the loading and racking of combat stores in compliance with the flight mission;

(f) check the optical sight for functioning from the external power supply source (the check procedure is laid down in subsection "Handling Optical Sight");

(g) after completing the checks, set the optical sight and radar switches to the positions required for fulfilling the mission.

Before taxiing out, check again that the armament switches and selector switches are set in the positions corresponding to the flight mission; turn on the GS; CG (ПРИЦЕЛ, ФКП) circuit breakers and select the STANDBY mode on the radar control panel.

After takeoff proceed as follows:

(a) set the GYRO - MSL (FIXED) switch to the GYRO position and adjust the brightness of the sight reticle;

(b) make sure that the sight is in good condition, turning the aircraft through small angles: every time the sight reticle should drift to a side opposite to the turn direction;

(c) set the GYRO - MSL (FIXED) switch in the MSL position; then, 3.5 to 5 min since setting up the STANDBY mode of the radar, check the latter for serviceability in the TEST mode of operation.

Flights for Employment of Missiles

Missile Launching Conditions

232. The aircraft can carry air-to-air guided missiles either of one and the same type or of several types at a time (the so-called "mixed variant" of missile suspension). The recommended mixed variants are given in Tables 7 and 7a.

233. The P-13M, P-3C and/or P-3P missiles may be launched in singles when the aircraft is flying at steady engine settings, provided the conditions specified in Table 16 and Paras 237 and 238 are satisfied.

234. Salvo launching of missiles P-3C and/or P-3P would not increase the probability of hitting areal targets; salvo launching is permissible under the same flying conditions and at the same power settings as launching in singles.

WARNING. It is forbidden to launch the P-13M missiles in salvos, since it would affect the engine steady run.

235. The aircraft is equipped with an engine automatic anti-blowout start system; therefore, there is no need to turn on the AIR RELIGHT (ЗАПУСК В ВОЗДУХЕ) circuit breaker before launching missiles, because this system gets engaged automatically for 6 s at every push of the firing (launch/release) button, irrespective of the time interval between pushes, once the armament selector switch is set to launching of missiles. The anti-blowout start system functioning is monitored by illumination of the SWITCH OFF IGNITION! light.

Note. Before performing flight involving simulated launch of missiles, turn off the ENGINE STARTING UNITS circuit breaker after starting the engine, when still on the ground, in order to preclude operation of the anti-blowout system in responce to pushes of the firing button in flight.

Table 16

Parameter	Missile type		
	P-13M	P-3C	P-3P
Limits of permissible launch ranges produced by radar, depending on attack conditions (km)	1 to 15	1.0 to 7.6	
Limits of recommended ranges for launching missiles when radar cannot produce launch conditions (km)	1.5 to 2.5 at altitudes up to 5000 m (at altitudes above 5000 m, from 1.5 km till range numerically equal to half of interceptor flying altitude)	1 to 2 at altitudes up to 5000 m (at altitudes above 5000 m, from 1 km till range numerically equal to 1/3 of interceptor flying altitude)	-
Limits of target aircraft flying altitudes (m):			
(a) when radar is used by interceptor	From 1000 to interceptor service ceiling		
(b) when radar is not used	From 50 to interceptor service ceiling		-
Permissible limits of interceptor indicated airspeeds and Mach numbers during missile launch	Not less than 750 km/h; $M \geqslant 0.8$	Not less than 550 km/h; $M \geqslant 0.8$ (or $M \geqslant 0.6$ at above-zero surface temperatures)	Not less than 550 km/h; $M \geqslant 0.8$
Permissible g-loads during missile launch	Not more than 3.7 g	Not more than 2 g (or 1.6 g at altitudes above 12,000 m)	
Admissible weather conditions and time of the day	Day or night out of clouds, sun relative bearing being not less than: 30°	20°	Day or night, in any weather conditions

Table 16, continued

Parameter	Missile type		
	P-13M	P-3C	P-3P
Ground targets that can be hit	-	Heat-contrast targets in daytime, except targets positioned on snow-covered surfaces	-

Note. The indicator of the optical sight can produce the maximum range of missile launch, depending on the flying altitude, for all types of missiles, in the limits of 2 to 5.5 km.

236. In the event of the engine surge with a sharp rise of the jet-pipe temperature, or if the engine develops a flameout as a result of launching of the missiles, shift the throttle lever to SHUT-OFF for 1.5 to 2 s and relight the engine as prescribed in Paras 296 through 299.

In the case of spontaneous extinguishing of the afterburner during the launching process (which is indicated by the drop of jet-pipe temperature below $450^{\circ}C$ as well as by the fact that the LP rotor speed exceeds that of the HP rotor by 8 - 12%), set the throttle lever to the FULL THROTTLE position.

237. The missiles shall be launched when the interceptor is in the rear hemisphere of the target aircraft, at the following target aspects: not more than 3/4 for the P-13M missiles, and not more than 2/4 for the P-3C and P-3P missiles.

The time interval between missile shootoffs should be not less than 3 s.
less than 3 s.

238. The missiles shall be launched with observance of the conditions mentioned in Table 16, when:

(a) the maximum strength of the sound signal of the P-13M and/or P-3C missile heads is obtained and the LNCH light signal illuminates;

(b) the sound signal of the P-3P missile head is obtained and the LNCH light signal illuminates.

239. When only heat-seeking missiles are carried, or only P-3P missiles are attached, their launching priorities and the quantity of missiles to be launched at a time, are determined by the position of the armament selection switch (i.e. positions "1, 2, 3, 4" for single (selective) shootoffs, and positions "1-2" and "3-4" for salvo shootoffs, two missiles being fired at a time, from the corresponding stations).

Note. When the armament selector switch is set at "1", the missiles should be launched in this succession: station No. 1, 2, 3 and 4; when the switch is set at "2", the succession is 2, 1, 3 and 4; when at "3", it is 3, 4, 1 and 2; and when at "4", the succession is 4, 1, 2 and 3.

240. Should some missile (or pair of missiles) fail to shoot off, set the armament selector switch to the position corresponding to the next-in-turn missile (or pair of missiles) and push the firing button another time.

241. When only heat-seeking missiles are carried in any of the mixed variants mentioned in Table 7, it is practical to launch first the P-13M missiles.

Note. When the P-13M missiles are carried together with the P-3C rockets, the radar computer will produce the permissible launch zone for those missiles whose station numbers are selected by the armament selector switch.

242. When heat-seeking missiles are attached together with radar-guided missiles P-3P, the launching priorities are determined by the position of the MSL - NEUT. - RGM selector switch (to launch the heat-seeking missiles first, set this switch to MSL; to launch the P-3P missiles first, set the switch to RGM).

When the switch is in the MSL position, all the heat-seeking missiles will be launched at first in response to every push of the firing button, then the P-3P missiles will be fired (the launch priorities being as follows: Stn No. 1, 2, 3 and 4).

When the switch is in the RGM position, all the P-3P radar-guided missiles will be launched at first in response to every push of the firing button, then the heat-seeking missiles will be fired (in the launch priorities: Stn No. 3, 4, 1 and 2), provided the armament selector switch is set in positions corresponding to selective missile shootoffs.

If the armament selector switch is set in positions corresponding to salvo missile shootoffs, the launch priorities of the corresponding missile pairs will be determined by the position of the MSL - NEUT.- RGM switch.

Flight for Launching Missiles at Aerial Targets

243. After taking the seat in the cabin, the pilot must do the following in addition to instructions given in Para. 231:

(a) set the GYRO - MSL (FIXED); AUTO - MAN.; F-B; RKTS - GUN and GS PF: AIR - GROUND switches to the MSL, AUTO, F, RKTS and AIR positions, respectively;

(b) set the armament selector switch as required by the flight mission;

(c) order the ground crew to remove the protective caps and bands from the missile heads and fuzes;

(d) after the ground power source has been connected, turn on circuit breakers DC GEN.; BAT., EXT. PWR SUP.; MSL, RGM, CG HEAT.; PWR TO RKT PODS, M-SH. RACKS 1-2; PWR TO EXT. STORES 3-4 and make sure that the station status lights have come on in the light panel (if only two missiles are attached, switch on the PWR TO RKT PODS, M-SH. RACKS 1-2 circuit breaker if the missiles are carried on the inboard stations, or tu on the PWR TO EXT. STORES 3-4 circuit breaker if the missiles are attached to the outboard stations).

CAUTION. It is forbidden to switch on the PWR TO RKT PODS, M-SH. RACKS 1-2 and/or PWR TO EXT. STORES 3-4 before the protective caps are removed from the missile heads lest the heads may be put out of order;

(e) going on a mission to launch the P-13M and/or P-3C missiles, switch on the R/SET circuit breaker and check (hear) the sound signal produced by the missile heads (when the technician directs the beam of a flash light onto the missile heads from a distance of 0.5 to 1 m); adjust the signal volume by means of the LOCK-ON: HI-LO knob;

(f) switch off the MSL, RGM, CG HEAT.; PWR TO RKT PODS, M-SH. RACKS 1-2 and PWR TO EXT. STORES 3-4 circuit breakers.

Preparatory to taxi out, do the following in addition to the instructions given in Para. 231:

(a) switch on the MSL, RGM, CG HEAT.; PWR TO RKT PODS, M-SH. RACKS 1-2 and PWR TO EXT. STORES 3-4 circuit breakers (with respect to the quantity of missiles carried and their station numbers).

CAUTION. The missile heads may be rendered unserviceable if their heads are not supplied with electric power in the course of taxiing, takeoff and/or landing;

(h) after ordering to remove the chocks, make sure that the safety pins have been removed from the launchers (the technician should show them).

After takeoff, do the following in addition to the instructions given in Para 231:

(a) going on a mission to launch the P-3P missiles, in 3.5 to 5 min after selecting the STANDBY mode of the radar operation, during monitoring of its functioning in the TEST mode (when it changes over to the autotracking mode), listen to the sound signals produced by the P-3P missile heads and adjust the volume of the signals, manipulating the LOCK-ON: HI-LO knob.

Note. In this case, when the sound signal from the port inboard P-3P missile is heard, the HR light illuminates on the bezel of the radar scope.

244. Upon receiving the "straight ahead" command from the fighter direction center (hence, in the third phase of interception), start the radar run by setting the selector switch to RUN ON and begin target search, looking for the target blip on the radar screen while maintaining the altitude, airspeed and heading given in the course of target designation.

Having detected the target, identify its nationality and report it to the CP.

245. On taking the decision to attack (or on receiving the respective command from the CP), turn on the MSL, RKT, RGM LCH (ILCK CC, PC, PHC) circuit breaker and continue closing upon the target aircraft.

Maneuver the aircraft in heading so as to bring the target blip into the radar lock-on zone with respect to azimuth, then superimpose the range gates on the blip and carry out lock-on. If no lock-on occurs in the result, repeat the procedure at a shorter range.

After the radar has locked on the target, perform aiming to allow the missile heads to lock on the target. In the process of closing upon the target, select the type of missiles to be used first, proceeding from the specific conditions (e.g. presence of clouds, interference, relative bearing of the sun, etc.), acting in compliance with Paras 233, 239 and 241.

246. When in range to launch the missiles, i.e. upon closing to the permissible (recommended) launch range, launch a missile (or missiles), provided the conditions mentioned in Para. 233 and Table 16 are satisfied; to do so, pull the firing (launch/release) button trigger lever and keep it in this position for 2 s or till missile shootoff (or shootoff of a pair of missiles in case they are launched in salvos). After the missile (missiles) shootoff the respective station status light(s) will die out in the light panel.

If necessary, launch other missiles in the same attack, complying with the recommendations given in Paras 234, 239, 242 and Table 16.

247. Should some missile (of the P-3C, P-13M or P-3P type) burst short of the target, fly on so as to pass through the center of the burst if you are going to launch another missile or rocket or fire the gun at the target in the same attack, as well as when it is not required to break away immediately.

Should the radar fail or if the target is employing active (jamming) or passive electronic countermeasures, attack it and launch missiles in compliance with the recommendations of Paras 214, 215, 217, 218, 249 and Table 16.

248. After recovery from the attack (having launched all missiles), having fulfilled the mission, switch off the radar and cut out the MSL, RGM, RKT LCH; PWR TO

RKT PODS, M-SH. RACKS 1-2; PWR TO EXT. STORES 3-4 and MSL, RGM, CG HEAT. circuit breakers.

In the case of landing with missiles aboard, cut out the MSL, RGM, CG HEAT.; PWR TO RKT PODS, M-SH. RACKS 1-2 and PWR TO EXT. STORES 3-4 circuit breakers after taxiing in to the parking.

249. If the missiles have failed to shoot off the launchers in response to actuation of the firing button by the trigger lever, emergency launch may be used. To do so, depress the MSL, RGM EMERG. LCH button; then all the missiles will shoot off simultaneously and fly on an almost ballistic trajectory (no homing will be accomplished, but the proximity fuzes will stay operative).

Note. No engine anti-blowout start is effected during the emergency launch; therefore, turn on the AIR RELIGHT switch prior to pushing the MSL, RGM EMERG LCH button, and turn off this switch 6 to 8 s after launching of the missiles.

Aim for launching the missiles in the emergency way by the same method as for launching free rockets.

It is permissible to launch missiles in the emergency way at altitudes not higher than 16,000 m within the range of Mach numbers from 0.8 to 1.0 M, at an airspeed of not more than 1000 km/h and at g-loads of less than 1.2 g.

Launching Heat-Seeking Missiles at Targets Flying Below 1000 m

250. When launching heat-seeking missiles at targets flying below 1000 m, give due consideration to the following peculiar features:

(a) necessity of visual contract with the target at the time of attack;

(b) limited interceptor vertical maneuverability owing to the low altitude;

(c) loud clutter in the earphones, hampering discrimination of the lock-on signal, and turbulence interfering with target lock-on by the missile heads;

(d) absence of the permissible launch range or present target range indication;

(e) difficulty of determining the target present range with the help of the optical-sight additional reticle; necessity to memorize the recommended launch ranges for every type of missiles;

(f) limited permissible launching range spectrum.

Low-altitude targets should be attacked at a stepped-up separation providing target projection on the ground surface, which promotes discrimination of the sound signal and prevents the interceptor from getting into the target wake.

Take aim with the aid of the optical sight in the MSL (FIXED) mode; it is practical to use the additional sight reticle.

Should the engine develop flameout or surging, do as recommended in Paras 295 and 296.

Launch heat-seeking missiles at targets flying at altitudes below 1000 m from the rear hemisphere, at a target aspect of not more than 2/4 (break off the attack at a rate which depends on the target range and closure speed).

Launching P-3C and P-13M Missiles at Transport Aircraft

251. The conditions for launching missiles P-3C and P-13M at turboprop transport aircraft are similar to those for launching those missiles at turbojet transport aircraft.

When launching missiles P-3C and P-13M at piston-engined transport aircraft, take into account the fact that discrimination of the sound signal from such targets presents certain difficulties under complicated clutter background conditions.

Piston-engined transport aircraft shall be attacked from the rear hemisphere, at target aspects of 0/4 to 3/4, with a downward vertical separation of 300 to 500 m.

Launch the missiles when the target sound signal is quite distinct, at ranges of 1400 to 1800 m.

Take aim with the aid of the optical or radar sight. Determine the range to the target, when using the optical sight, with the help of the optical range-finder or with the help of the sight additional reticle (using the data of Table 15).

Launching P-3C Missiles at Ground Targets

252. After taking the seat in the cabin, do as mentioned in Para 243. Going on a combat training mission, set the GS PF: AIR - GROUND switch in the GROUND position before flight; under combat conditions, set the switch to this position upon taking the decision to attack the ground target.

When in the target area, on obtaining the permission for attack, turn on the MSL, RGM, RKT LCH circuit breaker.

253. When launching the P-3C missiles at ground targets, mind the following specific features:

(a) the attack is attainable only in the daytime;

(b) loud clutter in the earphones hampers discrimination of the target lock-on signal;

(c) there is no indication of the permissible launch range;

(d) it is necessary to switch off the missile proximity fuze (PF).

254. Launch the P-3C missiles in singles, with the engine set at a steady run (from the IDLE to the FULL THROTTLE one) and at dive angles of 15 to 30°. The missiles can be used against heat-contrast targets (say, aircraft) positioned either singly or in groups on unpaved or concrete grounds (except for targets positioned on snow-covered surfaces) as well as against POL dumps or depots located in the open, with heavy metal reservoirs, etc.

The effective launching ranges are as follows: 1.5 to 4 km at strategic bombers, 1.5 to 3 km at tactical bombers, 1.5 to 2.5 km at fighters and 1.5 - 3 km at POL depots or dumps located in the open.

Maintain an airspeed of 800 to 1050 km/h at the time of launching.

255. When attacking targets from the sun, or when there are dense clouds, the permissible launch range should be decreased by 30%.

Take aim with the aid of the optical sight operating in the MSL (FIXED) mode, or use the sight additional reticle. Launch missiles while avoiding sideslip as far as possible. Launch one missile in an attack.

Recover the aircraft from dive immediately after the missile has left the launcher. In the case of launching missiles at the minimum permissible ranges or at ranges close to the minimum ones, the g-load in dive recovery should be 4 g at least (or it should be the one which is maximum possible for the given attack conditions). The minimum height of clearing the missile bursts should be not less than 500 m.

If a missile fails to leave the launcher during 2 s since the firing button actuation by the trigger lever, flip the lever in the safety position and break off the attack immediately.

After launching the missile, flip the trigger lever in the safety position (in the process of recovering from the attack). The mission completed, cut out the MSL, PGM, RKT LCH circuit breaker.

Flights for Employment of Rockets

256. It is allowed to launch type C-5 rockets within the scope of the operating limitations imposed on the aircraft carrying this type of external stores, at any steady or transitional engine power settings; the C-24 rockets may be launched at altitude of not more than 5000 m and airspeeds of not less than 600 km/h, with the engine running at IDLE and AIR RELIGHT switch cut in (regardless of the availability of the engine anti-blowout start system).

When 3 to 5 s remain before firing the rockets, shift the throttle lever to IDLE; start increasing the engine speed not earlier than 3 to 5 s after the end of firing (at any other power settings the engine may run unsteadily).

Before launching the C-24 rockets, once the throttle has been set at IDLE, do not fail to turn on the AIR RELIGHT switch; cut out this switch after launching the rockets, having made sure that the engine is running steadily.

Once the AIR RELIGHT switch has been cut out, report the fact over the radio.

257. If the engine develops surging with a sharp rise of the jet-pipe temperature or in case the engine develops a flameout, proceed as recommended in Paras 293. through 296.

258. After taking the seat in the cabin, do the following in addition to the instructions given in Para 231:

(a) check whether the GYRO - MSL (FIXED); AUTO - MAN.; F - B and RKTS - GUN switches are set in the MSL (FIXED), AUTO, F and RKTS positions, respectively;

(b) set the armament selector switch in a position required by the flying mission (or in compliance with the chosen variant of rocket launching);

(c) after the external power source has been connected, turn on the MSL, RGM, RKT LCH and PWR TO RKT PODS, M-SH, RACKS 1-2 circuit breakers and make sure that the No. 1 RKT ZERO PSN, No. 2 RKT ZERO PSN, No. 3 RKT ZERO PSN and No. 4 RKT ZERO PSN lights have come on (in compliance with the variant of the armament suspension and loading), then cut out the MSL, RGM, RKT LCH and PWR TO RKT PODS, M-SH, RACKS 1-2 circuit breakers.

WARNING. It is prohibited to launch the C-24 rockets in salvos for training purposes if the aircraft electrical system has not been modified to provide a 0.1-s time interval in shootoff of the C-24 rockets.

259. Mind the following in preparing for and performing flight involving launch of one C-24 rocket:

(a) the rocket should be attached so that the wind would blow from the attachment side in takeoff and landing;

(b) if there is no crosswind component, the stick sideways deflection to oppose the aircraft banking tendency at the time of unsticking, is 1/5 to 1/4 of the stick full travel in aileron control, and the stick forces are 2 - 3 kgf;

(c) prevent the aircraft from yawing in the process of takeoff run and landing roll, using the brakes and pushing rudder accordingly;

(d) when in flight, the rudder deflections and forces required to oppose sideslip will grow with indicated airspeed and Mach number; at an IAS of 1000 km/h and altitudes below 5000 m the rudder forces are 15 to 20 kgf, and as the Mach number increases at a constant indicated airspeed, they increase, too, and become as high as 90 to 100 kgf at 1.3 M.

Flight for Launching Rockets at Aerial Targets

260. After taking seat in the cabin, in addition to the instructions given in Para.258, set the GS PF: AIR - GROUND switch to the AIR position and set the armament selector switch to the position corresponding to the desired variant of rocket launching.

261. Before taxiing out and after takeoff proceed as mentioned in Para. 231.

Having arrived in the target area and received the appropriate command from the direction center, do as follows:

(a) turn on the MSL, RGM, RKT LCH and PWR TO RKT PODS, M-SH, RACKS 1-2 circuit breakers;

(b) set the selector switch on the radar control panel to RUN ON; set the GYRO - MSL (FIXED) switch to GYRO;

(c) if the flying altitude is less than 3000 m, turn on the LOW ALT. switch;

(d) detect the target (find the target blip) on the radar screen and close upon the target to the visual range.

Proceed as follows after detecting the target and determining its type:

(a) using the SPAN (БАЗА) knob, set in the span corresponding to the target size on the sight inner scale and assume the initial position for attack;

(b) prior to starting the turn to the target (from the initial position for attack), depress the LOCK-ON - DAMP. button;

(c) lock the radar on the target by superimposing the caged (damped) sight-reticle central dot on the target (when lock-on is obtained, a green light illuminates on the optical sight and a "birdie" appears on the radar screen).

262. In closing upon the target, proceed as follows:

(a) after the target is locked on, evaluate the target aspect and airspeed; begin tracking the target, offsetting the damped sight reticle central dot forward, on the extension of the target longitudinal axis through a lead of about 60 mils when the target aspect is 1/8 (or through a lead of 120 mils when the target aspect is 2/8) and above the extension of the target longitudinal axis through 20 to 25 mils; the positions of targets on the sight reticle in attack of a non-maneuvering aerial target (or a target maneuvering at minor g-loads) at the time of damping button release and at the time of opening fire, are shown in Fig. 26 (when the damping button is released, the sight reticle will move slightly down);

(b) equalize the angular velocities of the aircraft and the target, then release the LOCK-ON - DAMP. button;

(c) superimpose the central dot on the target and perform synchronization by keeping the central dot on the target for 3 to 5 s.

At a range of the order of 600 to 800 m, open fire by successive pulls of the firing button trigger lever, in compliance with the preset launching variant, until the target is hit, the aiming being adjusted after every salvo or ripple (if the target range is less than 600 m, the BREAKOFF light will illuminate on the sight). During every launching, keep the firing button depressed for at least 1 - 1.5 s (in order to provide the minimum time required for shootoff of 16 folding-fin air rockets (FFAR) of the C-5 type).

In the course of successive actuations of the firing button, rockets will be fired at first from both inboard rocket pods, in compliance with the preset launch variant (i.e. RKTS-4, 8 or 16), then the outboard rocket pods will begin to unload their rockets (automatic switchover will take place after all rockets have been fired from the inboard pods and once the firing button is depressed another time).

263. When the УБ-32 pods are being used, after the first half of their ammunition is fired (i.e. 16 rockets), the rocket fire control unit zero position lights will come on, and they will go off as the second half of the ammunition begins to shoot off.

When through with launching of rockets, flip the firing button trigger lever in the safety position.

264. Should the range-finding channel of the radar fail or if lock-on is frustrated in the course of attack, a 600-m fixed range is introduced into the sight (in the GYRO, AUTO mode). Then carry on the attack and launch rockets at the time when the target is framed by the range-finding ring (considering the diamond ring inner diameter).

If the target is not framed by the ring at the 600-m range (which happens when the target span is less than 13 m), determine the firing initial range visually, comparing the target visible size with the diameter of the central dot or with other elements of the sight reticle.

265. Should the sight automatic components fail (e.g. if the reticle remains stationary during performance of turns, or if it moves sharply off the view), set the GYRO - MSL (FIXED) switch in the MSL (FIXED) position and proceed to using the additional fixed reticle.

Flight for Launching Rockets at Ground Targets

266. After taking the seat in the cabin, do the following in addition to the instructions set forth in Para. 258: flip the GS PF: AIR - GROUND switch in the GROUND position and place the armament selector switch in the position corresponding to the desired variant of rocket launching.

267. Before takeoff proceed as mentioned in Para. 231.

After takeoff do the following in addition to the instructions given in Para. 231:

(a) set the FIXED BEAM - OFF switch in the FIXED BEAM position;

(b) introduce a 50-m span into the sight.

When in the target area, set the radar mode selector switch to the RUN ON position, set the GYRO - MSL (FIXED) switch at GYRO and turn on the MSL, RGM, RKT LCH circuit breaker; going to launch the C-5 type FFAR, switch on also the PWR TO RKT PODS, M-SH. RACKS 1-2 circuit breaker.

Attack a ground target in compliance with the recommendations of subsection "Handling Optical Sight".

Launch the C-24 rockets from the outboard stations first (i.e. from Stn. Nos 3 and 4), having placed the armament selector switch in the "C-24: 3-4" position, and then from the outboard stations, having placed this switch to the "C-24: 1-2" position.

When at the permissible ranges, pull the firing (launch/release) button trigger lever to fire the rockets. Start dive recovery immediately after rocket shootoff, pulling 3.5 to 4 g in the process. The height of clearing the bursts of type C-5 rockets should be at least 200 m, and that for the C-24 rockets should be at least 500 m.

The minimum ranges of launching type C-5 FFAR should be not less than 1200 m (or 1300 m for 40° dive angles); for launching the C-24 rockets the minimum ranges are 1600 - 1700 m. When those ranges are reached, the LNCH light dies out on the sight head and the BREAKOFF light comes on instead.

Should the rockets be launched at closer ranges, the aircraft will fly through the splinter zone in the process of pullout with the recommended g-load.

Having launched the rockets, flip the firing button trigger lever in the safety position (in the process of pullout).

268. When through with the mission, cut out the MSL, RGM, RKT LCH circuit breaker and the PWR TO RKT PODS, M-SH. RACKS 1-2 circuit breaker.

269. To launch rockets in the MSL mode with computation of averaged angular corrections, place the GYRO - MSL and AUTO - MAN. switches in the MSL and AUTO positions, respectively.

Arrange an appropriate maneuver and take aim, bearing in mind than in this mode of operation, the sight will compute precise angular corrections for a TAS of 800 km/h at the launching moment, when the dive angle is 35°, and for a TAS of 900 km/h at a dive angle of 20 - 25°, provided the launching range is 1300 m for type C-5 rockets, and 1700 m for the C-24 rockets.

If the attack conditions differ from the rated ones, or if the sight automatics fail in the GYRO and/or MSL modes, shift the AUTO - MAN. switch to MAN. Introduce the firing corrections manually, with the aid of the ANGLES (УГЛЫ) knob in compliance with the recommendations set forth in Table 10.

When attacking a ground target in the MSL (FIXED) mode, do not fail to eliminate sideslip after entering dive, and to offset the reticle central dot with regard to the target in order to account for the wind velocity and target speed.

Launch rockets as soon as the precalculated ranges are reached.

270. Should the range-finding channel of the radar fail, the target range shall be introduced into the sight from the slant-range unit. Then the diameter of the range-finding ring will be varied automatically and the range indicator pointer will be automatically deflected.

Note. The error in determination of the target range introduced into the sight by the slant-range unit, depends on the barometric pressure in the target area as well as on the total position and shock-wave error correction for the pitot-static system.

271. If the slant-range unit fails, introduce the range into the sight from the external-base optical range-finder, for which purpose set the AUTO - MAN. switch in the MAN. position.

Determine the rocket launching initial range visually, by comparing the target visible size with the ring diameter (using the lines of the additional fixed reticle) or with the diameter of the reticle central dot, as well as by reference to the pressure altimeter (referring to the precalculated initial launch altitude for the given dive angle and launch airspeed, considering also the total correction for the pitot-static system).

Flights for Gun Firing

Checking Armament before Gun-Firing Flight

272. After taking the seat in the cabin, do the following in addition to the operations mentioned in Para. 231:

(a) make sure that the GYRO - MSL (FIXED); AUTO - MAN.; F-B and RKTS - GUN switches are set to the MSL (FIXED), AUTO, F and GUN, respectively, that the GS PF: AIR - GROUND is adjusted to AIR, preparatory to flying for firing at aerial targets, or to GROUND before flight for firing at ground targets;

(b) when the ground power source has been connected, turn on the GUN (ПУШКА) switch and make sure that the READY (ГОТОВН.) light has come on (to indicate that the gun movable parts are in their extreme positions), then cut out the GUN switch.

Flight for Gun Firing at Aerial Targets

273. After taxiing out and taking off, proceed as mentioned in Para. 231.

Upon arrival in the target area, having received the appropriate command from the direction center, do the following:

(a) turn on the GUN switch;

(b) reload the gun by pressing the RELOADING 1 (ПЕРЕЗАРЯДКА 1) button: the READY light must come on to indicate that the gun is ready for firing;

(c) set the radar mode selector switch in the RUN ON position and place the GYRO - MSL (FIXED) switch in the GYRO position;

(d) for flying the mission at altitudes below 3000 m, set the OFF - H SIGNAL - LOW ALT. switch at LOW ALT.;

(e) detect the target blip on the radar screen and close upon the target to the visual range;

(f) determine the target type;

(g) set in the target span on the sight inner scale, manipulating the SPAN knob, and assume the initial position for attack depending on the target type and flying conditions.

Then, in attacking a non-maneuvering target or a target maneuvering at minor g-loads, follow the directions of Para. 262.

Note. While aiming the gun at an aerial target, after lock-on has been effected, equalize the angular speeds of the interceptor and the target, then offset the central dot of the damped sight reticle forward, on the extension of the target longitudinal axis through a lead of about 30 mils when the target aspect is 1/8 (or through a lead of about 60 mils when the target aspect is 2/8). The target positions on the sight reticle in attack of a non-maneuvering target (or a target maneuvering at minor g-loads) at the time of damping button release and at the time of opening fire, are shown in Fig. 26.

When the gun is being fired, about 1/4 of the entire ammunition is spent in 1 s.

Should the range-finding channel of the radar fail, if the lock-on gets frustrated or if the optical sight is functioning in the MSL (FIXED) mode, proceed as mentioned in Paras 264 and 265.

While attacking a vigorously maneuvering target, use the optical sight in the GYRO mode with the 300-m fixed range introduced into the sight, or in the MSL (FIXED) mode, following the recommendations given in subsection "Handling Optical Sight" as well as in Paras 227 and 228.

The target positions on the sight reticle, when it is being attacked in the GYRO mode with the 300-m fixed range introduced into the sight, at the time of opening and ceasing fire, are shown in Fig. 25.

Up to the 12,000 m altitude, the gun may be fired in bursts of any duration, even in one continuous burst till all ammunition is spent.

At altitudes above 12,000 m, it is recommended to fire the gun in bursts of not longer than 2 s with an intermission of 1 to 1.5 s. In an urgency the ammunition may be spent in one burst.

274. After the entire ammunition is used up, proceed as follows:

(a) reload the gun and release the gun moving parts for checking purposes;

(b) flip the firing button trigger lever in the safety position;

(c) turn off the armament system switches and circuit breakers which are not to be used during subsequent flight; switch off the radar and optical sight, set the GYRO - MSL (FIXED) switch in the MSL (FIXED) position.

275. When the ammunition is not fully used up by the moment the firing mission is completed, flip the firing button trigger lever in the safety position, turn off the GUN circuit breaker and switch off the radar; set the GYRO - MSL (FIXED) switch to MSL (FIXED);

276. In case of stoppage (the gun fails to fire when the firing button is depressed, but the READY light is shining), reload the gun by depressing the RELOADING 2 button. If stoppage persists, depress the RELOADING 3 button, having made sure that the READY light is ON.

If the stoppage fails to be cleared in flight, turn off the GUN switch and report the trouble over the radio prior to landing.

Note. The reloading buttons may be depressed in any sequence.

CAUTION. When reloading the gun, do not depress two reloading buttons at a time, since this may disable the gun.

Flight for Gun Firing at Ground Targets

277. After climbing into the cabin, perform the operations mentioned in Para. 272.

Prior to taxiing out, do as laid down in Para. 231.

After takeoff, in addition to the operations mentioned in Para. 231, do the following:

(a) set the FIXED BEAM - OFF switch to FIXED BEAM;

(b) introduce a fixed 50-m span into the sight.

When in the target area, do the following:

(a) set the radar mode selector switch in the RUN ON position; place the GYRO - MSL (FIXED) switch to GYRO;

(b) turn on the GUN switch;

(c) reload the gun by depressing the RELOADING 1 button; refer to illumination of the READY light to make sure that the gun is ready for firing.

Attack a ground target in compliance with the recommendations of subsection "Handling Optical Sight".

Fire the gun by pressing the firing button when the target is within the permissible range limits. Immediately after firing, recover from dive at a g-load of 3.5 to 4.0 g. The burst clearing height should be at least 200 m.

Notes: 1. If a span of 33 m is introduced in the sight, the firing range is 1500 m as soon as the reticle ring diameter starts increasing in the GYRO and AUTO modes.

2. It shall be remembered that all the gun ammunition is sufficient for a continuous 4-s burst of fire.

3. The minimum initial range for firing the gun must not be less than 1200 m (or 1300 m for the 40° dive angle). When the 1200-m range is reached, the LNCH light dies out on the sight head and the BREAKOFF light comes on instead.

Having finished firing the gun, flip the firing button trigger lever in the safety position.

When firing the gun at ground targets in the MSL (FIXED) mode, should the radar range-finder channel fail or if the slant-range unit fails, follow the instructions of Paras 270 and 271.

In attacking a ground target with gun fire, the sight operating in the MSL (FIXED) and AUTO modes, arrange the maneuver and take aim, proceeding from the fact that in the MSL and AUTO modes the optical sight will compute precise angular corrections for a TAS of 800 km/h while the gun is being fired at dive angles of 30 - 35°, and/or 900 km/h at dive angles of 20 - 25°, provided the firing range is 1300 mm.

After the firing is over, when the ammunition is fully or partially consumed, as well as if stoppage occurs, follow the instructions of Paras 274 through 276.

Bombing Mission

278. After taking the seat in the cabin before flight for bombing or dropping incendiary tanks, type ЗБ-500, do the following in addition to the instructions given in Para. 231:

(a) set the GYRO - MSL (FIXED), AUTO - MAN. and F - B switches to positions MSL (FIXED), MAN. and B, respectively; set in the precomputed angular correction by means of the ANGLES knob;

(b) set the armament selector switch in the position corresponding to the chosen release variant;

(c) after the external power source has been connected, make sure that the INBD STA 1; INBD STA 2; OUTBD STA 3 and OUTBD STA 4 station status lights illuminate in full accord with the racking of bombs on the stations;

(d) cut in the PWR TO RKT PODS, M-SH. RACKS 1-2 circuit breaker and the TACTICAL RLS switch; make sure that the ARMED (ВЗРЫВ) red light comes on in this case, then turn off the TACTICAL RLS switch.

Note. When a practice bombing (or incendiary tank dropping) mission is to be performed without employing other types of weapons, the optical sight may not be subjected to a full-scope check and the radar may not be checked at all.

After takeoff adjust the brightness of illumination of the sight reticles and check again that the required angular correction has been set on the ANGLES scale.

When in the target area, proceed as follows:

(a) when on the combat run, shift the TACTICAL RLS switch to ON: the ARMED red pilot lamp should light up; flip the firing button trigger lever into the combat position;

(b) after entering a dive, perform aiming with the use of the optical sight, with allowance for drift; the correct moment of bomb release is obtained by matching the line of sight with the target and by reaching the required release altitude at the rated angle of dive;

(c) release the bombs (and/or incendiary tanks) by depressing the firing button trigger lever (if the tactical release circuit fails, the bombs can be dropped by depressing the EXT. STORES EMER. JETT.: OUTBD - INBD (АВАР. СБРОС ПОДВЕСОК: ВНЕШН. - ВНУТР.) buttons;

(d) after releasing the bombs (and/or incendiary tanks), break off the attack vigorously and hinge the firing button trigger lever into the safety position; the height of clearing the bomb bursts must be not less than 600 m in bombing with 100-kg caliber bombs, and not less than 700 m in bombing with 250 and/or 500-kg caliber bombs.

The minimum altitude for dropping incendiary tanks, type ЗБ-500, from level flight should be not less than 200 m (in order to provide time for the remote-arming fuze to get armed).

Notes: 1. It is possible to release bombs (or incendiary tanks) from all the four stations by one pull of the firing (launch/release) trigger lever, with the armament selector switch placed in the "B1-4" position.

2. Selective-salvo release (two bombs in a salvo) shall be performed from the outboard stations first, for which purpose the armament selector switch has to be placed in the "B3-4" position, then the firing (launch/release) button trigger lever shall be pulled. To release bombs from the inboard stations, set the armament selector switch to the "B1-2" position and pull the firing button trigger lever.

Selective-salvo release (two bombs in a salvo) is also practicable by actuation of one of the buttons: EXT. STORES EMER. JETT.: OUTBD - INBD, in any of the armament selector switch positions.

279. Upon recovering from attack, check for release of the bombs (or incendiary tanks) by extinguishing of the respective station status lights in the light panel, then flip the firing button trigger lever in the safety position.

The bombing mission completed, switch off the armament control elements.

280. For toss bombing, place the aircraft on the bomb run and 4 to 5 s before ariving at the maneuver starting point, establish an airspeed of 1000 km/h and absolute altitude (height) of 200 m relative to the target (when calculating the indicated altitude, make due allowance for the pitot-static tube total position and shock-wave error as well as for the target barometric altitude).

When on the bomb run, turn on the TACTICAL RLS switch and flip the firing (launch/release) button trigger lever in the combat position.

On reaching the maneuver starting point (for releasing bombs at a pitch-up angle of 45°) or on overflying the target (for releasing bombs at a pitch-up angle of 110°), bring the aircraft into the maneuver at a rate providing for pulling of 5 g in 3 to 4 s. When executing the maneuver for toss bombing at a pitch-up angle of 110°, maintain the 5-g overload until reaching the 70 - 80° pitch-up angle, with subsequent decrease of this g-load so as to obtain 1.5 to 2 g at the upper point of the maneuver. Upon attaining the required pitch-up angle, release bombs by pulling the firing button trigger lever.

After passing the upper point of the maneuver and reaching a negative (pitch-down) angle of 25 - 30°, roll the aircraft through 180° and fly off the target in a direction opposite to that of maneuver entry.

281. Should the tactical release circuit fail, the emergency release (jettison) circuit can be used, either in the armed condition (for bomb release over the hostile territory or over a practice bombing range) or in the safe condition (when over the friendly territory).

Proceed as follows to release bombs in the armed condition: turn on the TACTICAL RLS switch and push the EXT. STORES EMER. JETT.: OUTBD button first, then press the EXT. STORES EMER. JETT.: INBD button.

WARNING. The PWR TO RKT PODS, M-SH.RACKS 1-2 circuit breaker must be turned on in order to ensure emergency release (jettison) of bombs, whether in the armed or safe condition.

Note. To effect emergency bomb release in the safe condition, cut out the TACTICAL RLS switch.

Flights with Mixed Variants of Combat Stores

282. When on a mission in which mixed variants of combat external stores are to be used (e.g. missiles and rockets, missiles and bombs, etc.), the pilot has to set the armament selector switch in a position corresponding to the chosen weapon and the variant of its use, before employing this or another kind of armament; then proceed as mentioned in the respective paragraphs dealing with employment of the specific kind of armament.

External Stores Emergency Jettison

283. Jettison the missile and rocket launchers, pods in straight-and-level flight, observing the release sequence (first the outboards, then inboards) and, depending on the type of missiles and rockets, under the following conditions:

(a) launchers with P-3P, P-3C missiles and C-24 rockets (or empty launchers) and rocket pods, at altitudes of 4000 to 6000 m and airspeeds of 700 to 800 km/h;

(b) launchers with P-13M missiles (or empty launchers), at altitudes of 1000 to 5000 m and airspeeds of 600 to 700 km/h.

For emergency release (jettison) of external stores, flip open the safety cap of the EXT. STORES EMER. JETT.: OUTBD button and push this button, then flip open the EXT. STORES EMER. JETT.: INBD button safety cap and depress this button.

Upon jettison of the stores, the INBD STA 1, INBD STA 2, OUTBD STA 3 and/or OUTBD STA 4 lights should go out in compliance with the unloaded stations.

CAUTION. 1. <u>It is forbidden</u> to jettison the АПУ-68 launchers when empty.

2. Bombs carried on multi-shackle racks are released in the safe condition together with the multi-shackle racks.

284. If it proves impossible to employ or jettison some weapon, cut out the switches controlling all kinds of the aircraft armament and make a decision to land (taking into account the limitations imposed on the aircraft by the specific kind of armament).

Section Eight
EMERGENCY PROCEDURES

285. The safety of flight will largely depend on whether the pilot is ready to face emergency situations likely to occur in flight.

Upon detecting some malfunction, check calmly whether the control valves and selector switches have been operated properly, assess the situation and take a proper decision. Report the failure and your decision to the flight control officer or to the control post.

Subsequently, proceed depending on the actual situation in compliance with the flight control officer or control post directions.

Switch on the DISTRESS signal when you are faced with an emergency situation in which assistance shall be required.

Abandon the aircraft immediately if the situation spells danger to your life.

FIRE IN ENGINE COMPARTMENT

286. Symptoms: the COPU button light is flickering and the FIRE light flashes up in the light panel.

Additional symptoms of fire (after operation of the fire alarm system) may be as follows:

- smoke or flame (visible through the periscope, reported by a ground observer or by the pilot of a neighbouring aircraft);
- smoke in the cabin;
- reflection of flame on the canopy at night, with the engine running at non-reheat power settings;
- drop of pressure in the hydraulic systems; failure of the aircraft control system with resultant changes in the aircraft behaviour;
- erroneous readings of the engine instruments.

287. Actions to be taken:

1. During the takeoff run:
- immediately discontinue the takeoff procedure;
- shut off the engine;
- take measures to stop the aircraft;
- hinge off the cap marked FIRE EXT. and depress the button;
- switch off the booster pumps and fuel transfer pumps;
- if smoke enters the cabin, depressurize the canopy and close the air supply valve;
- abandon the aircraft as soon as it comes to a standstill;
- if there is a danger of collision with an obstacle or your life is endangered in some other way, eject if the airspeed is above 130 km/h; if otherwise, jettison the

canopy, retract the landing gear after the aircraft rolls off the runway, and de-energize the aircraft.

2. If the takeoff procedure cannot be safely discontinued prior to aircraft unsticking, owing to the short runway portion available, eject or do as follows if safe ejection or takeoff abortion is not ensured:

- proceed with the takeoff;
- hinge off the cap marked FIRE EXT. and depress the button;
- after the aircraft becomes steadily airborne, retract the landing gear; retract the wing flaps at an altitude of not less than 100 m and an airspeed of not less than 400 km/h;
- at an airspeed of not less than 600 km/h turn off the afterburner in case the takeoff has been accomplished at reheat power;
- never allowing the airspeed to drop and without changing the engine power setting, climb in a direction safe for ejection or aircraft fall;
- as soon as favourable conditions for ejection are ensured, immediately abandon the aircraft (shut off the engine before abandoning the aircraft, if practicable).

3. If fire starts in flight, proceed as follows:

(a) if favourable conditions for ejection exist, shut off the engine and immediately abandon the aircraft (prior to abandoning the aircraft, depress the FIRE EXT. button, if practicable);

(b) if no ejection can be performed, do as follows:

- turn off the afterburner (if it was on);
- while flying at a low altitude and low airspeed, depress the FIRE EXT. button and turn in the direction safe for ejection or aircraft fall; provide conditions for safe ejection, and abandon the aircraft as soon as ejection becomes possible (shut down the engine prior to ejection, if practicable);
- when flying at a high speed, shut off the engine, disengage the AFCS, depress the FIRE EXT. button, turn in a direction safe for ejection or aircraft fall, provide conditions for safe ejection, then abandon the aircraft.

If no symptoms of fire show up after operation of the fire alarm system, turn off the afterburner, (if it was on), discontinue the mission and proceed flying to the nearest airfield while providing safe conditions for probable ejection.

POWERPLANT FAILURES OR MALFUNCTIONS

Powerplant Failure on Takeoff

288. Inadvertent opening of jet nozzle during takeoff at FULL THROTTLE.

Symptoms:

- jet-pipe temperature drop below 450°C;
- increase of the LP rotor speed over the HP rotor speed in excess of 8 to 12%;
- illumination of the JET NOZZLE OPEN light in the panel.

Actions to be taken:

- immediately discontinue the takeoff procedure and take measures to stop the aircraft; shut off the engine, if necessary;
- if the jet nozzle flaps open during the second half of the takeoff run, when abortion of takeoff would endanger the pilot's life, turn off the FULL THROTTLE, REHEAT switch and continue takeoff, minding that the rated takeoff run distance will be 2500 - 2700 m in this case. If the engine parameters fail to restore in 3 - 4 s, eject.

289. **Afterburner flameout on takeoff.**

Symptoms:

- jet-pipe temperature drop below 450°C;
- LP rotor speed increase over the HP rotor speed in excess of 8 to I2%.

Actions to be taken:

- immediately discontinue the takeoff procedure and take measures to stop the aircraft; shut off the engine, if necessary;
- if the failure occurs during the second half of takeoff run, when discontinuation of the takeoff procedure presents an immediate danger, do as follows:

(a) when taking off without external loads, or carrying two or four УБ-16-57 pods, or two (four) missiles, or a 490-L drop tank, cut out the FULL THROTTLE, REHEAT switch, select FULL THROTTLE and continue to take off at this setting, minding that the rated takeoff run distance will be 2500 - 2700 m in this case; if the engine parameters fail to restore in 5 - 7 s, eject;

(b) when taking off with heavier external loads, eject: continuation of takeoff is unsafe, since under these conditions the rated takeoff run length will exceed 2700 m (estimated data).

Powerplant Surge

290. Symptoms:

- sharp multiple pops in the nose portion of the aircraft, owing to air intake surge;
- multiple (or separate) pops in the aircraft tail portion, owing to engine surge;
- abrupt decrease of the engine speed and jet-pipe temperature, accompanied by engine flameout, occurring, as a rule, during powerplant surge at Mach numbers in excess of 1.8 M;
- fluctuation of the engine speed and jet-pipe temperature, associated with powerplant surge at Mach numbers of less than 1.8 M;
- in some cases, abrupt decrease of the engine speed and increase of the jet-pipe temperature (owing to use of the armament, etc.).

291. Actions to be taken:

1. Whenever powerplant surge is accompanied by decrease of the engine speed or increase of the jet-pipe temperature, proceed as follows:

- immediately shut off the engine (to avoid damaging the engine);
- use the manual control switch to open the anti-surge shutters (derumble doors); close the shutters as soon as pops cease;
- disengage the AFCS;
- attain the altitude and airspeed providing for reliable engine relight, then relight the engine;
- after relighting the engine, smoothly move the throttle lever to bring the engine to a desired power setting, discontinue the mission and fly to the landing airfield.

Note. Engine surge will not be discontinued by setting the throttle lever to IDLE, though the symptoms of surge may disappear (no pops, the jet-pipe temperature drops below the maximum permissible value, the engine speed is close to the idle speed specified for the given altitude and airspeed). Subsequent opening of the throttle will inevitably result in recurrence of engine surge.

2. In the case of powerplant surge at Mach numbers below 1.8 M, accompanied by fluctuation of the engine speed and jet-pipe temperature, proceed as follows:

- use the manual control switch to open the anti-surge shutters;
- turn off the afterburner;
- reduce the flight speed;
- close the anti-surge shutters as soon as surge ceases;
- by smoothly shifting the throttle lever, bring the engine to a desired power setting, discontinue the flight mission and fly to the landing airfield.

Engine Flameout

292. Symptoms:
- a peculiar pop or change of the engine noise;
- abrupt decrease of the engine speed and jet-pipe temperature;
- the cone position indicator pointer deflects to the extreme right position.

Note. In most cases, engine flameout occurs in transient engine operating conditions (acceleration, throttling, acceleration and throttling within the adjustable reheat range) and owing to use of armament.

Actions to be taken:
- set the throttle lever to SHUT-OFF;
- disengage the autopilot;
- establish the altitude and airspeed providing for reliable engine relight; relight the engine;
- after relighting the engine, smoothly shift the throttle lever to FULL THROTTLE to check the engine for proper operation; discontinue the mission and fly to the landing airfield.

Engine Relight

293. Evaluate the chances of relighting the engine. The pilot should act promptly in the process of relight, because the aircraft descends at a rate of 50 m/s with the engine inoperative.

When the altitude is sufficient, turn the aircraft towards the airfield and start fulfilling a dead-engine runway approach in compliance with Paras 297 through 305.

294. Engine relight is ensured: at altitudes of 8000 to 10,000 m, from an airspeed of 550 km/h up to Mach numbers of 0.9 M; at altitudes below 8000 m, from an airspeed of 450 km/h up to Mach numbers of 0.9 M.

Proceed as follows to relight the engine:
- set the throttle lever at SHUT-OFF;
- turn on the AIR RELIGHT circuit breaker and make sure that the relight system is on, referring to illumination of the SWITCH OFF IGNITION! light in the panel.

When at altitudes from 6000 to 10,000 m, shift the throttle lever from the SHUT-OFF position to IDLE (the engine must gain the idle speed in 10 to 20 s).

When at altitudes of less than 6000 m, do the following (to speed up the process of engine acceleration to the required run):
- when the LP rotor speed is below 30% of the full value, shift the throttle lever from SHUT-OFF to IDLE. and when the LP rotor speed becomes 30%, shift the throttle lever to any desired non-reheat setting;
- when the LP rotor speed is equal to or in excess of 30%, shift the throttle lever to any required non-reheat power setting without any delay; then the engine will accelerate to the preset power setting, up to the FULL THROTTLE setting, in not longer than 25 s.

Note. It is allowable to relight the engine at altitudes below 6000 m in the way specified for the 6000 - 10,000-m altitude range, but then the time required for the engine to accelerate to the preset power setting is increased by 2 to 5 s.

The relight of the engine is monitored by increase of the engine rpm and specific sound of the running engine. The jet-pipe temperature grows slowly, therefore it cannot be regarded as a sure symptom of engine relight. Once the engine has picked up the idle speed, smoothly move the throttle lever to FULL THROTTLE to check the engine for normal run; then cut out the AIR RELIGHT circuit breaker.

If the engine has failed to get relighted, cut out the AIR RELIGHT circuit breaker and set the throttle at SHUT-OFF; then make another relighting attempt.

CAUTION. It is prohibited to leave the AIR RELIGHT circuit breaker cut in for longer than 45 s.

The last attempt at engine relight should be made at an altitude of not less than 3000 m. If the engine fails to start at an absolute altitude of at least 2000 m, adopt a decision either to abandon the aircraft or to proceed performing a dead-engine landing approach.

Note. The engine oxygen supply system will permit five attempts at engine relight, provided the AIR RELIGHT circuit breaker is kept closed for not more than 30 s.

295. If engine surge (or flameout) occurs at an altitude of less than 3000 m, owing to launch of missiles or rockets, proceed as follows:

- immediately shift the throttle lever to SHUT-OFF and keep it in this position for at least 1.5 to 2 s;
- bring the aircraft into climb at a vertical speed of 7 to 10 m/s while turning to a direction permitting safe ejection or dead-engine landing;
- make sure that the AIR RELIGHT circuit breaker is turned on (turn on the circuit breaker if it has not been turned on before the launching);
- if the LP rotor speed is equal to or is in excess of 30%, shift the throttle lever to any non-reheat power setting required for flight continuation,without any delay;
- set the throttle lever to IDLE if the LP rotor speed is less than 30%; after the engine picks up a speed of 30%, shift the throttle lever to any desired non-reheat power setting;
- check the engine run, then turn off the AIR RELIGHT circuit breaker.

WARNING. When relighting the engine, do not allow the airspeed to drop below 500 km/h.

296. The minimum indicated airspeed sufficient for engine relight and acceleration to the required speed without altitude loss (owing to drag) is as follows:

(a) 600 km/h at altitudes of 1000 to 2000 m;
(b) 700 km/h at altitudes below 1000 m.

In case the airspeed decreases (in climbing) to 550 km/h at an absolute altitude of or below 1000 m, or upon descending to an altitude of 1000 m (in gliding) at an airspeed of 550 km/h, give up further attempts at engine relight and either abandon the aircraft or perform landing approach with engine inoperative.

CAUTION. After an abortive engine relight avoid operating the controls in an abrupt manner (to spare the hydraulic fluid to allow dead-engine landing or flight to an area where ejection would be accomplished).

Approach and Landing with Dead (Windmilling) Engine

297. Dead-engine landing (with the engine windmilling) can be performed only with the LG extended, on an airfield or some strip well-known beforehand and visible

from an altitude ensuring landing estimation, either by reference to the check altitude or by reference to check points.

Landing by reference to the check altitude is accomplished on an airfield, with the use of radio aids only, when the landing area is visible or when the cloud base is not lower than 2500 m. The minimum altitude at which the maneuver should be entered above the outer beacon amounts to 5000 m.

Landing by reference to check points may be executed, also with the radio aids inoperative. The minimum altitude of maneuver entry above the first check point is 6500 m.

Both methods of landing are possible only with the engine windmilling.

Approach and landing with the engine windmilling will call for special training of the pilot in execution of approach and landing during a simulated engine failure.

298. After engine failure, proceed as follows:

- while turning in the direction of the airfield or landing area, or a terrain safe for ejection, establish an airspeed of 480 to 500 km/h;
- in the course of the turn report the engine failure to the flight control officer;
- set the throttle lever to SHUT-OFF;
- disengage the AFCS;
- turn on the PUMP UNIT switch (if turned off);
- check the pressure in the hydraulic systems;
- jettison the external stores over a terrain where due safety is ensured;
- switch off the fuel pumps and inessential electrical services.

Note. If the canopy becomes misted in descent from a high altitude with the engine inoperative, depressurize the cabin at an altitude of 5000 to 6000 m to eliminate misting.

299. Having taken the decision to perform dead-engine landing (with the engine windmilling), proceed as follows:

- while gliding with the landing gear retracted, maintain an airspeed of 480 to 500 km/h; perform turns at a bank of 40 to 50° while keeping the airspeed constant at the expense of minor increase of the angle of descent during the turn.

Note. When the engine cannot be relighted (owing to wedging, juddering, etc.), with the aircraft flying over the sea, mountains, desert or uninhabited area, jettison all external stores and glide at an airspeed of 470 to 490 km/h. Under these conditions, the maximum gliding distance will be ensured, which will amount to 6.0 - 6.5 and 2.5 - 3.0 initial altitudes, when gliding with the landing gear retracted and extended, respectively;

- in gliding, avoid (if practicable) abrupt deflections of the control stick; in the case of insufficient windmilling rpm, hence an insufficient pressure in the hydraulic systems, disengage the aileron boosters;
- do not use the air brakes or flaps; use the emergency system for extending the landing gear;
- while gliding and making landing approach, keep watching the pressure in the hydraulic systems.

300. When performing landing approach by reference to the check altitude, proceed flying to the airfield so as to approach the outer beacon on a course close to the runway direction, at an altitude of not less than 5000 m and an airspeed of 480 to 500 km/h.

Notes: 1. During landing estimation, keep on attempts at relighting the engine down to an altitude of 3000 m. Starting from an altitude of 3000 m, give major attention to landing estimation (after taking the decision to perform landing).

2. When performing landing approach by reference to the check altitude or by reference to the check points, up to the moment the angle of glide is decreased (at an altitude of 200 to 250 m), maintain an airspeed of 480 to 500 km/h. In this case the rates of descent with the landing gear extended amount to 45 - 60 m/s in turns, and to 30 - 40 m/s in gliding; the angle of glide amounts to minus 15 - 20° as indicated by the gyro horizon.

The moment when the outer beacon is overflown is considered to be the time when the radio compass pointer deflects by 30 to 40° from the zero relative bearing indication (i.e. from RB = 0°).

When flying over the outer beacon, note the altitude ($H_{initial}$) and bring the aircraft into a turn at a bank of 45 to 50° while maintaining an airspeed of 480 to 500 km/h. Performing the turn, calculate the check altitude (in meters) as follows:

$$H_{check} = \frac{H_{initial}}{2} + 800.$$

After performing a 180° turn, proceed gliding on the downwind leg at an airspeed of 480 to 500 km/h until the check altitude is attained. Then perform a turn through 90° at a bank of 45 to 50°. Perform the final turn so as to bring the aircraft in line with the runway. Extend the landing gear at an altitude of 2000 m by using the emergency system, so as to overfly the outer beacon at an altitude of 1300 to 1700 m. When performing landing into head wind of 8 to 10 m/s, extend the landing gear at an altitude of 1800 m.

Notes: 1. When planning approach from a check altitude of 5000 m, there will be practically no straight glide portions (the aircraft will perform a spiral 360° turn).

2. If the altitude of overflying the outer beacon is in excess of 11,000 m, perform a spiral 360° turn at a bank of 45 to 50° and airspeed of 480 to 500 km/h. Start planning the approach when over the outer beacon for the second time.

WARNING. If landing is being performed on a known strip rather than on the airfield, actuate the shoulder restraint prior to dead-engine landing, and jettison the collapsible canopy by using the emergency system at an altitude of 1000 to 1500 m.

After the final turn, the aircraft should glide into a point located at a distance of 600 to 800 m from the approach end of the runway.

At an altitude of 200 to 250 m start decreasing the glide angle so as to bring the aircraft to an altitude of 10 to 12 m at a speed of 380 to 400 km/h. Further, start flare-out and land in the same manner as when the engine is running.

If the landing estimation has brought about overshooting, 1 to 2 s after touchdown lower the nosewheel on the ground, fully depress the brake lever and smoothly shift the control stick all the way forward. Deploy the drag chute at a speed of not more than 320 km/h.

If there is a danger of colliding with some obstacles while rolling off the runway after landing on the airfield, jettison the collapsible canopy in the emergency way and retract the landing gear.

301. Estimation for landing by reference to the check points should be carried out with respect to the following check points: the first point is represented by the approach end of the runway (H = 6500 to 7500 m), the second point is located abeam of the approach end of the runway, at a distance of 5 to 6 km from the latter (H = 5000 to 5600 m), the third point is located abeam of the outer beacon (H = 4000 to 4600 m) and the fourth point is located in the vicinity of the outer beacon (H = 2700 to 3100 m).

The third and the fourth check points represent the points of entry into the turn to the base leg and the final turn, respectively.

The second and the third check points should be noted beforehand by reference to landmarks (during familiarization flight over the airfield).

302. Approach the airfield so as to overfly one of the check points at the recommended altitude, making allowance for the angle of turn.

303. Upon overflying the first check point on the inbound heading at an altitude of 6500 to 7500 m, enter the 180° turn at a bank of 45 to 50° without any delay.

If the altitude above the first check point is in excess of 7500 m, perform the 180° turn later, when the difference between the actual altitude and the assigned one diminishes by one half.

While performing the turn, adjust the bank so as to overfly the second check point on the downwind, at an altitude of 5000 to 5600 m.

After overflying the third check point, perform the base leg turn at a bank of 45 to 50° and glide in the direction of the outer beacon; the final turn may be performed in combination with the base leg turn.

If the landing gear is retracted and the altitude over the third check point is 4000 to 4600 m, extend the landing gear (using the emergency system); if the altitude over the third point is less than 4000 m, extend the LG (in the emergency way) just before reaching the fourth check point in order to be able to check landing gear extension, and to provide time to eject, should the LG fail to extend. If the altitude over the third check point is higher than 4600 m, commence the base leg turn somewhat later, when the difference between the actual altitude and the assigned one diminishes by one half.

304. Start the final turn at an altitude of 2700 to 3100 m and at a bank providing for placing the aircraft in alignment with the runway (in the vicinity of the outer beacon).

If the altitude is less than 2700 m at the point where the final turn is to be started, enter the turn somewhat earlier so as to cut short the distance.

If the altitude is in excess of 3100 m over the point where the final turn is to be entered, increase the angle of descent for a short time, to lose the excess altitude (this will increase the speed of glide by 10 to 20 km/h).

The rest of the approach and landing procedure is much the same as in approach by reference to the check altitude.

During landing approach in the presence of head wind of 8 to 10 m/s, the altitude over the third and fourth check points should be by 300 to 400 m higher than the recommended one.

Note. If the altitude is insufficient during approach of the airfield, fly to the second and third check point (depending on the altitude) on the appropriate course.

305. For training of pilots in landing estimation and approach during simulated engine failure (with the engine throttled down), approach and descend with the air brakes extended, the throttle lever set to BLC. The glide path under these conditions will be similar to that in gliding with the engine dead (windmilling).

Failure of Cone Automatic and Manual Control Systems

Cone Failure to Extend after Takeoff and LG Retraction

306. Symptoms:

- no CONE EXT'D light flashes up on the light panel;
- the cone position indicator pointer is set to zero.

Actions to be taken:

- refer to the LG/flaps position indicator to make sure that the landing gear is retracted;

- discontinue a training mission and fly to the landing airfield.

When fulfilling a combat mission, change over to manual control of the cone and proceed in accordance with the directions of Para. 308.

Cone Failure to Extend during Aircraft Acceleration at Constant Engine Power Setting or during Decrease of Engine Speed

307. Symptoms:

- the cone position indicator pointer fails to deflect at Mach numbers over 1.4 M;

- at supersonic airspeeds, with Mach number below 1.8 M, minor "bubbling" or pops are likely to be produced in the air intake duct; at Mach numbers in excess of 1.8 M powerplant surge may be experienced;

- the cone position indicator pointer fails to deflect in response to decrease of the engine speed.

Actions to be taken:

- by manipulating the setter (by rotating the setting knob), align the cone position indicator broad pointer with the slender one, then set the cone function switch to MAN.;

- while decreasing the airspeed, smoothly rotate the setting knob counterclockwise to set the wider pointer in a position, depending on the Mach number, in accordance with Table 17:

Table 17

Mach number	Less than 1.4 M	1.4 to 1.6 M	1.7 M	1.8 M and over
Cone indicator pointer position (%)	20	25	35	40

- in the case of unsteady run of the powerplant, proceed as mentioned in Para. 291;

- fully retract the cone before extending the landing gear.

308. If the cone automatic control system fails in combat conditions, proceed with the mission while controlling the cone manually, for which purpose manipulate the setter (rotate the setting knob) to align the pointers on the cone position indicator, and then set the cone function switch to MAN.

Subsequently, rotate the setting knob smoothly to set the pointer in a position corresponding to the Mach number in accordance with the data of Table 17.

Cone Failure to Retract during Aircraft Deceleration or Engine Acceleration

309. Symptom:

- the cone position indicator pointer fails to deflect in response to Mach number decrease or engine speed increase.

Actions to be taken:

- rotate the setting knob to align the cone position indicator broad pointer with the slender one, then set the function switch to MAN.;

- discontinue a training mission and fly to the landing airfield (when fulfilling a combat mission, proceed as laid down in Para. 308 after changing over to manual control of the cone);

- during airspeed reduction and when making landing approach, proceed in accordance with Para. 310.

310. If the cone fails to get retracted manually in flight or in landing approach, change the engine operating conditions by shifting the throttle lever in a smooth manner.

Note. At the LP rotor speed in excess of 85%, flight with the cone extended will result in air intake buzzing, which will increase with the engine speed. Buzzing will not affect steady operation of the engine.

When flying with the air intake cone fully extended, perform initial approach at an airspeed of 500 km/h. If level flight proves to be impracticable at this airspeed, approach the airfield area while descending. Then turns should be accomplished at a bank of not more than 30°.

Once in the airfield area, keep flying at an altitude of 2000 m to burn the fuel until the normal landing weight is attained.

Notes: 1. At an altitude of not more than 2000 m the aircraft is capable of level flying with the landing gear and flaps retracted, irrespective of the external loads carried.

2. Level flight at altitudes of not more than 2000 m with the landing gear extended and flaps retracted is possible, provided the engine is running at the maximum speed.

WARNING. No level flight is possible when the landing gear is extended and the flaps are lowered in the takeoff position.

During landing approach, extend the landing gear only on final; extend the flaps in the landing position on overflying the outer beacon (at an altitude of 200 m). Approach should be planned in the usual manner; it is advisable to perform descent between the outer and inner beacons at an LP rotor speed of 85 to 90%.

WARNING. It is forbidden to turn on the BLC system in approach with the cone extended.

The decision to go around (if required) should be taken at an altitude of not less than 100 m. To execute the missed approach procedure, smoothly increase the LP rotor speed to 100% without changing the flying conditions and select landing gear retraction. Without decreasing the flight speed below 370 km/h, bring the aircraft into level flight and then into climbing. Climb at a constant speed of 370 to 390 km/h. At an altitude of not less than 100 m increase the airspeed to 400 km/h by reducing the angle of climb, retract the flaps and repeat the approach.

CAUTION. Go-around with the cone fully extended is only possible with the landing gear retracted. Retraction of the landing gear during the missed approach procedure will result in an altitude loss of about 40 m.

Failure of Jet Nozzle Control System

311. Symptoms: selection of reheat, engine operation at sustained full reheat power, or shifting of the throttle lever to FULL REHEAT from the MINIMUM REHEAT position would cause fluctuation of the engine instrument readings and longitudinal oscillations of the aircraft.

Actions to be taken: turn on the 2-PSN NOZZLE EMERG. CTL switch;make sure that the FULL THROTTLE, REHEAT switch is on, and use the engine power setting of up to FULL THROTTLE and FULL REHEAT.

312. Symptoms: when the afterburner is turned off after setting of the throttle lever to FULL THROTTLE, the JET NOZZLE OPEN light continues to burn in the panel, the engine fails to develop sufficient thrust, the jet-pipe temperature dropping below 450°C and the LP rotor speed exceeding the HP rotor speed by 8 to 12%.

Actions to be taken: turn on the 2-PSN NOZZLE EMERG. CTL switch. If the nozzle fails to shift to the position corresponding to the FULL THROTTLE setting, turn off the FULL THROTTLE, REHEAT circuit breaker and use power settings up to FULL THROTTLE.

313. Symptoms (during engine operation at non-reheat power settings):

- insufficient engine thrust;

- at the FULL THROTTLE setting, the jet-pipe temperature is below 450°C and the LP rotor speed exceeds the HP rotor speed by more than 8 to 12%;

- the JET NOZZLE OPEN light comes on in the light panel.

Actions to be taken: turn on the 2-PSN NOZZLE EMERG. CTL. If the nozzle fails to shift to the position corresponding to the FULL THROTTLE setting, turn off the FULL THROTTLE, REHEAT circuit breaker and use power settings up to FULL THROTTLE.

Notes: 1. If the engine fails to develop sufficient thrust after the 2-PSN NOZZLE EMERG. CTL switch is turned on and the FULL THROTTLE, REHEAT circuit breaker is turned off (the nozzle failing to shift to the position corresponding to the FULL THROTTLE setting), jettison the external stores in a safe area and proceed to the airfield along the shortest path, bearing in mind that level flight, climbing at a vertical speed of up to 5 m/s and elementary maneuvers are possible only with the landing gear and flaps retracted, at an airspeed of 450 to 500 km/h within an altitude range of 500 to 3000 m. No level flight is possible with the landing gear extended.

2. The engine will run less steadily at non-reheat power settings with the jet nozzle in the reheat position and the HP rotor speed ranging from 70% to maximum. The engine may develop a flameout during aircraft maneuvers at such engine settings.

Second Reheat Failure to Cut In, or
Its Spontaneous Disengagement

314. Should second reheat fail to cut in (with the SECOND REHEAT switch turned on), or if it gets disengaged spontaneously at altitudes below 2500 to 4000 m (the SECOND REHEAT light failing to illuminate in the light panel and no engine rpm increase up to 102 - 103.5% being observed), turn off the SECOND REHEAT switch and, further, use power settings up to FULL REHEAT.

Drop of Fuel Pressure

315. Symptoms: the COPИ centralized warning system button light is flickering, and the SERVICE TANK light flashes up in the light panel.

Actions to be taken:

- discontinue the mission and fly to the landing airfield;
- turn off the afterburner and set the throttle lever to any non-reheat power setting required for flight continuation;
- push the СОРЦ system button light;
- descend at the maximum possible vertical speed to an altitude of less than 15,000 m and throttle down the engine to the LP rotor speed of less than 95%; perform further descent;
- proceed flying at an altitude of not more than 6000 m (when using fuel T-1 or TC-1) or at an altitude of not more than 4000 m (when using fuel T-2).

WARNINGS: 1. It is forbidden to apply near-zero or negative g-loads when flying with the fuel booster pump inoperative.

2. Flying at or below the 15,000-m altitude, never allow the LP rotor speed to exceed 95%.

Engine Seizing

316. Symptoms:

- aircraft juddering;
- one or both rotors fail to windmill;
- the tachometer indicator does not read any discrepancy in the rotor speeds in response to variation of the engine power settings (owing to rotor coupling);
- no oil pressure, or illumination of the OIL lamp (owing to seizure of the HP rotor).

Actions to be taken: depending on the situation, report the engine failure and the decision taken, switch on the DISTRESS signal, provide conditions for ejection and abandon the aircraft after reporting your approximate position over the radio.

Drop of Oil Pressure. Chips in Oil

317. Symptom: the oil pressure drops below 3 kgf/cm^2, or the OIL warning light comes on.

Actions to be taken:

- discontinue the mission;
- turn off the afterburner, set the throttle lever to obtain the minimum rpm practicable, and fly to the nearest airfield.

WARNING. If the oil pressure is below 1.3 kgf/cm^2, while the OIL light is shining, make ready for ejection at a safe altitude in the case of engine stoppage. Engine stoppage may result from engine speed change and compressor surging owing to rotor coupling on account of discontinuation of oil feed to the bearings.

FAILURES OF HYDRAULIC SYSTEMS

Failure of Both Hydraulic Systems with Engine Running

318. Symptoms:

- the СОРЦ centralized warning system button light is flickering;
- the WATCH MAIN SYST. PRES. and WATCH BSTR SYST. PRES. lights come on in the light panel;

- the pressure in both hydraulic systems keeps decreasing below 165 kgf/cm^2 (with the НП-27Т pump unit switched on).

Actions to be taken:

- disengage the AFCS;
- by utilizing the hydraulic pressure still available, provide conditions suitable for ejection, avoiding vigorous operation of the controls, if practicable;
- disengage the aileron boosters at an indicated airspeed of less than 1000 km/h or at less than 1.4 M;
- if the pressure has not been restored even in one hydraulic system after conditions for safe ejection have been provided, abandon the aircraft immediately.

Failure of Booster Hydraulic System with Engine Running

319. Symptoms:

- the СОРЦ button light is flickering;
- the WATCH BSTR SYST. PRES. light comes on in the light panel;
- the pressure in the booster hydraulic system keeps decreasing below 165 kgf/cm^2.

Actions to be taken:

- discontinue the mission and fly to the landing airfield;
- reset the СОРЦ button light;
- check the pressure in the main hydraulic system regularly in the process of flight and landing approach.

During flight and when flying the approach maneuver, do not use the air brakes. Extend the landing gear by using the emergency system and perform landing with the flaps up.

Notes: 1. Emergency pump unit НП-27Т should be switched off in case the time to landing exceeds 15 min, provided normal pressure is available in the main hydraulic system; switch on the pump unit only upon approach to the airfield.

2. If the pressure in the booster system is maintained within the limits of 165 to 195 kgf/cm^2 after the pump unit has been switched on, use the normal procedure for extending the landing gear, flaps and air brakes when in landing approach.

Failure of Main Hydraulic System with Engine Running

320. Symptoms:

- the СОРЦ button light is flickering;
- the WATCH MAIN SYST. PRES. light comes on in the light panel;
- the pressure in the main hydraulic system keeps decreasing below 165 kgf/cm^2.

Actions to be taken:

- discontinue the mission and fly to the landing airfield;
- reset the СОРЦ button light;
- check the pressure in the booster system;
- check the cone position; if the cone is extended, proceed as laid down in Para. 310;
- in performing landing approach, extend the landing gear by using the emergency system; do not extend the flaps or air brakes (they would not extend).

Failure of Main or Booster Hydraulic System with Dead (Windmilling) Engine

321. Symptoms:

- the COPЦ system button light is flickering;

- the WATCH BSTR SYST. PRES. or WATCH MAIN SYST. PRES. light comes on in the light panel;

- the pressure in the main or booster hydraulic system keeps decreasing below 165 kgf/cm^2.

Actions to be taken:

- disengage the AFCS;

- depress the COPЦ system button light to reset it;

- check the pressure in the main system in the case of the booster system failure, and check the pressure in the booster system in the case of the main system failure;

- in the case of failure of the booster system, check to see that the PUMP UNIT circuit breaker is turned on;

- proceed to descending, avoiding abrupt operation of the aircraft controls, if practicable. When flying over the sea (mountains, desert or uninhabited area), jettison all external loads and glide at an airspeed of 470 to 490 km/h. This will provide the maximum glide distance, which will amount to 6 - 6.5 initial altitude values when the landing gear is retracted;

- take measures to relight the engine down to an altitude of 3000 m.

If the engine fails to relight to an altitude of 2000 m, abandon the aircraft.

Note. If the aircraft cannot be abandoned in the case of failure of the main hydraulic system, with a pressure of 165 to 195 kgf/cm^2 available in the booster hydraulic system, a dead-engine landing is possible (with the engine windmilling). Under these conditions, extend the landing gear by using the emergency system when performing landing approach; do not extend the flaps or air brakes (they would not extend).

Failure of Aileron Boosters

322. Symptoms: jerking, creeping or excessive loading of the stick in aileron control.

Actions to be taken:

- switch off the AFCS;

- if the symptoms of aileron booster failure persist, disengage the aileron boosters and take all measures to decrease the indicated airspeed below 1000 km/h or Mach number below 1.4 M.

During flight with the aileron boosters disengaged, the aileron-control stick forces will considerably increase owing to the hinge moments and friction of the booster rods.

With the aileron boosters disengaged, when the aircraft is trimmed with respect to lateral control, straight flight can be performed at an airspeed of not more than 1000 km/h and Mach number of not more than 1.4 M. Turns are practicable at an indicated airspeed of not more than 600 km/h.

Failure of APУ Controller

323. Symptoms:

- with airspeed increase (altitude decrease) the aircraft responds too readily to deflections of the control stick (at an indicated airspeed of 800 km/h and altitude of less than 7000 m the stick forces decrease 1.5 to 2 times, which may result in dangerous pitching oscillations involving increase of alternating g-loads);

- with airspeed decrease (altitude increase) the aircraft responds sluggishly to deflections of the control stick (at an indicated airspeed of 450 to 500 km/h the stick forces may increase 1.5 to 2 times against the usual values); in flight under these conditions at altitudes over 7000 m or at airspeeds of 450 to 500 km/h the STAB. FOR LDG light would come on in the light panel.

Actions to be taken:

(a) in the first case:

- discontinue the mission;

- fix the control stick, smoothly bring the aircraft into climb, throttle the engine to idle speed in a smooth manner, then reduce the airspeed to a value allowing normal handling of the aircraft (to 500 - 550 km/h IAS);

- disengage the AFCS (to prevent possible oscillations of the aircraft);

- flip the pitch-channel automatic transmission ratio controller switch from AUTO to MAN. (it is not allowed to flip the switch from MAN. to AUTO);

- subsequently, operate the self-resetting switch to set the transmission ratio controller rod (the indicator pointer) in a position corresponding to the indicated airspeed and flight altitude;

(b) in the latter case:

- discontinue the mission;

- disengage the AFCS;

- change over to manual control of the transmission ratio controller and establish an airspeed of 550 to 600 km/h;

- subsequently operate the self-resetting switch to set the transmission ratio controller rod (the indicator pointer) in a position corresponding to the airspeed and altitude of flight.

Before landing approach, operate the self-resetting switch to change the transmission ratio controller over to the larger arm (set the indicator pointer against the left stop); as a result, the STAB. FOR LDG light should come on in the light panel. In this case no peculiar features will be involved in either landing estimation or landing proper.

If the automatic transmission ratio controller fails during execution of a combat mission, it is allowed to perform further flight while controlling the transmission ratio controller manually; operate the self-resetting switch to set the transmission ratio controller rod (the indicator pointer) in a position corresponding to the indicated airspeed and altitude of flight. Flying under these conditions, avoid executing vigorous maneuvers or discrepancy between the indicated airspeed and the reading of the transmission ratio controller indicator pointer by more than 100 - 150 km/h.

Landing with APY Controller in Smaller or Intermediate Arm Position

324. If operation of the self-resetting switch would not result in changing of the transmission ratio controller rod over to the larger arm (to the takeoff/landing position), perform landing with the transmission ratio controller rod in the smaller or intermediate arm position. In this case, the aircraft should overfly the outer beacon at an altitude of 150 to 180 m, whereas the airspeed of overflying the outer and inner beacons, flareout initial speed and touchdown speed should be increased by 20 to 30 km/h as compared with the speeds associated with the normal landing procedure without use of the BLC system (with the flaps down in the takeoff position).

After extending the flaps in the takeoff position, at an airspeed of 400 to 420 km/h, trim out the stick forces with the aid of the pilot's trim.

With the transmission ratio controller rod set to the smaller arm, the maximum angles of stabilizer deflection will be reduced by nearly one half as compared with the normal angles of deflection, when the transmission ratio controller rod is set to the larger arm. Landing then will call for greater caution and precise stick manipulations by the pilot in pitch control. The pull stick forces, prior to touchdown, may grow 1.5 to 2 times and amount to 20 - 25 kgf.

WARNING. In the case of failure of the transmission ratio controller, landing should be performed without use of the BLC system, at a landing weight not exceeding the normal one, irrespective of the transmission ratio controller rod position (whether set to the larger, smaller or intermediate arm position).

FAILURE OF AFCS

325. Proceed as follows in case the aircraft experiences a rolling or pitching dash, if the pitch angle or heading starts changing spontaneously, provided that it has not been caused by unbalance deriving from change of the flight conditions, release of external stores, extension (or retraction) of the landing gear and/or wing lift augmentation devices (which might cause a short-time change of the aircraft attitude with subsequent return into the original attitude):

- oppose at once the rolling or pitching dash, heading or pitch variation caused by the AFCS failure;

- disengage the AFCS, pushing the A/P OFF button located on the control stick; as this is taking place, some short-time deviation of the aircraft attitude may take place in the direction of the controls deflection for opposing the dash or attitude variation; this happens due to return of the PAY servo unit rod into the neutral position, following the AFCS disengagement.

It must be remembered that after the failed AFCS has been switched off, the rod of the pitch (roll) servo unit may happen to remain in a position other than the neutral one, due to which fact the longitudinal (lateral) trim of the aircraft may be disturbed.

Under these conditions, longitudinal trim of the aircraft can be provided by removing the stick forces with the aid of the pilot's trim mechanism; and lateral trim can be provided by deflecting the control stick sideways (through not more than 1/5 of the stick full travel).

Note. If the pilot's trim mechanism fails to trim up the aircraft after the AFCS has been switched off, this will testify to failure in the trim mechanism.

If the aircraft is not trimmed in roll (the control stick being deflected through up to 1/5 of its full travel) or in pitch after disengagement of the AFCS, abort the mission and fly back to the landing airfield. Piloting and landing of the aircraft present no special difficulties under these conditions.

In the case of longitudinal (and/or lateral) self-induced aircraft oscillations whose amplitude is either constant or growing, disengage the AFCS by depressing the button inscribed A/P OFF.

WARNING. It is forbidden to attempt at counteracting the aircraft self-induced oscillations that would develop with the AFCS engaged.

If the aircraft fails to maneuver properly to intercept the localizer and glide path transmitter beams while in automatic control for landing approach, i.e. if there are deviations from the localizer and/or glide path beam center lines, the bank exceeding 35°, cut out the AFCS external modes of operation, using the OFF button on the AFCS control panel, and execute landing approach either in the manual control mode or using the radio compass for the purpose.

If the command control pointers of the FDI are producing readings which run counter to the indications of the FDI or CCI position bars while the aircraft is flying within the localizer and glide path transmitter beams (with the exception of the process of intercepting the beams) in the command control or automatic control mode, immediately cut out the AFCS external modes of operation by pushing the OFF button on the AFCS control panel; then carry out landing approach in the manual control mode or using the radio compass for the purpose.

LIFE-SUPPORT EQUIPMENT FAILURES

Failure of Pilot's Oxygen System

326. Symptoms:

- discontinuation of oxygen feed into the pressure helmet or mask at a cabin altitude of over 2000 m (the segments of the oxygen flow indicator are closed and fail to respond to deep inhalation or exhalation with the diluter handle set to "100% O_2");
- abrupt drop of the oxygen pressure as read by the ИК-52 oxygen flow indicator pressure gauge;
- no oxygen is supplied into the pressure suit tensioner bladders, no overpressure is built up in the pressure helmet (in the mask) when cabin depressurization occurs at altitudes of over 11,000 m.

Actions to be taken:

- change over to oxygen supply from the КП-27М parachute oxygen set;
- descend to an altitude of 4000 m at as high vertical speed as possible;
- at an altitude of 4000 m and an airspeed of not more than 700 km/h open (remove) the pressure helmet visor (remove the oxygen mask).

Misting or Overheating of Pressure Helmet Visor

327. When the helmet visor gets misted in flight, check to see that the pressure helmet heating wire bundle is not disconnected; change over to manual control of the helmet visor heating, turn the heating rheostat all the way clockwise and eliminate the visor misting by operating the HLT FAST HEAT. button.

After the visor misting has been eliminated, turn the pressure helmet heating rheostat 1 to 2 divisions to the right of the initial position.

If the above measures are of no avail, proceed as follows:

- discontinue the mission;
- descend to an altitude of 4000 m at as high vertical speed as possible;

- switch on emergency oxygen supply in the process of descent;

- at an altitude of 4000 m and an airspeed of not more than 700 km/h open (remove) the pressure helmet visor and switch off the emergency oxygen supply.

If the pressure helmet visor keeps being misted after the emergency oxygen supply has been switched on, it is allowed to open the visor of pressure helmet ГШ-6 while descending (at an altitude of not more than 8000 m); when wearing pressure helmet ГШ-4, remove the visor and set it against your face so that the upper edge of the visor is below your eyes, covering the nose, and does not block the view of the instruments. At an altitude of 4000 m switch off the emergency oxygen supply (having moved the visor of pressure helmet ГШ-4 away from your face).

Note. By way of exception, it is allowed to perform short level flight at an altitude of not more than 8000 m with the ГШ-6 pressure helmet visor open (with the ГШ-4 pressure helmet visor held close to your face), the emergency oxygen supply being switched on, until the oxygen pressure in the system drops to 30 kgf/cm^2. During flight, keep watching the oxygen reserve, since the rate of oxygen flow will materially increase.

328. If the pressure helmet visor becomes overheated, change over to manual control of the heating system, and turn the rheostat through 1 to 2 divisions counterclockwise. If the visor fails to be cooled down, turn the rheostat all the way counterclockwise.

If the measures taken are of no avail, descend to an altitude of 4000 m and open (remove) the pressure helmet visor at an airspeed of not more than 700 km/h; then disconnect the visor heating wire bundle.

Cabin Depressurization at High Altitude or Breakage of Canopy Glass Panels

329. Symptoms:

- perceptible variation of the differential pressure (resulting in earache);

- mist appearing in the cabin for a short time;

- abrupt increase of the cabin altitude and decrease of the differential pressure as read by the УВПД-20 indicator;

- overpressure is built up in the partial-pressure suit tensioner as well as in the pressure helmet (in the mask) at altitudes over 11,000 m.

Actions to be taken:

- descend at as high vertical speed as possible to a cabin altitude of less than 11,000 m (as read by the УВПД-20 cabin altitude and differential pressure indicator);

- check the position of the cabin air supply valve handle and canopy pressurization lever (the valve handle should be set to OPEN, whereas the pressurization lever should be brought all the way up);

- if the handle and lever are found to be in the correct positions, watch functioning of the oxygen equipment and the rate of oxygen consumption more attentively; if the pressure in the oxygen system drops to 30 kgf/cm^2, descend to an altitude of less than 4000 m;

- in case of abrupt cabin temperature drop and misting of the pressure helmet visor, use the HLT FAST HEAT. button;

- if the cabin becomes depressurized owing to breakage of the canopy glass panels or to breakaway of the collapsible canopy, immediately reduce the airspeed, descend to an altitude of 4000 m and fly to the nearest airfield.

Notes: 1. The maximum speed for flying without the collapsible canopy is specified in Table 6.

2. At a cabin altitude of over 7000 m, symptoms of decompression sickness are likely to appear (pain in joints, muscles, etc.). To relieve pain, descend to a cabin altitude of less than 7000 m (as read by the cabin altitude and differential pressure indicator).

Failure of Air Temperature Controller

330. Symptom: abrupt increase or decrease of the air temperature in the cabin, not complying with the flight conditions.

Actions to be taken:

- change over to manual control by setting the cabin heating switch to COLD if the temperature is too high, or to HOT if the cabin temperature is too low. After the mixer shutters have been fully shifted over to HOT or COLD, the cabin temperature will start changing in 2 to 3 min. When descending, it is advisable to increase the engine speed to ensure rapid heating of the cabin air.

If the high cabin temperature persists, descend to an altitude of less than 11,000 m and switch off the cabin air supply. Discontinue the mission and proceed to the landing airfield if the cabin temperature is extremely unfavourable.

Misting of Cabin Canopy Glass Panels during Descent

331. Actions to be taken:

- check the position of the cabin air supply valve handle (the handle should be in the OPEN position);
- set the cabin heating switch to HOT;
- if misting persists, reduce the rate of descent and increase the engine speed; extend the air brakes, if necessary.

Smoke in Cabin

332. Actions to be taken:

- when flying at an altitude of less than 4000 m, immediately put on the oxygen mask or close (put on) the pressure helmet visor (if open or removed);
- change over to breathing pure oxygen by setting the air dilution valve handle to "100% O_2";
- switch off the cabin air supply and descend to an altitude of less than 11,000 m at as high a rate as possible;
- if smoke keeps flowing into the cabin, decrease the airspeed, depressurize the cabin and act in accordance with the actual situation (jettison the collapsible canopy in an urgency).

WARNING. It is not allowed to open the collapsible canopy in flight.

ELECTRICAL POWER FAILURES

DC Generator Failure

333. Symptoms:

- the СОРЦ system button light is flickering;

- the DC GEN. OFF light flashes up in the light panel;

- the voltmeter reads a voltage of 21 to 22 V instead of 28 to 29 V;

- the pointer of the ampere-hour meter deflects towards zero, thereby indicating the storage battery discharge.

The DC generator failure will cause automatic disengagement of the radar, No. 1 tank group pump, inverter ПО-750 No. 2 and missile control system.

334. Actions to be taken:

- discontinue the mission and fly to the nearest airfield so as to be in the air for as short time as possible;

- push the СОРЦ system button light;

- disengage the AFCS;

- establish an engine speed of not more than 95% (LP rotor);

- descend to an altitude of less than 6000 m at as high vertical speed as possible, to permit flight without the use of the fuel system booster pumps.

When the DC generator fails, with the aircraft services fed from the storage battery, the time of safe flight will amount to about 15 min, both in the daytime and at night.

In 15 min since the DC generator failure the voltage indicated by the voltmeter should be 22 to 21 V and the remaining battery capacity should be at least 11 A·h as read by the MCA indicator.

To increase the time of safe flight, it is permissible to switch off the services which are not needed for execution of flight. After the 450 L FUEL REMAINING lamp comes on, it is allowed to switch off the No. 3 tank group pump.

When the voltage in the aircraft mains drops below 20 V (which is indicated by the voltmeter, by considerable dimming of the lamps, by failure of the radio set and other aircraft equipment), proceed as follows:

- in day flight under bad weather conditions, when no visual orientation or approach to the landing airfield after a leader is possible, or when no conditions for visual approach are provided, as well as at night under bad weather conditions, abandon the aircraft;

- under fair weather conditions both in the daytime and at night, when the horizon is visible and adequate visual orientation is possible which permits approach to the landing airfield, and when the readings of the vertical speed indicator, altimeter, airspeed and tachometer indicators can be normally taken, fly to the nearest airfield (use a leader, if practicable, for approaching the airfield and making landing approach)

Calculate the fuel remainder proceeding from the fuel gauge pointer indication at the time when the instrument was deenergized, as well as from the flying time since the power-off moment and the fuel consumption rate under the given flying conditions.

Extend the landing gear, using the emergency system. Mind that the flaps, drag chute and anti-skid unit may fail to operate under the circumstances.

Failure of Inverter ПО-750А No. 1

335. Symptoms:

- no radio communication (on all channels);
- the radio compass stops responding to turns performed by the aircraft;
- the oil pressure gauge pointer sets to zero;
- the cone position indicator pointer smoothly deflects to the extreme position (100%).

Actions to be taken:

- turn on the INV. EMERG. CNGOVR (АВАР. ПЕРЕКЛ. ПРЕОБР.) circuit breaker on the right-hand horizontal console. This will cause the above loads to be changed over to inverter ПО-750А No. 2 (the equipment will become operative in 1 to 1.5 min); under these conditions the radar and optical sight will get cut off this inverter.

R/T FAILURE

336. Actions to be taken:

(a) with the R/SET circuit breaker turned on and the radio set failing, check the following:

- the adapter wire bundle for secure attachment to the pressure helmet (headset) connector;
- the twin switches on the УК-2М amplifier for proper setting;
- the communication radio set controls and adjustment elements for proper position (make sure that the assigned communication channel number is selected; see that the volume control is set in the extreme right-hand position; ascertain that the RADIO - COMP. switch is set to RADIO); switch off the noise suppressor;
- radio set operation on other communication channels;

(b) if the checks fail to reveal the cause of the trouble and communication is not reestablished, proceed as follows:

- discontinue the mission and fly to the landing airfield, sending messages in the predetermined points with due observance of the radio traffic procedures;
- switch on the DISTRESS signal; mark your position at regular intervals, depressing the СОД АТС IDENT. button, having made sure that the СОД АТС transponder mode selector switch is set in GUIDANCE: COARSE position;
- do not enter the clouds in case communication is interrupted when under the clouds;
- if communication was interrupted when the aircraft was flying in or above the clouds, proceed to the landing airfield while observing strictly the preset flying conditions and continuing to send the routine R/T messages; perform landing approach;
- if the radio set fails during night flying out of clouds, adjust the navigation lights to the maximum brightness; if flying at an airspeed of not more than 500 km/h, designate your position at regular intervals by switching on the landing light (in the final turn or before overflying the outer beacon).

337. If the radio beacon is furnished with additional equipment permitting the flying control officer to send messages through the beacon transmitter, resort to the radio compass for receiving the commands. In this case proceed as follows:

- use the radio set to report standing by on the radio compass frequency;
- set the RADIO - COMP. switch on the radio set control panel to COMP.;
- set the ANT. - COMP. switch to ANT.;
- after receiving the commands of the flight control officer, set the ANT. - COMP. switch at regular intervals to COMP. for checking the relative bearing of the radio beacon (if approaching by the radio compass).

FAILURES OF FLIGHT AND NAVIGATIONAL SYSTEMS

Failure of FDI Gyro Horizon

338. Symptoms:

- illumination of the red warning light on the gyro horizon indicator (to indicate failure of power supply);

- tilting of the miniature airplane and of the pitch scale on the gyro horizon indicator in level flight, or failure of the gyro horizon indications to agree with the aircraft attitude (which is determined by comparing the gyro horizon readings with visual evaluation of the aircraft attitude or with the readings of combined instrument ДА-200, the altimeter, compass system and radio compass).

Actions to be taken:

- disengage the AFCS;

- cage the gyro horizon in straight-and-level flight by depressing the button for a short time; this should cause the warning light on the indicator to illuminate for not more than 15 s;

- if the serviceability of the gyro horizon is not restored after the warning light goes out, change over to the stand-by vertical gyro, for which purpose turn off the GYRO HOR. circuit breaker. In case the gyro horizon becomes serviceable again, proceed with the mission.

If the gyro horizon remains unserviceable after it has been changed over to the stand-by vertical gyro, discontinue the mission and fly to the landing airfield by referring to combined instrument ДА-200 and watching the readings of the altimeter, airspeed indicator, compass system and radio compass.

Failure of PCБH Equipment

339. Either the entire PCБH equipment might fail in flight, or just a part of it, i.e. only the navigational section or the landing approach section.

340. Symptoms of navigational section failure in cross-country flight:

- the displayed aircraft azimuth and/or distance from the navigational beacon do not comply with the actual position of the aircraft;

- the difference between the relative bearing of the navigational (PCБH) beacon and that of the homing beacon picked up by the radio compass, is more than 7° at a distance of more than 40 km to the beacons.

Actions to be taken: stop using the navigational section of the PCБH equipment any longer.

Return to the airdrome and come in to land by the radio compass, having placed the PCБH-ARC switch in the ARC position. After hitting the runway approach course, at a distance of not more than 40 km to the runway (i.e. on long final), set the NAVIG. - LETDOWN - LDG switch in the LDG position and execute landing approach in the automatic, command control or manual control mode.

341. Symptoms of landing approach section failure:

- when the aircraft is within the coverage of the localizer and glide path transmitter beams and the LANDING mode is selected, the failure warning flags of the CCI have failed to close their windows, or they opened the windows in the course of the approach;

- the readings of the ППД distance indicator fail to comply to the aircraft actual distance to the runway.

Actions to be taken: disengage the automatic or command control mode, pushing the OFF button on the AFCS control panel.

Carry out runway approach by the radio compass.

Failure of Compass System

342. Symptoms:

- during aircraft turns the indicator scale remains motionless or moves chaotically;

- in sustained straight flight the scale keeps fluctuating at an amplitude exceeding $\pm 2^{\circ}$.

Actions to be taken:

- disengage the AFCS;

- discontinue the mission;

- approach the landing airdrome by the radio compass, periodically checking the distance and heading by referring to the direction finder and ground radars; or use the РСБН system for approaching the airdrome;

- landing under bad weather conditions by day as well as night should be performed with the use of a ground-controlled approach system.

Note. If the normal readings of the compass system are restored in straight-and-level flight at a constant speed, with the slaving button depressed (which is indicative of failure of the gyro unit), determine the magnetic heading in steady straight-and-level flight with the slaving button depressed. Under these conditions, the compass system will produce wrong readings during aircraft maneuvers with the slaving button depressed.

343. To perform initial approach to the landing airdrome with the use of the РСБН system, rotate the SC course setting knob of the CCI to align the set course pointer with the relative bearing pointer. Then the vertically-disposed position bar of the FDI will settle in the limits of the simulated aircraft position circle.

Further, so handle the plane that the FDI vertically-disposed position bar is kept within the limits of the circle.

To avoid the ambiguity error, refer to the ППД distance indicator: if its readings are ever increasing, turn the plane through 180° to fly to the navigational beacon.

Failure of Pressure-Actuated Instruments
(Failure of Pitot-Static System)

344. Symptoms:

- the readings of the УС-1600 airspeed indicator and УИСМ-И indicator fail to agree with the engine power setting and/or the aircraft flight conditions;

- the readings of the altimeter and of the vertical speed indicator incorporated in the ДА-200 combined instrument fail to agree with the gyro horizon indications and flying conditions;

- the differential pressure in the cabin (as read by the УВПД-20 indicator) fails to agree with the actual flight altitude.

Simultaneous failures of only the УС-1600 and УИСМ-И instruments at a supersonic flight speed are indicative of failure of the pitot system.

Wrong readings of the same instruments at a subsonic airspeed may be also indicative of failure of the first static system. In both cases, functioning of the АРУ controller and AFCS will be affected.

Simultaneous failures of the УС-1600, УИСМ-И, ВДИ-30К and ДА-200 instruments in supersonic flight will testify to failure of the first static system. Simultaneous failures of the ВДИ-30К, ДА-200 and УВПД-20 instruments in subsonic flight will be indicative of failure of the third static system. Failure of the first static system also affects functioning of the АРУ controller, AFCS and air intake anti-surge shutters automatic control.

345. Actions to be taken:

(1) Check to see that the PERISCOPE, AA XDCR, P-S TUBE, CLOCK and SIDE P-S TUBE circuit breakers are turned on; turn on the circuit breakers, if turned off (to heat the main and side pitot tubes).

When the circuit breakers are switched on, the instruments should become serviceable again in 2 - 3 min.

(2) If the instruments become serviceable 2 to 3 min after the PERISCOPE, AA XDCR, P-S TUBE, CLOCK circuit breaker is turned on, proceed with the mission.

(3) If circuit breaker PERISCOPE, AA XDCR, P-S TUBE, CLOCK has proved turned on, or if the instruments have failed to give correct readings 2 to 3 min after the circuit breaker is turned on, proceed as follows:

(a) if the static systems failed:

- disengage the AFCS, if engaged;
- change over to manual control of the АРУ automatic transmission ratio controller;
- abort the mission and fly to the landing airfield;
- change over the instruments to supply from the side pitot-static tube, setting the pitot-static switch lever to the P-S TUBE: STBY position. Should the instruments restore normal functioning when supplied from the side pitot-static tube, refer to their readings while completing the flight.

If the instruments fail to restore serviceability when supplied from the side pitot-static tube, change over their supply to the main pitot-static tube, setting the pitot-static switch lever to the P-S TUBE: MAIN position.

When flying to the airfield and approaching to land, check the flying conditions by reference to the УУА-1 angle-of-attack indicator, gyro horizon and LP rotor rpm in compliance with the data given in Table 18. Check the flying altitude by reference to the УВПД-20 cabin altitude and differential pressure indicator (considering that the cabin altitude equals approximately half the flying altitude in flight above 2000 m, and the cabin altitude is nearly equal to the flying altitude in flights below 2000 m) and by reference to the radio altimeter in flight below 600 m;

(b) if the pitot system failed:

- disengage the AFCS, if engaged;
- change over to manual control of the АРУ controller;
- discontinue the mission and proceed to the landing airfield;
- change over the instruments to supply from the side pitot static tube;
- when flying to the airfield, descending, approaching to land and landing, check the flying conditions by reference to the УС-1600 and УИСМ-И instruments which are supplied from the ПВД-7 side pitot-static tube.

Note. When executing a combat mission with the static system of the main pitot-static tube serviceable, the pitot-system being supplied from the side pitot-static tube, bear in mind that the air intake anti-surge shutters automatic control will be inoperative.

Table 18

Flying conditions	Angle of attack by УУА-1 indicator (deg)	Angle of pitch by АГД-1 gyro hor. (deg)	LP rotor rpm (power setting) (%)	V_{IAS} (km/h)	Vertical speed (m/s)
Climb to (LG and flaps up):					
2000 m	-	12	FULL THROTTLE	850-870 TAS	35 - 45

Table 18, continued

Flying conditions	Angle of attack by УУА-1 indicator (deg)	Angle of pitch by АГД-1 gyro hor. (deg)	LP rotor rpm (power setting) (%)	V_{IAS} (km/h)	Vertical speed (m/s)
4000 m	-	IO	FULL THROTTLE	850-870 TAS	30-40
Level flight (LG and flaps up) at H = 5000 m	-	3-5	88-90	600	0
Descent (LG down, flaps up):					
H over 2000 m	5-7	-6 to -8	80	500	40
H = 2000 to 1000 m	-	-3 to -5	88	500	15
H = 1000 to 600 m	-	-2	92	500	10
H = 600 to 300 m	-	0-1	92	450	3-5
Level circuit flight at 600 m:					
(a) LG down, flaps up	-	2-3	95-100	500-550	0
(b) LG and flaps up	-	1-2	80-85	600-650	0
Gliding on final (LG and flaps down, BLC on) from altitude of 200 m	-	4	78-80	400-360	5
Descent at optimum airspeed of maximum glide distance (LG and flaps up), H = 10,000 to 1000 m	5-7	-	IDLE	500-550	-
Descent on final, H = 600 to 200 m:					
(a) LG down, flaps down in takeoff position:	6-7	-	-	470-450	3-5
over outer beacon	-	-	77-80	450	3-5
over inner beacon	-	-	73-75	380-360	3-5
flareout initiation	11-12	-	68-70	360-340	-
(b) LG and flaps down, BLC on:					
over outer beacon	-	-	90-92	400	3-5
over inner beacon	-	-	85-87	330-320	3-5
flareout initiation	9-10	-	77-80	320-310	-

LANDING GEAR FAILURES

Failure of LG to Extend Normally

346. If the landing gear extends partially or fails to extend altogether when the pressure in the main hydraulic system is normal, make sure that the landing gear signalling system is functioning properly (by depressing the light test button). If one of the lights remains dead after the button is depressed, leave the LG control valve in the LG: DOWN position. Report the trouble and fly over the control post to demonstrate the landing gear to the flight control officer. Perform landing after the control officer confirms that the landing gear is extended.

In case the signalling system is functioning normally, set the landing gear control valve to LG: UP at first, and then shift it to DOWN without lingering in the neutral position. Refer to the signalling system to make sure that the landing gear is extended. If the landing gear fails to extend or stops midway, proceed as recommended above two or three times in succession. Simultaneously, depending on the actual situation and flying conditions, apply alternating g-loads by maneuvering the aircraft (at an airspeed of not more than 600 km/h).

If all three legs fail to get released from the up-locks, extend the landing gear by using the emergency system as instructed in Para. 347.

Emergency LG Extension

347. To extend the landing gear from the emergency system, use the following procedure:

- decrease the airspeed to 500 km/h;
- set the landing gear control valve to UP, then shift it to the neutral position;
- actuate the nose leg autonomous extension handle to open the up-lock, and refer to the LG/flaps position indicator red lamp (which should go out) to make sure that the nose leg is normally released from the up-lock;
- open the landing gear emergency control valve; refer to the LG/flaps position indicator to make sure that the landing gear is extended.

If the main LG legs fail to extend, land on an unpaved runway (crash strip), using the nose leg, extended air brakes and empty drop tank (if available).

Abandon the aircraft by ejection in case the nose leg or one of the main legs fails to extend.

Failure of One LG Leg to Extend

348. If one of the landing gear legs fails to extend, with normal pressure available in the main hydraulic system, make two or three attempts at leg extension by shifting the landing gear control valve from DOWN to UP and vice versa. In doing so, apply alternating g-loads, depending on the actual situation and flying conditions (at an airspeed of not more than 600 km/h).

If it does not cause extension of all the three LG legs, proceed as follows:

- retract the landing gear;
- make sure that the main LG legs are engaged by the up-locks (the red landing-gear-up lights burning) and set the landing gear control valve to the neutral position;
- by operating the handle for autonomous extension of the nose leg, open the nose leg up-lock and make sure that the nose leg is normally released, referring to the respective red lamp on the LG/flaps position indicator (the lamp should go out);
- if the nose leg has extended,but failed to get engaged by the down-lock, increase the airspeed to 700 km/h, apply alternating g-loads and make sure that the nose leg is extended, referring to the LG/flaps position indicator green lamp (which should flash up);
- perform landing on an unpaved runway (crash strip), using the nose leg, extended air brakes and empty drop tank (if available); under these conditions, approach to land while carrying the minimum amount of fuel. Before starting the base leg turn, be sure to lock the safety harness and jettison the collapsible canopy.

In landing, avoid high flareout and holding-off; shut off the engine prior to touchdown. After touchdown, deploy,the drag chute and switch off the storage battery.

Note. Cut out the PRESET (LIMIT) ALT. switch before landing with the main LG legs retracted.

WARNING. Landing on the airfield or off-field forced landing should be performed after extending all the three LG legs or only the nose leg. In all other cases the pilot must abandon the aircraft.

349. If the nose leg fails to extend, with normal pressure available in the main hydraulic system, make 2 or 3 attempts at extending the nose leg by shifting the landing gear control valve from DOWN to UP and vice versa. In so doing, depending on the actual situation and flying conditions, apply alternating g-loads (at an airspeed of not more than 600 km/h).

If it is of no avail, do as follows:

- retract the landing gear;
- set the landing gear control valve in the neutral position;
- operate the handle for autonomous extension of the nose leg, to open the up-lock; refer to the red light on the LG/flaps position indicator to make sure that the nose leg is disengaged from the up-lock (the red lamp should go out);
- set the landing gear control valve to DOWN and make sure that the landing gear is extended, referring to the LG/flaps position indicator.

If the nose leg has extended,but failed to get engaged by the down-lock (no respective green light illuminating on the LG/flaps position indicator), increase the airspeed to 700 km/h and apply alternating g-loads. Refer to the green light on the LG/flaps position indicator to make sure that the nose leg is down and locked.

In case the nose leg fails to be engaged by the down-lock, notwithstanding the steps taken, abandon the aircraft.

Main Wheel Blowout on Takeoff or Landing

350. Symptoms:

- heavy jolting;
- yawing and banking towards the broken wheel (or tyre).

Actions to be taken:

(a) during takeoff run:

- abort the takeoff procedure;
- deploy the drag chute and brake the wheels in the usual manner, preventing yaw with the brake of the sound main wheel; if necessary, disengage the anti-skid unit;

(b) prior to unsticking, if safe abortion of takeoff is not ensured:

- proceed with takeoff;
- brake the wheels immediately upon unsticking; do not retract the landing gear, if not on a combat mission;
- perform landing with the minimum amount of fuel;
- before landing approach, disengage the nosewheel brake; make sure that the safety harness is tight and locked;
- upon touchdown, lower the nosewheel and deploy the drag chute;
- shut off the engine, if necessary;
- during landing roll,use the normal procedure for brake application; counteract yaw by pushing rudder and braking the sound main wheel; if necessary, disengage the anti-skid unit.

OFF-FIELD FORCED LANDING

351. The decision to perform an off-field forced landing is taken by the pilot. An off-field forced landing is allowed to be performed:

- with the engine inoperative - on a site whose dimensions and surface characteristics are known to the pilot, only with the landing gear extended;
- with the engine running normally - after ascertaining that the site is suitable for landing, with the landing gear extended or only with the nose leg extended.

WARNING. If you are not sure of safe landing, provide favourable conditions for ejection and abandon the aircraft.

Proceed as follows on taking the decision to perform an off-field forced landing:

- report your decision and the location of the landing site to the flight control officer or to the control post;
- jettison the drop tanks in a safe area (if they contain fuel); jettison the missiles, rockets and bombs (safe); jettison the rocket pods;
- extend the landing gear;
- tighten and lock the safety harness by all means;
- at an altitude of 1000 to 1500 m (or in level flight at an altitude of not less than 500 m when the engine runs normally) and airspeed of 400 to 700 km/h, lean towards the instrument board and jettison the collapsible canopy (when flying at a lower altitude, the decision to jettison the canopy will depend on the actual situation);
- extend the flaps into the takeoff position at an altitude of not less than 100 m when performing a powered landing;
- shut off the engine prior to touchdown; deploy the drag chute as soon as the aircraft touches down, after which switch off the storage battery;
- use the wheel brakes to reduce the landing roll length as required by the situation (e.g. intensity of aircraft deceleration, soil density, precision of landing estimation, etc.).

When performing forced landing on the enemy territory, destroy the IFF transponder by depressing the IFF DEST. button on the destruction and distress signalling unit.

Note. Cut out the PRESET (LIMIT) ALT. switch before landing with the main LG legs retracted.

BAIL-OUT PROCEDURES

Getting Ready to Bail Out

352. The pilot should act deliberately in any emergency situation.

Upon taking the decision to eject (the situation permitting), proceed as follows:

- if the flight altitude is low, increase the altitude to 2000 - 3000 m (above the terrain), making use of the engine thrust and airspeed; when flying at a high altitude, descend to an altitude of 3000 to 4000 m;
- bring the aircraft into climb or level flight and reduce the airspeed to 400 - 600 km/h;
- if there are clouds, abandon the aircraft before entering the clouds;
- when performing overwater flight, head in the direction of the coastline;
- when proceeding near the state border, fly in the direction of the friendly territory;
- switch on the DISTRESS signal and transmit your approximate position over the radio;

- before abandoning the aircraft, depress the IFF DEST. button if the aircraft is likely to fall on the territory of a foreign country;

- tighten the waist restraint harness by operating the restraint lever.

In case of immediate danger, bail out without any delay.

Ejection

353. Having taken the decision to bail out, proceed as follows:

- lower the crash helmet light filter or close (put on) the pressure helmet visor; tighten the pressure helmet tensioner;

- grip the ejection control twin handle with both your hands, paws inside;

- press your body tightly against the backrest, and your head against the headrest cushion.

WARNING. It is not allowed to take your feet off the pedals or set them on the foot guard levers;

- compress the locking levers of the ejection control twin handle, then vigorously pull the handle towards you, upward, keeping it firm in your hands, without moving the elbows aside; do not ease the force on the handle throughout its travel. Keep the handle firmly in your hands till the very moment of descending with the seat (the moment the pilot gets separated from the seat, the handle will get detached, too).

Note. If one hand is injured, ejection is possible by using any handle, provided the correct sequence of actions is observed.

WARNINGS: 1. If the collapsible canopy fails to get jettisoned, jettison it by means of the canopy jettison handle, having hinged the handle away from yourself, then pull it downward towards yourself as far as possible. In so doing, hold the seat ejection handle with the left hand (without pulling it out) in order to prevent the handle from slipping out of your hands under the action of the airstream after the canopy is jettisoned. This cone, eject in the usual way.

2. If jettison of the canopy fails to result in seat ejection, remove manually the seat ejection-to-canopy jettison interlocking system, for which purpose vigorously pull (with your right hand) a handle located on the left arm guard. Then proceed to eject in the usual way.

3. If no ejection occurs in response to actuations of the ejection system, abandon the aircraft without ejection, proceeding as mentioned in Para. 360.

354. After abandoning the aircraft, override the functioning of the seat automatic control system, proceeding as follows:

- if ejection was performed at altitudes above 3000 m, continue descending together with the seat to an altitude of approximately 3000 m; when it becomes certain that the altitude is less than 3000 m, override the system functioning: grip and pull, all the way towards yourself, the pilot-from-seat separation handle; this handle is located on the right panel of the seat pan; then vigorously push away the seat with the hands; 3 s after separation from the seat, deploy the parachute by pulling the D-ring;

- if ejection was performed at altitudes below 3000 m, 3 s after the ejection, override the functioning of the seat automatic control system, proceeding as described above.

355. Safe ejection in flights over mountainous terrain is ensured if the appropriate safety altitude and time are set on the ППК-type release automatic unit.

When abandoning the aircraft over mountains whose height exceeds 3000 m, the pilot has to pay special attention to the altitude at which he ejects (referring to the altimeter).

After ejecting over mountainous terrain, override functioning of the pilot-from-seat separation and the main (life-saving) parachute deployment automatic control system at an altitude of not over 5000 m, but not lower than 1000 m with regard to the terrain relief.

WARNING. It is prohibited to separate from the seat and deploy the parachute manually at altitudes above 5000 m.

Landing Procedure

356. After making certain that the parachute has deployed normally, do as follows:

- tuck the main sling of the parachute harness under the hips;

- remove the oxygen mask, open the light filter of the crash helmet or the visor of the pressure helmet (at altitudes of not more than 4000 m);

- at an altitude of 500 to 300 m let out the survival kit by pulling the rope located at the right hip; in this case the survival kit will hang down at the end of a 15-m rope and the life raft will get inflated automatically.

CAUTION. When parachuting over forests, never let out the survival kit to prevent it from being caught up by the trees.

Notes: 1. In the case of ejection at a low altitude, when there is no time to let out the survival kit, it is admissible to land without letting out the survival kit.

2. On aircraft equipped with an ejection seat that is provided with type KOMAR radio beacon, the latter is let out automatically after deployment of the life-saving parachute canopy; in this case the survival kit and the life raft will come out also automatically at altitudes not above 500 m, after the pilot has separated himself from the seat. If the survival kit fails to come out automatically, let it out manually, by harshly pulling its rope located at the right hip.

In the case of parachuting over forests with the survival kit already let out, separate the connector of the cable running from the power supply unit to the KOMAR radio beacon (if the power supply unit is arranged in the pocket of the pilot's flying outfit or flying clothing), pull up the calibrated seam of the rope, tear it apart by tearing the orange end off the main rope. Holding the survival kit rope in the hand, disconnect the safety cord snap hook from the ring on the outfit and let go the rope when the height above the tree tops is 15 to 20 m.

357. Before touchdown, when the altitude is 150 to 100 m, do as follows:

- turn downwind;

- join the knees and feet, then bend the knees and, depending on the wind force, move the joined legs forward;

- position the feet parallel to the ground up to touching down. Touchdown must be accomplished on full feet of both legs.

Upon landing under strong wind conditions as well as in the case of landing on mountainous terrain, get rid of the harness immediately after touching the ground. If it is impossible to quickly get rid of the harness or to collapse the parachute canopy, cut the shroud lines or the harness risers with a knife.

Alighting on Water

358. When alighting on water surface, if altitude is available, proceed as follows:

- lift the light filter of the crash helmet;
- remove the oxygen mask or open (remove) the visor of the pressure helmet (at altitudes not above 3000 m);
- make certain that the parachute has deployed normally and determine the direction of the coast;
- disconnect the hoses of the oxygen mask (pressure helmet) and partial-pressure suit from the parachute harness, for which purpose pull the pin out of the КП-52М oxygen regulator emergency connector;
- disconnect the hoses of the anti-g suit and ventilated suit from the upper block of the ОРК common connector (quick disconnect assembly), and pull apart the electric connectors of the communication rig and helmet visor heating system;
- let out the survival kit at heights of 300 - 500 m by pulling the rope located at the right hip; then the survival kit will hang down at the end of a 15-m rope, and the life raft will get inflated automatically; if the life raft fails to get inflated, jerk the rope upward.

Note. On aircraft equipped with an ejection seat that is provided with type KOMAR radio beacon, the radio beacon is let out automatically after the deployment of the life-saving parachute canopy; the survival kit and life raft are also let out automatically at altitudes of not over 500 m, after the pilot has separated himself from the seat.

If the survival kit fails to come out automatically, let it out manually, for which purpose harshly pull the cord positioned at the right hip;

- tuck the parachute harness main sling under the hips;
- grip the right shoulder loop with the left hand and open the harness central lock with the right hand;
- vigorously pull at the starting head of the АСЖ-58 life jacket inflation bottle with the right hand, to inflate the jacket.

WARNING. It is prohibited to start the life jacket inflation system when the harness central lock is closed;

- hold on the harness, having joined both hands together and lowered them downward;
- at an altitude of 7 to 10 m, grip the harness risers, one after another, with the hands;
- when touching the water, straighten out the body and legs, open the hands and slip out of the parachute harness.

WARNING. If the parachute harness has not been removed, the АСЖ-58 life jacket will not ensure safe floating of the pilot.

After surfacing on water:

- inflate the АСП-74 floating (safety) belt by vigorously pulling at the filling device cords;
- turn downwind (with the back to the wave front) and additionally inflate the floats of the life belt or life jacket, if required;
- tear the calibrated seam of the survival kit rope by tearing the orange end off the main rope; then make use of the life raft and survival kit.

Notes: 1. Enter the life raft from its narrow end, having sunk the raft under your body. In doing so, take care not to tear the life raft by metal parts of the flying outfit.

2. When the АСП-74 life belt is used, shift its floats behind your back prior to climbing into the life raft.
3. If the pilot fails to get rid of the parachute harness and if it is impossible to get into the life raft, hold on the latter by fastening yourself to the raft.

To issue location signals, make use of the signalling aids available in the survival kit.

Note. The recommendations on the use of the survival kit are contained in the special Instructions enclosed in every survival kit.

WARNING. When a distressed airman is to be lifted from the water surface by a helicopter, it is prohibited to grip the rescue line before the latter touches the water surface, to exclude discharging of the helicopter static electricity through the body.

359. In the case of surfacing on water with the parachute harness non-detached and the survival kit not let out, do as follows:
- inflate the АСП-74 safety belt by pulling at the filling device cords vigorously;
- lift up the light filter of the crash helmet;
- remove the oxygen mask from the face (open or remove the pressure helmet visor).

WARNINGS: 1. Before removing the oxygen mask (opening or removing the helmet visor), halt breathing to prevent water suction through the oxygen hoses at the time of splashdown.

2. If the parachute draws the pilot over the water surface, cut one of the parachute canopy risers with a knife;

- open the connector lock on the main sling and the parachute harness central lock;
- vigorously pull at the АСЖ-58 life jacket bottle starting head with the right hand in order to inflate the life jacket;
- turn downwind (with the back to the wave front); if required, additionally inflate the life belt floats or the life jacket;
- harshly pull at the rope to remove safety pins from the flaps of the survival kit;
- pull up the life raft to yourself with the help of the raft rope; jerk the rope to start the life raft inflation system;
- disconnect the hoses of the oxygen mask (pressure helmet) and of the partial-pressure suit from the parachute harness, for which purpose pull the pin out of the КП-52М oxygen regulator emergency connector;
- disconnect the hoses of the anti-g and ventilated suits from the upper block of the ОРК common connector, and set apart the electric connectors of the communication rig and helmet visor heating system;
- tear the calibrated seam of the survival kit rope by tearing the orange end off the main rope, once the life raft is inflated;
- when the АСП-74 safety belt is used, shift the harness right shoulder strap behind your back and pull the left float of the safety belt (together with your left hand) under the harness left shoulder strap;
- bring the leg loops out of the harness D-rings, separate yourself from the harness and make use of the life raft and survival kit.

Bailing Out with Ejection System Disabled

360. It is allowed to escape from the aircraft without ejection only in case the ejection system fails and the collapsible canopy is removed. Then proceed as recommended below:

- if possible, reduce the flying speed to 350 - 400 km/h;

- if no compulsory harness restraint is accomplished, tighten the harness in the normal way, for which purpose unlock the harness restraint handle on the left panel of the seat pan by pressing the lever to the pan; pull it all the way toward yourself; press the shoulders to the seat back, then release the restraint handle;

- turn on the КП-27М parachute oxygen set by pulling the oxygen set manual control handle (painted red);

- grip and pull up the pilot-from-seat emergency separation handle as far as it will go (this handle is located on the right side of the seat pan);

- after the locks have opened, lean forward through 100 to 200 mm;

- roll the aircraft upside-down; harshly push the stick forward to accomplish bail-out.

After separating from the aircraft:

- immediately open the parachute by pulling the D-ring if the altitude is equal to or less than 3000 m;

- if the altitude is more than 3000 m, open the parachute after a free fall to an altitude of approximately 3000 m.

WARNING. Open the parachute with not less than a 5-s delay if the flying speed is in excess of 400 km/h.

EMERGENCY ESCAPE ON GROUND

361. If an emergency situation occurs on the ground (when the aircraft is motionless), rapid abandoning of the aircraft can be ensured by the following actions:

- shut down the engine;

- disconnect the survival kit snap hook.

Note. On aircraft equipped with an ejection seat that is provided with type KOMAR radio beacon, pull apart the connector of the cable running from the power supply unit to the radio beacon, if the power supply unit is located in the pilot's outfit (flying clothing);

- pull out the safety pin of the emergency connector on the КП-52М oxygen regulator and disconnect the hoses of the oxygen mask (pressure helmet) and partial-pressure suit;

- in the case of wearing an anti-g suit or a ventilated suit, pull their hoses out of the couplings in the upper block of the ОРК common connector;

- disconnect the cables of the communication rig and helmet visor heating system;

- open the connector lock on the main sling and the harness central lock, then quickly get rid of the harness;

- using the service control handle, open the canopy locks and the canopy, abandon the aircraft in a way ensuring safety.

If the service control canopy-opening system gets wedged, jettison the collapsible canopy by means of the emergency canopy jettison handles, having first leaned towards the instrument board.

AMENDMENT RECORD SHEET

The book contains 208 sheets and 2 insets.

When some sheets or insets are superseded, new sheets or insets are inserted as well as when amendments are introduced in the text, fill in the columns of this table:

No.	Classification	Alteration OUT-Ref. No. and date	Alteration IN-Ref. No. and date	Alteration brief description	Nos of amended pages	Nos and qty of new pages and insets	Pages facing insets	Nos and qty of deleted pages and insets	Total qty of sheets and insets in book upon alteration by (date, rank, signed)	Date, organization and official who accepted deleted sheets and insets, signed

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CONTENTS

Page

Page

Инструкция летчику
самолета МиГ-21БИС
(с системой ПОЛЕТ-ОИ)
(на английском языке)
8/011446-П7