

DCS
MIG-21 BIS
BY LEATHERNECK SIMULATIONS



★ **FLIGHT MANUAL** ★



DCS: MiG-21bis by Leatherneck Simulations - Flight manual



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1. About DCS: MiG-21bis by Leatherneck Simulations

DCS: MiG-21bis by Leatherneck Simulations is third party developed add-on package (module) which integrates into DCS World, enabling you to fly famous USSR tactical fighter aircraft MiG-21BIS.

In order to use this module, you need to have DCS World installed on your PC.

You can download DCS World from www.digitalcombatsimulator.com

Note the **Minimum system requirements for DCS World:**

OS 64-bit Windows Vista, 7 or 8;

CPU: Core 2 Duo 2.0 GHz;

RAM: 6 GB;

Free hard disk space: 10 GB;

Video: 512 MB RAM card, DirectX 9.0c - compatible;

Sound: DirectX 9.0c - compatible;

Internet connection (on demand).

This manual contains most of the information you need to successfully master the DCS: MiG-21bis by Leatherneck Simulations. However, for general DCS environment understanding and usage, refer to the *DCS User Manual*. You may also wish to *read manuals that come with other DCS products, such as the Su-25T Flight Manual which comes with the core DCS installation.*

All of these manuals can be found in your DCS World installation folder and in corresponding module folders.

NOTE: For abbreviation purposes, full product name “DCS: MiG-21bis by Leatherneck Simulations” is abbreviated to “DCS MiG-21BIS” or “MiG-21bis” or similar shorter forms.



2. Mikoyan-and-Gurevich Design Bureau 21BIS, short historic overview

Development of what would become the MiG-21 began in the early 1950s, when Mikoyan OKB finished a preliminary design study for a prototype, designated Ye-1 in 1954. This project was very quickly reworked and the redesign led to a second prototype, the Ye-2. Both of these and other early prototypes featured swept wings, and the first prototype with delta wings as found on production variants was the Ye-4. The Ye-4 made its maiden flight on 16 June 1955 and its first public appearance in July 1956. The MiG-21 was the first successful Soviet aircraft combining fighter and interceptor characteristics into a single aircraft. Its basic layout was used for numerous other Soviet designs.



1955: The Ye-4 was the true predecessor of the MiG-21

It was a lightweight fighter, achieving Mach 2 with a relatively low-powered afterburning turbojet, and thus comparable to the American Lockheed F-104 Starfighter and Northrop F-5 Freedom Fighter and the French Dassault Mirage III.

Like many aircraft designed as interceptors, the MiG-21 has a short range. The issue of the short endurance and low fuel capacity of the MiG-21F, PF, PFM, S/SM and M/MF variants — though each had somewhat greater fuel capacity than previous — led to the development of the MT and SMT variants. These had an increased range of 250 km (155 mi) compared to the MiG-21SM, but at the cost of other performance degradation, such as the lower service ceiling and slower climb.



1961: MiG-21I "Analog", test-bed for research and development of Tu-144 passenger airplane wing

The delta wing, while excellent for fast acceleration and supersonic speeds, was not the best option for low speed flying and close air-to-air (AA) combat. This was partially improved with the introduction of an emergency afterburner, which improved thrust/weight ratio at altitudes up to 4000m, enabling the plane to fly at low speeds while performing sharp maneuvers and to quickly recover from low speed stall conditions. The use of a tail in conjunction with the delta wing, aids stability and control at the extremes of the flight envelope, enhancing safety for less skilled pilots.

A climb rate of 235 m/s (46,250 ft/min) was possible with A-A, combat-loaded MiG-21BIS aircraft, which doesn't fall very short of the performance of the later F-16A. Given a skilled pilot and reliable missiles, it could put up a good fight against contemporary tactical combat aircraft. It was eventually replaced by the newer, variable-geometry MiG-23 and MiG-27 for close support missions. However, it was not until the MiG-29 (mid 1980-ies) that the Soviet Union would ultimately replace the MiG-21 as an interceptor and maneuvering dogfighter to counter new American fighters.



1966: MiG-21PD, experimental aircraft with short take-off and landing to develop lift engines of MiG-23PD aircraft

The MiG-21 was exported widely and it is still in use in several more or less modified versions. While technologically inferior to the advanced fighters it often faced in the last three decades, low production and maintenance costs made it a favorite of nations buying Eastern Bloc military hardware.



1972: MiG-21BIS Izdeliye 75, NATO "Fishbed-L/N"

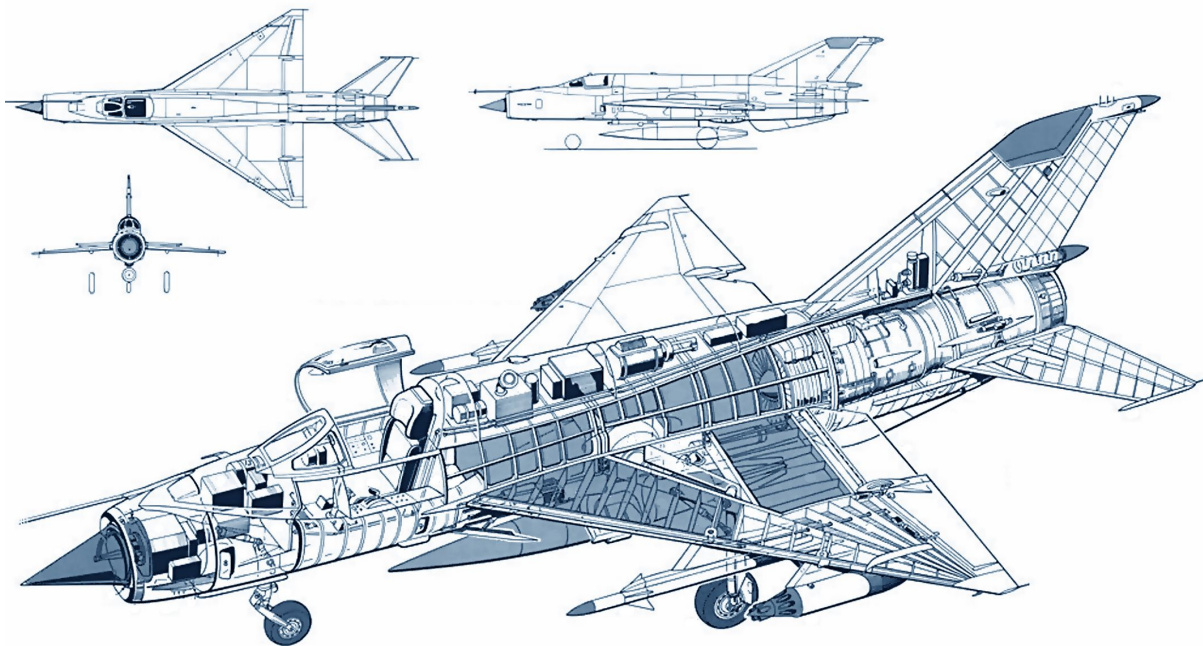
The MiG-21BIS 75AP (МиГ-21бис Изделие 75) was the ultimate development of the MiG-21, fitted with a Tumansky R25-300 turbojet engine and a great number of other advances over previous types. Those MiG-21BIS that were constructed for the Soviet PVO (Air Defense Force) were equipped with the Lazur GCI system (NATO: "Fishbed-L"), while those for the Soviet Air Force were fitted with the Polyot ILS system (NATO: "Fishbed-N"). It's fitted with instruments and electronic equipment ensuring safe flights by day and at night under fair and bad weather conditions. The MiG-21BIS is considered to be a third-generation jet fighter. Some 50 countries over four continents have flown the MiG-21, and it still serves many nations a half-century after its maiden flight. Several companies offer upgrade programs for MiG-21, designed to bring the aircraft up to modern standards, with greatly upgraded avionics and armaments.

The MiG-21 broke a number of aviation records and it is still the most produced supersonic jet aircraft in aviation history.



Mikoyan-Gurevich MiG-21BIS Specifications

- Crew: 1
- Length: 15.0 m (with Pitot) (49 ft 2.5 in)
- Wingspan: 7.154 m (23 ft 5.66 in)
- Height: 4.125 m (13 ft 6.41 in)
- Wing area: 23.0 m² (247.3 ft²)
- Empty weight: 5,339 kg (11,770 lb)
- Gross weight: 8,725 kg (19,235 lb)
- Powerplant: 1 × Tumansky R25-300, 44 kN static thrust dry, 71 kN static thrust with afterburner



Performance

- Maximum allowed speed: 2350km/h TAS, 1300km/h IAS
- Maximum allowed Mach: 2.05M
- Range: (internal fuel) 1,210 km (751 miles)
- Service ceiling: 17,500 m (57,415 ft)
- Rate of climb: 225 m/s (44,280 ft/min)
- Take-off speed: 340-370km/h IAS
- Touchdown speed: 260-270km/h IAS
- Cruise speed: 800km/h TAS



Technical data

- Wheel base: 4.71m
- Track width: 2.69m
- Wing load: 385kg/m²
- Plane empty weight: 5339kg
- Normal takeoff weight: 8725kg
- Max takeoff weight: 10,400kg
- Nosecone movement: max 200mm
- Flaps angles:
 - Take off: 25°
 - Landing: 45°
- Ailerons angles: ±20°
- Air-brake angles:
 - Front flaps 35°
 - Rear flap 40°
- Horizontal stabilizer (tail) angles: +7.5° / -15.7°
- Rudder angles: ±25°

Fuel capacity

- Main: 2850l = 2225kg
- Drop tanks: 490l = 382kg (+52kg tank weight)
- Drop tanks: 800l = 625kg (+57kg tank weight)

l/kg ratio: 1kg = 1.279l; 1l = 0.781kg

Fuel specific of gravity: 0.775gr/cm³

Fuel weight characteristics depend on fuel temperature.

Typical Fuel consumption

- 100% on ground 3.2l/s (2.5kg/s)
- AFB1 sea level: 4.2l/s (3.3kg/s)
- CSR2 sea level 5.5l/s (4.3kg/s)
- AFB M1.06 6.4l/s (5.0kg/s)
- CSR M1.06 8.8l/s (6.9kg/s)
- Taxi: 80l
- Take-off: 250l (~2min ~25km)
- Level flight: 1485l (550km)
- Landing circle (school pattern): 200l
- Recommended fuel for landing (including reserve fuel for two landing attempts): 700l

¹ AFB – full afterburner

² CSR – additional afterburner, sort of second stage afterburner



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

- by 10% at an altitude of 10,000 – 11,000m
- by 5% at an altitude of 5000m
- by 0.5% at an altitude of 500m



3. Installation and module set-up

Make sure you have the latest version of DCS World installed on your PC. If necessary, check that your DCS World installation is updated to the minimum version of 1.2.10 (version info is on the main DCS World screen, at the lower right corner).

If you don't have DCS World installed on your PC, you can download and install it for free from following Internet address: [Download DCS World](#)

Make sure you have DCS World installed and updated to version 1.2.10 before you continue.

To install the DCS MiG-21BIS, double click the DCS_MiG_21_setup.exe file and follow the on-screen instructions.

The first time you run a mission with the DCS MiG-21BIS, the protection system will prompt you to activate your software. The best way to activate is online, simply by providing your registration number (type or copy-paste it in provided text box).

If you don't have an Internet connection, you can activate the DCS MiG-21BIS using offline registration system (telephone call or e-mail Leatherneck Simulations).

For detailed instructions please visit the [StarForce product activation instructions](#)



Flight controls setup

The MiG-21BIS was – just like any other fighter – built for speed, maneuverability and agility. The main problem concerning the fighter’s agility is that of control surface deflection at different speeds. For example, if you fully pull the stick at 500km/h, the horizontal tail will deflect fully, enabling you to perform sharp turns with relatively low g-load (around 2-3g). However, if you increase the speed to e.g. 1000km/h and pull the stick same way, if there were no control system, you would instantly reach very high g-load, most likely beyond pilot’s limits and possibly airplane structural limits. So the horizontal tail won’t deflect fully this time, but only partially, still allowing you to perform high g turns and maneuvers.



Image 3.1: Before flying with the DCS MiG-21BIS, you have to set up your flight controls.

To correctly set-up your joystick sensitivity and enable a well balanced response of the airplane at both low and high speeds, we recommend to you the following procedure:

No matter which joystick type you have, go to the DCS main screen, choose Options, select Controls tab (first image) and then select MiG21-BIS as your aircraft type (1). Select Axis Commands (2) and then select Pitch (3). Click on Axis Tune (4): pop-up screen called Axis Tune Panel will open (second image) enabling you to adjust axis curve and other settings.

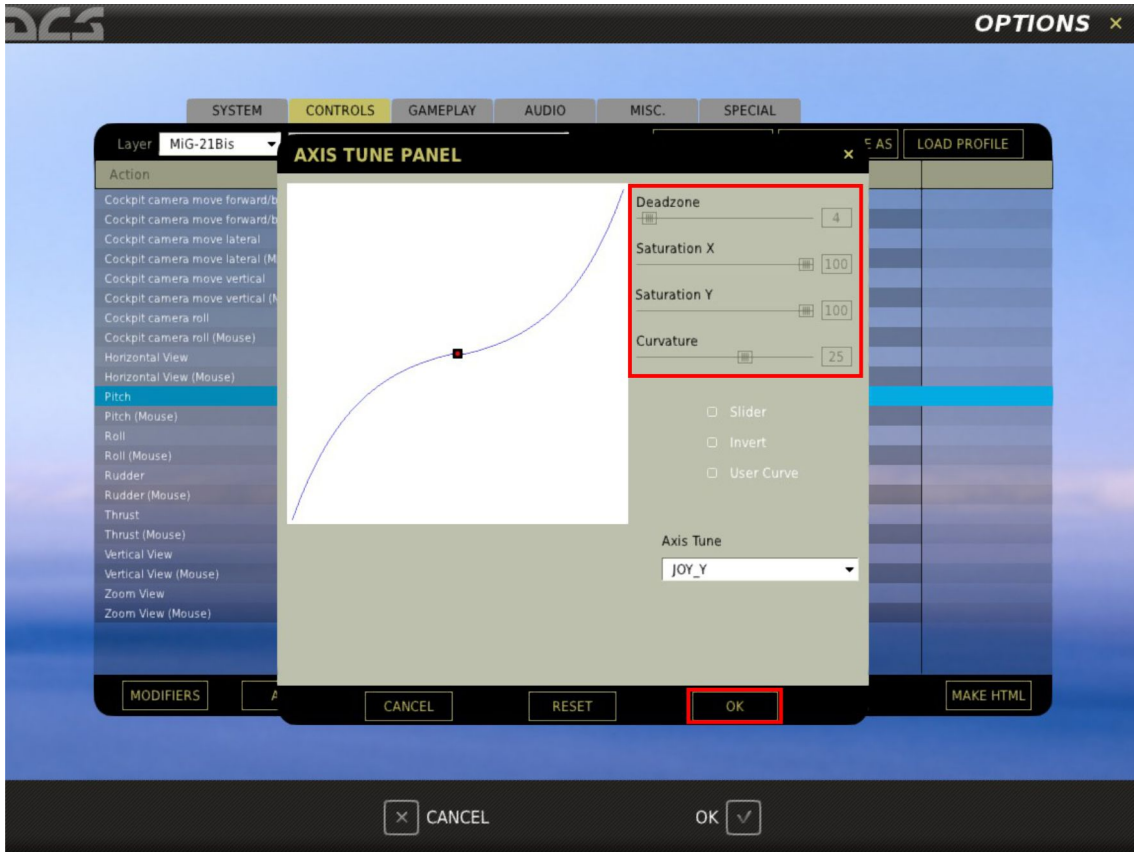


Image 3.2: Adjust axis control sliders according to data in the table.

On Axis Tune Panel you have four sliders: deadzone, saturation X, saturation Y and curvature. Other options are not currently important. Move those four sliders for each axis individually (pitch, roll, and rudder) according to following table:

Table 3.1:

	Pitch	Roll	Rudder
Deadzone	1-3	1-3	1-5
Saturation X	100	100	100
Saturation Y	100	100	100
Curvature	20-25	10-25	20-25

Don't forget to click OK on each Axis Tune Panel window, and for the overall Options screen.



Setting your DCS MiG-21BIS gaming options

DCS offers many options for game settings according to your needs. Apart from the usual options well described in the **DCS User Manual**, DCS MiG-21BIS offers some additional options and has some specific features that the player needs to be made aware of.

Specific DCS MiG-21BIS features

The so called “specific features” are built-in (hard coded) features of the aircraft systems and engine. They are listed and described in following table.

Table 3.2: Specific DCS MiG-21BIS built-in features

Feature	Description
Aircraft systems stress	<p>Whenever you turn ON/OFF your aircraft systems, they will suffer very small amounts of stress. During normal aircraft exploitation you will never notice it during gameplay, and it won't interfere with your activity. However, in extreme circumstances, you might overstress one or more aircraft systems, which will result in a failure.</p> <p>Note: Whenever you fly, your aircraft resources will be slowly consumed (fluids, working resources, stress applied etc). <u>Once you land and require refueling, the systems will “self repair” after the refueling is done.</u> You might notice this when your canopy opens (if it was closed), some switches flipping back into the OFF position and aircraft fluids recovering to normal values. Watch the compressed air manometer (RH61), pilot's oxygen (LV39) and engine oxygen (LV2) indicators to assess whether your systems are repaired.</p> <p>Note: Internal systems “self repair” are coupled with refueling. However, to make repairs of damaged hardware (fuselage, wings, tail, gears) you need to call the ground crew and ask for repairs. The same applies for rearming.</p>



Engine stress

The engine will suffer stress during normal operations, regardless of failure settings in the mission options. Whenever the engine is started, any afterburner used, negative, high side g force or around zero g force experienced etc. the engine will accumulate small amounts of stress.

Like in the previous case, during normal flight operations you will never be aware of the engine stress level, and your engine should not fail in flight (apart from shut-downs caused by other factors, e.g. low fuel pressure). However, if your engine reaches the maximum stress level, it will shut down and you won't be able to relight it in flight.

Your engine will reset stress level to zero, once you land and shut it down. This will happen along with aircraft systems self repair event. You don't need to do anything apart from being patient for max. 4 minutes.

Canopy freezing

Whenever you fly in an atmosphere in which the temperature is between 0°C and -10°C (32°F / 14°F) while your IAS is between 400 - 500km/h, you might experience canopy freezing. To unfreeze the canopy, either increase TAS to >700km/h (or IAS >500km/h, depending on the situation) or use your anti icing device for a temporary unfreeze.

Pitot system freezing

Similar to the previous feature, your Pitot system will start to freeze in the aforementioned atmospheric conditions. Pitot freezing takes some time, and it is hard to notice initially. At later stages of freezing, you will notice a discrepancy between your engine power setting and your speeds (IAS, TAS and M), along with odd altitude and vertical speed values.

To prevent Pitot freezing, turn on the Pitot tube heaters (CL74 & 75) before you takeoff. If you start the mission in the air, the heaters will be ON by



default.

However, if you experience Pitot freezing anyway, note that turning the heaters on in flight requires some time before the Pitot system unfreezes. This time is no longer than two minutes even in maximum freezing situations.

Battery freezing

The aircraft's battery will freeze if you fly above 4000m without Battery heating turned ON (RV41). This process takes some time, but as soon as it does occur, the battery will suffer stress. Since the battery is a back-up for the DC generator, loosing the battery is certainly not a good idea.

Check that you have turned on battery heating before takeoff.

Pitot system errors are calculated for all ranges of speeds and altitudes. In most cases the errors are so small that you can't notice them.

However, when flying at a M between 0.95 and 1.05, you might notice odd Pitot related instrument behavior. Speeds, barometric altitude and vertical speed will deviate from their previous values. This error is most visible on the Altimeter and DA-200.

Transonic Pitot system error

There is nothing you can do to prevent or avoid this error from occurring.

Normally, you will fly through the so called "transonic zone" very quickly, in a matter of seconds, so this error won't affect your flying. However, if you remain in the transonic zone for any reason (e.g. payload is preventing you from accelerating beyond M 1.05) you need to take this error into account. Note that flying in the transonic zone is extremely uneconomic from the point of flight duration and power reserves.

SARPP flight data recorder operations

If you turn the aircraft's SARPP flight data recorder ON (RV 30), it will record your flight parameters once per second. The data will be written to HDD



once you exit the mission, so no in-game HDD spamming. The SARPP is capable of storing 120 minutes of records. If it happens that your mission lasts more than that (e.g. Multiple flights in one session), once the end of the record is reached, the recording will start rewriting old data.

You can find your SARPP records in the MiG-21/SARPP folder.

SPRD start rockets (Rocket-assisted Takeoff - RATO)

The MiG-2BIS can be equipped with SPRD start rockets in order to shorten takeoff distance by increasing acceleration. The SPRDs provide a thrust increase for about 7 seconds. To enable the use of SPRD rockets, equip the aircraft with SPRD rockets (in the Mission Editor), turn on SPRD power and drop switches (RH51, RH50). Start your takeoff run normally (at full afterburner): when your speed reaches about 120-150kmh, the SPRD will engage automatically. You can engage it manually using the CV91 button, however, this is not recommend. To drop (jettison) SPRD after takeoff, use the LH60 button.



DCS Gameplay options

Customizing game options is something that you should be familiar with in DCS. Once again, refer to the **DCS User Manual** for details concerning any options you are interested in. I will explain how certain options affect the DCS MiG-21BIS gaming experience.

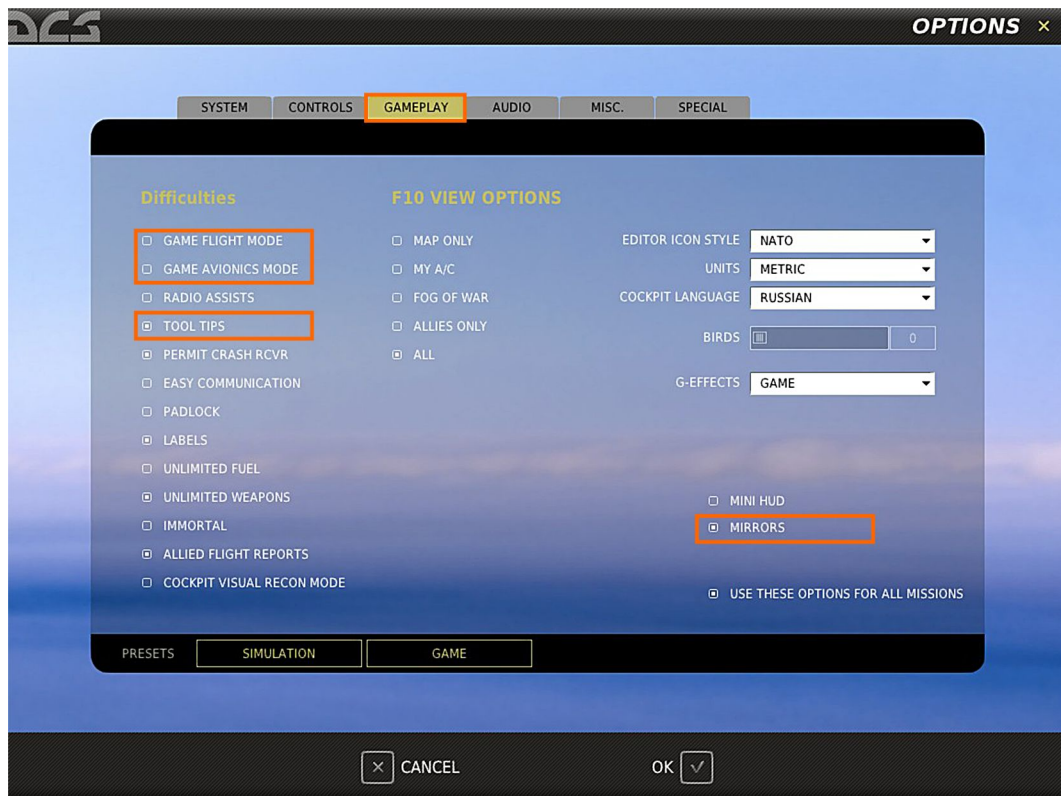


Image 3.3: OPTIONS screen with selected GAMEPLAY window. Orange boxed fields have special significance in DCS MiG-21BIS gaming experience - read description in following text.

GAME FLIGHT MODE - selecting this option will simplify flight model in following ways:

- stalling the aircraft is very difficult, yet possible,
- spinning the aircraft is impossible,
- aircraft stability is increased by 10-20%,
- landing gear will automatically retract after takeoff, gear handle will be placed in proper position after this (neutral),
- user has to manually extract the gears for landing,
- in case of go-around or low-pass during landing attempts, gears will auto retract,
- engine stress is not calculated.



GAME AVIONICS MODE - if you select this mode, you will prevent all internal stress calculations. Your equipment might fail only if you turned on failures in the mission editor, or if you wasted some systems related resources (fuel, oil, oxygen, compressed air, alcohol). The radar screen will appear overlaying the main screen, so you can use your radar even if you are “flying outside the cockpit” (using F2 key).

TOOL TIPS - both Russian and English cockpits have tool tips defined. You can turn them ON/OFF using this option.

MIRRORS - DCS MiG-21BIS has a mirror (called periscope) situated on top of the canopy. You can enable or disable it with this option.

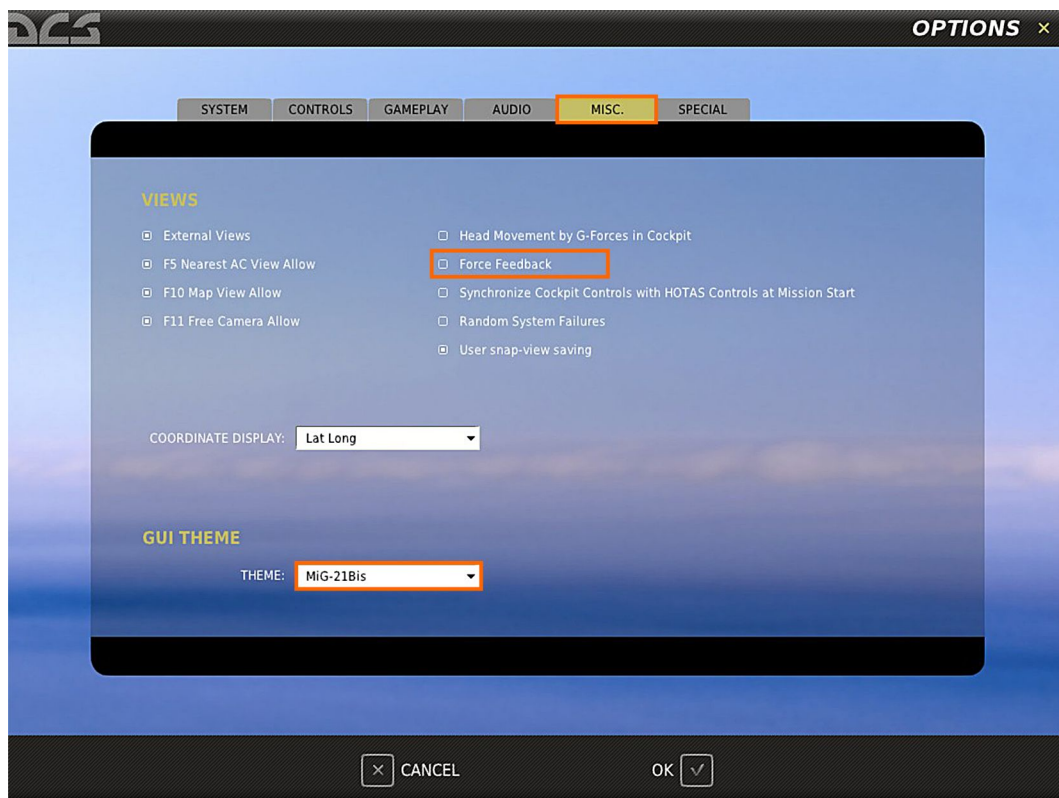


Image 3.4: OPTIONS screen with selected MISC. window. Orange boxed fields have special significance in DCS MiG-21BIS gaming experience - read description in following text.

FORCE FEEDBACK - DCS MiG-21BIS supports force feedback (FF). If you have a FF capable joystick, turn this option ON, it will give you a unique flying experience, and might improve aircraft handling.

GUI THEME - includes main DCS screen wallpaper, windows, menus and background music tweaks.



DCS MiG-21BIS specific options

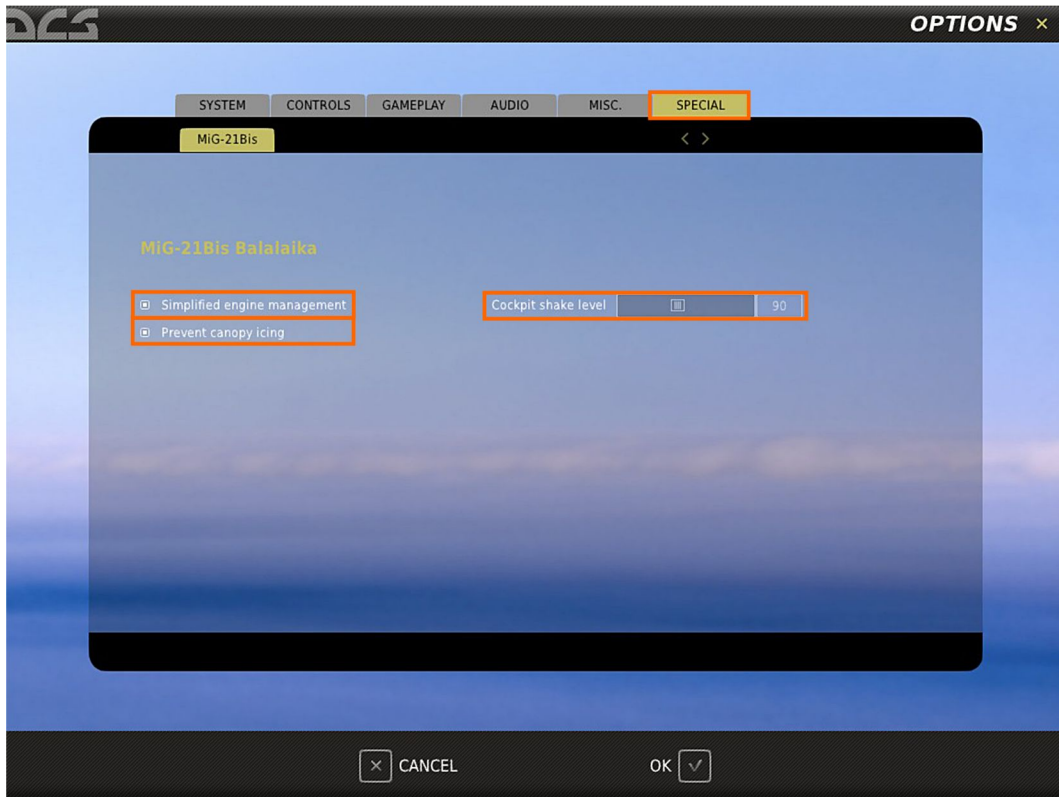


Image 3.5: OPTIONS screen with SPECIAL window selected. Find “MiG-21Bis” tab and click on it to open this window.

SIMPLIFIED ENGINE MANAGEMENT - If this option is selected, in-flight engine failures and shutdown due to any kind of stress will be prevented. Engine shutdown can be a frequent event for inexperienced players. Every time the engine stops in the air, you will have to attempt to relight it. Note that you have a limited number of restart attempts. Restarting the engine in the air can be complicated or even impossible in some circumstances.

PREVENT CANOPY ICING - if enabled, canopy icing will be prevented.

COCKPIT SHAKE LEVEL - you can tune the level of cockpit shake with this slider. The default value is 100%, meaning normal cockpit shake level. If you fly precise aerobatics for example, you might want to set 0% cockpit shake for increased flight precision. Maximum shake level (e.g. For video filming) is 200%.



BASIC INFORMATION





4. DCS MiG-21BIS basic information

The MiG-21BIS aircraft was designed as 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 R25-300 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 R-802G, automatic radio compass (ARC), type ARC-10, marker beacon receiver MRP-56P and aircraft distance transponder SOD-57 (also referred to as the air traffic control (ATC) transponder);
- (e) Pitot-static tubes: type PDV-18-5M (main) and type PDV-7 (emergency);
- (f) pressure altimeter VDI-30 and low-level radio altimeter RV-1M;
- (g) combined instrument, type DA-200, consisting of a vertical speed indicator, turn indicator and slip indicator;
- (h) built-in gun Gsh-23;
- (i) sighting system consisting of radar RP-22SMA "Sapphire" and optical sight ASP-PDF fitted with an additional fixed reticle and transparent range scale;
- (j) automatic pitch channel transmission ratio controller ARU-3VM which improves the aircraft maneuvering characteristics and controllability at transonic and super-sonic airspeeds and reduces stick forces, as compared with the ARU-3V controller;
- (k) angle-of-attack indicator UUA-1 and limit angle-of-attack warning unit SUA-1;
- (l) radar illumination warning system SPO-10;
- (m) automatic flight control system (AFCS) SAU-23ESN;
- (n) short-range radio navigation and landing system POLYOT-01 (RSBN/PRMG);
- (o) centralized dangerous conditions warning system SORC-1;
- (p) airborne IFF interrogator/transponder, type SRZO-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 GSR-ST-12000W;
- (b) AC generator G04PCh4;
- (c) storage batteries 15SCS-45B;
- (d) DC/AC inverters PO-750A (two), PT-500C, PT-125C, PO-250-VCh-M.

DCS MiG-21BIS has five external store stations (pylons) on which the following stores can be carried:

- (a) guided missiles R-3S, R-3R, R-13M, R-55, R-60;
- (b) type UB-32 or UB-16-57 rocket pods with folding-fin air rockets;
- (c) free rockets of the S-24 type;
- (d) radar guided Kh-66/23 Grom missile;
- (e) aerial bombs of the 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 or one ventral tank of 800l capacity.

The aircraft can also have an SPS-141 jammer container, ASO countermeasures (chaff/flare) dispenser and smoke pipe (near engine nozzle).

The pilot's cabin is pressurized; it is fitted with an ejection system, type KM-1M, which can ensure safe ejection throughout the range of operating altitudes as well as during the takeoff run and landing roll, when the speed is higher than 130 km/h; the cabin is also furnished with a 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 minimum $\pm 10^\circ$ sideways;
- (b) with inclining and turning of the head: up to 20° up and up to $\pm 40^\circ$ sideways;

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 a main system and an emergency one.

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. It is assumed that in all complicated situations, not covered by this manual, the pilot will use his own judgment to cope with the situation at hand.



OPERATIONAL LIMITATIONS



5. Operational limitations

The maximum permissible indicated airspeeds, Mach numbers and g-loads for the aircraft carrying various external loads are given in Table 5.1; other limitations are presented in Table 5.2.

Table 5.1:

Parameter	External load variants					
	No external loads, or missiles only	Pods, type		Bombs, rockets S-24, inc. 500kg bombs	Drop tanks	Eight bombs OFAB-100
		UB-16-57	UB-32			
Airspeed (km/h)	1300			1000		800 (or 1000 with reinforced racks BD3-60-21D1)
Mach number	2.05	1.7	1	1.3	1.6	1
G-load	At $M \leq 0.8$: with two missiles 8g at $G_{fuel} \leq 1300L$ otherwise 7g at $G_{fuel} > 1300L$ At $M > 0.8$: 7g at $G_{fuel} \leq 800L$ with two missiles otherwise 6g with two or four missiles.		5g		5g with 490L drop tank or 4g with 800L drop tank	5g

Notes: 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.

Warning: It is not recommended to build up a g-load in excess of 3 g in flight with two UB-32 pods, or two UB-32 pods and two UB-16-57 pods, or eight 100-kg caliber bombs, or two 500kg bombs and two guided missiles (or two UB-16-57



pods, or two OFAB-100 bombs), or with four 250-kg caliber bombs, or four S-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.

Table 5.2:

Aircraft limitations	Cause
<p>1. Maximum takeoff weight when using concrete runway, 9800 kgf.</p> <p>WARNING</p> <p>It is permissible to take off with the load variants > 10,000 kgf 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.</p> <p>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).</p>	<p>Landing gear strength.</p> <p>Not to exceed liftoff ground speed of 370 km/h for KT-92D LG wheels fitted with tires model 42A.</p> <p>Landing gear strength</p>
<p>2. Takeoff weight when using perforated steel plate (PSP), unpaved or snow-covered runways, is 8800 kgf, max.</p>	
<p>3. The maximum permissible angle of attack in flight and during the performing of any aircraft maneuvers, is +28° by UUA-1 indicator (stall occurs when a +33° angle of attack, as read by the UUA-1 indicator, is exceeded).</p>	<p>Stall safety margin of angle of attack</p>
<p>WARNING</p>	
<p>It is forbidden to exceed a +15° angle of attack, as read by the UUA-1 indicator, in flight with the load variants > 10,000 kgf due to the small amount of g-load stability margin.</p>	
<p>4. Maximum unstick ground speed, 360 km/h for tyres 800 x 200, model 41, and 370 km/h for tyres of model 42A.</p>	<p>Tyre strength ability to retract LG, stability and controllability during LG extension.</p>
<p>5. Maximum permissible airspeed for landing gear retraction and extension is 600 km/h; maximum permissible airspeed for flying with landing gear extended is 700 km/h.</p>	<p>To prevent surpassing maximum IAS and/or Mach number.</p>
<p>6. It is forbidden to exceed a minus 20° pitch angle in descent at airspeeds over 1100 km/h and Mach numbers in excess of 1.8 M.</p>	<p>Aircraft would sink by 25 - 30 m due to automatic disconnection of BLC</p>
<p>7. Maximum permissible airspeed for going around with BLC system operating is 360 km/h.</p>	
<p>8. It is forbidden to extend landing gear and flaps or to fly with</p>	



landing gear and flaps extended when carrying eight FAB-100 bombs, or three drop tanks, or four S-24 rockets or two FAB-500 bombs, or four FAB-250 bombs or two UB-32 and two UB-16-57 pods (two guided missiles), or two UB-16-57 pods (two FAB-100 bombs) and two S-24 rockets (or two FAB-250 bombs) when fuel remainder is 700 to 1100 L.

In emergency situations, when it becomes necessary to land immediately with above indicated fuel remaining, jettison external stores from the outboard stations over a safe place before extending LG, and then land in the usual way.

9. Rated landing weight for using concrete, un-paved or snow-covered runway, 6800 kgf, BLC system being used by all means. This landing weight is obtained when the aircraft:

(a) has no external loads, fuel remainder not exceeding 700 L;

(b) carries two missiles, or two UB-16-57 pods, or two FAB-100 bombs, or carries no combat stores but has empty drop tanks attached, fuel remainder being 500 L.

This fuel remainder ensures performance of a tight-visual-circuit go-around maneuver and landing, the flight endurance totalling about 6 min.

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 an instrument approach to land under bad weather conditions, in order to ensure the ability to perform a two 180° turn or tight-circuit go-around maneuver.
- 3. The rated landing weight with the BLC system not in use is 6500 kgf. This weight is obtained when the aircraft carries no external loads and the fuel remainder is 400 L.**

10. Landing of an 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 UB-16-57 pods, or two FAB-100 bombs and empty drop tanks, fuel remainder not exceeding 800 L;
- (b) when carrying two empty UB-32 pods and two missiles or two FAB-100 bombs, or two loaded UB-16-57 pods; when carrying four guided missiles or four loaded UB-16-57 pods; or two missiles and two loaded UB-16-57 pods (two FAB-100 bombs); or four FAB-100 bombs, or two S-24

system by microswitch as flaps are being pressed by force into the retracted position at higher airspeeds.

Insufficient margin or g-load stability.

Landing gear strength



<p>rockets, or two FAB-250 bombs, or two loaded UB-32 pods, fuel remainder not exceeding 600 L.</p> <p>Landings with weights in excess of 6800 kgf shall be made with employment of the BLC system and drag chute in all cases.</p> <p>NOTES</p> <p>1. In the case of landing with four empty UB-16-57 pods or with only two empty UB-32 pods, the fuel remainder with which landing is permissible can be increased by 350 L as compared to the above figures.</p> <p>11. Takeoff and/or landing with one bomb of up to 250 kg caliber or S-24 rocket asymmetrically racked on the inboard station, may be accomplished if the crosswind component (directed from the side opposite to that on which the external load is attached) does not exceed 8 m/s.</p> <p>12. Ground speed of main LG touchdown must not exceed 330 km/h.</p> <p>13. Maximum permissible drag chute deployment speed, 320 km/h.</p> <p>14. Ground speed of initial brake application, when drag chute is not used in landing roll, must not exceed 330 km/h.</p>	<p>Ability of roll counter-action</p> <p>LG wheel strength</p> <p>Strength of drag chute attachment elements</p>
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Powerplant limitations (in flight)	Cause
15. Maximum low-pressure (LP) rotor speed must not exceed:	
<ul style="list-style-type: none"> (a) 101.5% at first, partial and minimum reheat settings as well as at full throttle non-reheat setting; 	Compressor and turbine strength
<ul style="list-style-type: none"> (b) 103.5% at second (emergency) reheat setting. 	Compressor and turbine strength
16. Maximum high-pressure (HP) rotor speed, not over 107.5%	Turbine strength
17. Maximum permissible jet-pipe temperature:	
<ul style="list-style-type: none"> (a) not over 770°C at full throttle setting; 	
<ul style="list-style-type: none"> (b) not over 850°C at reheat and second reheat power settings. 	
18. Minimum permissible oil pressure:	
<ul style="list-style-type: none"> (a) at least 1 kgf/cm² at idle setting; 	
<ul style="list-style-type: none"> (b) at least 3 kgf/cm² (warning light OIL (MACЛO) 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:	
<ul style="list-style-type: none"> (a) 15 s at non-reheat engine settings; 	
<ul style="list-style-type: none"> (b) 5 s at reheat settings; 	Amount of fuel available in negative g-load tank unit
<ul style="list-style-type: none"> (c) 3 s at second reheat setting. 	
21. Flight with g-loads approximating zero (± 0.2 g) should not last for longer than 1 - 2 s.	Ensuring continuous fuel feed into engine
WARNING Negative or near-zero g-load flight is allowed provided the tanks contain at least 500 L of fuel	
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.	To ensure flight safety
<ul style="list-style-type: none"> (a) 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; 	



<p>(b) 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 air-speed of not less than 500 km/h.</p> <p>NOTE The engine may be run at minimum reheat power when the altitude is less than 17,000 m.</p> <p>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.</p>	<p>Ensuring stable functioning of afterburner, preventing its flameout</p> <p>To ensure stable run of powerplant</p> <p>Turbine strength</p>
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Life-Saving and Life-Support Equipment limitations	Cause
<p>25. Safe abandoning of aircraft is ensured under the following flight conditions:</p> <p>(a) during takeoff run and landing roll, at airspeeds not less than 130 km/h,</p> <p>(b) in level flight, at airspeeds:</p> <p>(i) not more than 500 km/h, without any limitations as to height over ground relief,</p> <p>(ii) 500 to 1150 km/h, at height of not less than 30 m over ground relief;</p> <p>(iii) 1150 to 1200 km/h, at flight altitude of not less than 1000 m;</p> <p>(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);</p> <p>WARNING: Should it become necessary to abandon the aircraft in flight, take all measures possible before ejection so that the airspeed does not exceed the above limitations.</p> <p>26. It is permissible to jettison the canopy at airspeeds of 400 to 700 km/h in straight flight at altitudes below 5000 m</p> <p>27. Flight with the canopy jettisoned may be performed under any conditions.</p> <p>28. All flights, irrespective of airspeed and altitude, shall be performed with the use of oxygen equipment.</p> <p>29. Flights over water shall be made with use of sea survival equipment.</p>	<p>Ensuring conditions for normal operation of parachute system elements</p> <p>Providing time for operation of parachute system elements; minding strength of ejection equipment</p> <p>Providing time for operation of parachute system elements</p> <p>Ensuring conditions for canopy to clear fin safely</p> <p>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</p>



Aircraft Systems limitations	Cause
<p>30. It is allowed to fly with the AFCS engaged in RECOVERY mode, for stabilization of heading and altitude, at altitudes not lower than 100 m over ground relief</p> <p>31. It is forbidden to engage the AFCS into RECOVERY mode for training purposes when the pitch angle is more than +50° at altitudes below 13,000 m, or more than +20° at altitudes above 13,000 m.</p> <p>WARNING In aircraft equipped with the SAU-23ESN 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</p>	<p>Accuracy of altitude hold</p> <p>To ensure stable run of engine due to negative and near-zero g-loads</p>

COCKPIT INSTRUMENTS AND EQUIPMENT





6. Cockpit instruments and equipment

If you've ever had the chance to fly a Soviet or Russian airplane in Lock-ON, Flaming Cliffs (1/2/3), or now in DCS World, you must have noticed that most of the cockpit instruments are the same or very similar. The philosophy behind the use of identical or similar instruments and equipment in all Soviet planes (MiGs, Suhoys, Tupolevs, Yakovlevs etc.) was to enable easy maintenance, parts supply and war field support to any kind of airplane, and to make it easier for the pilots to familiarize themselves with the cockpits of different planes in the case of transfer from one plane type to another. If you have experience with Soviet cockpit instruments use, then you can just briefly look at this section and read some of the information explained here. *However, if you are not well introduced to the use Soviet cockpits, you should familiarize yourself thoroughly with the MiG-21BIS cockpit instruments and equipment.*

Metric system: *The MiG-21BIS, like all other Soviet planes, mostly uses the International System of units (SI), particularly measurements are based on meters (length, altitude), meters per second (horizontal and vertical speed), angular degrees (all sort of angles and angular velocities), liters (volume) and bars (pressure). However, some non-SI units are also in use, like Celsius degrees (atmosphere and engine temperature).*



Cockpit segments and three-sign code

For easier orientation, the cockpit of the DCS MiG-21BIS can be divided into seven segments when observed from the pilot's perspective.

Three main segments are: right (R), central (C) and left (L) segments. The right and left segments could be further divided into horizontal (H) and vertical (V) segments, while the central segment could be divided into lower (L), main (M) and upper (U). The pilot's stick is a separate segment marked with two letters PS. When we need to explain a location of some instrument, switch, lever, button or light in the cockpit, we will use this "map" to locate it by marking its position with a two-letter code (like RV, CM or PS) and a number representing the switch.

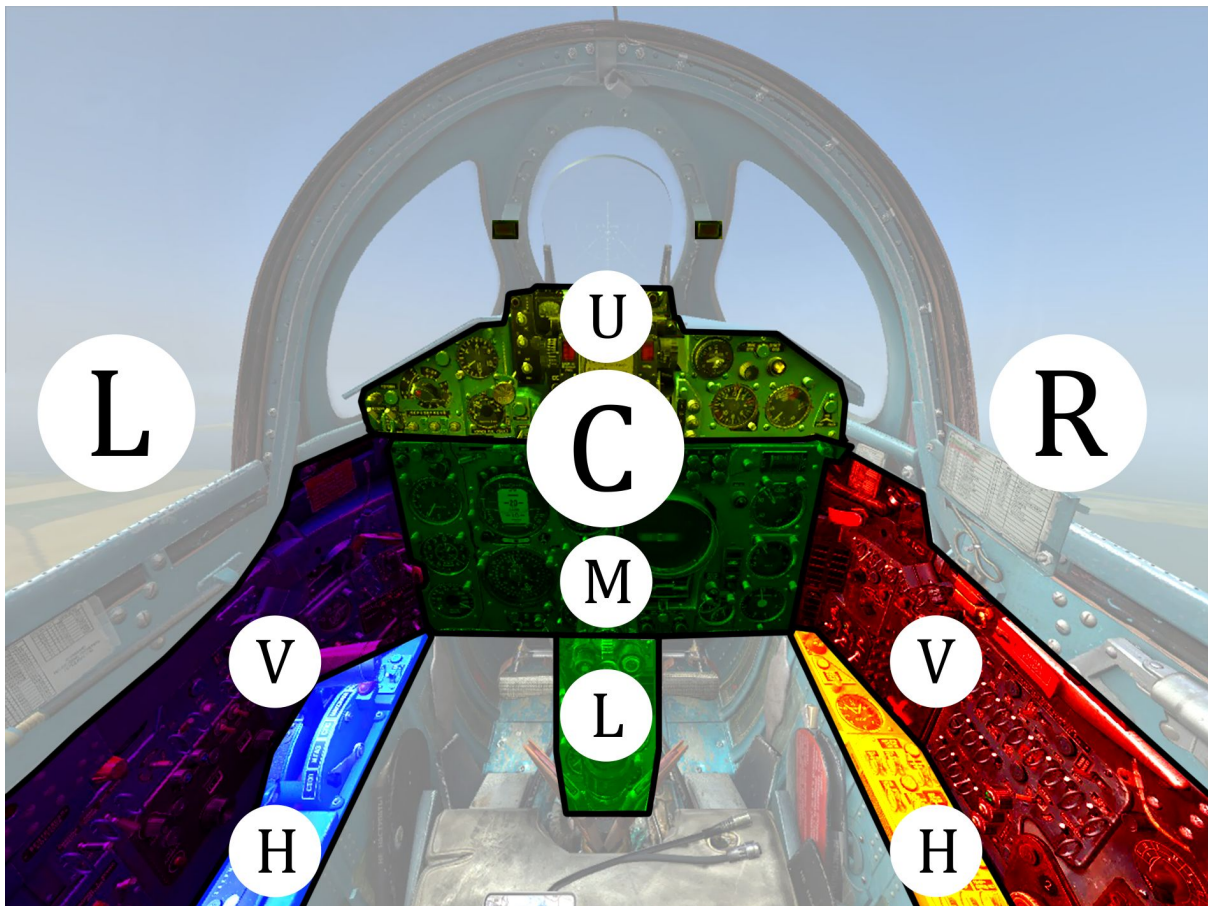
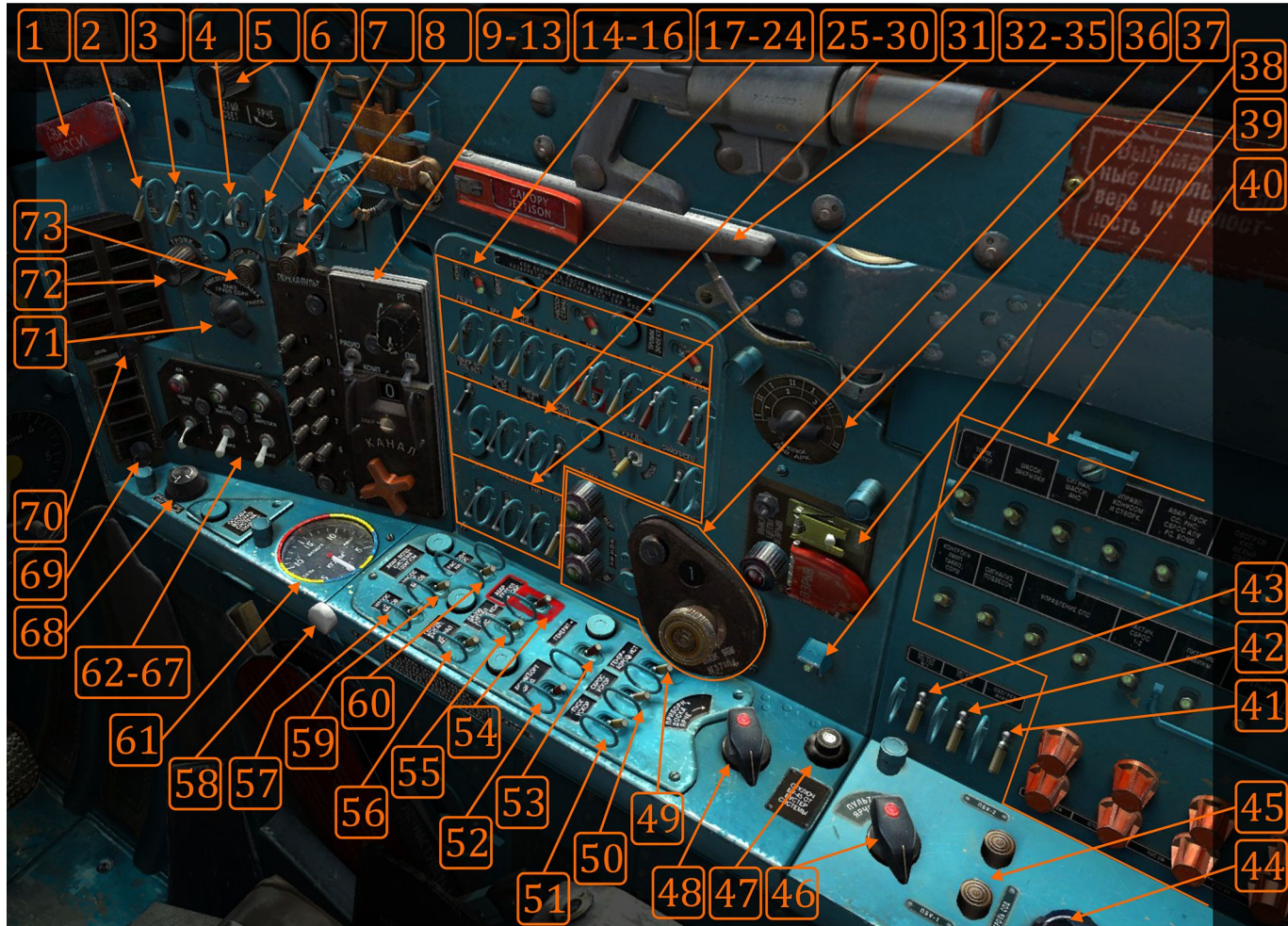


Image 6.1: Cockpit segments. For easier in-cockpit orientation we will use a two-letter code like RH (right-horizontal) or CM (central-main). [This image is available for hi-resolution print \(Mods\aircrafts\MiG-21BIS\Doc\Manual_Images\).](#)

R segment



R segment contains interface for turning on/off all the airplane systems. Along with that, RV segment contains main radar control panel, radio station channel selector and ARC station selector.

Image 6.2: R cockpit segment. Grouped switches are numbered from left to right, top down. This image is available for hi-resolution print (Mods\aircrafts\MiG-21BIS\Doc\Manual_Images).



1. **Emergency gears** extraction lever
2. Aircraft distance transponder **SOD-57** power switch
3. Aircraft distance transponder **SOD-57 channels** (wave) selector switch
4. **Type 81 IFF transponder** switch
5. **Cockpit white-lights** control knob
6. **SPO-10** Radar Illumination Warning System power switch
7. **ARC** operating **mode** switch (COMPASS / ANTENNA)
8. **ARC channels** selector buttons
9. **Radio station** volume control knob
10. **Radio** or **compass** sound selector switch
11. **Radio** noise **squelch** switch
12. **Radio channel** window
13. **Radio channel selector** knob
14. **Nose cone** power switch
15. **Auxiliary hydro pump** switch
16. **Trimmer** power switch
17. **Radio station** power switch
18. **ARC** power switch
19. **Radio altimeter** power switch
20. **RSBN/PRMG** power switch
21. **KPP main/aux** power switch
22. **NPP** power switch
23. **Autopilot** power switch
24. **Autopilot pitch channel** power switch
25. **Heating** for IR/SARH missiles and **Gun-camera**
26. IR/SARH missiles **master arm** power switch
27. **Pylons 1-2** power switch
28. **Pylons 3-4** power switch
29. **Formation lights** switch (central – off, up – medium, left - weak, right – strong)
30. **SARPP-12 Flight data recorder** “Black box” power switch
31. Emergency **canopy jettison** lever
32. Gsh-23 **gun** power switch
33. **ASP-PFD optical sight** switch
34. **Gun-camera** power switch
35. **SRZO-2** (IFF) power switch
36. **SRZO-2** (IFF) control **lights** (emitter on, code on, decipher on) + channel selector
37. **ARC frequency** range selector knob
38. **Emergency Transponder** + SRZO-2 (IFF) **self-destruction** control panel
39. **Electric Bus No.2 circuit breaker**
40. **Fuses/circuit breakers** box
41. **Battery heating** switch
42. Electric current converter **PO-750 No 2** switch
43. Electric current converter **PO-750 No 1** switch
44. **Air bleed doors** 1.5 Mach **test** button
45. Aircraft distance transponder **SOD-57 PVU-1** and **PVU-2** control block **test** buttons
46. **Panel-text** red **backlights** control
47. Test button for **disengaging** the **ailerons boosters**
48. **Instruments** red **backlights** control
49. **AC generator** switch
50. **SPRD** rocket boosters **jettison power** supply switch
51. **SPRD** rocket boosters **starter power** supply switch
52. **Battery** switch
53. **DC generator** switch
54. **Emergency** current **converter** power switch



- 55. **Gyros for DA-200, NPP, SAU and radar** switch
- 56. **Gyros for NPP, SAU, radar and KPP** switch
- 57. **3rd fuel tanks group pump** switch
- 58. **Canopy air conditioner** open/close handle
- 59. **1st fuel tanks group pump** switch
- 60. **Dispense fuel tank pump** switch
- 61. **Main and auxiliary air pressure** gauge
- 62. **RP-22 radar main mode** switch (off/standby/on)
- 63. **RP-22 radar error light**
- 64. **RP-22 radar low altitude / sidebeam compensation** switch
- 65. **RP-22 radar low altitude light**
- 66. **RP-22 radar fixed beam** switch
- 67. **RP-22 radar fixed beam light**
- 68. **Red-floodlights** control
- 69. **Warning lights** group/test and backlight control knob - **Fuel systems**
- 70. **Warning lights** group/test and backlight control knob - **Engine/Main systems**
- 71. Aircraft distance transponder **SOD-57 modes** control panel
- 72. **ARC sound** control knob (for Morse NDBs codes)
- 73. Aircraft distance transponder **SOD-57 interrogation** button



C segment

C segment is the main pilot-aircraft information interface. Here the pilot reads most of the information needed to fly the plane, perform combat operations and manage the airplane's weapon system.



Image 6.3: C cockpit segment. Grouped switches are numbered from left to right, top down. This image is available for hi-resolution print (Mods\aircrafts\MiG-21BIS\Doc\Manual_Images).



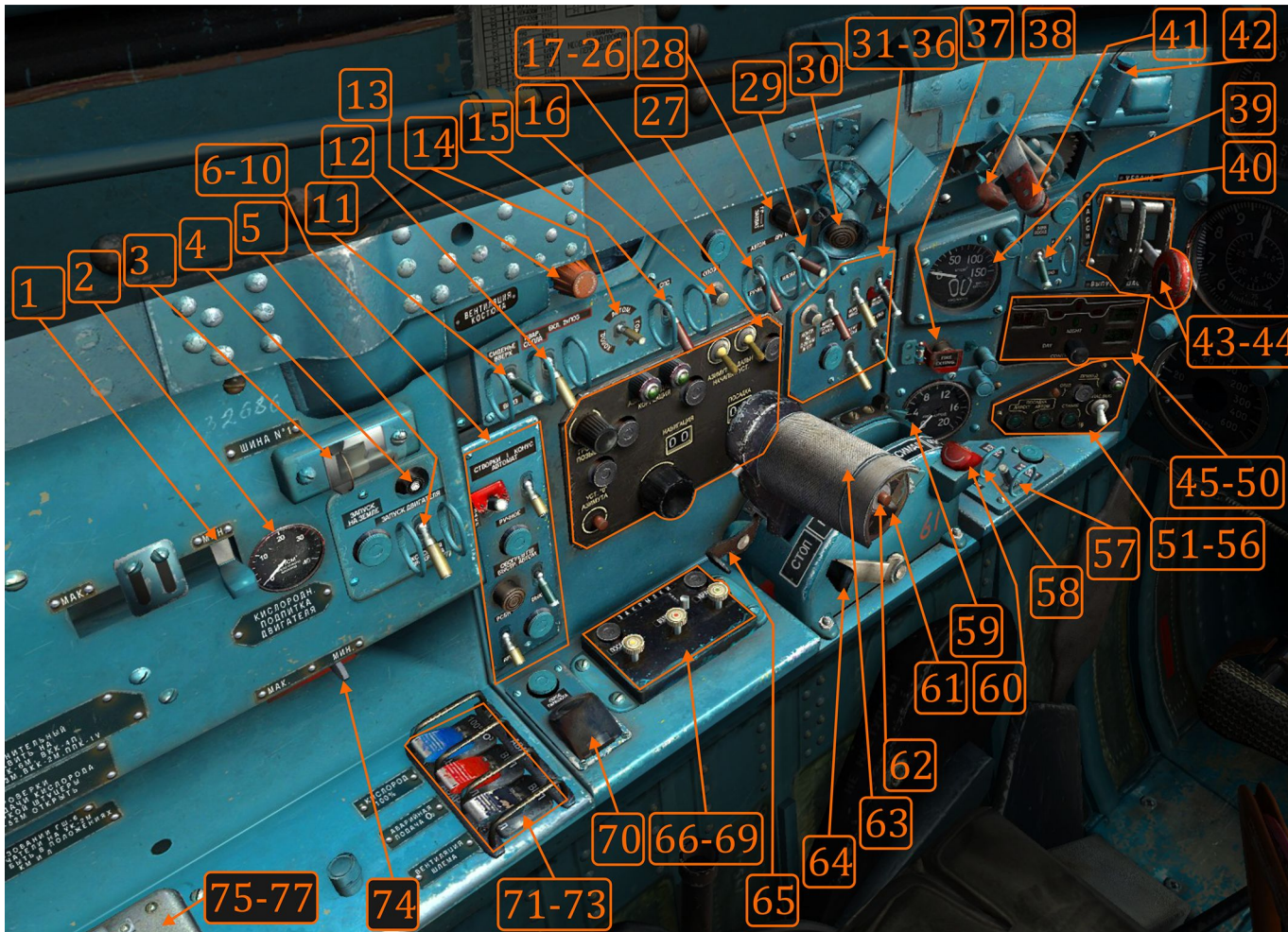
1. **Gun ready** light
2. **ASP-PFD master mode** select switch
3. **AA missile type** select switch
4. **Gun load/reload** button **1**
5. **Gun load/reload** button **2**
6. **Gun load/reload** button **3**
7. **Pylon** and **weapon** type **selector** knob
8. **ARU-3VM** gauge
9. **Nosecone position** gauge and emergency **manual control**
10. **Anti-icing** system lever (deicing front cockpit)
11. **RSBN/PRMG** operating **mode** selector switch (descend, navigation, landing)
12. **ASP-PFD launch authorized** light
13. **ASP-PFD gun/rocket-missiles** switch
14. **ASP-PFD firing/bombing** switch
15. **ASP-PFD auto/manual** switch
16. **ASP-PFD missile** launch **distance** scale
17. **ASP-PFD target** size **knob**
18. **ASP-PFD target** size **scale**
19. **ASP-PFD** piper mode **missile/gyro** mode lever
20. **ASP-PFD scale backlight** control knob
21. **ASP-PFD fixed-net light** control knob
22. **ASP-PFD fixed-net** on/off switch
23. **ASP-PFD piper** on/off switch
24. **ASP-PFD piper light** control knob
25. **ASP-PFD angular correction** knob
26. **ASP-PFD angular correction** scale
27. **ASP-PFD backlight** preset knob (not intended for pilot's use, pre flight setup)
28. **ASP-PFD break-off** attack light
29. **ASP-PFD lock-on** light
30. **ASP-PFD distance** scale
31. **ASP-PFD distance** scale **needle**
32. **SUA** (high AoA light **warning** system)
33. **Gun-camera** (not visible on presented image)
34. **SPO-10 night/day** mode selector
35. **SPO-10 test** button
36. **SPO-10 volume/mute** knob
37. **Accelerometer**
38. Aircraft distance transponder **SOD-57 emission** indicator light
39. **UUA-1 (AoA)** gauge
40. **RS-2US** missile **1 readiness** light
41. **RS-2US** missile **2 readiness** light
42. **R-60** missiles **readiness** light
43. **RSBN distance** indicator
44. **Pitot tube** selector lever (**main, auxiliary**)
45. **RP-22 radar** jamming **filter continuous** mode button
46. **RP-22 radar** jamming **filter intermittent** mode button
47. **RP-22 radar** jamming **filter passive** mode button
48. **RP-22 radar** jamming **filter weather** mode button
49. **RP-22 radar** jamming **filter interrogation** mode button
50. **RP-22 radar** jamming **filter low-speed** mode button
51. **RP-22 radar self-test** button
52. **RP-22 radar reset** button
53. **Engine RPM** gauge (tachometer)
54. **Low oil** pressure light
55. **Radar screen** with controllable **sun-filter**
56. **Engine** exhaust **temperature** gauge



57. **Warning lights** group/test and backlight control knob - **control systems**
58. **Fuel quantity** gauge + setting knob
59. **Gyro reset** indication light (for SAU, NPP and radar gyros)
60. **Hydro pressure** gauges (command and main hydro systems)
61. External stores **emergency jettison** button - **outer** (pylon 3-4)
62. External stores **emergency jettison** button - **inner** (pylon 1-2)
63. **Emergency nose gear** release handle
64. **Warning lights** group/test and backlight control knob - **UB pods**
65. **Warning lights** group/test and backlight control knob - **weapons**
66. **Battery** capacity meter gauge
67. **Gear brakes** air **pressure** gauge (left and right main gears)
68. **Cockpit** altitude and **pressure** gauge
69. **Radio** altimeter **low altitude** selector knob
70. **Oil pressure** gauge
71. **Emergency A-A missiles launch** button
72. **Tactical release** “bombs armed” warning **light**
73. **Tactical release** switch (for bombs only)
74. **Main Pitot** tube, mirror, AoA sensor **heater** switch
75. **Auxiliary Pitot** tube **heater** switch
76. **Volt meter** gauge
77. **Clock**, stopwatch, time-of-flight stopwatch gauge
78. **SAR missile** radar **frequency** selector (Training / Live) switch
79. **Radar screen illumination** gain (not intended for pilot’s use)
80. **Radar screen** magnetization - **erase** button
81. **M** meter and **TAS** meter gauge
82. **NPP** course system + 3K **course set** knob
83. **DA-200** combined **vertical velocity** – **slip** and **turn** gauge
84. **Radio altimeter** gauge
85. **KPP** gauge
86. **KPP gyro reset** button + horizontal set knob
87. **Barometric altimeter** + atmospheric **pressure set** knob
88. **IAS** instrument
89. **Low altitude** warning **light**
90. **Emergency brakes** lever
91. **SPRD** rocket boosters **start** button
92. **Far-near** landing **NDB** switch
93. **SORC** - **main warning** light button/light
94. **Wing fuel tanks jettison** button
95. **NPP** course magnetic **correction** button
96. **ARC** to landing NDB frequency **self-adjustment** indication **light**
97. **Nosegear** brake lever



L segment



L segment holds the engine management interface along with engine nozzle controls, gears/flaps/brakes controls, the ARU-3VM control panel, RSBN/PRMG control panel, life support system interface, and important emergency engine controls.

Image 6.4: L cockpit segment. Grouped switches are numbered from left to right, top down. This image is available for hi-resolution print ([Mods\aircrafts\MiG-21BIS\Doc\Manual_Images](#)).



1. **Anti-g suit air pressure** lever (not intended for pilot's use)
2. **Engine emergency O₂** pressure gauge
3. **Electric Bus No.1** circuit breaker
4. **Engine start-up** button
5. **Engine start-up mode** switch (start-up / cold start (bow out))
6. **Engine compressor anti-surge doors control** switch (automatic/manual)
7. **Nose cone control** switch (automatic/manual)
8. **RSBN/ARC mode** selector switch
9. Hermetic **helmet glass fast heating** button
10. Hermetic **helmet glass heating** mode switch (automatic/manual)
11. Ejection **seat up/down** set switch
12. **Emergency nozzle** 2 position switch (maximal and afterburner)
13. **Hermetic suit pressure** control knob
14. **Cockpit air-conditioning** 4 positional switch
15. **SPS (BLC)** switch
16. Aircraft distance transponder **SOD-57 identification** button
17. **RSBN sound** control knob (for Morse NDBs codes)
18. **RSBN zero azimuth set** button
19. **RSBN azimuth correction light**
20. **RSBN distance correction light**
21. **RSBN azimuth correction** switch
22. **RSBN distance correction** switch
23. **RSBN navigation channel** indicator
24. **RSBN navigation channel** selector knob
25. **RSBN landing channel** indicator
26. **RSBN landing channel** selector knob
27. **ARU-3VM operating mode** selector switch (automatic/manual)
28. **Missile lock sound** volume knob
29. **ARU-3VM control** switch (HI-speed/LOW-speed) (has affect in manual mode only)
30. **Opening drag chute** button
31. **RSBN test** button
32. **Gear ABS** brake system switch
33. Afterburner and 100% RPM ("maximal") **engine nozzle control** switch
34. **In-flight engine start-up** system switch (100% O₂ engine supply)
35. **Fire extinguisher system** switch
36. **Engine start-up system** switch
37. Engine **fire extinguisher** button
38. **Cockpit pressurization** lever
39. **Pilot O₂ level** gauge (also breathing indication)
40. **Aircraft lights** (landing, taxi, retracted/off)
41. **Canopy lock** lever
42. **Cockpit lock/pressurization warning light**
43. **Landing gears** lever **safety** lock
44. **Landing gears** lever (up, neutral, down)
45. **Landing gear warning** light
46. **Landing gears up** lights
47. **Landing gears down** lights
48. **Flaps out** light
49. **Airbrakes out** light
50. **Warning lights** test and backlight control knob - **gears, flaps and airbrakes**
51. SAU-23ESN **autopilot landing** mode **directional** button-light
52. SAU-23ESN **autopilot landing** mode **automatic** button-light
53. SAU-23ESN **autopilot level hold** button-light



- 54. SAU-23ESN **autopilot disengage** landing modes button
- 55. SAU-23ESN **autopilot stabilization** light
- 56. SAU-23ESN **autopilot low altitude** mode switch
- 57. **Second** (emergency) **afterburner** on/off switch
- 58. **Ailerons hydro boosters** switch
- 59. **Pilot's O₂ pressure** gauge
- 60. **SPRD** rocket boosters **jettison** button
- 61. **Airbrake** control switch (extracted/retracted)
- 62. **Radio PTT** button
- 63. **Throttle** rotating **cylinder** (control radar TDC gate or ASP piper size)
- 64. **Throttle movement locking** lever
- 65. **Throttle engine-stop** and **locking** lever
- 66. **Flaps landing** position button
- 67. **Flaps take-off** position button
- 68. **Flaps retracted** position button
- 69. **Flaps** position **reset** button
- 70. **Jettison** drag **chute** button
- 71. Life support - **100% O₂** switch
- 72. Life support - **emergency O₂** switch
- 73. Life support - **helmet ventilation** switch
- 74. **Hermetic suit pressure** control lever
- 75. UK-2M **Radio** station **microphone amplifier GS/KM** switch
- 76. UK-2M **Radio** station **microphone amplifier preset** knob (not intended for pilot's use)
- 77. UK-2M **Radio** station **microphone amplifier M/L** switch



PS segment

The Pilot's stick holds weapon and SAU management switches.

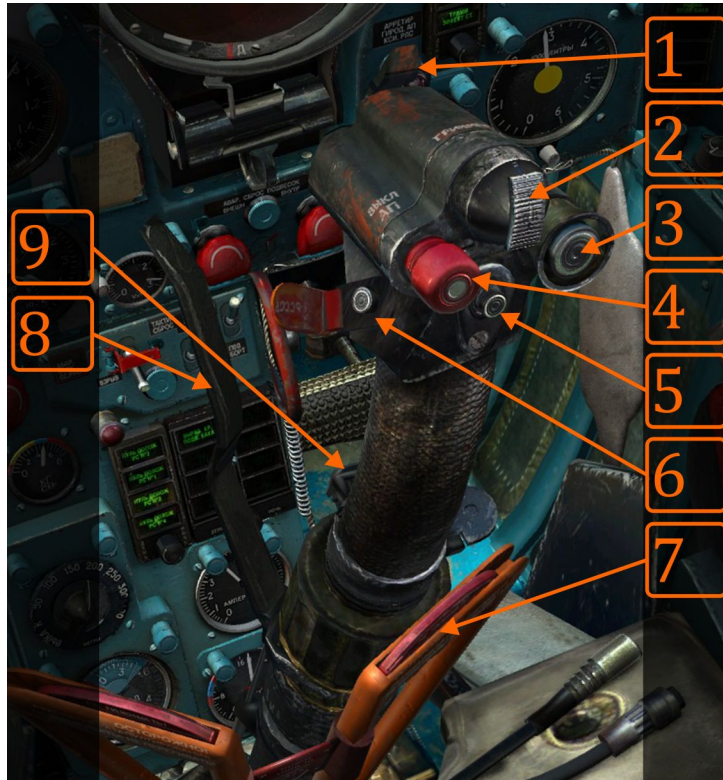


Image 6.5: PS cockpit segment. This image is available for hi-resolution print (Mods\aircrafts\MiG-21BIS\Doc\Manual_Images).

1. **Gun trigger** (upward position – SAFE, downward position – ARMED, pulled – FIRE)
2. **Trimmer button** (pitch only)
3. **Autopilot “recovery” mode engage button**
4. **Autopilot disengage button** (for Recovery and Stabilization modes only)
5. **Radar lock-on button** (also **pipper stabilization** when using ASP optical sight)
6. **Bomb, rockets, missiles fire button** (under visible red cap)
7. **Ejection handle**
8. **Gear brake lever**
9. **Fuselage (center) fuel tank jettison button**



Instruments and control panels

***Clarifications:** all cockpit information presenting devices are called “instruments”; some of them are often called by their abbreviated codes, like in the case of the NPP or KPP. Some instruments are – at the same time – instruments and control devices or control panels. If they are not exclusively control panels, we will consider them instruments.*

To more easily explain cockpit instruments and control panels, we will separate them into three categories: flight and navigation, engine and flight-controls, and weapons systems. Every category could be further divided into subcategories. As you progress in learning on how to distribute your attention to different instruments and control panels in a stressful situation, especially when you have to “extract” only important information from the whole, you will develop your own “attention-distribution model”, and find your own essential instruments and controls for every situation.



Flight and navigation instruments and control panels

Warning: Whenever the outside temperature is around or below 0°C (at any altitude) the pilot should turn-on the Pitot tube heating (CL31 and CL32). Although the MiG-21BIS Pitot installation is not prone to freezing due to speed dynamic heating (air-friction heating effect), freezing might still happen.

IAS indicator

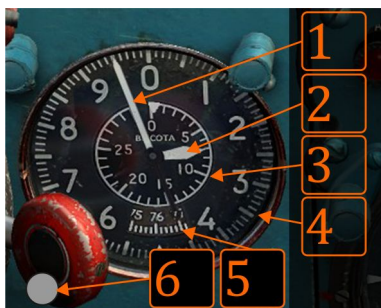


The IAS indicator (US-1600) shows Indicated Air speed up to 1600km/h. It has one needle (2) and one window (1). This window will show “1” when IAS is >1000km/h.

Operational requirements: None. The Instrument will work as long as the main Pitot installation is in order (if the main Pitot installation fails, switch to the auxiliary Pitot installation using the lever: Pitot tube selector lever (CU44)).

Dependence on other systems failures: Failure of main Pitot installation. Frequent cause is Pitot tube freezing.

Barometric altimeter



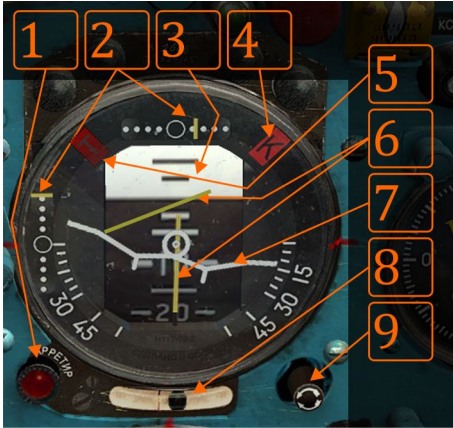
The Barometric altimeter (VDI-30K) measures barometric altitude up to 30km. The small needle points to an altitude in km (scale 3) while the big needle points tens of m (1). The pilot can set the desired atmospheric pressure in window (5) using button (6).

Operational requirements: None. The instrument will work as long as the main Pitot installation is in order (if the main Pitot installation fails, switch to the auxiliary Pitot installation using the Pitot *tube selector lever (CU44)*).

Dependence on other systems failures: Failure of the main Pitot installation. Frequent cause is Pitot tube freezing.



Attitude directional indicator – ADI



The Attitude Directional Indicator (KPP-1, often referred as AGD), shows airplane attitude: bank (7), pitch (3) and slip (8). It holds the RSBN/PRMG directional needles (6) which are shown if the RSBN is selected as the main radio-navigation source, along with the active RSBN station which is in range. It also holds auxiliary PRMG (Russian ILS) needles (2) which show aircraft position in reference to a localizer (or selected radial) and glide slope signals (or descent rate). If there is a need to reset the KPP gyro, use button (1). During a reset, the airplane must be in straight, horizontal flight with no slip (use other instruments to control your flight). Reset usually

takes 3-4 seconds and is indicated with warning light. Button (9) serves to change the pitch setting if needed.

Operational requirements: *Gyros for NPP, SAU, radar, KPP switch (RH56)* and *Gyros for DA-200, NPP, SAU, radar switch (RH55), KPP main/aux power switch (RV21)* in either position (down position is “auxiliary”, up position is “main”); “main” is obligatory for normal operations.

Dependence on other systems failures: Total electric system failure. Otherwise, it will never fail.

Precautions: Some other systems use KPP state to calculate their parameters (like autopilot). If the KPP is not working as expected, even after few resets, switch to the auxiliary backup.

Course system



The Course System (NPP) is a complex instrument showing current magnetic heading, direction to a selected NDB or RSBN station (9, pointer at tail), desired course or radial (6, pointer at head, set up with button 5), correct reception of localizer (3, K - “kurs”) and glide slope (8, G - “glisada”) signals, aircraft position in reference to localizer and glide slope signals (central white needles), relative angles necessary for landing pattern creation (7) and relative

course system (2). Since the NPP is gyro-magnetic device, it has to be adjusted to the Earth’s magnetic field. To adjust it, press and hold the **NPP course magnetic correction button (CM95)**; you will see that the compass circle is adjusting. Once it stops, you can release the button. In normal conditions, you need to do this only once before taxiing.



Needle (9 is needle tail) will point to active ground station with circled end towards the station. If the RSBN system is selected using proper settings with **RSBN navigation channel selector knob (LV24)**



and **RSBN/ARC mode selector switch (LV8)**, the distance to the RSBN station will be shown on the **RSBN distance indicator (CM43)**. The pilot can set up the desired course (e.g. runway landing course, next route leg course etc.) using button (5); the needle (6) will move according to pilot's input. When PRMG is active and your on-board equipment is receiving signals, windows (3) and (8) will become black. If something is wrong (e.g. no particular signal, weak – unreliable signal, out of signal range etc.) one or both windows will become white. When in PRMG mode, the pilot uses the localizer and glide path needles (located in center of NPP) to fly the plane along the landing approach path. In VFR meteo conditions, and particularly over an unfamiliar airbase, the pilot can use indexes (7) to fly along a landing pattern based on the RSBN located at that airbase. *More on RSBN/PRMG use in the navigation section.* If the pilot needs a quick definition of polar courses, scale (1) gives 10° references.

Operational requirements: *Gyros for NPP, SAU, radar, KPP switch (RH56) and Gyros for DA-200, NPP, SAU, radar switch (RH55), ARC power switch (RV17), RSBN/PRMG power switch (RV20), NPP power switch (RV22), NPP course magnetic correction button (CM95) for magnetic synchronization (occasionally, if needed), correct RSBN and ARC settings on their respective control panels **ARC channel selector (RV8) and RSBN navigation channel selector knob (LV24).***

Operational requirements: *Gyros for NPP, SAU, radar, KPP switch (RH56) and Gyros for DA-200, NPP, SAU, radar switch (RH55), ARC power switch (RV17), RSBN/PRMG power switch (RV20), NPP power switch (RV22), NPP course magnetic correction button (CM95) for magnetic synchronization (occasionally, if needed), correct RSBN and ARC settings on their respective control panels **ARC channel selector (RV8) and RSBN navigation channel selector knob (LV24).***

Dependence on other systems failures: Course indication will fail with a total electric system failure, gyros failure or become unreliable if the magnetic sensors suffer failure (extremely rare). Otherwise, course indication won't fail. RSBN, PRMG and NDB information might be absent if their system does not operate correctly or no signal is present. Either way, **needle 9 will settle in right 045° position without moving, indicating that radio navigation is not operational (either ARC or RSBN, or both).** Pilot can confirm that the system is not receiving signals by hearing a noise sound. Otherwise, the appropriate Morse code of a tuned ground station will be heard.

Precautions: NPP should be thoroughly checked before takeoff. Check the course indication while on the runway (compare runway course with indication). Use the **NPP course magnetic correction button (CM95)** to align course scale to Earth's magnetic field. Check NDB and RSBN signals while on the ground. Tune at least 2 different stations in range, wait for needle movement and then listen to the Morse code. **If needle (9) deflects 045° to the right, check for a Morse code sound, and if needed, compare other information to make sure whether the NPP is operating as expected.**



Combined indicator DA-200



The DA-200, often referred to as the “variometer”, will give you precise information about vertical velocity up to 20m/s, and rough information from 20m/s to 200m/s. The Slip ball (2) will indicate slip, while the turn indicator (3) will show you the turn rate. This indicator is specially designed to indicate bank up to 45° in steps of 15° when the airplane is flying at 500km/h IAS. The purpose of this function is to replace the KPP if it fails, and enable safe landing pattern creation.

Operational requirements: For turn indication, *Gyros for DA-200, NPP, SAU, radar switch (RH55)* must be on. The instrument will work as long as the main Pitot installation is in order; if the main Pitot installation has a failure, switch to the auxiliary Pitot installation using the lever: *Pitot tube selector lever (main/aux) (CU44)*.

Dependence on other systems failures: Failure of the main Pitot installation or gyro 1 (turn indication only). Frequent cause is the Pitot tube freezing. Other causes are moisture in installation and failed hermetization (air-seal).

M and TAS meter



Thick needle 1 shows the M number starting from 0,6M. Thin needle 2 shows the TAS starting from 600km/h (on 0,6 mark). Scale indication follows this logic.

Operational requirements: None. Instrument will work as long as the main Pitot installation is in order (if main Pitot installation fails, switch to auxiliary Pitot installation using *Pitot tube selector lever (main/aux) (CU44)*).

Dependence on other systems failures: Failure of main Pitot installation. Frequent cause is the Pitot tube freezing.



Radio altimeter



The Radio Altimeter shows the altitude above ground (AAG) up to 600m. Altitude is being measured directly below the aircraft, ignoring banks and pitches up to 20°. It is good to know its scale by heart, so that the pilot can tell his AAG with one quick glance at the instrument. The pilot can set up the low altitude warning (or turn it off) using **Radio altimeter low altitude selector knob (CL69)**. If the proper mode is selected, the autopilot will recover the plane from a low altitude zone. To turn this autopilot feature on/off use the **Autopilot low altitude mode switch (LV56)**. Low altitude recovery (autopilot feature) is not operational if your landing gear is extended and will not operate correctly if the aircraft's bank/pitch is more than $\pm 20^\circ$.

Operational requirements: *Radio altimeter power switch (RV19), Radio altimeter low altitude selector knob (CL69)*, if coupled with *Autopilot low altitude mode switch (LV56)*.

Dependence on other systems failures: Will fail if the DC generator fails.

Precautions: If the autopilot is used in low altitude recovery mode, recovery can be blunt.

Accelerometer



The Accelerometer shows current (1) and maximum/minimum g-load (3) achieved during flight. Maximum and minimum loads can be reset using button (4). This is a very important instrument, especially if the aircraft has external loads and g-load needs to be controlled to avoid the load falling off, possibly damaging the airframe or other planes in formation, or causing damage to civilian infrastructure or people.

Operational requirements: None.

Dependence on other systems failures: None.

Precautions: None.



AoA indicator



The UUA-1 shows current AoA (3). Readings are precise if IAS > 100 km/h and flaps are retracted. If flaps are extended, readings are 2-3° smaller than the actual AoA. The yellow-black sector (2) indicates the best performance zone (maneuverability considering AoA) while the red-black sector (1) indicates the danger AoA zone (critical AoA is 33°, which - if exceeded - will cause a stall, possibly followed by spin). A pilot can safely perform maneuvers up to 28° AoA at any altitude and speed (except if other limits exist, such as the g-load limit).

A dangerous approach to the critical AoA zone is followed by **SUA – high AoA light warning system (CU32)**; this light warning system is abbreviated SUA. SUA will activate depending how fast the pilot approaches critical AoA: the faster the increase of AoA – the earlier the SUA will activate (as early as 22°).

Operational requirements: None.

Dependence on other systems failures: DC Generator.

Precautions: None.

ARU-3VM gauge



The ARU is a device that controls the ratio between stick pitch and horizontal tail movement. The ARU-3VM gauge shows the current position of the ARU arm transpositioned to a speed-altitude scale. The Speed scale (1) and altitude scale (2) serve to provide a rough orientation whether the ARU system functions as expected. For example, the ARU should be at “long arm” (needle to utmost left, maximum horizontal tail deflection available) if the speed is ≤ 450 km/h, and at “short arm” (needle to utmost right, partial horizontal tail deflection available) if the speed is > 850 km/h. Reverse logic follows the altitude rules (the higher the altitude, the longer the arm). However, the ARU works by combining IAS and altitude in a complex way, so most of the time the needle will be between extreme positions. The ARU is designed to operate in an automatic mode; if needed, the pilot can switch it to manual mode.

Operational requirements: For normal ARU functionality the **ARU-3VM operation mode switch (LV27)** should be in “AUTOMATIC” position.

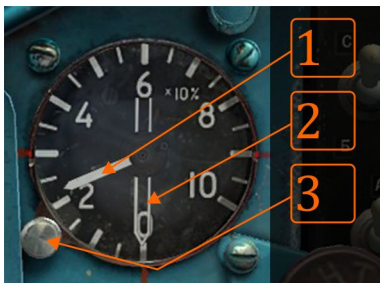
Dependence on other systems failures: The ARU; while not prone to failures, can do so. In that case, the pilot should start decreasing IAS immediately, and change the ARU operational mode to



“MANUAL” using the **ARU-3VM operation mode switch (LV27)** switch, and using the **ARU-3VM control switch (LV29)**. Then, use the ARU indicator to set the ARU arm to the appropriate position according to IAS criteria. For example, if IAS is 600km/h, the pilot should move the needle to index 6 at the outer scale, abort the mission and perform an emergency landing.

Precautions: The ARU should be at the “long arm” (needle outmost left) position prior to landing and when flying at altitudes >7000m. ARU failure – especially total failure including inability of manual control – is a very dangerous situation: two worst case scenarios is landing with only partial functionality of the horizontal tail (aircraft is non-responsive, rough landing or crash), and in-flight horizontal tail over-functionality (aircraft is over-responsive, dangerous g-loads and uncontrollable oscillations around Y axis).

Nosecone position indicator



The Nosecone position indicator (UPES-3) shows the current nosecone position in % of maximum extended position (white needle). In case of automatic control system failure, the pilot can switch to manual by using the **Nosecone control switch (LV07)**. A particular nosecone position is set-up by using knob (3) and moving the black-white needle (2) to the appropriate position. As the pilot moves the needle (2), the white needle (1) will follow, indicating that the cone is moving to the desired position. In case of manual control, the pilot should follow the nosecone position instructions given in following table:

Table 6.1:

landing (gears extracted)	speed <1,4M	speed 1,4-1,6M	speed 1,7M	speed >1,8M
0%	20%	25%	35%	40%

Operational requirements: **Nose cone power switch (RV14)** on, **Nosecone control switch (LV07)** in “AUTOMATIC” mode.

Dependence on other systems failures: Failure of the PO-750A No1 converter: nosecone will fully extend. Possible complications include changed engine sound, decreased thrust, vibrations and compressor surge. In this case, the pilot should first read the M number, then move the black-white needle (2) to the appropriate position using knob (3), and finally switch to “MANUAL” control using the **Nosecone control switch (LV07)**. Abort the mission and perform an emergency landing. Prior gear extension, lower the IAS to 500km/h and then set the cone to a retracted position (0%). Keep in mind that nosecone failure could be complicated to manage if combined with other failures such as engine nozzle failure (loss of all thrust, most likely only one landing attempt available).



Precautions: The Nosecone won't operate if landing gear are extended: the pilot can check its functionality while on the ground with extracted gears by pressing and holding button LV50 for a few seconds. By doing so, the nosecone will start to move. This operation should be kept very short, as it could cause engine surge if prolonged. After takeoff and gear retraction, the pilot should pay attention that the nosecone is extending.

PPS



PPS indicates the state of the landing gear, flaps and air brakes. Warning light (LV45) indicates that flaps are extended while the landing gear is retracted; the message reads "Extract landing gears". Light (LV48) indicates that flaps are extended. Light (LV49) indicates that air brakes are fully extended.

Operational requirements: None.

Dependence on other systems failures: Total electric failure.

Precautions: None.

Flaps control panel



The Flaps Control Panel is used to operate flaps and indirectly indicate flaps position. Button (LV68) retracts the flaps, while buttons (LV67) and (LV66) serve to set the flaps to takeoff (25°) or landing positions (45°), respectively. Button (LV69) serves to set all the control buttons to upward position (to relieve the buttons' springs when aircraft is not in use; no in-game practical use).

Operational requirements: None.

Dependence on other systems failures: Total electric failure.

Precautions: None.



Radio station control panel



The Radio Station Control panel holds 20 preset radio communication channels (marked 0-19, 0 being the 20th channel) which can be selected by rotating the cross shaped selector (RV13) to either side. Channels are shown in a window (RV12). Switch (RV10) selects the audio source between radio station only or radio station and NDB station simultaneously. Switch (RV11) is a “noise cancellation” switch: if there are difficulties in receiving a signal from a distant station, the pilot can turn off “noise cancellation” and increase receiving capabilities of radio. In this case, the emitting station will be heard more prominently, but the pilot will hear permanent background noise.

Operational requirements: *Radio station power (RV17)* on.

Dependence on other systems failures: The failure of the PO-750A No1 converter or failure of radio station itself. Radio station failure is recognized by an absence of signals on any selected channel, and absence of self message in the pilot’s headphones when message transmission is attempted. If the PO-750 No1 fails, which can be identified by simultaneous failure of the radio station, ARC, engine oil pressure gauge, nosecone extraction and fuel quantity indicator, pilot should turn on *Emergency current converter power switch (RH54)*.

Precautions: The Radio needs around 5-10 seconds to heat-up and start operating at maximum efficiency.

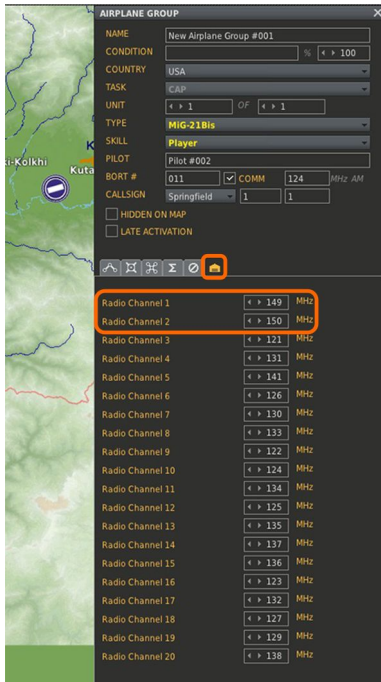
Setting and using the radio station

The Radio station is turned on with the **RV17** switch. When this switch is in the DOWN position, your radio station will serve as **intercom station**. In this mode you can talk to the ground crew in case you want to make repairs on the aircraft or to refuel / rearm the aircraft. In other cases you should place this switch to UP position which will turn-on the **radio station**. To use it, you will have to know which channel to set in order to send/receive messages to/from certain stations such as air-traffic control (ATC), ground controlled interception station (GCI), airborne warning and control systems (AWACS) or other aircraft groups.

You will most often contact ATC, so all the channels required are already preset to most of the ATCs in the current Black Sea map. In order to see the frequencies assigned to all 20 channels, open your mission in Mission Editor, select (or place) your aircraft on the map, and then open radio station tab. You can assign any frequency to any channel you want, but you should use the channels that are



assigned to the ATCs which you won't use in your mission. The best option is to use the first two channels (0 and 1) since they are not assigned to any ATC.



You can see the list of preset ATC channels if you open your Kneebord (RCtrl + Up arrow) and browse to the left (RCtrl + Left arrow) until you reach "Radio channels" page.

Radio stations have a certain range that depends on several things. For reference, you should expect a maximum range of the on board radio station to vary between 200 and 250km.

ARC main control panel

Note: See details on ARC use in Navigation chapter (MiG-21BIS radio navigation).



The ARC main control panel holds 9 preset NDB station frequencies. The pilot selects the desired NDB station by pressing the appropriate channel button. Small windows with channel numbers are illuminated during night flights. Since a similar control panel exists in the aircraft nose on ARC station itself, button (1) serves for control handover, in case the control remained on nosecone control panel. E.g. after station repairs or checks (no practical use in game). In order to hear NDB Morse code (station identifier), the pilot should use the radio station switch (RV10) (see *Radio station control panel*). Sound volume of the received Morse code is controlled with the **ARC sound control knob (RV72)**. In an emergency, the ARC could also be used as a voice radio station receiver (no emitting capabilities) by switching the operating mode from "COMPASS" to "ANTENA" (no practical use in game).

Operational requirements: *ARC power switch (RV17)* on, *ARC sound control knob (RV72)*, *Radio or compass sound selector (RV10)* on "COMPASS"

Dependence on other systems failures: Failure of PO-750A No1 converter or failure of ARC itself. ARC failure is recognized by ARC needle pointing to 045° without



moving, and absence of Morse code identifiers at any selected NDB station. If PO-750 No1 fails, which can be identified by simultaneous failure of radio station, ARC, engine oil pressure gauge, nosecone extraction and fuel quantity indicator, pilot should turn on **Emergency current converter power switch (RH54)**.

Precautions: The ARC needs around 5-10 seconds to heat-up. Prior takeoff, the pilot should check ARC reliability by selecting at least one NDB station within range (if available in game), checking that the ARC needle is showing appropriate values and listening Morse code. Note that the NDB station range increases with altitude, and could be severely degraded with obstacles such as hills and mountains.

RSBN/PRMG control panel

Note: RSBN/PRMG is implemented using simulated airport stations using the main airport runway position and direction for navigation and landing calculations and visual information presentation. *More on RSBN/PRMG principles and use in the Navigation chapter (MiG-21BIS radio navigation).*



Knob 23 is a RSBN channel selector, while knob 26 is the PRMG channel selector. Information lights 19 and 20 are illuminated when appropriate signals (navigation and landing) have been acquired. If signals are weak or the ground station is out of range, one or both lamps are off. Volume control 17 is used to adjust the volume of a RSBN station's Morse identification codes. Apart from these controls, button LV31 is used to send test signals to RSBN and PRMG receivers: when **RSBN test button (LV31)** is pressed and held, ARC/RSBN needle on NPP turns to point to azimuth 177°, while **RSBN distance indicator (CM43)** rolling distance counter to show 199km. After **RSBN test button (LV31)** is released, mentioned instruments revert to

their normal operating mode. When utilizing both ARC and RSBN at the same time, pilot needs to select which station is to be pointed to on NPP by selecting either ARC or RSBN with **RSBN/ARC mode selector switch (LV8)**. Selection has no effect on **RSBN distance indicator (CM43)** which will always point to RSBN station if its signal can be acquired and RSBN receiver is turned on. **RSBN/PRMG operating mode selector switch (CV11)** is used to select RSBN receiver operating mode. Pilot can select one of 3 modes: cloud penetration (descend), navigation, and landing. These modes are explained in *Navigation chapter / MiG-21BIS radio navigation*.

Operational requirements: **RSBN/PRMG power switch (RV20)**, **KPP power switch (RV21)**, **NPP powers witch (RV22)**, **RSBN/ARC mode selector switch (LV8)** to "RSBN", **RSBN/PRMG operating mode selector switch (CV11)** to appropriate position.



Dependence on other systems failures: Failure of PO-750A No1 converter or failure of RSBN/PRMG system. If PO-750 No1 fails, which can be identified by simultaneous failure of radio station, ARC, engine oil pressure gauge, nosecone extraction and fuel quantity indicator, pilot should turn on RH54 emergency converter power switch. RSBN/PRMG partial failure could be recognized by absence of signal acquisition (lights **19** and **20** are off), lack of station's Morse code sound, improper needle behavior (the NPP needle is turning randomly or the needle is stationary pointing to 045° right) and fixed distance on **RSBN distance indicator (CM43)**. Failure of PRMG could be recognized by blinks of NPP localizer and glide path windows, or permanent “no signal” windows state (**white**).

Precautions: The RSBN/PRMG needs around 5-10 seconds to heat-up. Prior takeoff, the pilot should check RSBN reliability by selecting at least one station within range, and checking whether the RSBN/ARC needle indication is correct and listening to Morse codes. Note that the RSBN station range increases with altitude, and could be severely degraded with obstacles such as hills and mountains.

Note: RSBN/PRMG stations ranges depend on altitude and distance. Generally, when on the ground, you will be able to check only the stations which are located closely to the airport from which you are taking off. Signals from remote stations could be acquired from certain altitudes. Obstacle signal interference could be experienced if flying near mountains or other obstacles that interfere with line-of-sight between aircraft and ground station. Interference may vary from a small deviation in indication to a complete loss of signal.

Automatic flight control system (AFCS, SAU) control panel



The AFCS (SAU, sometimes referred simply as autopilot or abbreviated “AP”) panel holds the major parts of SAU controls, except for two control buttons located on the stick: **Autopilot “recovery” mode engage button (PS3), and Autopilot disengage button (PS4)**. If engaged, “RECOVERY” mode will try to recover the aircraft from any attitude to level flight. Note that recovery is not always possible. The Two button-light: **Autopilot landing mode directional button-light (LV51), Autopilot landing mode automatic button-light (LV52)** activate “DIRECTIONAL” or

“AUTOMATIC” SAU RSBN/PRMG landing modes. They are mutually exclusive (only one can be active at a time). The **Autopilot disengage landing modes button (LV54)** disengages SAU selected **Autopilot landing mode directional (LV51) or Autopilot landing mode automatic (LV52)**. The **Autopilot stabilization button-light (LV53)** activates the “STABILIZATION” SAU mode, which dampens aircraft vibrations and stabilizes current aircraft position if stick is relieved of forces (using trimmer) and not held. This is done by filtering stick inputs. Additionally, the SAU will try to stabilize your heading and pitch (if your bank is small, lesser than $\sim 10^\circ$) or your bank and pitch (if your current bank is $> \sim 10^\circ$). The pilot disengages this mode by using the **Autopilot disengage button (PS4)**. When “RECOVERY” mode is active by using the **Autopilot “recovery” mode engage button (PS3)**, the



Autopilot recovery light (LV55) is on. The pilot disengages this mode by using the **Autopilot disengage button (PS4)**. The **Autopilot low altitude mode switch (LV56)** is used to activate or deactivate the “LOW ALTITUDE” SAU recovery mode.

Operational requirements: **Autopilot power switch (RV23)**, **Autopilot pitch-channel power switch (RV24)**, switches related to the KPP, NPP, radio altimeter, RSBN/PRMG (not necessary for basic functions)

Dependence on other systems failures: All failures connected with the KPP, NPP, radio altimeter, hydro system, ARU-3VM, along with SAU failure itself. The SAU must be turned off if these failures occur to prevent the risk of a crash.

Precautions: SAU failures are not dangerous, except during approach and landing. If the pilot suspects an error in the SAU system, he should first disengage the current SAU mode using **Autopilot disengage button (PS4)**, **Autopilot disengage landing modes button (LV54)** or **Autopilot low altitude mode switch (LV56)** on the SAU control panel. If the situation doesn't improve, the problem might not be the SAU. However, the pilot could decide to turn off the SAU completely by using the **Autopilot power switch (RV23)**, and **Autopilot pitch-channel power switch (RV24)**.

Engine and flight-controls instruments and control panels



Engine RPM indicator

The Engine RPM indicator is a self contained system that uses engine rotation to generate power and calculate the needles position. It has a 0-110% scale, indicating the current percentage of maximum allowed engine rotations per minute. Two needles (1 and 2) show current engine RPM state (RPM1 – low pressure compressor RPM2 – high pressure compressor). The difference in rotations between low and high compressors is normal, and it decreases with an increase of overall RPM. Usually, RPM2 is higher than RPM1, but RPM1 is used to set appropriate engine state. **In this manual you might find statements like “85% RPM” and it will always refer to RPM1 unless it is otherwise mentioned.**

Operational requirements: None.

Dependence on other systems failures: DC power; will fail if there is not any source of DC power.

Precautions: Outer border of this instrument is marked with blue, yellow and red colors. Note that RPM1 should never exceed 103,5% and RPM2 should never exceed 107,5%.



Engine exhaust temperature indicator

The Engine exhaust temperature indicator (EGT) indicates exhaust temperature in °C. Normal temperatures are up to 780°C without afterburner, and up to 850°C with afterburner. These extremes are rarely achieved, and the in-flight temperature usually reaches

740-750°C on afterburner.

Operational requirements: None.

Dependence on other systems failures: Will fail if PO-750 No2 fails. PO-750 No2 will fail if DC generator fails. There is no emergency electric current converter that could replace the PO-750 No2, so in case of PO-750 No2 failure, no temperature will be shown on the EGT.

Precautions: Temperature must never exceed 850°C.

Fuel quantity indicator and fuel state info panels



The Fuel quantity indicator shows overall remaining fuel state in liters. Knob (2) serves to set initial fuel quantity (pre-flight setup). If the fuel delivery system fails, e.g. fuel from wing tanks is not being used for some reason, indicated fuel quantity will be higher than the actual amount available. Therefore, the fuel state

info panel (RV69) and externals stores info panel (CL65) indicate remaining fuel quantity according to following table:



Table 6.2:

message and light color	source	meaning
“wings fuel tanks empty”	T-8 (CL65)	if plane have fuselage tank, remaining fuel state is 3200-3000 l if plane does not have fuselage tank remaining fuel state is 2700-2500 l
“ventral fuel tank empty”	T-4 (RV69)	if plane had ventral (central external) tank, remaining fuel state is 2700-2500 l if plane does not have ventral tank remaining fuel state is 2700 l



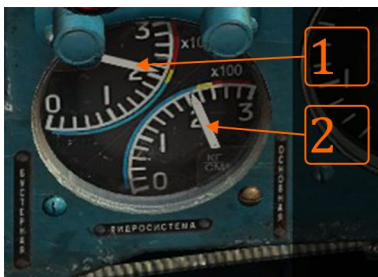
"1 st fuel tank group"	T-4 (RV69)	1 st fuel tank group is empty; turn-off 1 st fuel group pump (RH59); remaining fuel state is 700-1000 l
"450 l left"	T-4 (RV69)	minimum fuel; around 12 minutes of flight remaining, immediately land; remaining fuel state is 450-550 l
"3 rd fuel tank group"	T-4 (RV69)	3 rd fuel tank group is empty; turn-off 3 rd fuel group pump (RH57); around 7 minutes of flight remaining, immediately land; remaining fuel state is 250-350 l
"dispenser fuel tank"	T-10 (RV70)	low fuel pressure of no fuel; engine might stop anytime

Operational requirements: Proper fuel quantity pre-flight setup.

Dependence on other systems failures: Will fail if PO-750 No2 fails. PO-750 No2 will fail if DC generator fails. There is no emergency electric current converter that could replace PO-750 No2, so in case of PO-750 No2 failure no fuel flow will be registered. However, light warning system will be operational.

Precautions: In case of fuel quantity indicator failure, for by-heart calculations, assume average non-afterburner consumption of 40 l/min.

Hydro pressure gauges



Hydro pressure gauges indicate pressure in both hydro systems: main and command. Main hydro system (2) provides hydraulic pressure for nosecone movements, engine compressor anti-surge door operations, landing gear, flaps, airbrakes, engine nozzle, one hydro-booster chamber of the horizontal tail, tires breaking action during gears retraction, equipment air-conditioning door operations, and – in the case of command hydro system failure – it provides the operation of aileron boosters. The command hydro system (1) provides pressure for one hydro-booster chamber of the horizontal tail and ailerons boosters. If the pressure drops to 160-175kp/cm², a warning light on T-10 (RV70) will warn the pilot to pay attention to that particular hydro system.

Operational requirements: None.

Dependence on other systems failures: Will fail if PO-750 No2 fails. PO-750 No2 will fail if the DC generator fails. There is no emergency electric currency converter that could replace the PO-750 No2, so in case of PO-750 No2 failure, no hydro pressure will be shown. However, pressure will be generated and pilot can rely on the light warning system which will still be operational.

Precautions: In any case of hydro system problems, the pilot should abort the mission and land. If main system pressure is falling, it is a good idea to decrease IAS and extract landing gear to be ready for an emergency landing. If the pressure is too low (below 110kp/cm²) landing gear must be extracted using the emergency extraction system (more on emergency procedures in *Emergency*



procedures chapter). In this case, the flaps and airbrakes can't be used, the nosecone will retract and the engine nozzle will fully open, which seriously degrades the thrust and destabilizes engine operation. This emergency situation is to be taken very seriously.



Voltmeter

The Voltmeter displays the voltage level in the DC system. The aircraft's battery should initially have 22.5-24.5V, while the DC generator generates 28.5V. If DC generator fails, voltage will slowly drop. Refer to the *Emergency procedures* chapter for more information concerning DC generator failure.

Operational requirements: None.

Dependence on other systems failures: Total electric failure.

Precautions: In case of DC generator failure, remaining flight time is around 15 minutes, limited by the capacity of the on board batteries.

Oil pressure gauge



The Engine oil pressure gauge displays the current engine oil pressure. Normal engine oil pressure is 3-4kP/cm². The Engine low oil pressure warning light (CM54) will illuminate if the engine oil pressure drops below 1kP/cm² or metal particles are detected in the engine oil. Detection of metal particles indicates

severe engine problems which can lead to total engine failure.



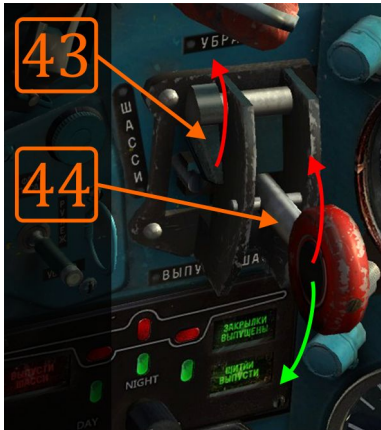
Operational requirements: None.

Dependence on other systems failures: Will fail if PO-750 No2 fails. PO-750 No2 will fail if the DC generator fails. There is no emergency electric currency converter that could replace the PO-750 No2, so in case of PO-750 No2 failure, oil pressure will not be registered. However, the light warning system will be operational.

Precautions: In case of low oil pressure, abort mission and land. Set the RPM at lowest necessary to perform a successful approach and landing at the closest friendly airbase.



Gears handle

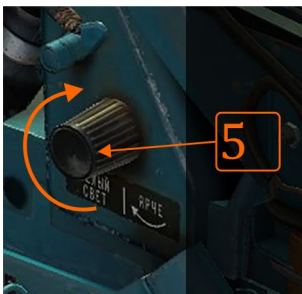


An important feature of DCS MiG-21BIS is the gears handle: it has a locker that prevents retracting the gears during ground operations. Whenever you start your mission, this locker (LV43) will be in the locked position, preventing you from retracting the gears. Before you retract your gears, you need to unlock it by placing it in upper position. On the other hand, there is no restriction when moving the gears handle to neutral or down (extract gears) position. Neutral position is important: when you retract your gears, compressed air is used to brake the tires and prevent them from rotating. Once you retract your gears, place the handle in neutral position to prevent further consumption of

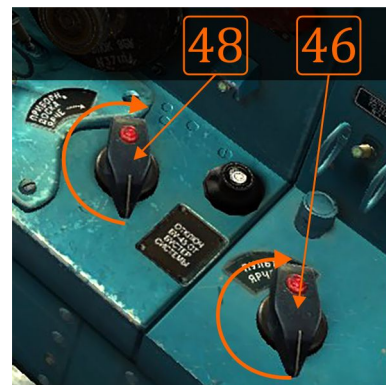
compressed air. If you forget to do this, you may waste all of your compressed air during flight, so when you land, you won't be able to use your brakes and drag chute, since these two important systems consume compressed air as an energy source.

Aircraft lights

Cockpit lights



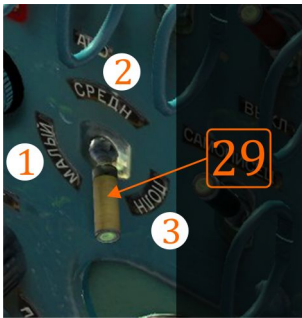
All cockpit light controls are located on the right side panels. There are four knobs for cockpit illumination control. With knobs RH46 and RH48 you control the front panel instruments illumination (48) and text illumination (46). Knob RV5 controls white light that illuminates right vertical panel: this light is used during the start-up procedure. White light is not suitable for night flights, so after you start-up the engine and turn on red lights, you should turn this light OFF. Finally, red flood lights are controlled by knob RH68. These lights will illuminate general cockpit area with red light suitable for night flights.



Apart from these, you have a flashlight at your disposal. It might come handy when you start the mission in pitch dark, ground cold. Default command for a flashlight is **RCtrl + L**.



External lights



External lights are positional lights and landing/taxi lights. Control switch for positional (AKA formation) lights is located on right vertical panel (RV29). This switch has four positions: neutral position - lights OFF, position 1 - small intensity lights, position 2 - medium intensity lights, position 3 - maximum intensity lights.

The Landing/taxi lights switch (LV40) is positioned next to the gears handle. It has three positions: 1 - lights off (retracted), 2 - taxi, 3 - landing. **Note that the DCS MiG-21BIS has retracting lights: if you forget to retract them after take-off and you reach IAS >700km/h you will damage and brake them.** Retract them as soon as you retract your gears.



Table light signals and warnings

The MiG-21BIS has many light signals and warnings. Most of them are organized in logical groups and assigned to appropriate containers - or "tables". The placement of these tables around the cockpit is dictated according to priority levels: the higher the table is located, the more important a signal it holds.

Signals are colored in three colors: red - warning or very important information, orange - events that require pilots attention and monitoring (like hydro pressure drop), green - ordinary information that needs to be noted.

Signals can blink or go ON or OFF depending on the status of the system they monitor.

Tables 6.3: T-10 table (above) and T-4 table (below), located on RV cockpit side (see button RV70). T-10 is a high-priority table containing different important signals, while T-4 is the fuel state table. Most of your flying time will be spent looking at these two tables.



Engine start up	Dispenser fuel tank (means no fuel pressure or about 80 liters remaining)
Afterburner engaged	Emergency afterburner engaged
DC generator not operational	AC generator not operational
Engine compartment in fire	Nozzle open
Monitor buster hydro system pressure	Monitor main hydro system pressure



Ventral fuel tank empty

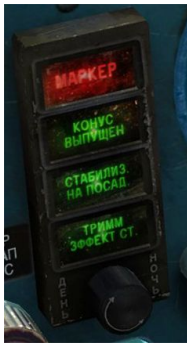
1st fuel tanks group empty

450l remaining

3rd fuel tanks group empty



Tables 6.4: T-4 table (CM57). This is the table with high priority signals that are frequently triggered in flight. Most of the time you will just check that signal is either present or no, to make sure your systems are operating as they normally should.



Marker
(on when over the one of landing NDBs). Will blink and beep marker Morse code for about three seconds.
Cone out
Indicates cone is operational. As a general rule, cone should be in only when landing gear is extracted.
Tail for landing
Indicates ARU system is set-up for low speed tail movements (max movements). If this signal is ON and you have IAS > 450km/h, your ARU system is broken.
Trimmer neutral
Indicates trimmer is in neutral position.

Tables 6.5: T-4 and T-8 tables are weapons related. Low priority signals, most of them as “check and forget” signals. You might look at these tables to make sure you dropped your bombs or that your UB launchers are empty.



Rockets on pylon 3 in zero position (empty)	Wing drop tanks empty	Ventral fuel tank connected
Rockets on pylon 1 in zero position (empty)	Pylon 1 inner	Pylon 2 inner
Rockets on pylon 2 in zero position (empty)	Pylon 3 outer	Pylon 4 outer
Rockets on pylon 4 in zero position (empty)	JATO rocket left	JATO rocket right



MARKET
& LANDING



7. Takeoff and landing

Note: Apart from description in this manual, a set of interactive training missions related to ground, takeoff and landing procedures are available with DCS MiG-21BIS installation. You should read this chapter before attempting to fly those missions.

Engine and aircraft systems start up

The MiG-21BIS is known as one of the fighter aircraft with the shortest engine and aircraft systems start up time. In normal circumstances, maximum engine start up time is 45 seconds (usually around 35-40 seconds) while other systems start up and check time takes an additional 2 minutes, at most. In emergency procedures, such as scramble situations, the aircraft is ready to takeoff in less than 60 seconds counting from the moment when the pilot entered the cockpit.

I will explain the start up procedure using a table with the following structure:

Table 7.1:

<i>switch or action</i>	<i>location</i>	<i>note</i>	<i>cockpit indication</i>
<i>text</i>	<i>code</i>	<i>text</i>	<i>text or image</i>

switch or action – denotes cockpit switch to be turned or pilot's action to be performed

image – image of the switch, lever, stick etc.

location – location of the switch, lever or else in the cockpit in two-letter code and number

note – additional explanation of action, side-action or other important events connected with current action

cockpit indication – if it exists, cockpit indication connected with current action will be explained here using text and/or image

You should learn the start-up procedure and perform it the same way every time. Remember, the start up procedure is the most important phase of the pre-flight preparation; making a mistake in this procedure often leads to a prolonged start up, failed start, aircraft systems stress, and complications during takeoff and flight.



*Known for its short start-up time, MiG-21 was often used in last minute during real emergency operations: usually, early warning (EW) crews postpone the decision to scramble MiG-21 fighters until the last moment. This usually led to a “rush” among 21 crews who were trying to spare some time during the start-up and taxi procedures in order to compensate the EW crews’ lost time. Sometimes this led to problems in aircraft systems operations eventually causing a mission abortion. After many such occasions, 21 pilots adopted a rule: **“You can not compensate time that someone else already wasted. Never rush.”***



Table 7.2: Start-up procedure. Print this table.

<i>Switch or action</i>		<i>Location</i>	<i>Note</i>	<i>Cockpit indications</i>
<i>Original Russian Text</i>	<i>In English</i>			
ЗАПУСК ПО -750 No.1	1. PO-750 Current Converter On	RV43	Turn this switch before start-up.	
ЗАПУСК ПО -750 No.2	2. PO-750 Current Converter On	RV42	Turn this switch before start-up.	
ОБОГРЕВ АККУМ	Battery heating	RV41	Turn this switch before start-up.	
АККУМ	DC battery	RH52	Check Voltage. Onboard battery not less than 24.5V (unloaded voltage).	All red lights, PPS lights (green legs), SORC, canopy warning light, SLEDI DAVL x 2 + GENERATOR = + SOPLO + RASHODNI BAK warning lights on T-10 are ON, VIRAB PODV BAKA on T-4 is ON (if no fuselage fuel tank), STABILIZ NA POSAD + TRIMM EFFEKT ST on T-4 are ON.
Генератор =	DC Generator On	RH53		
Пожар оборуд.	Fire Extinguisher On	LV36		
Рация	Radio Power On	RV17	Set up ATC channel.	Radio light goes ON.
Самописец	SARPP-12 "Black Box" On	RV30		Press ANY of DAY-NIGHT buttons to make sure ALL warning lights in cockpit work (all lights are ON as long as you hold the button). This includes SUA and 3 green lights on ASP.
	Contact tower, ask for start-up	-	Upon start-up approved, proceed with the sequence.	
Насос 1 гр. баков	Fuel pump 1st Tank Group	RH57		



	On		
Насос 3 гр. баков	Fuel pump 3rd Tank Group	RH59	
	On		
Расход. насос	Fuel pump Drain Tank On	RH60	
Агрегат запуска	APU Start On	LV35	
РУД – (ручка управления двигателем) →Малый газ	Move throttle to idle		Move the throttle forward a bit more from IDLE (this is an in-game request, due to specific throttle axis mapping).
ЗАПУСК ДВИГАТЕЛЯ	Check Engine Start state switch (It must be “Engine start” not “Cold start”)	LV5	
ЗАПУСК НА ЗЕМЛЕ	Engine Start On (2-3s)	LV4	<p>Engine is starting-up. Normally, it will take up to 45 sec. for the engine to reach idle RPM. WAIT UNTILL THE PROCESS IS OVER! Otherwise, you may interrupt it, overloading the electrical system. Engine idle RPM should be around 35% (1) and 50% (2). This may increase if atmosphere pressure is low and/or temperature is high.</p> <p>ЗАЖИГАНИЕ on T-10 is ON. It stays ON during the start up. When the engine reaches the idle RPM, it goes OFF. If it does not go ON or OFF as described, the start up MUST be canceled (turn off LV21 and move RUD to STOP, then turn off other switches in reverse start-up order). In this case, wait until the engine stops and repeat whole process. The red warning lights go OFF one by one (Следи давление x 2, Сопло, Генератор =...), green lights stay ON (Стабилизатор, Триммер, ППС...). When the process is over, the APU switches OFF: now the Генератор~ red light on T-10 goes ON.</p>
Гирод. КСИ, АП, РЛС, сигнал АП	Gyro for Instruments 1 On	RH56	You hear the gyros start spinning fast. You notice the AGD start adjusting. Арретир. light goes ON,



				and after 2-3 seconds it goes OFF.
ДА-200, сигнал гирод. КСИ, АП, РД	Gyro for Instruments 2 On	RH55		Same as above, except the Appetир light.
Генерато. ~ аэрод. ист.	AC Generator On	RH49		Red warning light GENERATOR ~ goes OFF.
АРК	Automatic Radio Compass On	RV18		ARC light is ON. Compass is ready. If the sound is on (check) you can hear the NDB Morse code and you can see the ARC needle on NPP moving towards NDB.
РВ МРП	Radio Altimeter + Marker	RV19		You can hear short "beep" sound. Marker is ready.
РСБН	Navigation System On	RV20		Курс - Глисада needles and white windows on KPP move a bit if the RSBN can acquire the landing signal.
КПП	ADI On	RV21	KPP is self adjusting. No intervention needed.	KPP has two working states: main and auxiliary. Now you switched the MAIN mode which means that the AUXILIARY mode was on. So, KPP just moves a bit, Appetир. light goes ON, and after 2-3 seconds it goes OFF. KPP is ready. Basically, you can't switch off KPP unless you switch off all gyros...
КСИ (НПП)	HSI On	RV22		NPP is self adjusting...
САУ	Autopilot On	RV23		
САУ тангаж	Autopilot Pitch On	RV24		
Тримм. эффект.	Trimmer On	RV16		



Насосн. станц.	Emergency Hydraulic pumps On	RV15		
Конус	Nosecone and Air bleed doors Automatic On	RV14		
СПО	RWR On	RV6		If there is a GCA or other radar in vicinity you can hear the beeps and see the lights flashing on СПО.
СОД	SOD On	RV2	NOTE: СОД (SOD) is equipment/device similar to civilian transponder.	
Волны	SOD channel selector	RV3	Check СОД channel selector for proper channel setup.	
настройка КСИ	HSI adjust push button	CM96	Press and wait until the NPP scale self-adjust to correct magnetic course. Usually takes up to 5 seconds.	Now you adjusting the internal NPP gyro with electro-magnetic compasses located in wings. NPP moves several degrees left-right and stops, showing the correct magnetic course.
Запры фонарь	Lock the canopy	LV41 then LV38	First lever LV41 locks the canopy in closed position while second lever LV38 allows compressed air to fill the rubber cockpit hermetic seal.	
			Basic start-up procedure is finished. Check your airbrakes, extract flaps to takeoff position, check trim, check controls movement. Select desired NDB channel (1-9 channels, RV31) and see the NPP needle turns toward the station. If you don't plan to use weapons you are ready to taxi. If you have weapons onboard,	



proceed with the following sequence (must be done prior the taxi procedure).			
Обогр. СС, РНС, ФКП	Missile Controller Power On	RV25	Turn on if you have IR or radar guided missiles onboard.
Питан. 1-2 УБ, МБД	Pylon 1-2 Power On	RV27	
Питан. подв. 3-4	Pylon 3-4 Power On	RV28	
Прицел	Gun sight Power On	RV33	ASP lights, pipper and net are ON. The pipper moves in position according to armament control panel setup.
СРЗО	SRZO "IFF" On	RV35	At this point you are ready to taxi.
Although you powered up the weapon system, you are still not able to use weapons because several "hot" switches are still off. Use of these switches will be explained later.			



Taxi

Note: all engine power settings will be given in low-pressure compressor RPM which is indicated by the tachometer needle 1. This applies throughout the whole document, unless specifically noted.

Before conducting your taxi, check that your flaps are in the takeoff position (LH67 button, PPS green flaps light ON). Always call Air Traffic Control (ATC) and ask for permission to taxi; ATC will ensure you have a safe taxiing procedure and give you information with regards to the active runway, and wind direction and intensity on that runway. This is important because if you miss the correct runway (especially correct takeoff direction) you might end up in flames trying to takeoff downwind with a heavy load.

Place the rudder in the neutral position (rudder neutral). Press the brakes (PS8) and check that the braking pressure (CL67) is at least 8kp/cm² (usually it should be 10kp/cm²). Increase engine RPM to 80% and release the brakes. When the aircraft starts to move, press brakes again to check if braking is even and then release the brakes to continue your taxi. If you taxi straight from your parking place, allow the aircraft to gather about 40-60km/h (20-30nmi/h) then decrease the power to maintain that speed (~65%). At this speed you will be able to use the rudder to maintain direction, so you'll avoid wasting compressed air when braking to maintain direction. However, if you are making turns, you need to decelerate to 15-20km/h (9-11nmi/h) and use rudder controls and brakes to turn the aircraft.

Hold position and line-up

Sometimes ATC will stop you near the active runway at a line called "hold position". In such a case, while waiting for ATC clearance, you can check that the canopy is locked and sealed (levers LV41 and LV38 in front position). Apart from that, check a few RSBN/NDB stations in your immediate vicinity by selecting the appropriate stations/channels, watching for correct RSBN/ARC needle indications and listening to the Morse code. After you're cleared to line-up, taxi to the line up position and stop on the centerline. Check that the NPP course indication is correct and if needed, adjust the NPP so that the NPP shows an exact runway course (use the CM96 button). Check that the flaps are in the takeoff position (look at the flaps buttons panel and PPS), turn on the nose gear brake (use CU97 lever and place it in horizontal position), press full brakes (check pressure on CL67, should be 10kp/cm²) and increase RPM to 100%. Wait for the EGT to reach at least 600°C (look at the EGT indicator CM56). While the EGT rises, check engine oil pressure (should be at least 3kp/cm², no "МАСЛО" CM54 indication lights) and hydro-pressures (at least 170kp/cm², no warning lights on warning panel T-10, RV70 table).



Takeoff run

When the temperature reaches $>600^{\circ}\text{C}$, engage the afterburner and wait until it fires (it takes 1-2 seconds). You will need to positively identify correct afterburner operations in order to avoid complications during the takeoff run if afterburner failed to engage: first you will notice the “kick” which will start to move the aircraft even though the brakes are fully engaged. Next, the “Nozzle open” on the T-10 table indicates that the engine nozzle opened to enable correct afterburner operation and finally “Afterburner engaged” (1st afterburner) (and “Emergency afterburner engaged” (2nd afterburner), if turned on) lights on T-10 will light up. At this point, release the brakes and let the aircraft accelerate. During the takeoff run, control the aircraft’s steering only by using the rudder. Avoid using brakes because the steering will be very intense in these conditions and you will most likely violently disturb the plane, thus making it hard to control. A normal takeoff run without external loads during an average day at low altitude only takes about 15-17 seconds. When the speed reaches 250km/h, lift the aircraft’s nose to an angle of 4-5° according to the KPP (or 10° according to UUA) and takeoff at around 350-360km/h.

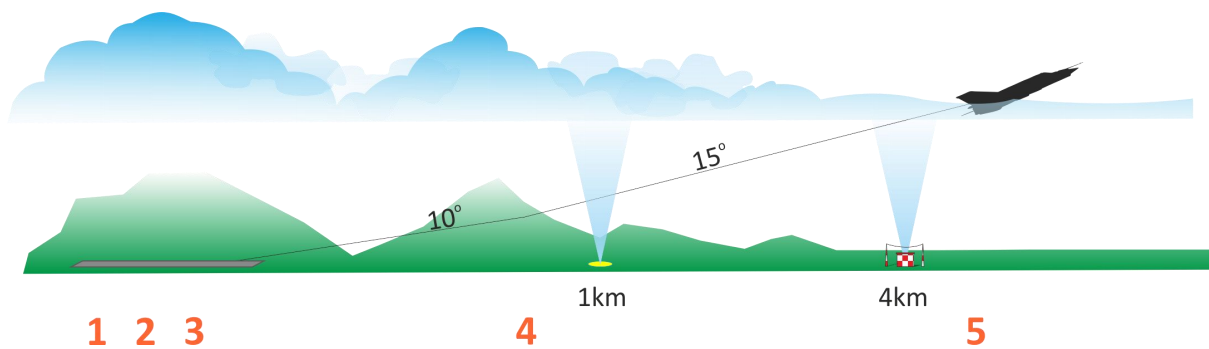


Image 7.1: Takeoff climb.

- 1 - Takeoff run: flaps 25°, full afterburner
- 2 - Rotate (nose up to 4-5°) at IAS 250-300km/h
- 3 - Takeoff IAS 360-380km/h, initial climb 10°, retract gears above 10m AGL
- 4 - Altitude 100m, flaps in, climb 15°
- 5 - Altitude min. 600m, IAS min. 600km/h, afterburner OFF, adjust power and climb

Takeoff climb

Once the plane has started to climb, wait until it reaches about 10m and retract the landing gears (place LV44 lever in upward position). Increase the climbing angle to 10° according to the KPP and



take a look at the PPS to make sure the gears are up and locked (PPS red gears lights). Place the LV44 in central position to release the automatic gears breaking system of compressed air (this system automatically breaks the gears rotation when the gears start to retract). Take a glance at the altitude: when you reach 100m AGL (look at the radio-altimeter CM84) retract flaps using the LH68 button and check flaps retraction by noticing the increase of pitch angle and slight sensation of loss of lift. At this point, the aircraft will start to accelerate even more, since you eliminated large amounts of external drag generated by the gears and flaps. Now check your speed: when it reaches 600km/h IAS, disengage the afterburner and set engine RPM to 95% for the rest of the climb.

Note: If you previously engaged “stabilization” autopilot mode, disengage it.

Climb

For your first flight, its best to climb to 5000m ASL. Altitudes from 1000m to 5000m ASL are called “medium altitudes” and they are best for first impressions concerning the aircraft’s stability and agility. During the climb, try to maintain 600km/h IAS by adjusting the climb angle without changing the engine RPM. Once at altitude, decrease RPM to whatever is needed to maintain 600km/h IAS and fly for a while in a straight line.

Basic aircraft behavior

Get a feel for the cockpit; try to assess what can be seen through the canopy, and what amount of airspace you can see. Perform few slow and fast rolls to see how aircraft reacts to your inputs. Note the altitude change during rolls and try not to change your altitude much. The next thing you need to feel is horizontal acceleration. Establish 600km/h IAS and engage the afterburner. During acceleration, the airflow around the aircraft changes, and so do lift and drag forces: use trim to maintain horizontal flight without significant changes in altitude. Let the plane accelerate to 1000km/h IAS and then disengage the afterburner; set engine RPM to idle. Engage airbrakes and let the aircraft decelerate to 400km/h.

Note: 1000km/h IAS at 4000m ASL is close to 1 Mach. Do not accelerate much beyond Mach 0.9 at your first flight.

Once at 400km/h IAS, retract the airbrakes and increase engine RPM to around 70% , maintaining 400km/h. Fly for a while at this speed and feel the plane’s behavior. Try to make few slow and fast rolls at this speed and notice the difference in aircraft behavior.

Note: Fighters don’t like it when they loose speed. Low speed demands higher AoA in order to keep the plane flying. This – in return – increases the overall drag which demands more engine power in order to keep the plane airborne. If the speed further continues to decrease (like in a sharp turn) drag will increase even more, demanding more power to support the plane.



At a certain point, the engine won't be able to provide enough power to sustain flight and this situation is known as "second regime" (or "region of reversed command"); in this situation, inexperienced pilots normally try to increase AoA in order to keep the aircraft flying or even make it climb. But this only complicates the situation since the engine can not provide more power to overcome increasing drag (plane "sinks" at high AoA and RPM). This could often end with crash if it happens on low altitude. This is dangerous situation which can be overcome only by decreasing the AoA, losing some altitude in order to increase IAS so that drag decreases and lift increases, after which the pilot should carefully set up a slow climb with a further speed increase. For the MiG-21BIS, maneuvering below 400km/h requires attention, not only because of this danger, but because of slow attitude changes (aircraft's reaction to pilot's inputs).

Increase the speed to 700km/h IAS. Once reached, maintain 700km/h in the next few 30-45° bank turns (you will need around 85% RPM). Perform a few full sharp turns with 60° bank angles. At 4000-5000m you will need around 95% RPM to perform these turns. Notice how quickly you can change altitude if not fully focused on guiding the plane in the turn. Mastering simple maneuvers without the help of a HUD requires some practice. When done, turn towards the airbase you took off from, and start making your way back for landing.

Longest range speed: 650-600km/h IAS (decreases with altitude)

Longest flight duration speed: 480km/h IAS (doesn't depend on altitude)

Table 7.3: Speeds conversion table

km/h	500	600	700	800	900	1000	1100	1200	1300
km/min	8,3	10	11,7	13,3	15	16,6	18,3	20	21,6
m/sec	139	167	194	222	250	277	305	333	361

Table 7.4: Altitude/fuel consumption ratio

altitude	0m	3000m	6000m	9000m	11000m
relative fuel consumption	100%	80%	65%	60%	55%



Landing, approach

Descending with the MiG-21BIS is really a matter of taste: you can get down quickly or you can save fuel and “glide” down by slowly losing altitude while maintaining operational speed (600-800km/h IAS). However, **when flying the MiG-12BIS, it is always a clever choice to save fuel.**

Note: You can engage the autopilot in “stabilization” mode, which will help “soften” the pitch and bank oscillations.

Start your initial descent towards the airbase with a 10m/s descent rate (look at the variometer, CM83) and adjust the RPM so that you maintain 600-700km/h IAS. Select the RSNB channel located at the airbase you’re landing at (if available). Stop descending at 1000m AGL and maintain 600km/h IAS. Pay attention to the RSNB/ARC needle on your NPP and adjust the airplane’s course to correspond to the landing course of the active runway. Try to fly the aircraft 14km from RSNB station in landing direction, at correct heading and at 1000m AGL with 600km/h IAS. Decrease power to 80% and extract landing gears. Check that the landing gears are extracted (PPS showing green gears lights, aircraft decelerating) and set up a descent at 5-10m/s. Speed can be allowed to drop below 500km/h but not below 400km/h. Take a look in front of your aircraft: you should see the runway at about 10km. When you reach 600m altitude, extract flaps to the first position (25°, middle button on flaps panel). Check proper flaps extraction (PPS showing green flaps info light, pitch decreases), maintain a descent rate of about 6m/s and allow a further speed decrease to 380km/h (if needed, use the throttle, avoid airbrakes use – you need to “feel” the engine).

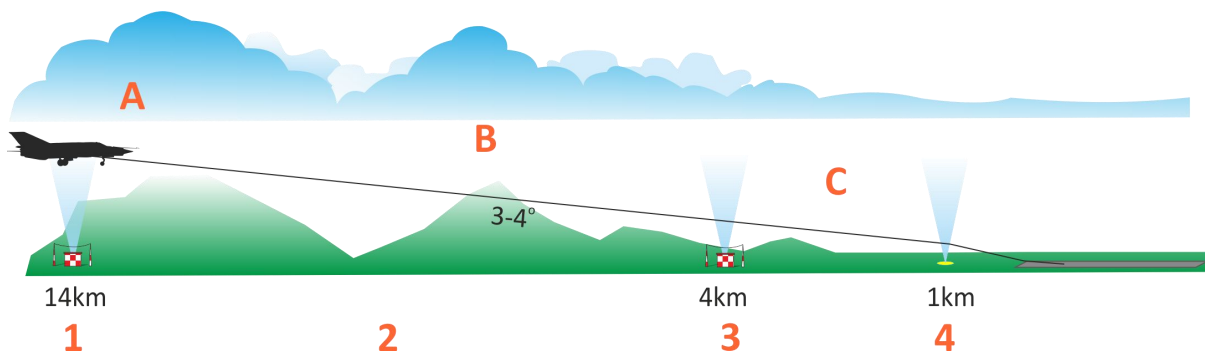


Image 7.2: Approach for visual and ARC landing (for ARC landing see Radio navigation chapter).

A - initial approach, B - long final, C - short final

- 1 - Altitude 1000m, IAS 500km/h, extract landing gear, initial descend 7m/s
- 2 - Altitude 600m, IAS 500km/h, flaps 25°, allow slow speed drop,
- 3 - Altitude 300m, IAS 380km/h, flaps 45°, do not allow IAS < 340km/h,
- 4 - Altitude 100m, IAS 360-340km/h, on threshold <340km/h.



Landing, final

If needed, line up the aircraft to the runway by making small heading corrections. For a correct approach angle, place the visible part of the aircraft's nose just below the threshold. At about 300m AGL and 380km/h IAS, extract flaps to the landing position (45°) and notice the changes in aircraft pitch, speed, and outside-cockpit visibility. If your approach angle is correct, you should be descending at about 5m/s, with your airspeed slowly falling to 340km/h IAS. The whole runway should be clearly visible in front of you. At about 1km from the runway you should be at 80m AGL, 340km/h IAS and 83-87% RPM. You will know you've reached this position by a marker sound and light indication ("MARKER" light on CM57 panel is ON for few seconds, you can hear short "beeps"). Your speed should still slowly fall, so when you enter the runway at about 2m altitude, you should be flying at around 340-320km/h.

Note: At higher speeds the aircraft will "refuse" to land, while at lower speeds the runway visibility will be severely affected by highly elevated aircraft nose. So, avoid lower approach speeds because your visibility will be degraded and – remember the "second regime" (region of reversed command) – your engine power might not be enough to safely recover the aircraft if the speed drops too much.



Image 7.3 (previous page): runway visualization during the final approach. Visibility can be very poor if you attempt to land overweighted aircraft or you have low speed and high AoA.

Decrease power and try to gently touch the runway by making small stick inputs. Note that at this point, the aircraft will still have some lift reserve, so if you abruptly increase pitch, you will end up at altitude with not enough airspeed for a safe “go around” procedure. This usually ends up by new assignment and a fresh new office, filled with a desk full of papers waiting for you to fill them up until the end of your “career”.

Note: 21 was designed to be used from ground and beaten snow runways. This means that it has a pretty durable landing gear which allows rough takeoffs and landings. If you have to choose, it is better to gently land with a bit greater speed than to hit the ground with low speed.

Landing run

Once on the ground, idle the engine, and keep the nose up at about 5° KPP. This will help you decelerate since the exposed wing area will create drag which will decelerate the plane. Once below 320km/h (which could be even before touchdown) and on the ground, activate the drag chute by using the LV30 button. The drag chute will quickly bleed off your speed and if you use brakes along with it, you might be able to stop in the first 1/3 of the runway. This will result in you having to taxi a significant distance down the runway... So assess the need for brakes use and use them to decelerate to taxiing speed and never to a full stop (unless you really need to stop). The reason for this is that every airbase has a place for drag chute jettison, and you need to taxi a bit to reach it, dragging your chute behind you. If you lose speed, dragging the chute could be fun for everyone except you, because the airplane will refuse to move once stopped with the drag chute.

When you reach taxiing speed, disengage the nose gear brake using CU97 lever (place it in vertical position) and approach to the downwind side of the runway. Jettison the drag chute by using the LH70 button; you can check if your chute fell off by looking in your periscope. Proceed to taxi and retract your flaps.

Note: If you previously engaged “stabilization” autopilot mode, disengage it.

Parking

Proceed to taxi according to ATC instructions and park your plane by making large turns around obstacles and parked planes. If you have any weapons on the plane, never turn your nose towards ground crew or other planes.



After parking, turn off the aircraft systems and the engine by following the reverse order described in start-up table. Finally, open your cockpit canopy and buy yourself a beer in the canteen.



**AEROBATICS &
MANEUVERING**



8. Aerobatics and maneuvering

All aerobatic or combat maneuvers should be performed in such a way that minimum speed in the maneuver is not less than 400km/h IAS (this speed is called *evolutive speed*). Although maneuvers can be performed at lower speeds, this is not rational since overall aircraft energy is very low and performance is below optimal.

In all maneuvers, the pilot should fly the aircraft according to allowed g-load if IAS is >600km/h, and according to allowed AoA if IAS is <600km/h.

In all maneuvers, the maximum allowed AoA is 28°, while optimum performance is reached if the pilot performs maneuvers between 21 and 28° AoA (yellow-black sector in UUA). Although the AoA could be greater than 28°, this is not recommended because of overall stability degradation, especially in the longitudinal (“nose swing”) axes, and difficulties in maintaining attitude and precise aiming.





Image 8.1: Instruments you should check often during the aerobatics are marked with red overlay. However, try to look outside the cockpit as often as you can.

In no circumstances should the pilot allow the AoA to exceed 33° , since the aircraft will stall. Stall intensity will depend on various circumstances, but generally, the more g-load is used to stall the plane – the more intensive the stall will be. In such cases, a stall can develop into a spin, which is very dangerous if not recognized in time and no altitude reserve exists. Generally, for safe spin recovery (either in normal or an inverted spin) an altitude reserve of minimum 5000m AGL must exist, for a safe recovery at 1000-2000m AGL. A spin could often be further complicated by your engine stalling, due to large instabilities in compressor operations, especially during an inverted spin. In such cases, the pilot should first recover the aircraft, and then perform an emergency engine relight procedure, according to the instructions located in the *Emergency procedures* section of this manual.

Note: Images in following subsections are made with [Tacview - Air combat maneuvering instrumentation software](#). Tacview is an excellent tool for recording and replaying DCS missions for later analysis.

Rolls

Slow or fast rolls can be performed in horizontal, positive or negative pitching angles, in normal speed domains. However, when the aircraft flies at supersonic speeds, rolls should not be performed with an angular (rolling) speed greater than $90^\circ/s$, because of greatly disturbed airflow around the tail which could cause an autorotation phenomenon.

Barrel rolls are more demanding than simple rolls, because they combine g-load and rolling, and are often sliding, which is not noted by inexperienced pilots. Although no spatial requirements exist in barrel roll performance, the pilot should pay attention to decreased g-load when inverted or otherwise the diving angle will be too high and second part of the maneuver will require a high g-load, which could be prohibited due to g-load limits (e.g. required 6-7g, available 5 because of payload), or low altitude. When performing a barrel roll at low speed, the pilot should cancel out all slips using the rudder, or otherwise the aircraft could stall or even enter a spin.

Split-S

Split-S is a vertical maneuver in which the aircraft loses altitude, increases its' speed and quickly changes heading by 180° . This is most often an "altitude-for-speed trade" maneuver.

Split-S is also called turn-over or somersault in original Russian terminology.

A Split-S can be performed at any speed (subsonic or supersonic) with respect to the fact that during the maneuver, maximum IAS and allowed g-load do not go beyond limitations. An optimal Split-S is



if the initial speed is 400-600km/h and with maximum allowed AoA applied right after the initial semi-turn. A Split-S can be performed with a speed increase, no significant speed change and speed decrease (braking). **It is up to the pilot to decide what kind of a Split-S is best for any given situation**, but as a general rule, speed increase is recommended.

The basic Split-S is performed from 4000m AGL at 85% RPM, with initial speed at 550km/h, establishing 10-15° climb just prior to the semi roll. The Semi roll should be executed in 2-3 seconds, briefly aligning the wings and canceling out the yaw, and then applying 18° AoA until the g-load increases with a speed increase to 4g. At this point the pilot should maintain 4g until the aircraft reaches about -20° diving angle. At this angle the pilot should increase RPM to 100% and wait until the speed increases to 850km/h (a few seconds) and then continue with at 2g until the aircraft is in horizontal flight. The reason for this delay is to accumulate enough speed for connected vertical maneuvers such as a loop or Immelman that usually follow the Split-S in training flights. At the end of the described Split-S, the aircraft should be at roughly 1500-1000m altitude.

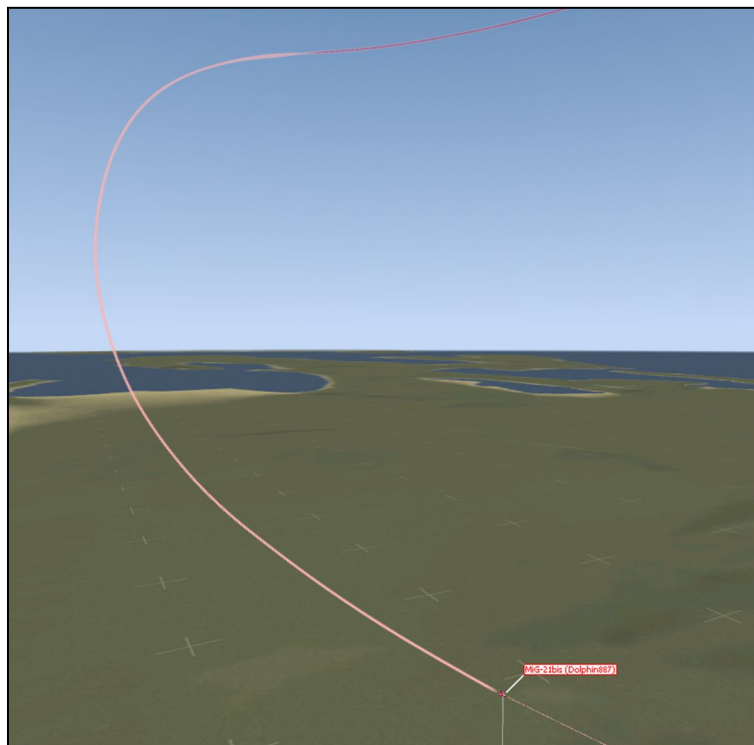


Image 8.2: profile of basic split-S, with initial altitude around 4000m and acceleration during dive.

Loops and Immelman turn

Loops can be performed in a strictly vertical or inclined plane. Vertical loops are simple with only a few requirements: minimum speed not below evulsive speed and maximum g-load not beyond allowed for the current external loads (if any). However, inexperienced pilots could easily find themselves in “high nose – low speed” situation during the first half of the loop. In this case, the



pilot should perform an Immelman turn³ instead of the loop, with the most important thing being to maintain low AoA – optimally keeping it between 21-28° and ignoring other parameters except yaw. No matter of the IAS, the aircraft will safely recover if the AoA does not enter the red sector. It is important to start the half-roll just when the speed reaches evolutive speed, not before that, because there is a risk that the pilot will pull the stick diagonally, increasing the AoA around the outer-rotating wing causing the aircraft to stall.

Evolutive speed is the minimum speed at which an aircraft can perform a horizontal turn with 60° bank. In case of the MiG-21BIS it is IAS 400-450km/h depending on the payload and altitude.

A Basic loop is performed from 1000m AGL at 900km/h, with afterburner, applying a 2g load until the climbing angle reaches 20° and then applying 4-5g until the speed falls to 600km/h (which should be around 90° vertical climb position). After that, the pilot should maintain 16° AoA until the plane reaches the top of the loop. At the top, the speed should be at least 400-450km/h IAS; at this time, the pilot should disengage the afterburner, set 85% RPM and increase the AoA to 18° until g-load increases with a speed rise to 4g. At this point the pilot should maintain 4g until the aircraft reaches about a -20° diving angle. At this angle, the pilot should increase RPM to 100% and wait until the speed increases to 850km/h (a few seconds). Continue with 2g until the aircraft is in horizontal flight. The reason for this delay is to accumulate enough speed for connected vertical maneuvers.

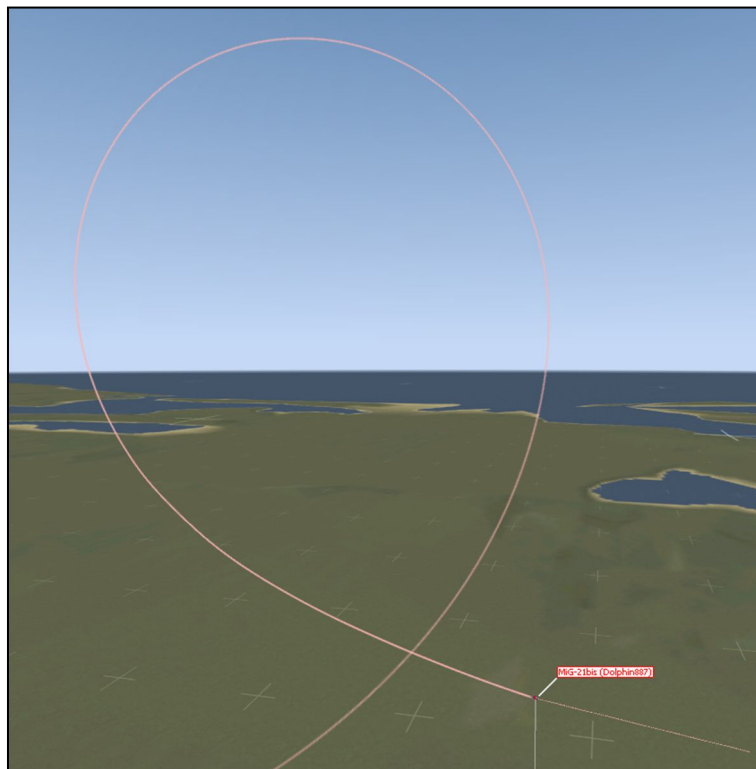


Image 8.3: profile of a basic loop, with entry at 1000m with 4-4.5g, top on 3500-4000m, and acceleration during exit-dive.

³ Immelman turn is actually first half of the loop which end with semi roll at the top.



Inclined loops are the most usable maneuvers for close air combat and general combat positioning. Since the plane is inclined from a strictly vertical position, they could be performed at almost every speed and g-load. Apart from that, they can be transformed and connected into other maneuvers at almost any time, preserving the high energy and space separation from a target. In most inclined loops, the pilot does not need to pay much attention to speed bleed-off and AoA, since the aircraft usually has more energy during the whole maneuver than it has in a strictly vertical maneuver like the Immelman.

Basic inclined loops are performed with 30° and 45° of bank. The most complicated part of the inclined loop is maintaining the inclination angle during the loop. This is hard because the bank constantly changes during the loop and the pilot needs to develop skills to control the bank according to known values. In inclined loops, starting bank will always increase in the climbing part of the loop and decrease in descending part of the loop. The bank will always be 90° at the $\frac{1}{4}$ and $\frac{3}{4}$ of the loop, while at the top of the loop ($\frac{1}{2}$) it will have the approximate negative value of the initial value (so, if the initial value was 30° , at the top of the loop it will be approx. -30° bank). The simple rule for inclined loop execution is to set up initial bank and then pull the stick straight without any further bank inputs. The best way to practice an inclined loop is to perform it over a straight ground object, such as a runway. If you exit the loop at the same place and direction as where you entered it, then it is a correctly performed inclined loop. The best inclined loops are performed at $30\text{-}45^\circ$ bank angles and with $700\text{-}1000\text{km/h}$ initial IAS, at maximal or afterburner power.

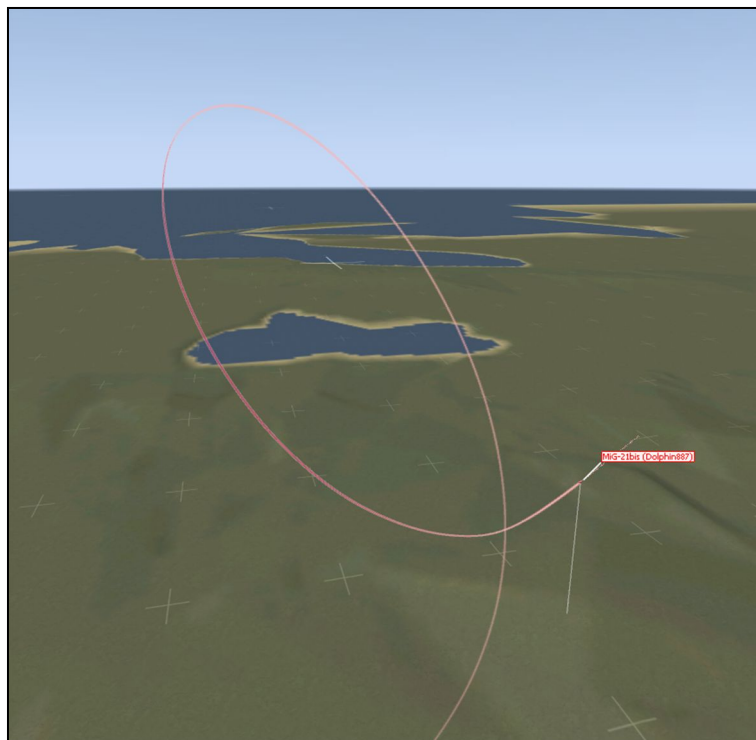


Image 8.4: profile of inclined loop, left in this case. Speed in inclined loop is better preserved than in a loop, so energy levels are higher. Inclined loop (or parts of it) are very useful during combat maneuvering.



Semi - turn over (or semi-somersault)

This is a maneuver in which the aircraft changes heading, and increases diving angle and speed. It is used to adjust the aircraft towards the ground, sea or a lower aerial target which is aside. Depending on the horizontal and vertical angles at which the target is located, observing from the fighters position, a semi-turn over could be performed as a pure semi-turn over or as a second part of the inclined loop.



Image 8.5: semi-turn over could be a bit tricky to visualize if you've never seen it. The image shows an aircraft turn-diving to the left, changing its heading by $\sim 90^\circ$ during the maneuver. This maneuver is often used for ground target attack, since the MiG-21 has poor down-forward visibility. Thus the target should be off to the side prior to the attack run.

A pure semi-turn over is performed when the target is at around $45\text{-}135^\circ$ aside and at vertical angles not greater than -40° . It is performed as a diving sharp turn, in which the pilot flies the plane in such a way that he ends the maneuver aligned with the target and at the requested diving angle for certain weapon type use. For example, for most of the bombs this angle should be -30° , so if the target is e.g. $\approx 90^\circ$ right and approximately $-10\text{...}-30^\circ$ down, the pilot will need to perform a sharp turn towards the target with the horizontal part of the turn (the target is $-10\text{...}-20^\circ$ below so we need to get closer before we start to dive to provide -30° attack angle) or immediate dive (the target is approx. -30° below so we can turn and dive at once). Deciding what the correct maneuver shape is, is a matter of practice and skill.

If the target is at horizontal angles greater than 135° and especially if it is "below the plane" in sense of vertical angle, a semi-turn over should be performed as a second part of the inclined loop.



Combat turn

The combat turn is a maneuver in inclined plane, during which the aircraft changes direction by $> 90^\circ$ (usually 180°) and gains altitude. The most practical use of this maneuver is a fast climb with direction change after an attack on ground targets: this decreases effects of ground close air defense units and it is most efficient in combination with chaff/flare use. It is performed with a high initial speed, by pitching the aircraft under $\sim 30^\circ$ while - at the same time - keeping a constant bank of $60-80^\circ$. The aircraft climbs and changes direction at the same time. After the combat turn is executed, the aircraft is usually ready to perform a repeated attack on the same ground target, which it engaged in the previous attack. Depending on the situation, it can be performed with either more or less altitude gain, and with an appropriate change in direction of flight: in other words, this is a flexible maneuver which can be adjusted to a specific situation. The most important thing is to end the maneuver with enough speed for next one, so whichever way you perform the combat turn, don't allow your IAS to drop below 400-450km/h.



Image 8.6: profile of a combat turn, image from the top of maneuver. Most beginner pilots have difficulties comprehending and executing this maneuver properly.

Inverted flight

Inverted flight can be performed at any flyable speed due to symmetric wing and tail airfoil. However, at lower speeds the horizontal tail movement might not be enough to enable inverted flight without altitude loss. Time limits at inverted flight are dictated by engine fuel reserve for negative g-load operations. The pilot can safely fly inverted for 15 seconds with up to 100% RPM, 5 seconds at normal and 3 seconds at emergency afterburner. For safety reasons, repeated inverted



flight after reaching the maximum allowed time is 30 seconds because of time needed to refill the inverted flight tank.

Note: In inverted flight the AoA will show negative values, but concerning the allowed AoA same laws apply as in normal flight, although the control of the AoA is limited since the UUA is showing only values up to -10° .

Basic training aerobatic suite

Fly to the designed training zone or zone above your takeoff base (if airspace is available) at 4000m AGL and 600km/h IAS. Upon arrival, make one 30° adjusting turn to align yourself in optimal heading (e.g. sun aside, over a lined object such as a river, parallel to mountain tops or along the coast). When ready, remember the heading and perform several sharp horizontal turns with 60° bank to either side. After that, decrease speed to 550km/h, set up 85% RPM and perform a semi-turn over followed by a combat turn to the opposite side. Execute at least two sets of semi-turns overs, followed by combat turns. Once you finish with that, check that your altitude is at least 3500m AGL, and execute a Split-S as described for the basic Split-S. After the Split-S, continue to a loop by engaging the afterburner. Perform the basic loop as described. After the loop, continue to the Immelman turn as described. Repeat the Split-S – basic loop – Immelman set until you reach about 1000-1200l of fuel. Return to base; and on your return make several slow and fast rolls. Perform one classic touch-and-go procedure. If you still have more than 800l of fuel, perform an additional school pattern with another touch-and-go procedure. Land when you've reached 600-700l remaining fuel.

Fly this suite as often as you can. Try to meet all the correct parameters for each maneuver. Once mastered, you can eliminate sharp turns and include inclined loops, barrel rolls, inverted flight, stalls, and spins...

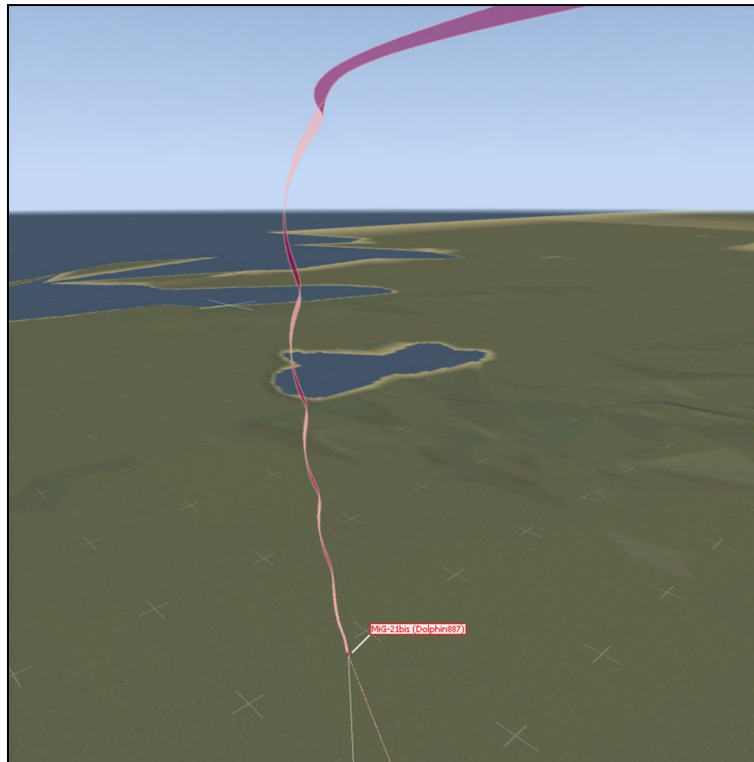


Image 8.7: profile of a flat spin after dynamic entry. On given image, each turn is about 500m altitude loss. If you experience a spin, expect your engine to shut down. When flying DCS MiG-21BIS always associate spin with high probability of engine shut down. If you manage to recover the plane, you will have to assess whether you have a chances of restarting the engine.

Combat maneuvering, basics

The only purpose of the basic and advanced aerobatic maneuvers is to make you ready for maneuvering the aircraft with as little as possible concentration on flying and as much as possible concentration on fighting.

Combat maneuvering is an art; the more talent the pilot has – the better. However, this art needs to be trained and perfected, so even an average pilot could develop exceptional skills if trained properly. Explaining combat maneuvering is a complicated task, while learning it is even harder. The best way to practice combat maneuvering is to fly 1 vs. 1 simulated fight with a live opponent flying the same aircraft type, without using weapons. The aim of this training is to maintain constant situational awareness and visual contact with the opponent. In the first several fights you should concentrate on flying your plane at the back hemisphere of your opponent; don't worry much about weapons use – this will come later. When you learn how to control your speed, altitude and distance to the target, try introducing simple cockpit operations like turning on and off the gun, missiles or changing radar modes. Practice this one operation at a time. When you master one, move to another. Eventually, this will teach you how to fly your plane without losing the sight to your opponent and – at the same time – manage weapons systems with minimal interruption to flying.



Image 8.8: Instruments you should check often during the combat maneuvering. Look outside the cockpit most of the time.

Once you feel comfortable in a 1 vs. 1 fight against the same aircraft type, move to 1 vs. 1 against different aircraft types (fighter is mandatory, other aircraft won't teach you much of aerial combat). You might be constrained to using an AI opponent (e.g. F-4, F-5, MiG-21); in that case start by giving the opponent the lowest possible skill level, and increase the level as you gain experience. If you fly against live, skilled opponents, who are flying the fighter with better maneuvering capabilities (e.g. MiG-29) ask him to start with simple maneuvers and to gradually introduce complex maneuvers.

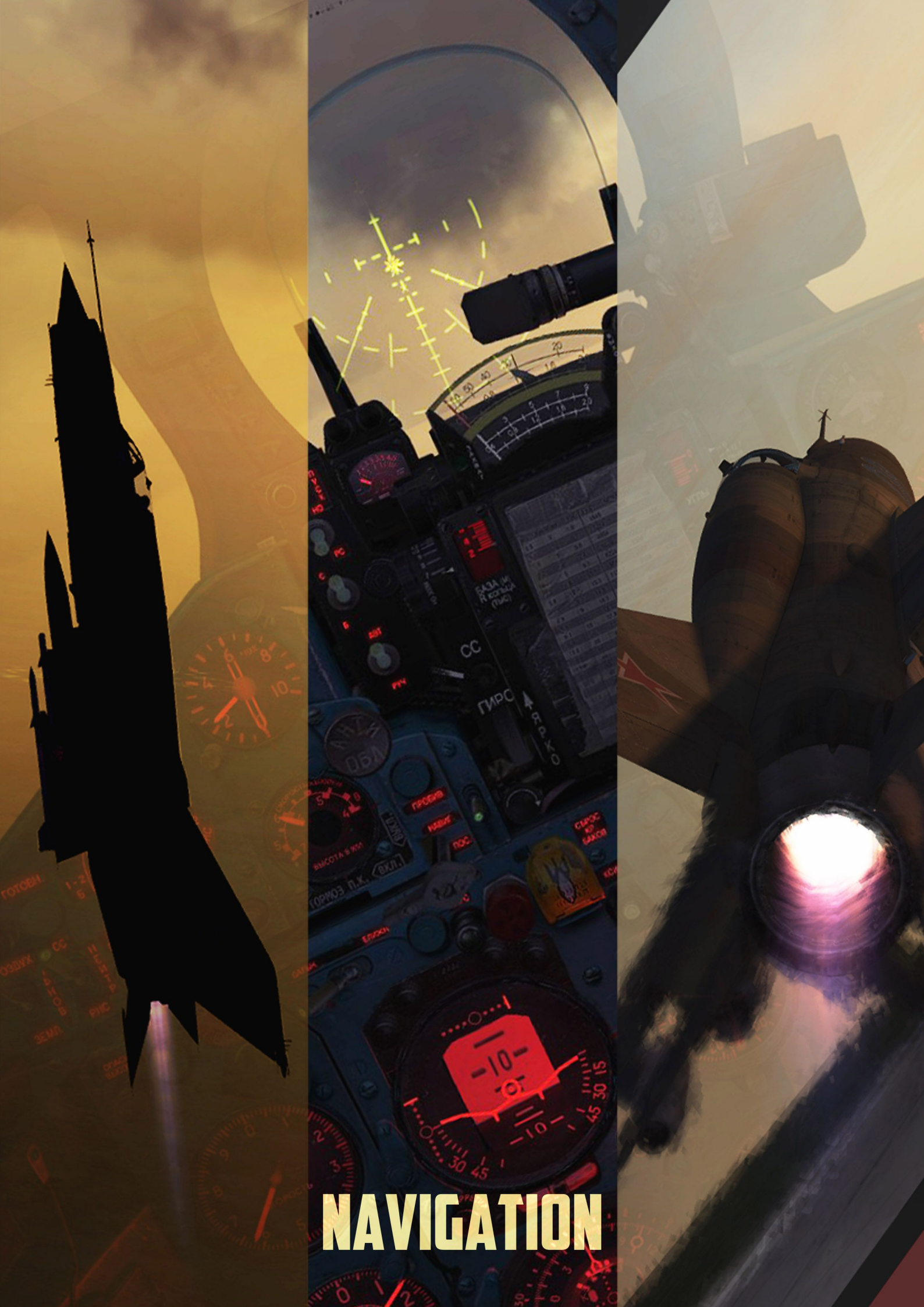
Remember that no matter how good you fly and fight, human-piloted fighters in DCS have superior weapons systems which will give you a hard time in live combat. In some cases, it is not shameful to safely withdraw from combat and save the aircraft for other fight.

When you develop some skills in fighting different aircraft, find some friends and try 2 vs. 1 (against superior opponents such as Su-27) or 2 vs. 2 (against approximately same or inferior opponents, e.g. F-4, F-5 etc). The focus of these training sessions is to develop awareness of friendly and enemy positioning and intentions in a dynamic environment. You will also discover difficulties with information exchange: a lot of radio conversation with many unimportant messages. If you can develop skills to filter out what is important and not to speak too much, you will benefit in many combat situations when you have several friendly pilots (or wingmen) on same radio channel. You



will also find that some of your friends are better suited to you; try to fly with friends who are at approximately the same skill level and who understand your intentions without much explanation. This will greatly improve your performances in a team. When you feel comfortable in 2 vs. 2 fights, use your developed skills to engage individual enemies or even larger groups of enemies in pairs: if you have a flight of 4 planes, split them in pairs and fight in pairs.

Although pair combat is a key to fighter success and survival, in simulated environments such as DCS, combats are often “single vs. single” or “single vs. many”. This means that you have to develop skills to fly and fight alone, hunting for an opportunity to kill without being killed. However, although this might result in some good results and experience, it will not take you very far. If you truly want to learn and simulate what real pilots do – fly and fight in pairs or larger groups.



NAVIGATION



9. Navigation

Note: Apart from description in this manual, a set of interactive training missions related to basic and advanced navigation are available with the DCS MiG-21BIS installation. You should read this chapter before attempting to fly those missions.

Basics

Navigation in the MiG-21BIS is performed by utilizing the following instruments: NPP (CM84), KPP (CM85/86), ARC (selector RV37, control panel RV8) and RSBN/PRMG system (control panel LV17/26).



Image 9.1:(left): KPP - above, NPP - below.

Besides showing the aircraft's attitude, the KPP also displays glide path and localizer radio beam information (see RSBN in text below).

The NPP shows current heading (underneath a little triangle caret on top of the instrument), bearing toward ground radio equipment (needle 9 with small circle – needle head), manually set course ("hollow" needle, tip on 6; course is set with the 3K knob nbr. 5), information about the glide path and localizer (glide path and localizer needles and flashers, 3, 4, 8) and contains markers for "large pattern" landing (7 white, dotted-markers on inner circle of the instrument numbered "2", "3" and "4").

According to the applied navigation method, navigation can be classified as visual, calculated (dead reckoning), radio navigation, inertial or satellite navigation. Navigation in the MiG-21BIS is visual, dead reckoning and radio navigation. In real life, satellite navigation can be applied as well by utilizing portable satellite receivers.

Visual is the simplest type of navigation, based on visually determining the aircraft position according to known, reference ground points/objects. This is the most basic navigation and is used as a backup method for determining aircraft position along with other navigational methods. Advantages are simplicity and fairly quick location finding. However, the disadvantages are that it can only be applied in fair weather, during daylight and above well-known terrain.

Dead reckoning is based on calculated aircraft position which can be compared with actual position determined by other navigational methods (e.g. radio navigation based on ground based radio station). Dead reckoning is always applied in low visibility conditions, at night and when flying above clouds. Dead reckoning navigation is based on observing ground speed and measuring time and



course between two points. Advantages are the ability of calculating a flight plan ahead of time and ability to determine aircraft flight path when it is not possible to use other navigational methods (e.g. lack of ground radio stations in the area). Disadvantage is in complexity of flight calculations, especially during combat missions.

Radio navigation is based on determining the aircraft's position by utilizing ground radio stations. Determining accurate aircraft position is possible depending on the aircraft and ground equipment type as well as applying simple or complex position determining methods. Advantages of radio navigation are speed and precision. Disadvantages are dependence on ground and aircraft equipment. Besides, during combat, an opponent could employ radio jamming techniques to jam your aircraft's radio equipment, thus partially or even completely disabling your radio navigation.

Note: There are several types of navigational ground radio stations. **Non-Directional Beacons (NDB)** radio stations transmit navigational signals which do not include directional information. **RSBN/PRMG** radio stations provide bearing and distance information.

Other types of navigation are not of interest when it comes to the DCS MiG-21BIS.

In the following text we will focus on radio navigation, thus assuming that you already know how to use visual and dead reckoning navigation methods.

MiG-21BIS Radio Navigation

MiG-21BIS radio navigation is accomplished by utilizing ARC and RSBN devices. These two devices allow for resolving the aircraft location and flight path under all conditions, assuming that the RSBN receives signals from at least one ground station and the ARC receives signals from at least two ground stations.

Automated radio compass - ARC

The Automatic Radio Compass is the most basic radio-navigational device on the aircraft. It allows the pilot to use 26 preset ground stations; however, the DCS MiG-21BIS is capable of storing up to 72 ground stations. The **ARC power switch (RV18)** is used to turn the ARC on.



Image 9.2: ARC frequency range selector or sector selector (RV37). There are four sectors (1 - 4) and each sector has two sub-sectors (I and II). This allows the storage of 72 stations ($4 * 2 * 9$).

Tuning to the radio station of interest is accomplished by, first, selecting the radio station sector and then selecting the radio station number (channel).

Each sector has two sub-sectors, each sub-sector being capable of storing 9 radio stations (total of 18 stations per sector). The **ARC frequency range selector knob (RV37)** is used to select sectors as follow:



- sector 1-I belongs to Krym and Ukrainian part of the map (administrative territory of Ukraine), and is preset with 9 ground radio stations.
- sector 1-II is not used. It is reserved for Krym and Ukrainian part of the map (administrative territory of Ukraine), for additional - optionally user defined - stations.
- sectors 2-I and 2-II belong to Russian part of the map (administrative territory of Russian Federation). First sector is preset with 9 ground stations. The second sector is preset with first 3 channels (1-3), while remaining 6 channels are not used. Like in previous case, these free channels could hold user defined stations.
- sector 3-I belongs to Georgian part of the map (Georgian administrative territory). First 5 channels are preset and remaining 4 are not used.
- other sectors, starting from 3-II are not used (available for custom stations).



Image 9.3: ARC sectors and channels

Select the sector of interest, and then select a ground station by pushing the appropriate channel button (1 to 9 on **ARC channel selector (RV8)**). **RSBN/ARC mode selector switch (LV8)** should be toggled to a lower position (ARC). This will “unhook” the NPP needle from the RSBN and the needle will be controlled by the ARC, showing the selected ground station.

The ARC needle on your NPP will be at 45° to the right of the NPP, as long as the ARC is not tuned to the selected ground radio station or the station is not in range. During that time, there will be no audible signal in the pilot’s headphones. Assuming that the selected channel was appropriately set, when the ARC gets into range and begins receiving radio signals, the ARC needle will move, showing the signal bearing (direction to selected ground radio station) and the pilot will hear ground station identification sound signals (place **RV10** switch to COMPASS position to enable the sound).



The ARC can receive a ground station signal at a maximum distance of 120km and at certain altitudes as shown in the following table:

Table 9.1:

Distance from the station (km)	20	40	60	80	100	120
Minimum altitude (m)	350	700	1050	1400	1750	2100

Note: Signals from NDBs can be acquired from certain altitudes and distances from the station. Required altitude rises with distance, while the maximum distance for all NDBs always remains constant (120km). Practically, this means that you won't be able to acquire signals from remote NDB while on ground; you will have to takeoff and climb before the signal can be acquired. However, you will be able to acquire the signal from a very close NDB even on the ground (during taxi or takeoff preparations).

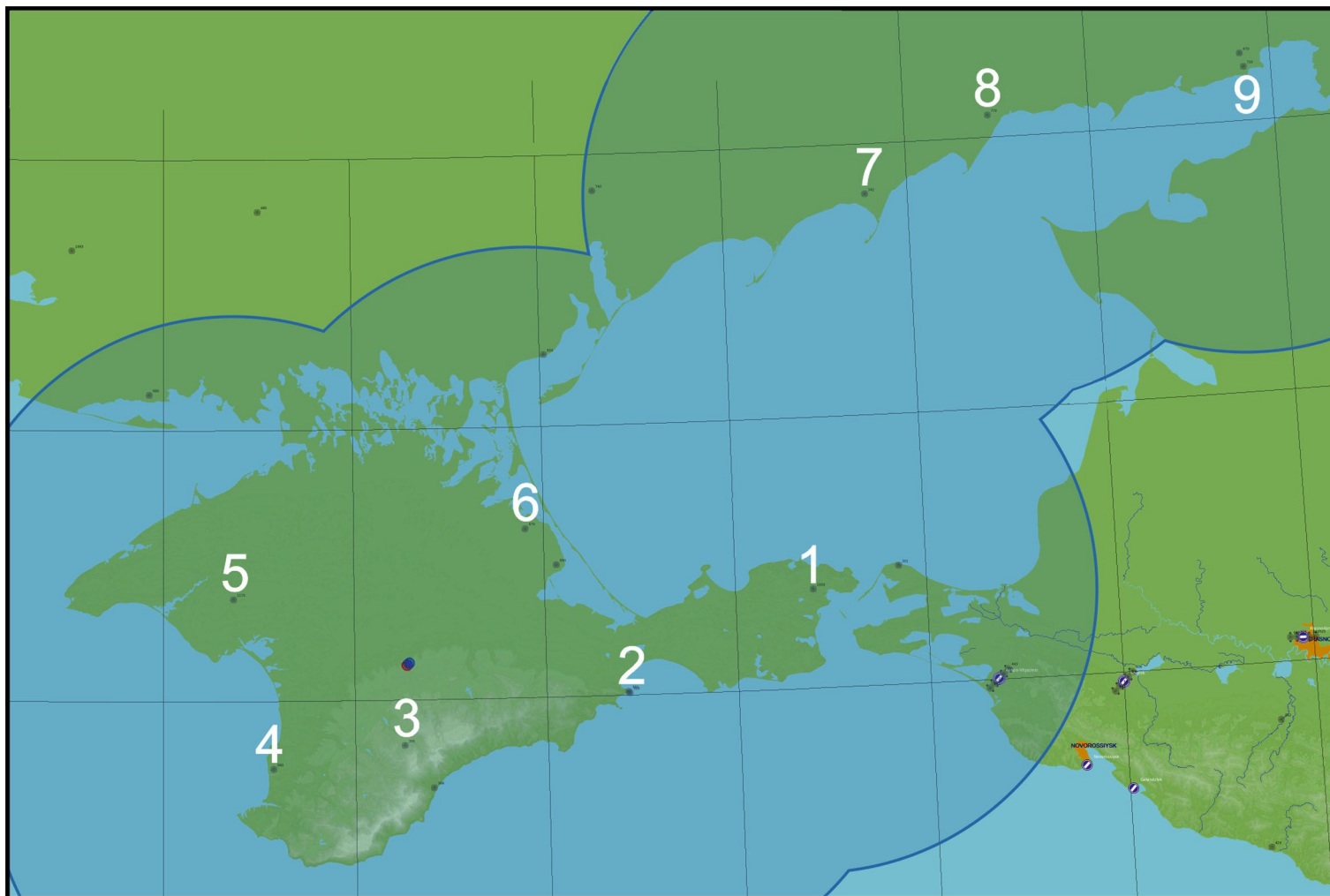


Image 9.4: Ground radio stations locations and ARC channels for sector 1-I. Outlined in blue lines is radio stations signals coverage area in this sector. [This image is available for hi-resolution print \(Mods\aircrafts\MiG-21BIS\Doc\Manual_Images\).](#)

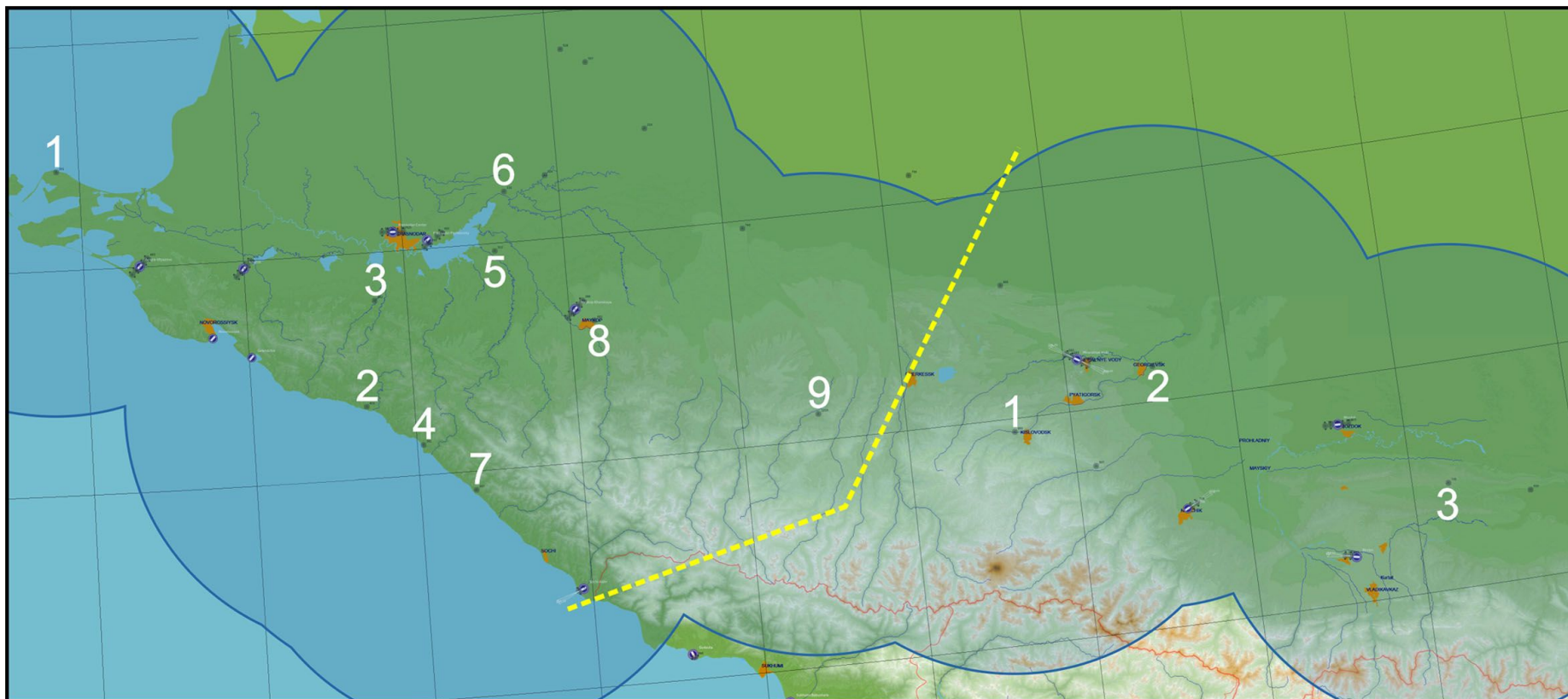


Image 9.5: Ground radio stations locations and ARC channels for sectors 2-I (left) and 2-II (right), divided by yellow dotted line. Outlined in blue lines is radio stations signals coverage area in this sector. [This image is available for hi-resolution print \(Mods\aircrafts\MiG-21BIS\Doc\Manual_Images\).](#)

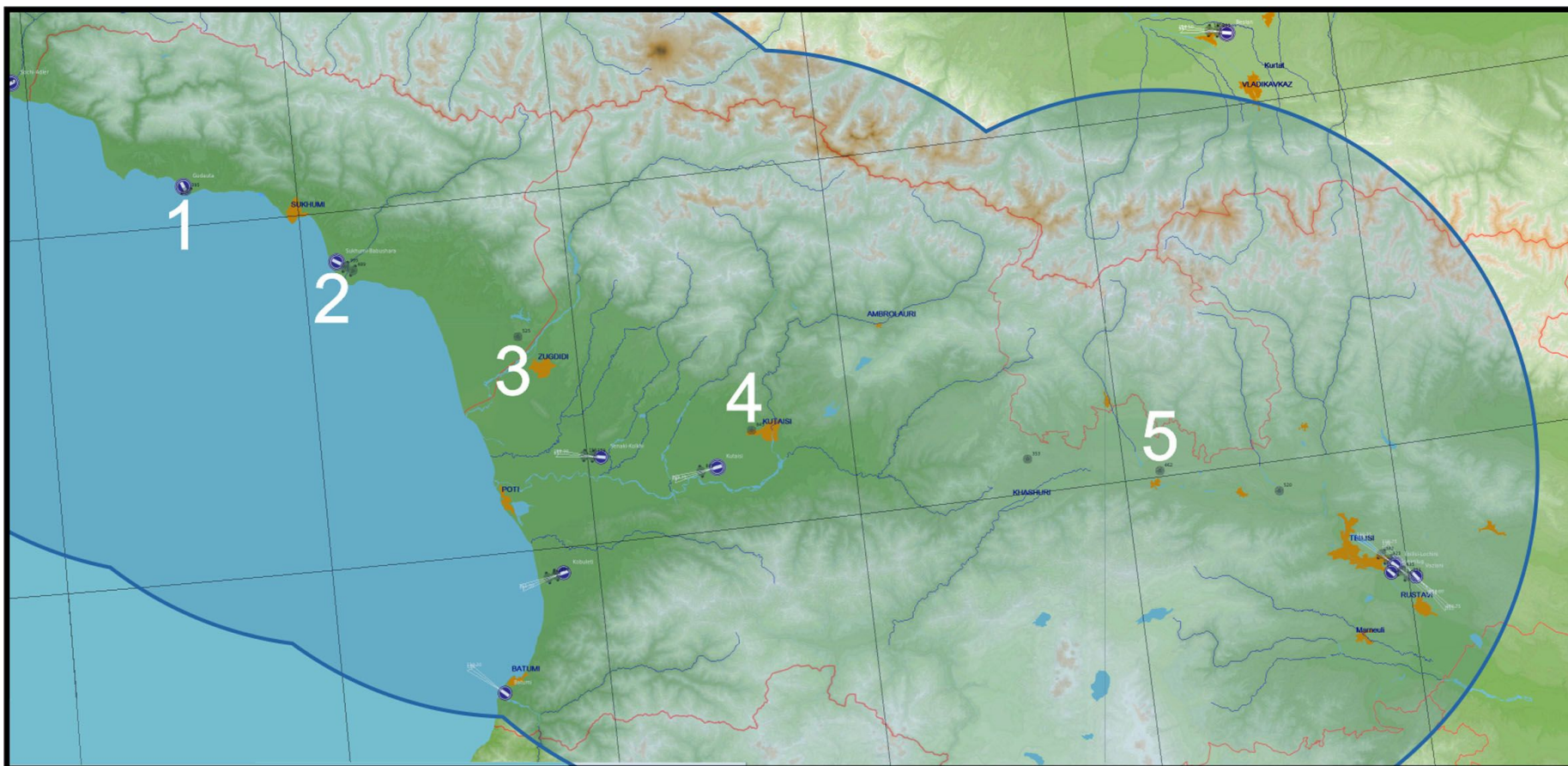


Image 9.6: Ground radio stations locations and ARC channels for sector 3-I. Outlined in blue lines is radio stations signals coverage area in this sector. This image is available for hi-resolution print ([Mods\aircrafts\MiG-21BIS\Doc\Manual_Images](#)).



Besides locating the aircraft and its flight path, an experienced pilot can use the ARC for an instrument landing approach. You need to know a physical location of the selected NDB station which is aligned with the runway you want to land on. You must fly your approach flying over the NDB station in the landing direction; you will recognize that you've just flown over the NDB station by observing the ARC needle suddenly turning 180° on the NPP. Basic NDB landing principles are illustrated in **Image 7.2**; decision altitude for ARC landing is 100m as read on radio altimeter.

Note: Regardless of your skill and experience, you must never attempt ARC instrument approach/landing under extremely low visibility!

RSBN and PRMG

RSBN („Радиотехническая система ближней навигации“ - Short Range Radio Navigation System) is a system of ground based radio stations, broadcasting omni-directional (360°) radio signals separated by 1°. It also broadcasts a radio signal that is used to measure distance (in km) to the RSBN. RSBN may be combined with PRMG (“Посадочная радиомаячная группа” - Landing radio stations group, basically the Instrument landing System) for precise instrument landings. DCS MiG-21BIS RSBN/PRMG receivers can tune 16 pre-set channels (01 - 16); channels enumeration is according to airfields enumeration (image 9.8). It is possible to select different RSBN and PRMG channels (e.g. RSBN 01 - Anapa, PRMG 02 - Krymsk) in which case the RSBN needle and distance meter will be set to the RSBN channel when the RSBN mode selector is in cloud penetration (descend) or navigation mode, and to PRMG distance and instrumental landing system when in landing mode. If both channels are the same, the distance meter will show the distance to selected airfield in all modes.

Note: ARC and RSBN are complementary devices; they complement each other to provide navigation information under various combinations of NDB and RSBN locations. For example, preset ARC and RSBN channels might be set for ground stations that are far apart. Thus, if the destination airport does not have RSBN (no preset RSBN/PRMG channel for that airport), it is very likely that the landing NDB is available and one of your ARC channels is preset for it. This will allow for an imprecise instrument approach to that airport.

The RSBN control panel LV17/26 and RSBN mode selector CU11 are used to control the operation of RSBN/PRMG. The NPP needle should be assigned to RSBN, so LV8 switch should be toggled to the upper position.

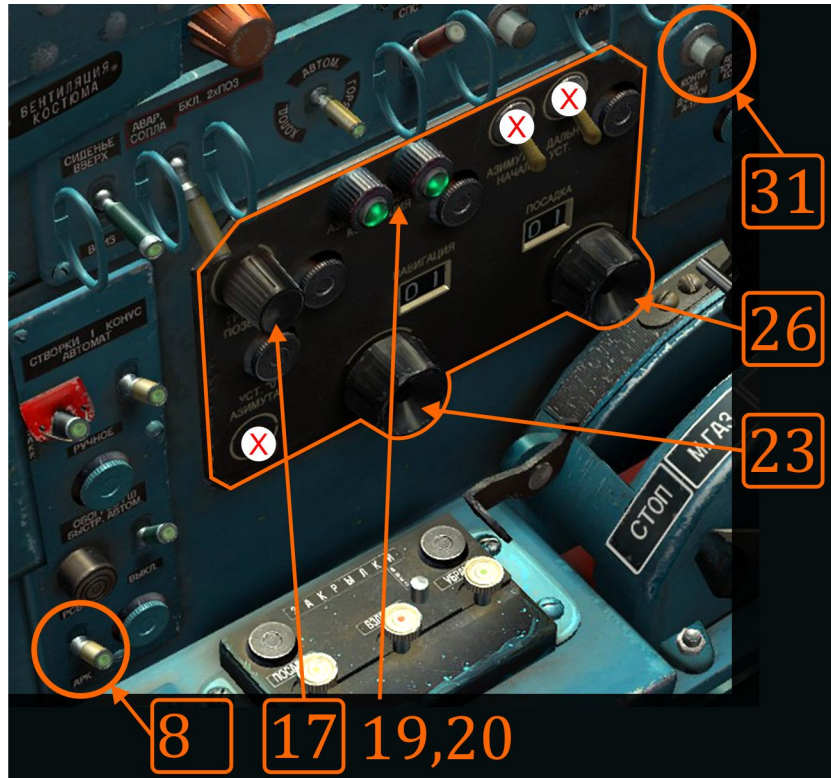


Image 9.7: RSBN control panel:

8 - ARC/RSBN NPP needle control switch (up for RSBN)

17 - sound volume control

19, 20 - RSBN and PRMG signals control lights (green - signal is OK)

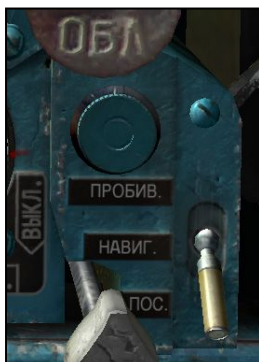
23 - RSBN channel selector with channel window

26 - PRMG channel selector with channel window

31 - RSBN self-test button (hold to test)

Controls crossed with red X are not in use.

RSBN receiver has three modes of operation:



- Clouds penetration - descend (standard, instrument descending), switch CU11 in upper position,
- navigation, switch CU11 in middle position,
- Instrument landing System (PRMG) approach, switch CU11 in lower position.

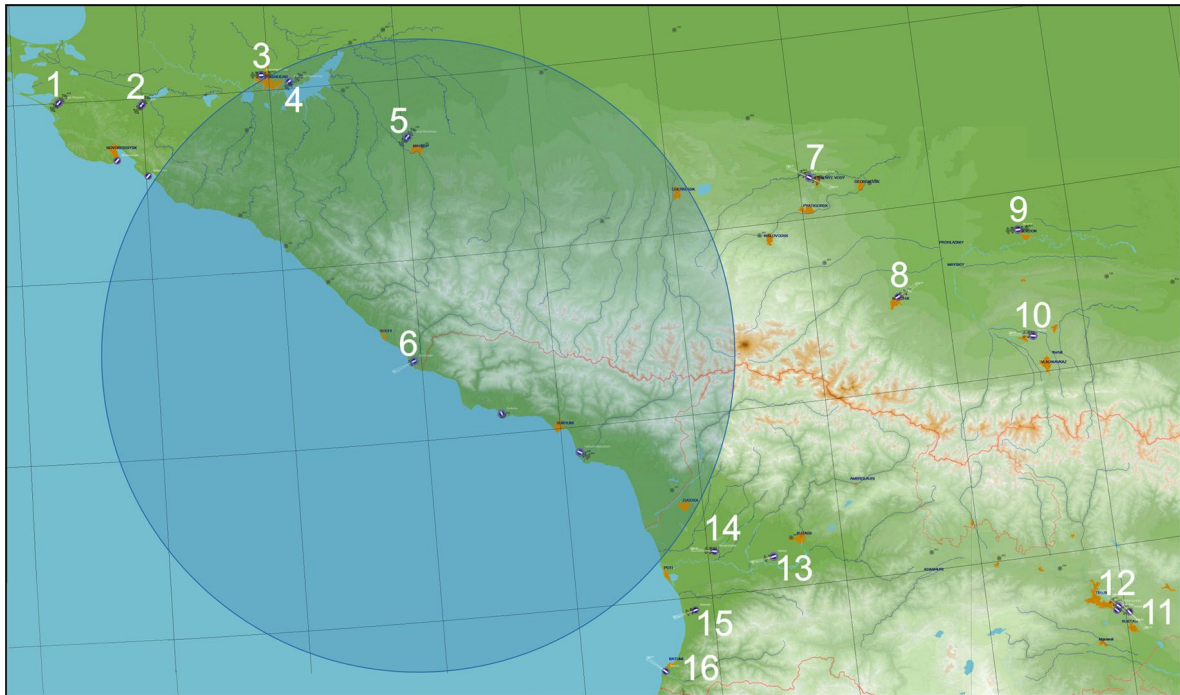


Image 9.8: RSN/PRMG ground stations at various airports, with channel numbers (1 – 16). RSN ground station range/coverage is given for Sochi-Adler only (showing range/coverage for all RSN's would cover entire image). This image is available for hi-resolution print ([Mods\aircrafts\MiG-21BIS\Doc\Manual_Images](#)).

Clouds penetration mode

Cloud penetration (descend) is a simple mode allowing the aircraft to safely descend over obstacles during approach to the selected airbase for landing. This mode is turned on when the airplane is approaching the selected RSN station for landing, before it reaches either the PRMG radio beams coverage range, or the pilot obtains visual contact with the runway. It is usually used during night missions or in IFR conditions. If this mode is selected, the horizontal directional needle will point to the calculated descent speed, which needs to be held in order to reach the desired descent altitude at a given distance from the runway. It operates regardless of the speed of the aircraft, enabling the pilot to fly the aircraft along a safe descent path. This mode allows an initial descent at a maximum distance of 120km from the runway. 20km away from the runway, the altitude should be 600m above the station, allowing the pilot to either acquire visual contact with the runway and continue a visual approach for landing, or to enter the PRMG approach. The pilot may also choose to fly directly to the station and then perform landing using a school pattern or a big box pattern.

Note that this mode does not take into account the direction of the runway automatically. The pilot needs to select the proper radial along which he wants to perform the descent. If the pilot chooses a radial using the 3K knob, he needs to intercept it using the localizer (kurs) needle, while at the same time descending using the glide path (glisada) needle.

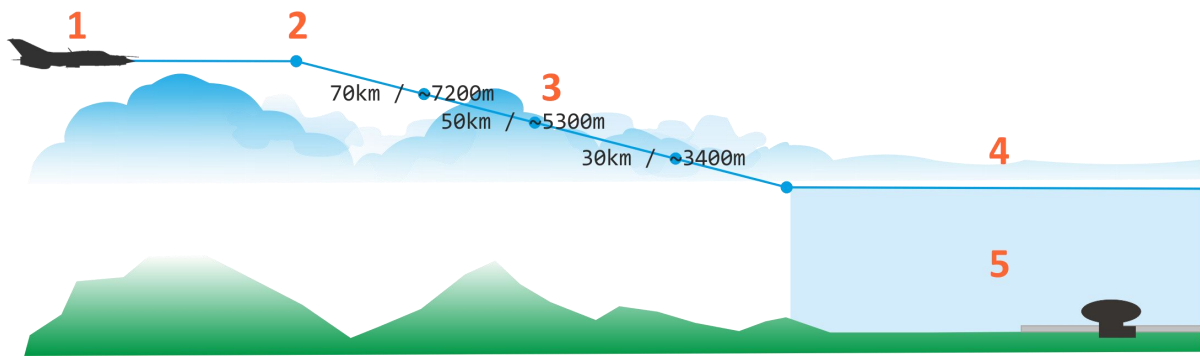


Image 9.9: guidance program for CLOUDS PENETRATION mode:

- 1 - Engage CLOUDS PENETRATION mode whenever you need it. At 120km or further from the RSBN station, your altitude should be 10,000m.
- 2 - Descent starting point is at 120km from station. Recommended IAS during descent is 600km/h.
- 3 - Keep the GLIDE director needle near the center of the aircraft silhouette on the KPP. If you are flying on a certain radial, keep the LOCALIZER director and needles around the center.
- 4 - 20km from the RSBN, altitude is 600m and the descent program ends: at this point you can engage the LANDING mode or you can proceed with a visual approach. If you continue with CLOUDS PENETRATION mode, the needles will instruct you to maintain 600m.
- 5 - Area of constant altitude of 600m within 20km around RSBN station.

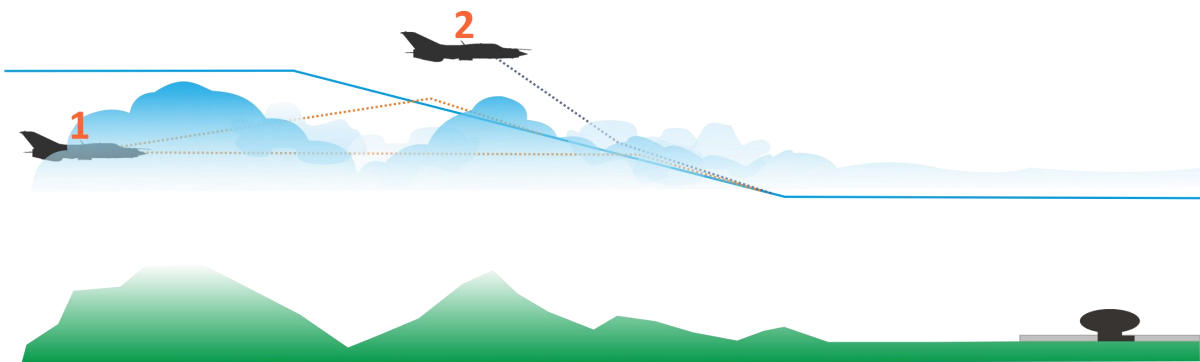


Image 9.10: intercepting penetration glide:

- 1 - Aircraft is below the descent path. Either fly horizontally until you intercept the descent path, or climb to intercept. Once you intercept the glide, continue your descent.
- 2 - Aircraft is above descent path. Increase descent rate to intercept descent path. Don't descend too fast or you will overshoot the glide path.

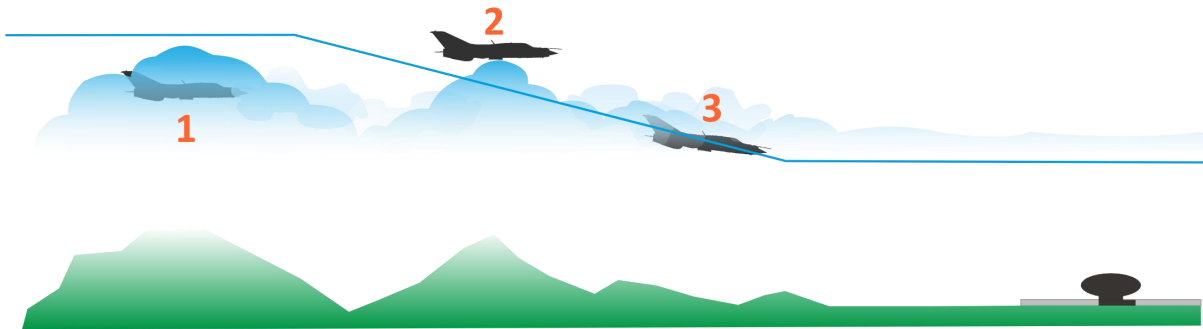


Image 9.11: relation between aircraft position and needle position:

- 1 - Aircraft is below glide path - needles indicating path are above “horizon” on KPP and NPP.
- 2 - Aircraft is above glide path - needles indicating path are below “horizon” on KPP and NPP.
- 3 - Aircraft is on glide path, needles are on “horizon”.



Image 9.12: Upper image shows aircraft at 71km from RSN station, while in CLOUDS PENETRATION mode. Note the glide path is below aircraft (glide needles) while vertical speed is within recommended by glide director needle (yellow needle on KPP). On lower image same aircraft is 24km from RSN station, on glide path and currently descending with greater than recommended vertical speed.



Navigation mode

Navigation mode is a main RSBN operation mode. In this mode the NPP needle shows direction to the ground station while CM43 displays range to the ground station in kilometers. The RSBN receiver can acquire a ground station signal at the maximum distance of 200km at certain altitudes as shown in the following table:

Table 9.2:

Distance from the ground station (km)	30	60	90	120	150	200
Minimum altitude (m)	530	1050	1570	2100	2620	3500

In this simulation, there are 16 RSBN/PRMG stations preset on the aircraft. All preset stations are located at the airports, thus an instrument approach is available for all preset stations. Preset channels are numbered from 01 to 16 and the rest of the channels are not in use. Remaining (free) channels could be used for user's stations creation.

This mode enables the use of radials and radials interception. Radials are selected using the 3K knob on your NPP: when you set the course using the 3K knob, the opposite value of the selected course is the selected radial. For any given radial, the course directory needle will deflect, giving you information about which side you need to turn the aircraft to, in order to intercept selected radial. The localizer needle will show the angular difference between the current and selected radial.

Radial interception

Radials are lines aligned with the course system with their origin at the ground radio-navigation station. Just like in the case of courses, there are 360 radials. Radial 0/360 is pointed to north.

For precise radio navigation, it is often required to fly along certain radial. To do so, you will need to execute a procedure called "radial interception". To intercept a radial from a RSBN station, you'll always need to perform four initial operations:

- set up the correct channel for the desired RSBN station (confirm signal reception),
- select the NPP needle to RSBN mode (RSBN/ARK needle selector switch),



- set up NAVIGATION mode for the RSBN,
- select the desired radial to intercept using the 3K knob on NPP.

The relation between your current course, radial, selected radial and RSBN station location will decide radial interception guidance logic. Intercepting solutions could be simple or complex, successful or not successful.

Without going into details that might just confuse you, you just need to remember that all you have to do in a radial interception is to “follow the needle” - that is the course director needle located on the KPP. The only thing you need to know is whether you want to fly towards the station (TO) or from it (FROM).

Here are a few examples of a radial interception, starting with the simplest:

	<p>A) You are currently crossing radial 040 from the selected RSBN station, maintaining heading 360. You want to fly along radial 360 which you have selected on the NPP (3K needle tip points to 180). The course director needle on the KPP will deflect to the left, meaning that you should perform left turn until the needle is in center. When you do that, you will be on an initial interception course. The needle will start moving relatively soon, the length of time depending on how far you are from the radial (the closer you are - the faster the needle movement). Whenever the director needle moves, leave it so it moves for about 1/4-1/3 to either side and then correct your heading. Once you approach $\pm 5^\circ$ to selected radial, the localizer needles will start moving, indicating a more precise deviation from the selected radial. When your localizer is around the central mark (circle), you are on the selected radial.</p> <p>This situation is known as FROM - FROM situation, and it is the simplest situation in radial interception procedure.</p>
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	<p>B) In next case you are also on the radial 040, but this time your heading is south, and like in the previous case you opted to intercept radial 360 (3K needle points to 180). In this case your course director will give you a right turn indication. Follow the needle until you are on the initial interception course. Correct your position when your needle is 1/4-1/3 aside. Like in the previous case, finalize the interception using the localizer needle.</p> <p>This situation is a variant of so called TO - FROM situation, and is more complex than the previous, because in the case that you are too close to the station, you will fly over it before the procedure is over, and you will enter another, even more complex situation called TO - FROM (gray aircraft silhouettes).</p>
	<p>C) In the next case lets assume you are flying towards the RSBN station on radial 180 with a northern heading. You have selected radial 140 for interception (3K needle points to 320). You will receive either a left or right turn instruction for final interception. If it happens that the director gives you a right turn - just start performing a left turn for final interception. This might happen because the RSBN computer incorrectly guessed your intentions. Note that this might happen in all described cases, so you need to know exactly what you want to do. Once you start turning left, it will correct the needle position. This is a situation with two opposite turns, therefore it is more complex than previous examples.</p> <p>This situation is a variant of so called TO - TO situation, and like in the previous case there is a probability of procedure failure if you are too close to the RSBN station when you initialized the procedure (gray aircraft silhouettes).</p>
	<p>D) Finally, imagine that you are flying on a radial 180 on a southern heading, while you have selected radial 140 and you want to fly towards the station (3K needle points to 320). The director will give you a left turn instruction, constantly giving you leftwards corrections. Apply the same logic as before, allowing for an error of 1/4-1/3 needle deflection before you start adjusting the position according to localizer needles.</p> <p>This situation is a variant of FROM - TO situation. If you initialize</p>



	<p>this procedure when to close to the station, you might overshoot the selected radial during the procedure, which then might become one of previously mentioned situations. In worst case, resulting in a failure to intercept the selected radial (gray aircraft silhouettes).</p>
	<p>Apart from these most common intercept situations, there are more complex ones, which you might encounter during flight like those shown in left image. In this example, you are on the radial 320 flying towards the station. Your intention is to perform an approach for landing using radial 180. If you select radial 180, the director will give you confusing instructions, since the selected radial is at the opposite side of the RSBN station. Therefore, you must perform an initial interception on the shortest side (which is your right in this case) until you fly past the RSBN station. At that point, the situation will become FROM - TO. Some possible solutions are given with slashed black lines.</p>

Instrument landing System mode - PRMG mode

The Instrument landing System (Rus. PRMG - „ПРМГ - Посадочная радиомаячная группа“) **mode** is used at a maximum range of 25km from the selected PRMG station and in the direction of approach for landing. In this mode, the range (distance) indicator displays current distance to the PRMG station. The NPP needle continues to show the direction to the selected RSBN station which can be on the same airfield as the selected PRMG station.

The NPP and KPP localizer and glide path needles show the aircraft position in relation to the programmed approach flight path (deviation from the approach course and altitude). The Localizer and glide path blinkers are white if the PRMG signals are not acquired (airplane is outside the PRMG signal zones). When the aircraft is receiving PRMG signals, the localizer/glide path („K“– course, „Г“– glide path) flashers will turn black.

The Instrument landing system for the MiG-21BIS is set at a glide path angle of 4°, with a course approach from both runway directions, and with the PRMG signals zones of $\pm 2^\circ$ for course (localizer) and $\pm 2^\circ$ for glide path. The implemented system automatically recognizes a pilot's intention to land from either direction according to runway orientation, and self-adjusts to accommodate the pilot's intention. For example, if the runway orientation is 090/270, the pilot can approach for instrument landing from either direction without any additional adjustment of the PRMG system. The pilot only needs to select the appropriate channel for the desired airport PRMG station using control knob LV26, and then select “landing” mode with switch/selector CM11. Optionally, the pilot can select the RSBN as a source signal for the NPP RSBN/ARC needle with the LV23 knob. When the pilot initiates



an approach in the desired landing direction (e.g. 090°), as he arrives in a zone which is $\pm 45^\circ$ from the landing direction, aircraft equipment will automatically self-prepare to display landing information for that landing direction. If the pilot changes his mind and decides to approach from the opposite direction, as soon as the aircraft is in a zone of $\pm 45^\circ$ from the new approach direction, the aircraft's equipment will automatically self-adjust to display appropriate information.

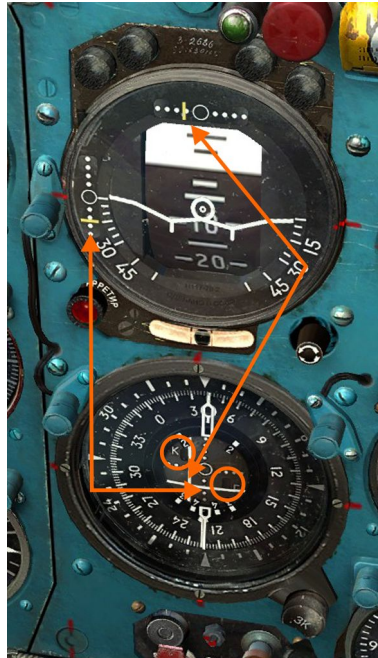


Image 9.13: NPP shows the aircraft is within the localizer/glide path radio beams. The presence of the localizer and glide path radio signals is indicated with black windows flashers on NPP (in circles). Localizer and glide path needles show same values both on KPP and NPP (arrows).

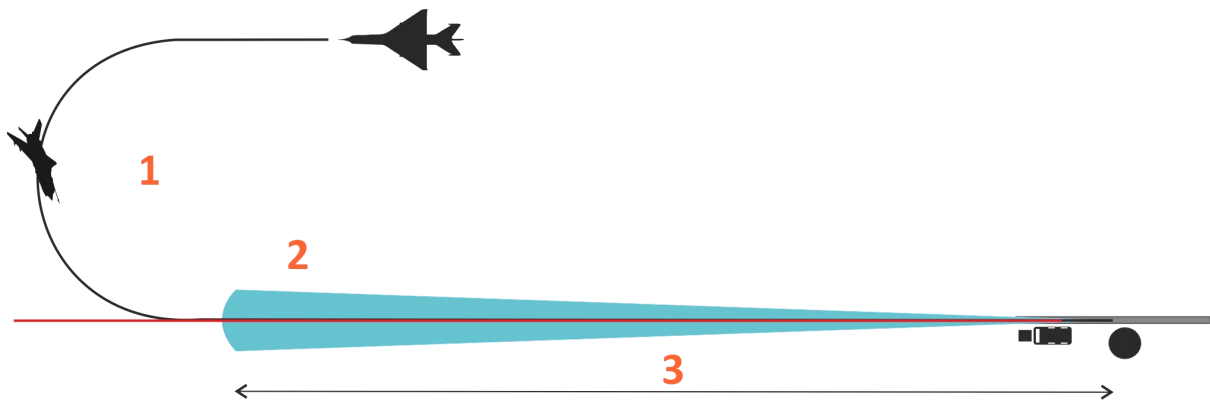


Image 9.14: Localizer features and basic interception principles (top-down view)

- 1 - Intercept the localizer by aligning your aircraft along the RSBN radial that lies along the runway direction. In the shown example, turn left to intercept 270° radial: make sure that RSBN/ARC needle on your NPP shows 90° towards the RSBN while your course is also $90^\circ \pm 2^\circ$.
- 2 - PRMG localizer signal zone is $\pm 2^\circ$.
- 3 - PRMG signal can be acquired at max. 25km from the PRMG station. The PRMG station is located near each end of the runway.

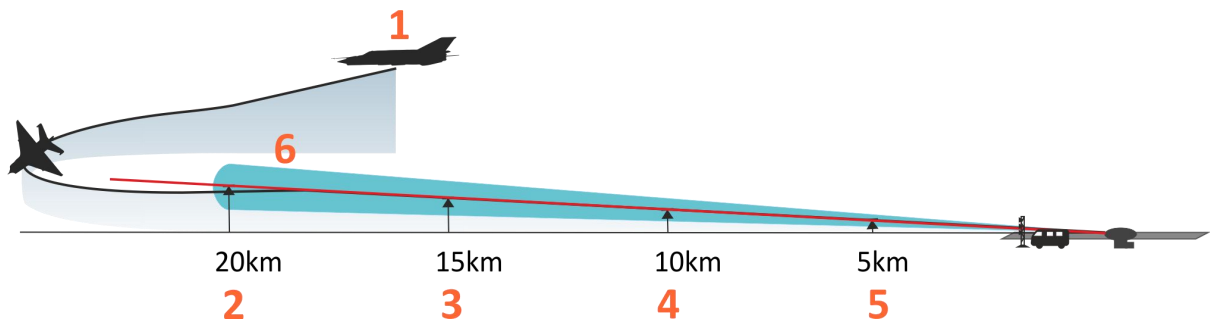


Image 9.15: Glide path features and basic interception principles (side view)

- 1 - Intercept glide path by descending to an initial altitude which is a bit lower than the expected glide path altitude at the interception point. For example, if you are intercepting the glide path at 20km, fly at 1000m above RWY altitude.
- 2 - Glide path altitude approx. 1400m
- 3 - Glide path altitude approx. 1050m
- 4 - Glide path altitude approx. 700m
- 5 - Glide path altitude approx. 350m
- 6 - Descend angle is 4° with vertical tolerance of $\pm 2^\circ$.

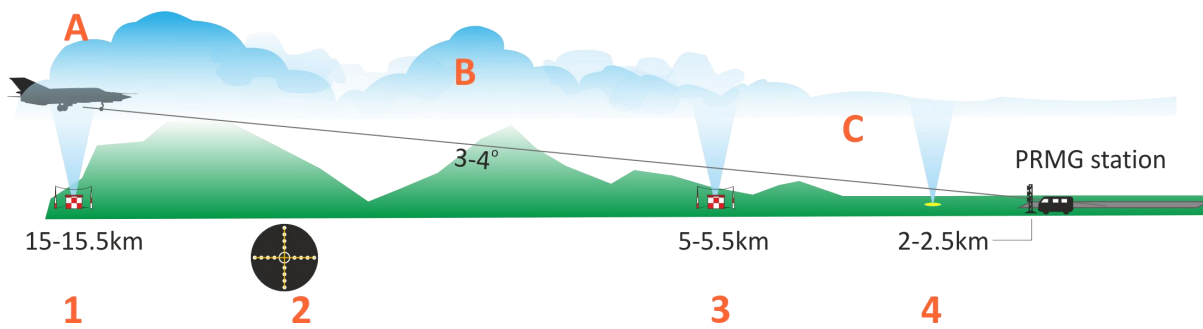


Image 9.16: PRMG approach and landing parameters. Picture also shows NDB stations and their distance to PRMG (or RSBN) stations. Note that the above shown NDB locations may not be available for every airfield in DCSW.

- 1 - Altitude 1000-900m, IAS 500km/h, extract landing gears, fly horizontally until both LOCALIZER and GLIDE signals are acquired - blinkers on NPP must be BLACK. Start descend according to GLIDE.
- 2 - At 11-12km from PRMG station: altitude 600m, IAS 500km/h, extract flaps to 25°, FULL PRMG ESTABLISHED
- 3 - Altitude 270m, IAS 380km/h, flaps 45°, be prepared for visual
- 4 - Altitude 120m, IAS 360km/h, decision height 100m - if you don't see the runway go around

Approach for landing in "Automatic" or "Directional" SAU modes

The SAU is coupled with the aircrafts' PRMG receiver. When the pilot is performing a PRMG instrument approach, he might decide to engage either the "Automatic" or "Directional" SAU modes. Note that neither of these two modes are actually meant to be used to land the aircraft, rather they are designed as an aid for the pilot during the instrument approach.

The first condition for engaging either of these two modes, is that both localizer and glide path signals are acquired ("K" and "G" blinkers on NPP are black).

The pilot engages the desired mode by pressing the LV51 button-light for "Directional", or the LV52 button-light for "Automatic" mode. Both modes are disengaged using the LV54 button.

When in the "Automatic" mode, the SAU will take control of the aircrafts' pitch and bank channels, while trying to maintain the aircraft on an ideal approach path (localizer and glide path are within the NPP central circle marker). Note that the SAU does not have control over the throttle, gears or flaps. Thus, the pilot should take care to adjust approach speed and deployment of gear and flaps. During an "Automatic" approach, the pilot should observe the aircrafts' altitude and disengage the SAU (using LV54 button), once the altitude measured from the runway threshold reaches 100m, which is about 1km out from the threshold itself. From that point on, the approach and landing are manual.



In the “Directional” mode, the SAU will provide pitch and bank cues on the KPP using the yellow RSBN/PRMG directional needles. If the glide path directional needle (horizontal one) is above the central position, the pilot should either decrease the aircrafts' descent rate or maintain horizontal flight, depending on the amount of vertical positioning error. It is the opposite if the needle is below the central position: the pilot should increase the aircrafts' descent rate. As for the localizer directional needle (the vertical one), things are rather self explanatory: if it is to the left, the pilot should decrease the heading, while if it is towards the right - heading should be increased. The pilot can land with the “Directional” mode turned on, since the SAU won't interfere with the pilots' inputs.

Landing approach with “the RSBN box”

Apart from providing solutions to usual navigation problems, the onboard RSBN equipment provides one additional feature: flying along the landing pattern with the help of a so called “RSBN box”. The RSBN box is a set of markers on the NPP's inner circle, enabling the pilot to create a landing pattern on any airbase equipped with a RSBN station. Performing a landing pattern using the box and RSBN does not require any additional equipment.

The RSBN box landing pattern can be constructed (flown) either as “the big box” or “the small box”. There are no crucial differences between these two, it is up to the pilot to decide which maneuver he will execute.

The big box's advantages are that it allows for a much more flexible pattern construction, more time, larger distance for approach enabling easier PRMG use. Small box advantages include more dynamic pattern construction, less time/fuel consumption, but requires more attention for the PRMG approach itself, since distances are smaller and altitudes are lower.

The RSBN big box approach is best performed when combined with a PRMG precise approach, therefore set LANDING mode to RSBN and make sure your NAV and LNDG RSBN/PRMG channels are set up correctly.

Look at next image for numbered references in the following text.

1 - Fly over the RSBN station in direction of the runway at 600m with an IAS of 600km/h. To fly along the so called “Big box”, initiate your first turn when you are 7km away from the station. To fly along the “Small box”, start your first turn at the 5th kilometer from the station. Note that all turns in both boxes need to be executed with 45° of bank, and for 90° of heading. While flying away from the station, set your COURSE SET (3K) needle to indicate your landing course (approach radial), and set LANDING RSBN mode.

***NOTE:** On shown image, small box is illustrated with dotted rectangle. Small box construction is not recommended for inexperienced players. You will not have enough time to handle the workload in final phases of approach.*



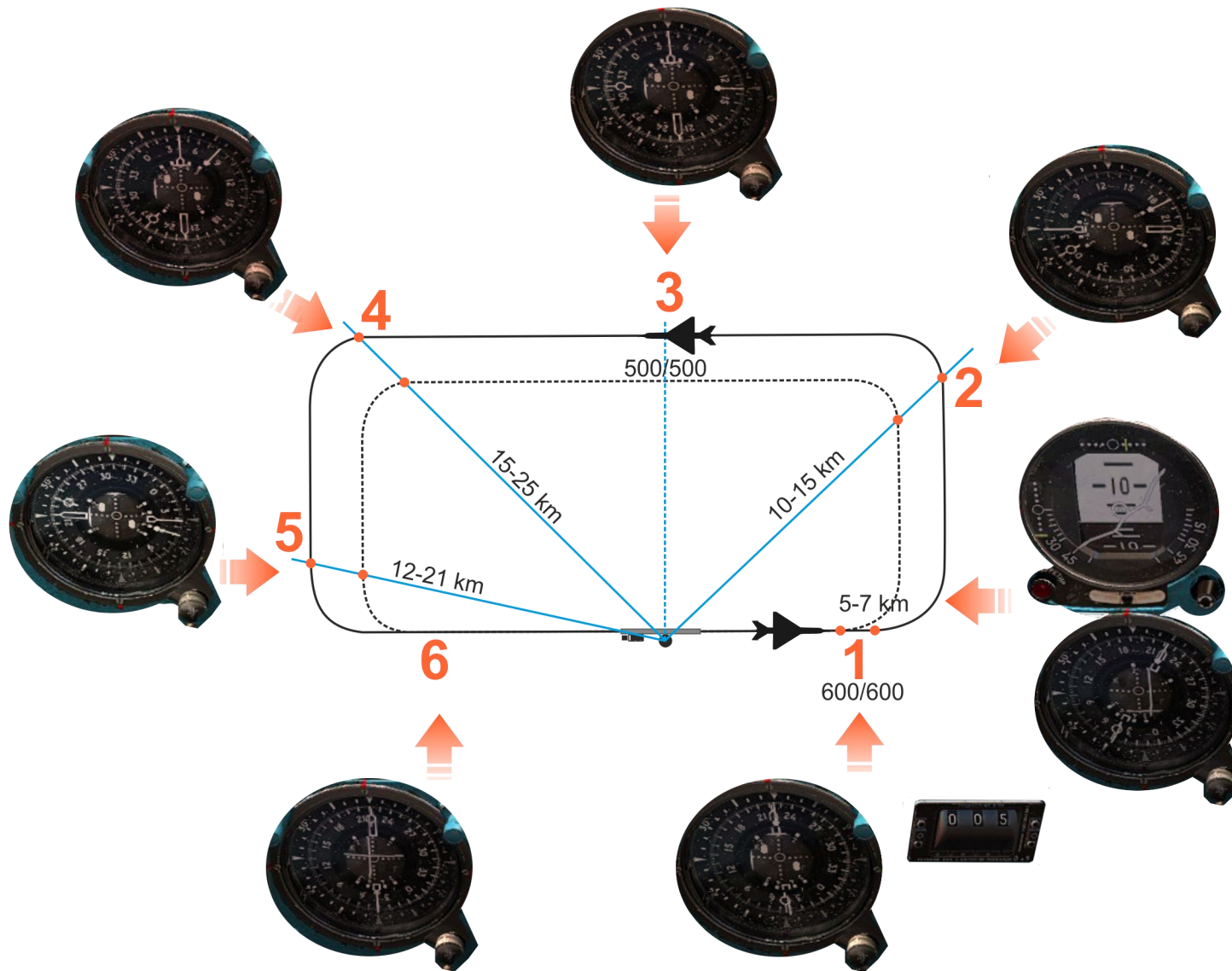
2 - When the tail of the RSBN needle reaches mark “2” on the inner NPP scale, perform a second turn. In the shown case, turn left and place the 3K needle vertically, so that the NPP shows it like appears on image 3. Once on course, decrease your speed to IAS 500km/h and descend to 500m.

3 - In this position, the RSBN station is precisely 90° aside, which indicates the position for landing gears extraction. Compensate gear drag and maintain IAS 500km/h, altitude 500m.

4 - When the tail of the RSBN needle reaches mark “3” on the inner NPP scale, perform a third turn. Remember, turn exactly for 90°. If you are flying along a small box, once you finish the turn, extend flaps to 25° and allow speed slowly drop towards 420km/h. If you are flying along a big box, simply continue with an IAS 500km/h, at 500m.

5 - When the tail of the RSBN needle reaches mark “4” on the inner NPP scale, perform your final turn. During this turn, watch the LOCALIZER and GLIDE needles along with PRMG signal markers. Once you are sure you have acquired both signals from the PRMG, you can switch to a precise instrument approach. In this case, you should have established the PRMG right after you exit the turn. Don’t forget to prepare the aircraft for landing by extracting flaps and slowing down to recommended speeds along the approach line.

Image 9.17 (on next page): RSBN “big” and “small” box schematics





Kneboard

The Kneboard is important feature when it comes to navigation in the DCS MiG-21BIS. Since you can't load your Flight plan to an on board computer like in case of other DCS aircraft, the only two way to navigate with the MiG-21 is either to create and print your flight plan so you can use it during flight, memorizing as much as possible before the flight, or to use the kneboard feature.

Access your kneboard with **RCtrl + Up arrow**. It will pop up in the left side of your window. You can browse it using **RCtrl + Right arrow** (browse to the right) or **RCtrl + Left arrow** (browse to the left). Browsing to the left is recommended since the left side will show all the custom things we pre-designed for you. Both sides are cyclic, so you will end where you started, but in the case that you browse to the right, you will have to browse through many pages before you reach the custom MiG-21 pages.

For the navigation however, you will have to browse right, through a few pages with maps on them. If you created a Flight plan in your mission editor, you will see it drawn over the map. Once you start flying, **you can mark your current position on the map using RCtrl + Down arrow**. By comparing the "position mark" with the route, you can tell the way you need to fly in order to correct your position if needed.

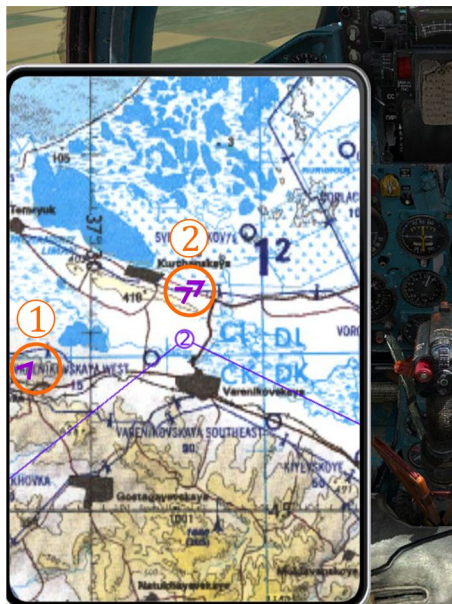


Image 9.18: Kneboard with map of proper scale, flight route and few "position marks". Position marks symbols are violet colored arrow-heads: tip of the arrow-head indicates aircraft direction. Mark 1 was taken several minutes before the screenshot, and it indicates the route is to the right side. I did not corrected my trajectory at this point. Few minutes later, I marked two sequential positions (mark 2). Compare positions and the route.

Apart from map and flight plan (route in particular), among the MiG-21 custom kneboard screens you will find a list of RSBN channels, radio channels, ARC sectors and stations list, and some empty



templates pre-set to fit the kneeboard screen.

If you want to put your images in your kneeboard, refer to MiG-21 installation folder, usually [Program Files\Eagle Dynamics\DCS World\Mods\aircrafts\MiG-21BIS\Cockpit\KNEEBOARD\indicator\CONTENT](#)

You will find *Template1-3.jpg* files there: edit them the way you want it, rename and save in the same folder. Next time you start the mission you will be able to see your images on the kneeboard. Handy stuff.



WEAPONS SYSTEM



10. Weapons system

Note: Apart from description in this manual, a set of interactive training missions related to basic weapons use are available with DCS MiG-21BIS installation. You should read this chapter before attempting to fly those missions.

The weapons system on the MiG-21BIS is built around two targeting systems: the optical sight (ASP) and the radar: RP-22SM “Sapphire”. The ASP allows the use of unguided and free-fall/drag weapons (guns, rockets, bombs) and use of infra red (IR) short range missiles against airborne targets, while the Sapphire radar allows the use of both air-to-air (AA) and air-to-ground (AG) semi active radar guided and IR missiles.

Although primarily designed as interceptor with the task of destroying strategic bombers, the BIS quickly became a multirole combat aircraft. As the threat of strategic bombers armed with nuclear bombs diminished, large numbers of MiG-21’s, small and fast interceptors, were tasked with new mission types. With a good thrust to weight ratio and excellent acceleration and climb rate, they often carried two AA missiles along with unguided rockets or bombs. Reconnaissance was also on the tasking list, along with close air support (CAS). However, built as a generic interceptor, it could not excel in those missions and could never compete with aircraft specifically built for air to ground tasks. Truth is that most of the MiG-21BIS longevity is due to the fact that it was quite a robust, modest and resilient machine, capable of performing most mission types with minimal maintenance requests and with long mean time between failures (MTBF).

Basic weapons system management

Before we get down to the ASP and Sapphire use, we have to explain the basic principles of weapons management. To manage the weapons system, the pilot uses the cockpit interface to activate a particular weapon system and weapon, select one or multiple launchers/weapons, set-up the aiming conditions, and finally use selected weapon. Following this order we can divide all cockpit weapons system interfaces down to a few groups: activation, selection, aiming (including target acquisition), and launching/firing.

Activation interface

The weapons activation interface allows for weapons launchers to be powered up. Without electric power, weapons can’t be used even if the aiming and remaining weapons subsystems are active. All necessary switches for weapons activation are located on the RV panel.



Warning: You must never arm the weapons while on the ground: this is a precautionary measure to ensure you won't activate the weapon by accidentally pressing a launch button or gun trigger, even knowing the weapons launch sequence is blocked while aircraft is on ground (ground lock is engaged by landing gear in extended position).

To power up the weapons system, you must follow certain procedures for safety reasons. The first set of switches which should be turned on are the **Power switch for 1-2 pylons (RV27)** and **Power switch for 3-4 pylons (RV28)**. They will power up the pylons and enable locks operation in order to release weapons. Next, if you have AA missiles you should turn on **RV25** which will power up the missiles. Switch **RV26** should be turned on just before you plan to use the rockets or missiles because this switch enables rockets/missiles to be launched; in other words, this switch powers up the launch subsystem. Otherwise, missiles or rockets won't launch even if everything else is turned on. You can think of it as a last precautionary measure. Apart from that, when using certain pylons with bombs instead of missiles, you should turn on the **Tactical release switch (CL73)**, which enables the bombs' fuses so they can explode on impact. If you don't enable tactical release, you will still be able to drop bombs, but they won't detonate on impact.



Image 10.1: Weapons activation interface on right-vertical panel.

If you want to use the gun, turn on the **Gsh-23 gun power switch (RV32)** a minute or two before using it. Although this will power up the gun itself, you still won't be able to fire it because you need to load the gun by activating one of 3 cannon pyrotechnic cartridges using the **Gun load/reload buttons (CU4-5-6)**. This procedure is for safety reasons.

The ASP itself can be turned on anytime without limitations, granted that other aircraft systems are up and running (especially the AC system and gyros). Use the **ASP-PFD optical sight power switch (RV33)** switch to turn the ASP on.



Finally, if you plan to use the Sapphire, you need to know that it needs time to warm up before it can be used. Therefore, you can turn the **RP-22 radar main mode (RV62)** to stand-by when your aircraft is ready for takeoff. Usually, it will take between 3 and 5 minutes for the radar to warm up. After the warm-up time has passed, you can test the radar using the **RP-22 radar self-test button (CM51)**. I will explain radar use later.

So far, we've covered system activation procedures. Next, you need to perform selection procedures which will enable certain weapons while - at the same time - safely disabling (deselecting) all other weapons.

Selection interface

All selection interfaces are located on the CU1/7 control panel. Note that ASP settings affect weapon selection, but those are explained in the *Aiming interface* section. The first switch is (CU2) which is the ASP master mode selector: by using this switch you are switching between AIR (up) and GROUND (down) mode.

Note: IR AA missiles can be used to engage ground targets with a heat signature. Although at the moment I don't know if this will be possible in DCSW, in this case you need to select the AIR master mode, regardless of the fact that you are engaging ground targets.

The next switch (CU3) is the AA missile type selector. When you want to use IR AA missiles it should be placed in the upper position. If you are using semi active radar homing AA missiles, it should be in lower position.

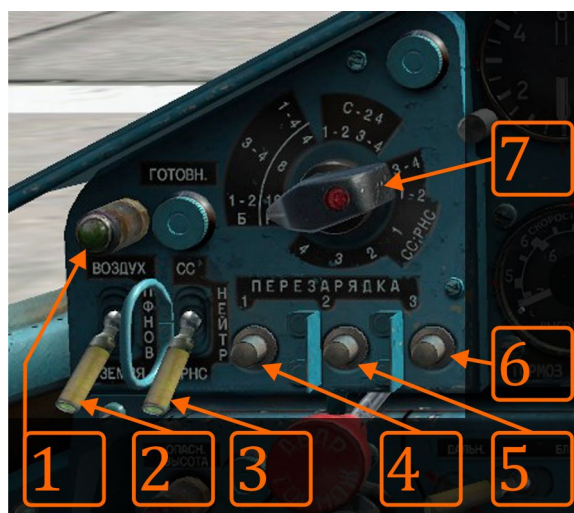


Image 10.2: Weapons selection interface on central-upper panel.

Gun load/reload buttons (CU4-5-6) are used to load the internal GSh-23 gun. Three buttons, each one of them activating its own pyro charge allow reloading the gun if it jams: in this case, you have to reload it (thus unjamming it) using the next button in order. For example, if you have used button



1 for initial gun loading, and the gun jams, you should use button 2 to reload (unjam) it. When you press the button, a distinctive sound of metal pounding to metal is heard, along with the explosion of one pyro cartridge. When the gun is loaded and ready, a green light (CU1) is illuminated. Light is OFF if the gun is empty (ammo used), not loaded or jammed.

Finally the ***Pylon and weapon type selector knob (CU7)*** is a pylon and a weapon selector at the same time. I will explain use of this selector using the polar coordinate system similar to clock numbers (12 is up, 3 is right, 6 is down, 9 is left etc.). The selector zone which starts from 9 to 11 is reserved for bombs and rockets launchers and quantity selection. The numbers are self-explanatory: for example, if you want to release bombs from launchers 3 and 4, you should place this selector in a 10 o'clock position (B 3-4). At the same time, if you are using rockets, this will enable the launch of 8 rockets from each pod (RS 8) regardless of the number of the pods on the aircraft (2 or 4). The zone starting from 12 to 1 is reserved for S-24 unguided rockets. Since they are always launched in pairs, you can select launchers 1-2 or 3-4. Because of the large quantity of smoke generated during a launch sequence which can interfere with safe engine operations, it is possible to launch only two rockets at a time. Finally, the zone starting from 2 to 7 is reserved for AA missiles. You can choose either to launch missiles in pairs (positions 1-2, 3-4) or from individual launchers.

The only exception to these rules is the Kh-66 Grom: to use it, place the weapon selector to S - 24 1-2 position. Grom launches as single missile, so be careful with aircraft handling after the launch because you will have significant asymmetric wing load.



Aiming interface

Optical aiming sight - ASP PFD

The Aiming interface is located on the ASP, radar control boxes, throttle and stick.

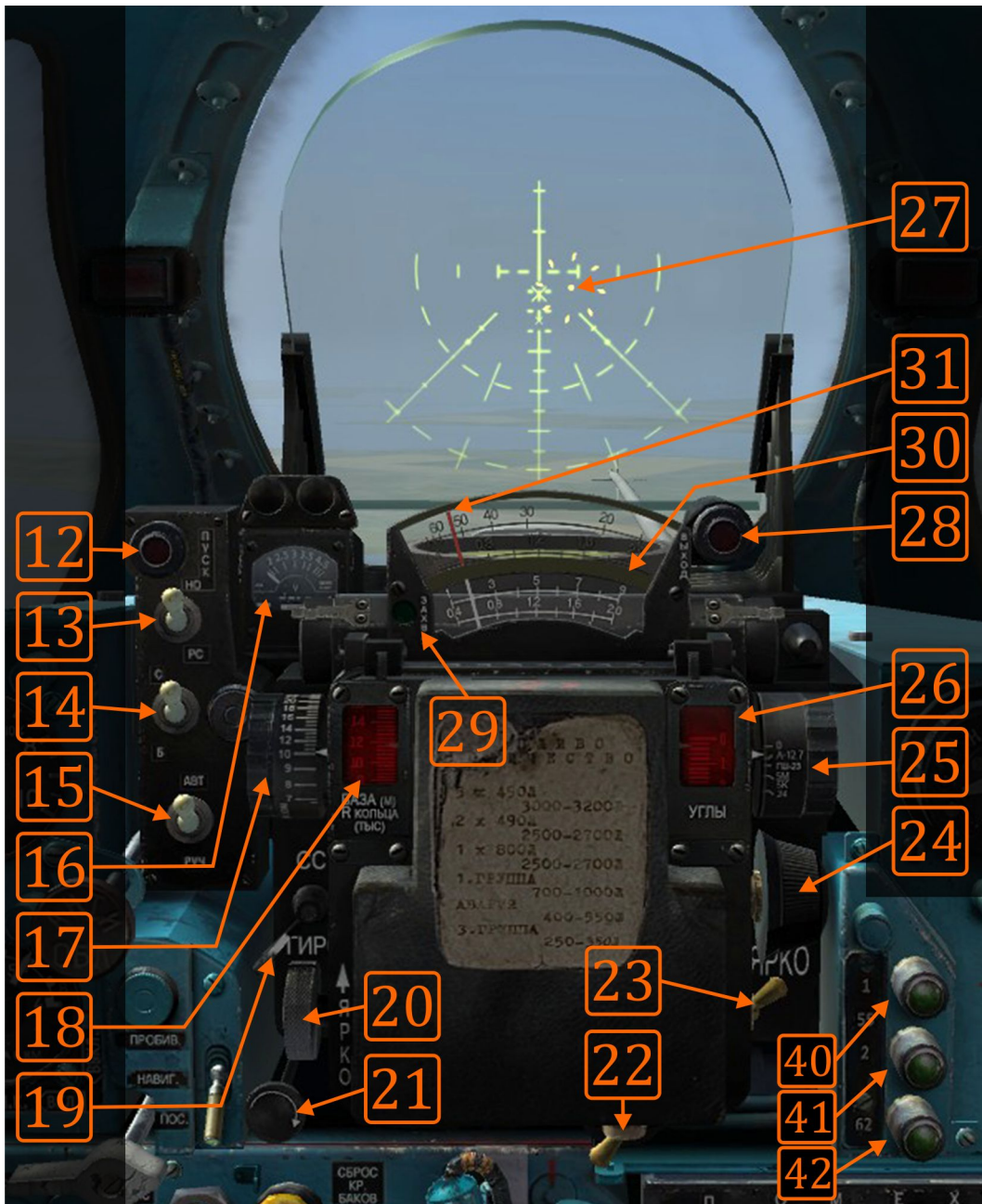


Image 10.3: ASP interface.

12 - Launch authorized (rather “within the launch zone”)

13 - guns or rockets/missiles



- 14 - firing (shooting) or bombardment
- 15 - automatic or manual
- 16 - distance scale for AA missiles
- 17 - target size in meters in A-A gun mode
- 18 - target size in meters in all other modes
- 19 - missiles or gyro pipper movement pattern
- 20 - scales backlight
- 21 - fixed net illumination level
- 22 - fixed net ON/OFF
- 23 - pipper ON/OFF
- 24 - pipper illumination level
- 25 - intercept angle knob
- 26 - angular scale in degrees
- 27 - pipper (reticle) and fixed grid (fixed net, setka)
- 28 - brakeoff light (brake the attack)
- 29 - radar lock light
- 30 - distance and angular scales
- 31 - scale needle
- 40...42 - AA missile lock lights

ASP-PFD has many switches and knobs that serve as an interface to set up necessary aiming conditions. The first switch (CU13) is used to select the ASP aiming mode for guns (up) or missiles/rockets (down). Below that is (CU14) which is used to select either fire/shooting (up) or bombardment (down). Bombardment mode is used exclusively for bombs, while fire mode is used for other modes. The third switch is (CU15), and it is used to select either automatic (up) or manual (down) distance and target size calculation. When in automatic mode, the ASP will draw the pipper according to either Sapphire data (if the airborne/ground target is radar-locked), or pre-set distance, target size and angular corrections that enable optimal use of ASP sight. Manual mode allows the pilot to introduce his own target size, angular corrections and to manually measure distance to the target.

The knob on the left side of ASP (CU17) is used to set up the target size in meters. The target size shown in the small red window (CU18) is used to set up the target size in meters in all cases except when in automatic AA gun mode. In this mode you can still set up the target size, however you have



to look at the scale drawn on the knob itself (not the scale in the red window). The opposite knob on the upper right side (CU25) is the angular correction knob. When in automatic mode, the ASP will rotate this knob and its scale (CU26) to set angular correction for the selected weapon (different angles for bombs, rockets, guns). Intercept angles are shown in the red window CU26. When in manual mode, the pilot can move this knob to set a correction angle in accordance to instructions for certain weapon. Distance scales on the top of the ASP (CU30) show current distance to the target starting from the right (max distance) and moving the needle (CU31) to the left (towards min distance). There are four scales:

- the bottom-most scale indicates distance for AG rockets and guns (400m - 2000m),
- the scale above indicates distance for AA missiles (>1km),
- second from the top scale indicates small distances (2000 - 400m, right to left), and is used for AA gun attacks; this scale is the same as the bottom-most scale.
- the topmost scale indicates diameter of piper in miliradians⁴.

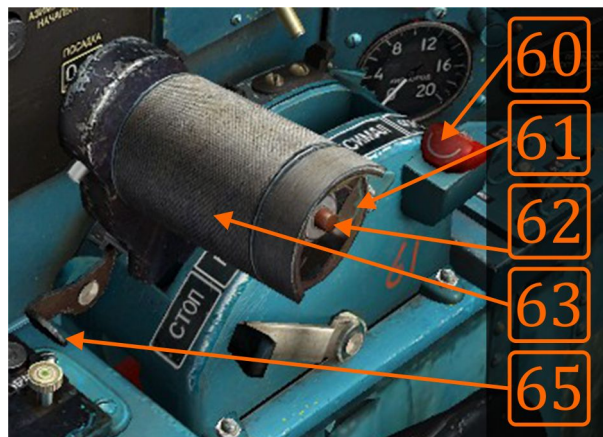


Image 10.4: Throttle rotator (LH63): when used with the radar it moves TDC up/down, when used with the ASP it is used to measure the distance to the target.

Only one needle is used for distance indication on all four scales. In automatic mode it will automatically move to indicate the distance for the selected weapon, but the pilot needs to know which scale to observe. In manual mode, it will move if the pilot manually changes piper diameter using the throttle rotator: by changing the piper diameter, pilot actually frames the target inside the piper and reads the distance to it on appropriate scale. This manual distance calculation is based on known (or assumed, best guessed) target dimension entered in the ASP using (CU17).

The small windowed scale on the top left side of the ASP is the AA missiles distances scale (CV16). It will show the distance to the radar-locked target. Since you will have other visual indications for launch permission, you don't need to pay much attention to this scale.

Below the four distance scales are two signal lights: RADAR LOCK-ON green light (left, CU29) and BREAK-OFF red light (right, CU28). Above (CU12) is LAUNCH AUTHORISED orange light which will illuminate when the target is within the weapon firing range. RADAR LOCK-ON will work only if the

⁴ Miliradian (mil) is angular measure; *one mil* equals to the angle at which object of 1m height is seen at a distance of 1000m. It is approx. 0.05729 degrees or 0.001 rad. In some countries it is often called "thousandth", because $\text{mil} = \text{rad} / 1000$.



radar is used for distance measuring (either for AA missiles or in fixed-beam mode for attacking ground targets). Since it won't work if the pilot doesn't use the radar, the pilot has the LAUNCH AUTHORISED light. One or two seconds after the LAUNCH AUTHORISED light illuminates, the pilot should use the selected weapon, and quit using it after the BREAK-OFF light illuminates (LAUNCH AUTHORISED will go OFF). Whenever the BREAK-OFF light illuminates, the pilot should perform a decisive brake-off from the attack. This rings true for both airborne and ground targets.



Image 10.5: Illustration of the relation between the distance (introduced with throttle rotator) and piper size and intercept angle.

The two position lever, MSL - GYRO is located on the lower-left side of the ASP (CU19). It is used to select a piper movement pattern. When in MSL mode, the piper movement is calculated using only 2 out of 4 parameters, rendering a stable piper. When in GYRO mode, the piper is pretty alive and jumpy, making it hard to aim, but once aimed - the weapon will hit the target if fired at a proper distance. The first mode is used for AA missile aiming. GYRO mode is used whenever the target is not very agile (all ground targets and airborne targets which are maneuvering with less than 3-4g).



Note: When engaging agile airborne targets which maneuver with more than 3-4g, you need to use the fixed net for targeting. This is because the pipper intercept angles could go beyond 7°, and the pipper can't be drawn within the ASP reflection glass.

Finally, three signal lights (CU40-41-42) which are not placed on the ASP itself but are a part of the aiming interface, indicate if the IR missile seeker head has locked a target. The green light "1" will light up if RS-2US missiles on the left wing have locked the target; while light "2" is for the RS-2US missiles on the right wing. "62" light is for selected R-60 missiles, regardless of pylon position. Therefore, to recognize that the IR missile seeker has locked the target, you need to hear the lock-on sound and see the lock-on light. If any of the two is missing, the missile could have locked the target only temporarily or locked on to some IR noise.

Radar aiming interface

I've already mentioned that the radar needs to warm up before use. To warm up the radar, move the main radar switch (RV62) to the middle position (stand-by or warm-up position). Normal warm up time takes 3 - 5 minutes after which it can be in stand-by mode for the next 35-40 minutes or used when needed. Overall longevity in the ON mode is 20-25 minutes. So, only turn the radar on when you really need it; otherwise, put it in the stand-by mode.

Note: Time limits for the radar are imposed by limited amount of its cooling liquid. If the radar overheats, the TURN OFF RADAR red light inside the radar screen will light on. In that case, turn off the radar to avoid radar failure.

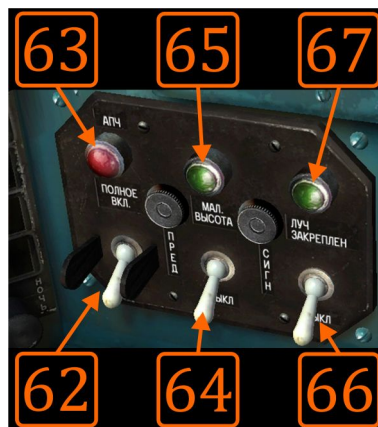


Image 10.6: Main radar control panel.

General radar health is indicated by the absence of an ERR red light (RV63) (above the main radar switch). If this light comes on anytime during radar use, turn off the radar.

Once you've warmed the radar, you can test it by pressing the TEST button-light (CM51). During the self test, false targets will appear on the radar screen. Move the TDC (also called "strokes") over the target using the throttle rotator and press the LOCK-ON button (PS5) for 2-3 seconds. The indication



on the radar screen will change from search to track mode, and you will see the target indication with the distance markers moving around the screen, and then moving itself in the center. The distance markers will move toward the center of the target, indicating closing to the target, and finally all the control lights will light in sequence: HEAD RDY, LAUNCH, and BRAKE-OFF (O). After that the image will disappear and the radar should get back to stand-by mode automatically. If this does not happen or if the radar won't enter test mode (e.g. you pressed TEST before the radar warmed up), press the CANCEL button (CM52), wait another few minutes and try again.



Image 10.7: illustration of radar self-test pattern



To turn on the radar, move the main radar switch on RV62 into the top position. The search image appears on the radar screen. The Sapphire's antennae can't be manually moved up-down or left-right like in modern fighters. Instead, it will scan $\pm 30^\circ$ in azimuth, and -1.5° and $+17^\circ$ in elevation, searching for any targets at a maximum of 30 km distance. Basically, you don't need to do anything except to fly at an appropriate altitude in order to actually "see" the target with your radar. Notice that the Sapphire will look for targets flying at your altitude and above, preferring targets above you. Therefore, always fly slightly below the assumed target altitude. If you're flying close to the ground with the radar on, ground reflections may appear on your radar screen, cluttering the bottom of the screen. If this happens, the best course of action is to increase your flying altitude; however, if you don't want to fly higher for any reason, you can try to compensate the clutter by turning on the compensation mode using the RV64 switch, set to the middle position, or - if that does not help - in the top position. When in the middle position, the radar will try to erase the lower side-lobes, thus cleaning the image; in the top position it will tilt its antenna upwards by about 1.5° . You can always fly with the compensation turned on if you wish.

The third switch is the FIXED BEAM (RV66) mode, which locks the radar beam along the longitudinal weapon axis (-1.5°) enabling distance measuring when you attack ground targets. In this mode, the Sapphire measures the distance to any obstacle that enters the narrow circle around the longitudinal weapon axis, thus giving you a precise distance to the target.



Image 10.8: Radar countermeasures and auxiliary control panel.

When in **search mode**, the radar screen shows a top-down image of the scanning area, drawing the discovered targets as enemies by default. Targets above you will be drawn using an inverted T sign, targets at your level will be drawn using a '—' (dash), while targets below you will be drawn using a T sign (note that this will be a very rare situation).

To identify friendlies you need to use the IFF system by pressing the (CM49) button. Friendly aircraft will be drawn with a double line = for several seconds.

Note: Few a seconds after identification, friendly targets will once again be drawn as enemies. If you lose contact with friendly aircraft after interrogation, once the targets appear again they will be drawn as enemies. Be careful when engaging targets to avoid a blue-on-blue kill.



To lock a target, you need to fly your fighter so that the target appears in the central radar screen zone marked with two vertical brackets. Once the target is inside, use the throttle rotator to move the TDC over the target and press and hold the LOCK-ON button in the middle of your pilots' stick head (PS5). Hold the button until the target is locked: you will know the target is locked by the change of radar screen imagery, and the activation of the LOCK-ON light on the ASP. In lock-on mode, the screen will show one horizontal bar indicating the locked target. Position of the target on the screen corresponds with target relative position from the longitudinal weapons axis. Position of the target on the screen is the same as if you could look at the target in front of you: for example, if the target is top-left on the screen, then the real target is up-left from your longitudinal aircraft axis. The distance to the target is drawn using two distance markers on the upper side of the bar. These bars move towards the center of the bar if you are closing to the target (which is what you want to do). If the target is faster than you and flying away, the bars will move towards the outer ends of the bar. The Launch zone is represented as empty space on the target bar, near the center of the bar itself. The longer the empty space on the bar, the greater the launch zone. Once your distance markers enter the launch zone, you can launch your missiles. This will also be indicated with LAUNCH lights on the radar screen and ASP.

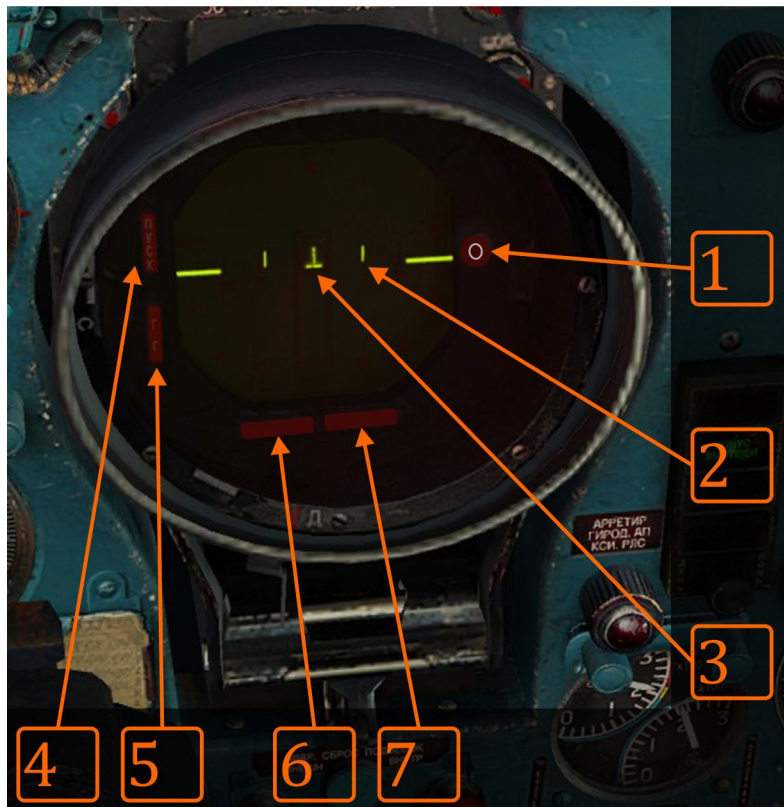


Image 10.9: Radar screen

1 - Disengage light (break the attack).

2 - Distance mark, within launch zone gate (empty space).

3 - Target ("the bird"). Distance, dynamic launch zone and horizontal bars are attached to the target mark, and will follow it around the screen.



- 4 - Launch light, will light up when the distance marks are within the launch zone.
- 5 - Missile head ready, will light when a SARH missile is selected and ready.
- 6 - Turn off the radar light. If you see this light - turn off your radar.
- 7 - Active jams (electronic counter-measures).

Note: Launch zone calculation is based on current fighter-target energy calculation and programmed missile trajectory. If you launch your missile just when distance markers entered the launch zone, and target's trajectory changes while the missile follows own trajectory, it could happen that the missile won't have enough energy for terminal maneuvers and you will either miss the target or have a "lagging missile". Therefore, let the distance markers enter the launch zone for about 1/4 to 1/3 to give your missile a bit more energy reserves. If you want to increase your kill chances, use two missiles with 3-5 seconds time delay between each other.

If you're engaging targets with semi active radar guided missiles, you will have to hold the lock until the target is either hit or missed. For IR missiles you don't even need to lock the target, although it will help in locking the missile IR head to the target.

If you wish to unlock the target, press the CANCEL (also used as RESET) button (CM52).

If you are **engaging slow flying targets** such as slow flying aircraft, helicopters or some unmanned aerial vehicles (UAVs), or you are pursuing the aircraft with small relative speed, press the LST button (CM50) while in search mode. LST stands for **Low Speed Target** which is a literal translation of the Russian MCL label. To get back to the normal mode, press the CANCEL button (CM52).

Note: The Sapphire needs three seconds to perform a full scan in search mode. When searching for targets, fly for 10-15 seconds in one direction to allow a thorough search of an illuminated volume of airspace. If you don't find what you are looking for, change your heading by about 20-30° and repeat the search. Note that you have to have valid information (or a very good guess) about the enemy's altitude so that you can position your fighter at the appropriate altitude.

Note: In an airborne targets engagement, as a native interceptor, the MiG-21BIS strongly relies on information provided by ground radars' crews. It was designed to be guided to an optimal attack position by ground control during the interception procedure. This procedure itself is known as ground controlled interception.

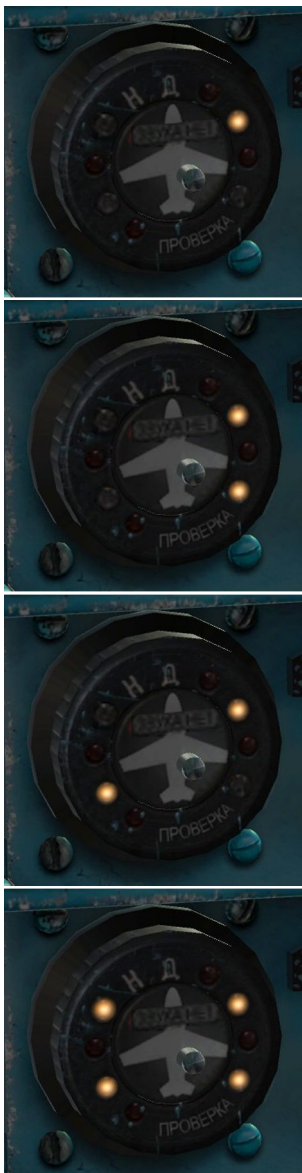


SPO - simple radar warning receiver

The SPO-10 is a device that will show you the relative direction of radar emission that is originating from a ground/naval or airborne source, and is pointed in your direction. This device is completely automatized, so you don't need to interact with it during flight, apart from simply turning it on (RV6). Unlike the radar, it does not emit any signals, so it's safe to use it at any time.



Image 10.10: 1 - flashing lights (“eyes”), white - for day, red - for night; 2 - self test button; 3 - sound volume knob.



It consists of four small lights (“eyes”), each representing one-quarter of horizontal area around the aircraft: upper left represents an area from the aircraft's nose to about 90° left, lower left is representing the area from about 90° left to tail, lower right from tail to about 90° right, and finally upper right from about 90° right to aircraft nose. These areas overlap a bit, primarily for better signal separation and - at the same time - consistent signal reception. At any time during flight, when the aircraft is “painted” by other radars, one or more lights will start to flash, along with a sound signal per each flash. If two adjacent lights flash at the same time, it might be that the source (emitter) is located in the overlapping area between the two: for example, if both left lights flash, and only one source exists, the source is about 90° on the left side of the aircraft. However, if there is more than one source, they might be separated, thus each eye would pick up one unique source signal.

Image 10.11: (top-down)

1. threat/s in front-right sector,
2. threats either in both right sectors or at 90° right,
3. threats in front-right and back-left sectors,
4. threats in all four sectors (if eyes flash and sound is interrupted) or lock (if eyes and sound are steady).

When there are several sources, all pointed towards the aircraft from different directions, the SPO will flash multiple eyes: in this case, it is difficult to tell which threat has priority. If the enemy radar locks the aircraft, all four lights will light up consistently, and an uninterrupted sound will play. This signal is considered a high priority warning and



should be taken very seriously. The issue then becomes that it is impossible to tell the direction of the threat, as the SPO-10 does not provide any relevant information. Therefore, when you fly a combat mission with the MiG-21BIS, you always have to be extra aware of your surroundings and the theatre threats.

Note that the SPO, like any other radar warning receiver, has 360° azimuth coverage and partial elevation coverage (about $\pm 45^\circ$). Keep this in mind! Practically, if the source is above relative 45° degrees or below relative -45° , your SPO won't be able to detect the threat, and you might have an incorrect impression that there simply is no threat. The same rule applies during the lock break maneuvers: when you start a maneuver and you "place" the threat in the blind SPO zone, it will cancel lock sound and lights, and you might think the lock is broken, while in fact, it is not.

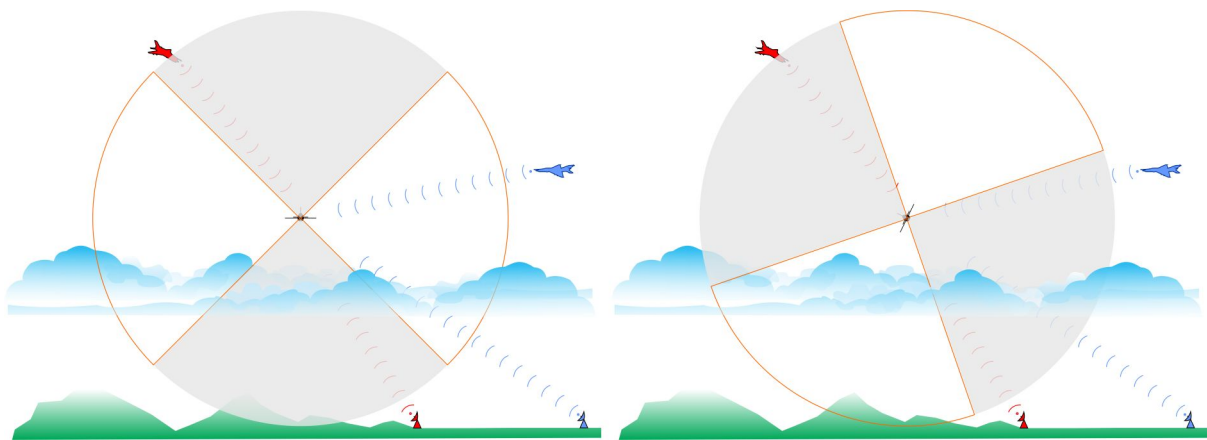


Image 10.12: Illustration of SPO signal reception principles. Grayed out zones represent blind areas with no signal reception, while white-orange zones represent zones with signals reception. On the left image, the aircraft is receiving two BLUE signals from its left side (aircraft is flying towards the reader). There is no reception of RED signals since they are in the gray zone. The pilot decides to make a right brake-turn in order to escape the BLUE signals. By banking the aircraft to the right (the right image), the pilot masked out all incoming signals (both BLUE and RED) and the SPO will show no threat at this point. Inexperienced pilots might assume that there is no threat anymore, while the fact is that the aircraft's SPO simply can't detect any signals in the currently observed areas.



Launching and firing

To launch a weapon or to fire guns is easy once you have acquired the target. Launching (missiles, bombs, and rockets) is performed with a long press of the PS6 button. For missiles you have to hold the button for about 2 seconds, which is the same for the bombs. Missiles will launch after 1-2 seconds while the bombs will fall-off almost immediately, but you will need to hold the button just to make sure they come off properly. Rockets will start firing immediately, but you need to hold the button pressed until the launching sequence is finished, otherwise you may interrupt the sequence which will continue from where it stopped the next time you press the button.

Warning: To drop bombs, you need to turn on the TACTICAL RELEASE switch (CL73). This will arm bombs fuses, thus allowing bombs explosion on impact. If you want to drop your bombs passively, leave this switch off.



Image 10.13: Tactical release switch (CL73) and BOMBS ARMED light (CL72). CL61 and CL62 are payload jettison buttons under the red caps.

To fire a gun you need to use (PS1) trigger. The gun will fire as long as you hold the button without any time limitations. It will stop if either ammo is depleted or the gun jam. It will not fire if the barrels are not loaded, the gun switch is not turned on or the landing gear is extracted.



Attacking ground targets

Attacking ground targets is always performed using the ASP with or without radar support. Both methods are almost equally efficient, and final outcome largely depends on pilot's knowledge and skills.

To attack ground targets you always have to have visual contact with the targets. In the case of fog, heavy precipitations and general low visibility, you won't be successful in finding the targets at first place, risking being shot down trying to find them. Once you find the targets you have to position your aircraft so that you can perform one or few attacks. **Never perform more than two attacks, although only one is the best.** Depending on type of weapons you have, your first attack should be with the bombs, then with rockets starting with largest caliber you have. Attacking ground targets with the internal cannon is not a good idea although it is effective against soft targets.

Common procedure for all AG weapons: Assuming that you have enabled the weapons system using switches on the right vertical panel, select GROUND master mode (CU2), set missile selector in NEUTRAL position (CU3), select AUTOMATIC mode using (CU15) and MSL mode using (CU13). If you know the target dimensions in meters enter the value using knob (CU17), otherwise set 10-12 meters as a target dimension.

To use bombs, set the rotating launcher selector (CU7) towards the appropriate pylons with the bombs (1-2, 3-4, 1-4), set ASP bombardment mode using (CU14). Finally, just before you attack, turn on TACTICAL RELEASE (CL73). No matter if you have Sapphire in fixed beam mode or no, your pipper will show correct aiming solution. The only things left to do are aim and drop the weapon with (PS6).

When using bombs, attack big targets from a high altitude, 4000m is a good starting altitude. Dive at angles of -30...-40°, and always IDLE your engine. Be careful when you pull-up, not to exceed g-load limit for other externals you may have. Drop the bombs as soon as the pipper appears in your ASP glass. You will need a lot of practice in order to increase probability of hitting just about anything with bombs using the MiG-21.

To use rockets, set the rotating launcher selector (CU7) towards appropriate number of rockets in one burst (4, 8, 16) or towards the pylons with the S-24 rockets (1-2, 3-4), set ASP to ROCKETS mode using (CU13) and FIRING mode using (CU14). Like before, the only things left to do are aim and launch the weapon with (PS6) button.

When using rockets, attack big or medium size targets from a medium or low altitude, 2000m is a good start. Dive at angles of -10...-30°, and set your engine to 70-80% power. Open fire at 1.7km distance.

To use the internal gun, load the gun using the button (CU4) and make sure that the gun is loaded which is indicated by the green light (CU1). Set the ASP to GUN mode using (CU13) and FIRING mode using (CU14) Aim and fire the gun using (PS1) trigger. If the guns jam at any time, use the next unused button (CU5-6) to unjam it.



Note: You can try to engage targets using the ASP in GYRO mode (CU19). **When you turn on GYRO mode, press and hold ENTER key to pacify the piper.** Place the piper just below the target: you can either release ENTER or continue to hold. Try both approaches. If the piper looks to jumpy for you, switch ASP back to MSL mode.

Using the gun on ground targets is similar as in case of rockets.



Image 10.14: AG gun attack sequence:

1 - Distance is >2500m, piper is placed slightly below the target and it is not moving up. Place the piper below the target during initial attack phase since it will start to move upwards once the distance is <2500m. This phase is known as coarse (imprecise, rough) aiming phase.



2 - Distance is <2500m and pipper started to move upwards. Keep it below the target and wait for another second or two for distance needle to move, indicating distances <2000m. From this point on you need to be very steady since you entering phase of fine (precise) aiming.

3 - Distance needle started to move, LAUNCH light is on. You should fire your gun or rockets while the needle is within the green marked distances range. Depending on your speed and dive angle, the needle will pass this sector either quicker or slower. During your attack, as the distance decreases, the pipper will move upwards more and more, so you need to compensate this by gently and precisely pushing the stick away from you by very small amounts. Compare the pipper position on images 1 and 5: you can see the pipper moved about 20 mils up.

4 - Gun burst might look strange since it appears that bullets will overfly the target. Don't worry - this is normal. Keep the pipper on the target or just a bit below it.

5 - The BREAK-OFF light is on, meaning it is time to brake the attack. This light goes on bit earlier than it should according to minimal distance to the target: this is because ASP takes into account your attacking parameters and time needed for an average pilot to take the aircraft away from the danger zone. Break off with 4-5g if you have a payload. Engage the afterburner if you want to climb, otherwise set 100% engine RPM and separate from the targets in straight low level flight or by using a combat turn.

6 - Target (marked with orange circle) is hit and the shrapnel (marked with orange arrow) is flying upwards. These represent a danger and can damage your aircraft, so once you fire and you have the BREAK-OFF light signal, break the attack with 4-5g (or more, depending on your payload).

Attacking airborne targets

Airborne targets can be attacked using the internal gun, rockets or AA missiles. Let's start with the most common weapon - AA missiles.

Common procedure for all AA weapons: Assuming that you have enabled the weapons system using switches on the right vertical panel, select AIR master mode (CU2), set missile selector in either IR MISSILE or RADAR GUIDED MISSILE position (CU32), select AUTOMATIC mode using (CU15), and MSL mode using (CU13). If you know the target dimensions in meters enter the value using knob (CU17). Finally, check that TACTICAL RELEASE (CL73) is turned off.



Image 10.15: Attack using the internal gun and ASP in automatic gyro mode (fixed distance 300m).

For AA missiles: set the rotating launcher selector (CU7) towards appropriate launcher numbers (1, 2, 3, 4, 1-2, 3-4), set ASP to ROCKETS mode using (CU13) and FIRING mode using (CU14).

To use AA missiles, in most cases you will want to have the Sapphire locked on the target, primarily because of the correct distance measurement. I already explained what you need to do to turn it on and how to use it in search and lock modes. As for the radar guided missiles, once you have locked the target, you will have to maintain a target image in the center of the radar screen. When the missile head is ready, you will see a MHR light on the radar screen and hear the lock sound. When the distance markers enter the launch zone, the light LAUNCH will become visible on the radar screen.

Note: This applies only for radar guided missiles. For IR guided missiles, no radar screen info lights will indicate missile state and launch permission: you have to rely on radar distance measurement, signal lights on ASP (missile ready, launch, brakeoff) and missile ready light (CU40/42) and sound signal.

Wait until the distance markers move about 1/4 - 1/3 inside the launch zone and press the PS6 button for about 2-3 seconds (hold it until the missile is launched). If you are launching a semi active radar guided missile, perform a course-deviation turn in to the appropriate side for about 10°. Hold the lock until the missile hits the target or until lock breaks. If you are using IR guided missiles you can perform any maneuver (no further radar lock is needed).



Remember: To significantly increase hit probability, hold the target marker near the center of the radar screen during the launch sequence. If you look at the ASP glass, the target should be around the fixed net center.

If you are using IR guided missiles you can't use the radar to directly lock the missile head to the target; radar is only a distance and position measuring device in this case. To lock the target either place it slightly below the ASP fixed net center and see if the IR missile head will lock on it, or - if you already have radar lock - place the target image in the center of the radar screen in order to align missile head with the target. You will notice the missile lock if you hear the head sound and if the lock-on lights are on (CU40/42). In this case, missile head will hold the lock around the wider area of the ASP and if you are certain that the target is within range (visually or according to radar data), you can fire it using PS6 long press.

To **engage airborne targets with the internal gun:** load the gun using button 1 on (CU4) and make sure the gun is loaded which is indicated with green light (CU1), set ASP to GUN mode using (CU13) and FIRING mode using (CU14). Select AUTO mode using CU15 switch, and GYRO mode using CU19 switch. This setting is for a distance of 300m, so don't waste your ammo if the target is further away. To know when you are at 300m distance, set the target size using the CU17 outer scale. When the target fills the pipper you are at the right distance. Note that you can aim using the pipper or fixed net (for agile maneuvering targets). Fire the gun using (PS1) trigger. If the gun jams at any time, use the next unused button (CU5-6) to unjam it.

Note: Engaging airborne targets with the gun is the most complex task you can perform with the DCS MiG-21BIS. It will take lot of practice and experience before you become effective in this task.

To engage heavy airborne targets such are heavy transporters, bombers or big helicopters, you might try to use unguided rockets. Heavy targets are quite resilient to small caliber guns fire, and you have to put a big deal of your gun ammo on to the target in order to destroy it. However, it takes only two hits with 57mm rockets to render such targets critically damaged. And it's fun! Anyways, you can create a mission with few heavy transport planes and practice.

To **use rockets on airborne targets**, set rotating launcher selector (CU7) towards appropriate number of missiles in one burst (4, 8, 16), set ASP to ROCKETS mode using (CU13) and FIRING mode using (CU14). Aim and launch the weapon with (PS6) button.

Note: It is not recommended to attack airborne targets with large caliber rockets (e.g. S-24) because performing attack maneuvers with such heavy load is not safe and using so much power with pretty high chances of a miss is not rational. But it's surely fun.



Flares and chaffs container - ASO



You can equip the DCS MiG-21BIS with an ASO container which holds 64 charges of either chaffs and flares. Using the Mission editor, you can control the ratio of chaffs and flares loaded in ASO. A recommendation is 48 flares and 16 chaffs. Note that the default value is 32/32, so you will have to edit the ASO container content if you decide to change it.

The ASO container needs to be powered up: since the ASO is mounted in the SPRD mounts, make sure you turned on SPRD power and drop switches (RH50 and RH51).

In order to launch passive countermeasures (chaff/flares) all you have to do is to press the SPRD drop button (LH60). Note that two flares and one chaff are launched for every 0.3 seconds, as long as you keep this button pressed. This means that you have about 9 seconds of passive countermeasures use. Also note that there is nothing in your cockpit that is telling you the number of remaining charges: once you use all available chaffs and flares, there will be no more launch “whoosh” sound.

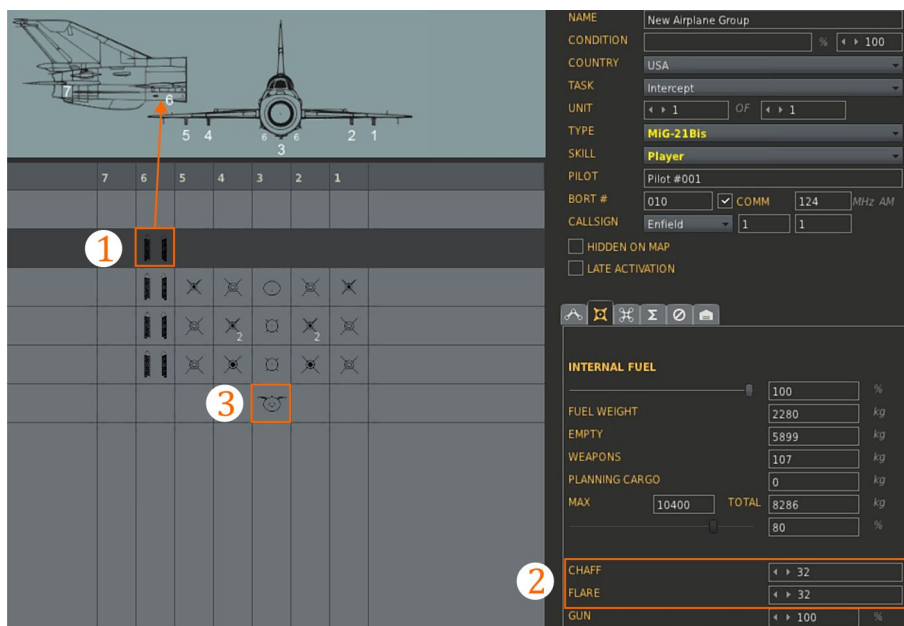


Image 10,16: 1 - equip ASO on station 6, 2 - edit amount of chaffs and flares you need for a mission, 3 - if you equip SPS-141 container note that it already have ASO built in.



Active and passive countermeasures container - SPS-141-100

The active and passive countermeasures container SPS-141-100 holds equipment for active and passive electronic countermeasures. This container is attached to the ventral pylon. You control the countermeasures pattern through the SPS Control box in your cockpit, above your ASP glass.



Image 10.17: SPS control box

- 1 - main switch, ON - up
- 2 - reception (down), emission (up)
- 3 - jamming patterns I (up) and II (down)
- 4 - “container ready” light. After you turn ON the SPS, it will take about 30 seconds to warm up. When this lights go ON, your container is ready.
- 5 - jamming pattern impulse (down), continuous (up)
- 6 - “aircraft painted by enemy radar” light
- 7 - self-test button. Self test can be performed after warming up.
- 8 - ASO control switch, automatic activation (down), manual activation (up)
- 9 - Flare launch programs: OFF - down; IN PAIRS - middle, SINGLE FAST - UP
- 10 - “ASO ready - launching” light (ON - ready, BLINK- launching)
- 11 - button for manual chaff/flare activation



“Nuclear” bombs

DCS does not support nuclear weapons, and I personally hope it never will. However, you have an opportunity to use a bomb that simulate **some** effects of so called “tactical nuclear explosions”.

You can equip one of two types of “nuclear” bombs: RN-24 or RN-28. These bombs are attached to the ventral pylon only, so you can only have one bomb at a time. To use it, you will have to manage the IAB control box that will appear in your cockpit above the ASP glass whenever you have the RN bomb equipped.

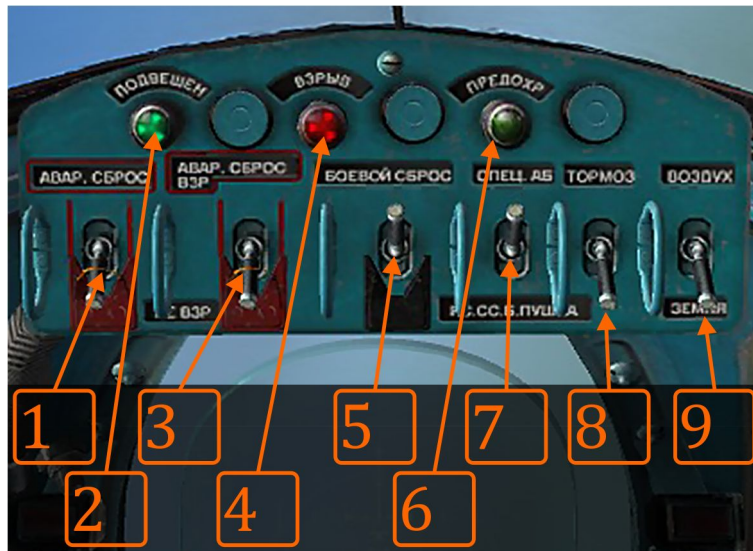


Image 10.18: IAB control box

- 1 - EMERGENCY DROP switch
- 2 - EQUIPPED (attached) light
- 3 - ARMED (up) or NOT ARMED (down) for EMERGENCY DROP only
- 4 - ARMED light
- 5 - COMBAT DROP switch
- 6 - SAFE light (not armed)
- 7 - weapon selector, UP for BOMB (working only with this weapon, have no effect on other aircraft weapons)
- 8 - RETARDED switch (must be DOWN all the time)
- 9 - GROUND (down) / AIR (up), selector for surface or aerial explosion (should be on GROUND only)



To use a “nuclear” bomb, place the switches on the IAB box into position like seen in the image above. Make sure that you have lights nbr. 2 and 4 ON, indicating that a bomb is equipped and that it will detonate on impact. To attack ground targets with this type of bomb, dive from high altitude (preferably above 5000m) with the engine at IDLE. Place the targets at the bottom of the ASP glass. Once you reach an altitude of 2500-2000m, release the bomb no regardless whether you still don't see the pipper. Break the attack as soon as the light nbr. 2 goes OFF (which means the bomb is dropped). Notice that if you continue to dive or you slowly pulling out of the attack, you will be blasted by your own bomb explosion.

Although it has big destruction potential, this simulated weapon is not even close to a real one, so it might fail your expectations. However, it could be useful for attacks on larger target groups, or big objects like airbases, harbors or cities. If you want to increase chances of successful attack, increase the number of aircraft equipped with this weapon.

UPK-23-250-2 control box

The UPK control box will appear above the ASP glass in your cockpit whenever you have UPK-23-250-2 gun containers on inner pylons. Note that UPK containers can't be mounted on outer pylons. UPK container hold one Gsh-23mm double barrel gun, same as the MiG-21BIS internal gun, with same number of rounds (250). Approximate firing time is around 4 seconds.



Image 10.18: UPK control box

- 1 - power for UPK containers
- 2 - internal gun (down) / UPK (up) selector



3 - status light (green - OK)

4 - UPK guns repeat/reload buttons (three buttons, usage from left to right as enumerated)

To use UPK guns, turn switch number 1 in up position to power up containers. Select UPK container (switch number 2 up) instead of internal gun which is selected by default (down), and prepare UPK guns using first repeat/reload button (buttons 4). After this you should see the green status light (3). If for any reason UPK guns are not ready or they are jammed, status light (3) will go off. If you think your gun is jammed, use next repeat/reload gun button (buttons 4) in order to reload or un-jam UPK guns. If the status light goes green again, you can continue to use UPKs. Otherwise, you have used all UPKs ammo in which case you may want to switch to internal gun (switch 2 in down position).

ASP setup for the UPK use is the same as for the internal gun, along with aiming principles.



Custom Ground Controlled Interception unit creation process

Having a “short range” and single target track radar, MiG-21BIS strongly relied on Ground Controlled Interception (GCI) support. To enable GCI support in DCS, you need to create a mission with some sort of early warning (EW) radar unit: it could be either ground EW radar or airborne EW radar (Airborne Warning and Control System - AWACS).

As a simple solution, you can use either the USA or RUS AWACS aircraft in orbit (E-2D, E-3A and A-50).

If you are playing in a coalition with Russia, you will also have ground EW radars available, namely 1L13 and 55G6 (under Air Defence unit type).

However, if you don't want to use AWACS, or Russian EW radars are unavailable, you can create your own custom GCI unit/group.

Note that custom units/groups creation is well explained in DCS User Manual, in “Create unit template” chapter, page 210 (at the moment this manual is written). I will explain how to create custom GCI unit/group so you can use it in any mission you create even if EW radars or AWACS aircraft are not available in coalition you are playing in.



Image 10.19: Start your DCS and select MISSION EDITOR.



Image 10.20: New mission template is automatically created. Select GROUND UNITS (1), click anywhere on the map to place a unit (2) and select RUSSIA from COUNTRY drop down menu (3).

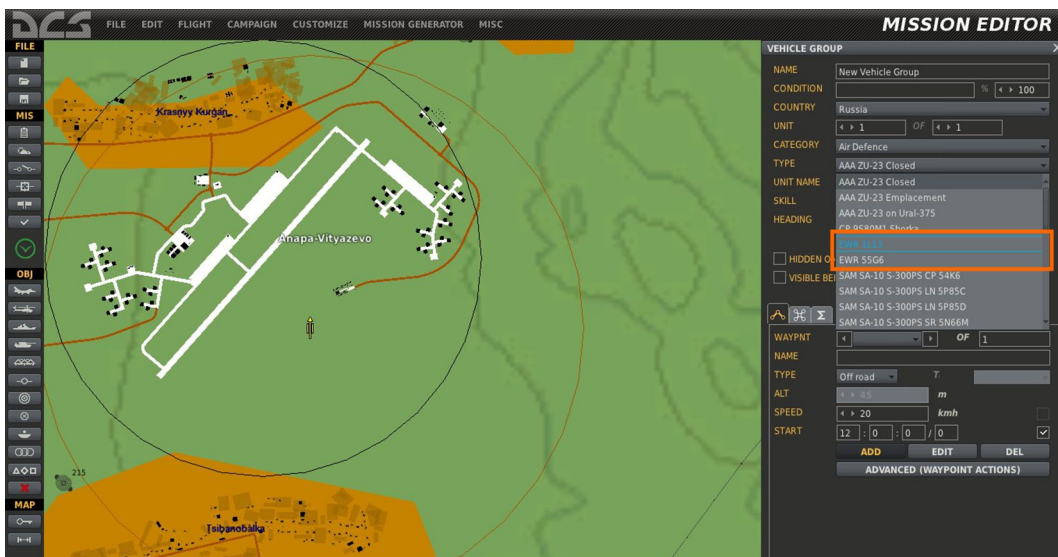


Image 10.21: On the right options window, select AIR DEFENCE from CATEGORY drop down menu. Open TYPE drop down menu, and select one of two available ground EW radars - either 1L13 or 55G6. You can find more on these units in DCS Encyclopedia.



Image 10.22: This step is optional. If you want to add more units to your core EW unit, increase the number of units (1) and define each additional unit CATEGORY and TYPE. You can define additional features of each unit you added, but it is not necessary to do so. However, if you want to do it, refer to DCS User Manual.



Image 10.23: Since all additional units will be automatically placed in diagonal column formation, you will have to edit their position in a group, to enable better performances in the simulation. Select each unit (1), choose its skill level (2, or skip this step if you wish) and select EDIT (3). This will enable you to move selected unit around the map, for better positioning around core unit which is your EW radar.

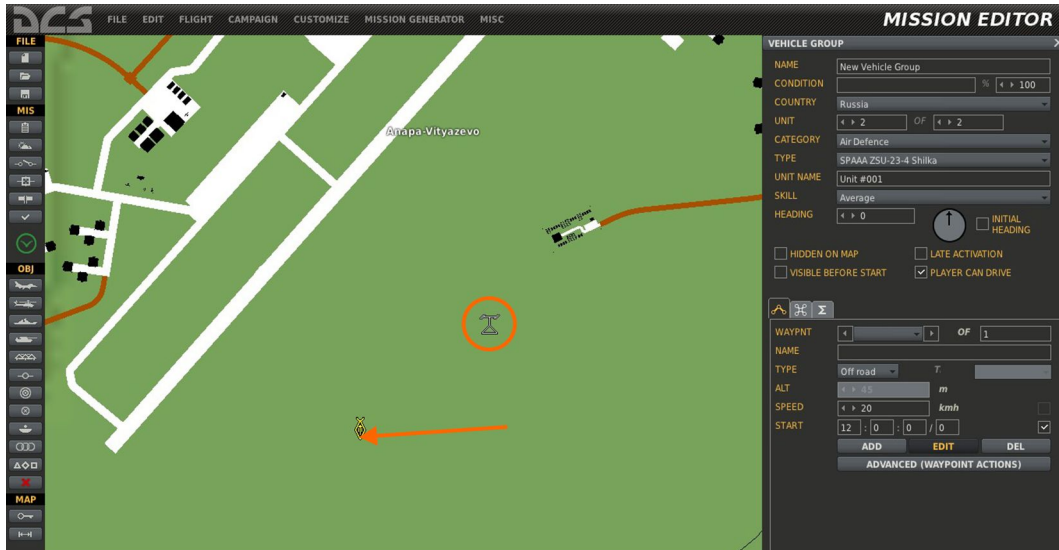


Image 10.24: I have moved Shilka (AAA) unit to the left from EW radar, as an example of previous step.



Image 10.25: Once you are satisfied how your group (or single unit) looks like, name it with some unique name (1). If you wish, you can name a leading unit in a group (2) but this is not necessary unless you want to create complex missions using triggering support.

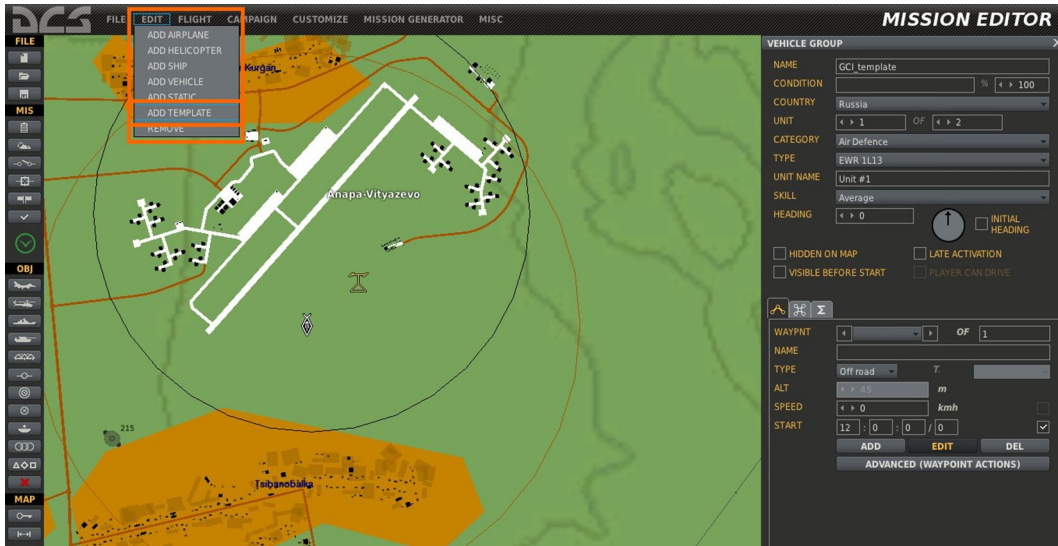


Image 10.26: With your group/unit still selected, open EDIT drop down menu, and select ADD TEMPLATE.

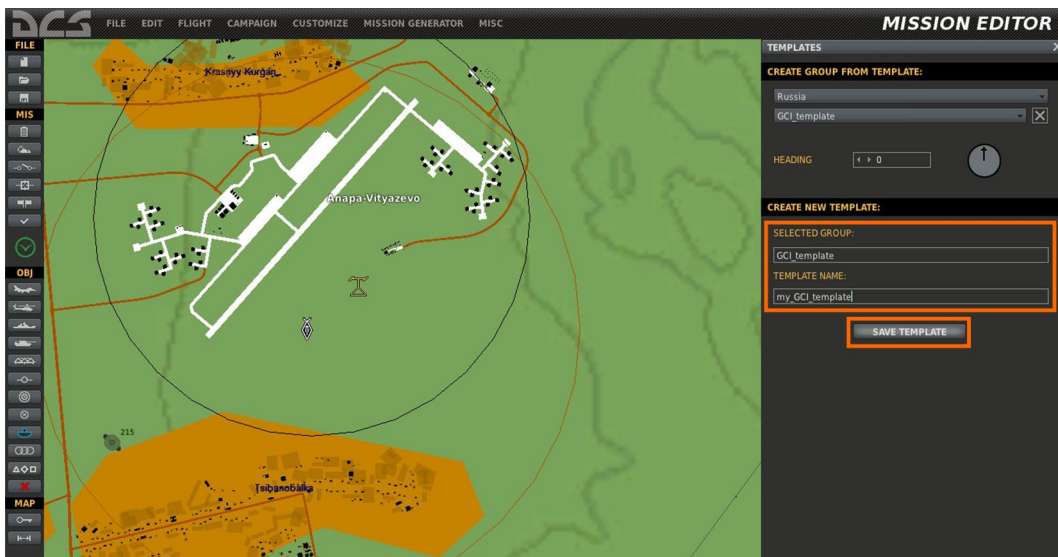


Image 10.27: Your group name will be automatically added to SELECTED GROUP text box, and you only have to name your template so you can recognize it among present templates when you create missions. Click SAVE TEMPLATE to save . From this point, your GCI template will be available for any country no matter the fact that particular country does not have specific units in it's arsenal.



Image 10.28: Test your template by creating a new, blank mission template. Open EDIT drop down menu and select ADD TEMPLATE option.

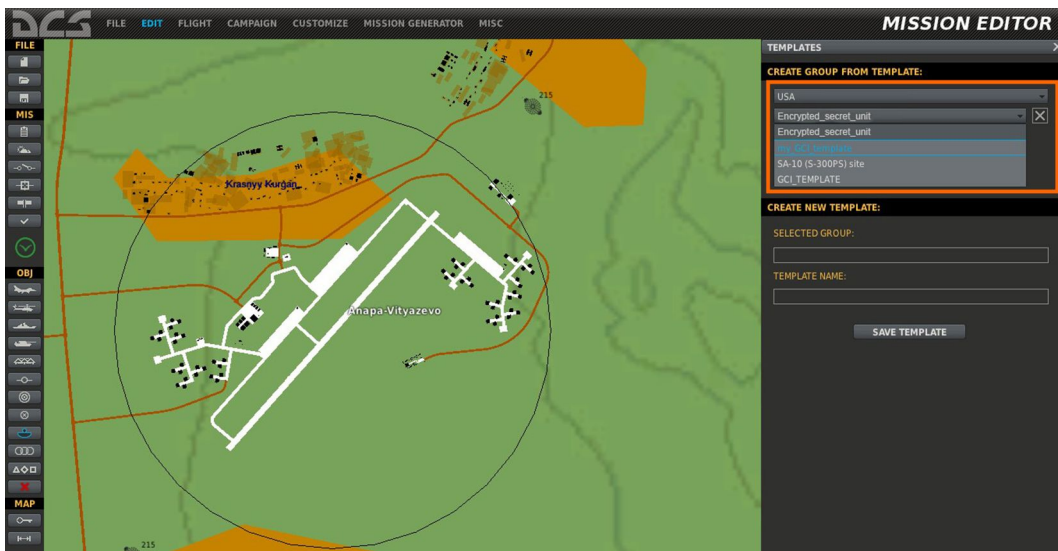
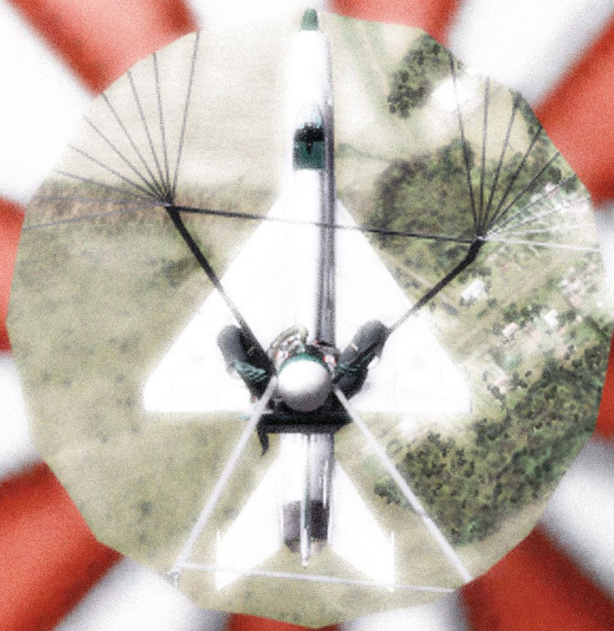


Image 10.29: In CREATE GROUP FROM TEMPLATE menu, select country you wish to assign your template (I used USA from the list of countries), and select your template from templates drop down menu. Click on the map - your template will be placed down along with appropriately assigned coalition color.



EMERGENCY PROCEDURES



11. Emergency procedures

Note: Most of the content elaborated here is available (implemented) in the DCS MiG-21BIS; some content – however – is not activated at the moment but it is left here for future compatibility.

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.

Abandon the aircraft immediately if the situation spells danger to your life.



1. Fire in engine compartment

Symptoms: the SORC (CM93) button light is flickering and the FIRE light flashes up in the light panel (RV70).

- smoke or flame (visible through the periscope, reported by a ground observer or by the pilot of a neighboring aircraft);
- 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 behavior;
- erroneous readings of the engine instruments.

Actions to be taken:

1. During the takeoff run:

- immediately discontinue the takeoff procedure;
- take measures to stop the aircraft;
- hinge off the cap marked FIRE EXT. (LV37) and depress the button;
- switch off the booster pumps and fuel transfer pumps;
- 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.

3. If fire starts in flight, proceed as follow shut off the engine and immediately abandon the aircraft. (prior to abandoning the aircraft, depress the FIRE EXT. (LV37) button, if practicable);

2. Powerplant failures or malfunctions

2.1. Powerplant Failure on Takeoff

2.1.1. 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 more than 8-12%;
- illumination of the JET NOZZLE OPEN light in the panel (RV70).

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 in the second half of the takeoff run, when abortion of takeoff would endanger the pilot's life, turn off the FULL THROTTLE, REHEAT switch (LV33) 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 after 3-4 s, eject.

2.1.2. 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 12%.

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 UB-16-57 pods, or two (four) missiles, or a 490-L drop tank, cut out the FULL THROTTLE, REHEAT (LV33) 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).

2.2. Powerplant surge

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 power-plant 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.).

Actions to be taken:

- use the Manual control switch to open the anti-surge shutters (LV6);
- turn off the afterburner,
- reduce the flight speed;
- close the anti-surge shutters (LV6) as soon as surge ceases;



- by smoothly shifting the throttle lever, bring the engine to a desired power setting.

2.3. Engine Flameout

Symptoms:

- a peculiar pop or change of engine noise;
- abrupt decrease of the engine speed and jet-pipe temperature;
- the cone position indicator pointer might deflect to the extreme right position.

Actions to be taken:

- set the throttle lever to SHUT-OFF;
- disengage the AFCS (PS4);
- establish an 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.

2.4. Engine Relight

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 Paragraph 2.5.

Engine relight is ensured: at altitudes of 8000 to 10.000 m, from airspeed of 550 km/h up to Mach numbers of 0.9 M; at altitudes below 8000 m, from 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 (LV34, in-flight engine start-up) circuit breaker and make sure that the relight system is on, referring to illumination of the SWITCH OFF IGNITION light in the panel (RV70).

At any given altitude 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.

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 check the engine for normal running then cut out the AIR RELIGHT (LV34) circuit breaker.

If the engine has failed to get relighted, cut out the AIR RELIGHT (LV34) 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.

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.

If engine surge (or flameout) occurs at an altitude of less than 3000 m, or during launch of missiles or rockets, proceed as follows:

- immediately shift the throttle lever to SHUT-OFF keep it in this position and 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);
- shift the throttle lever to any non-reheat power setting required for flight continuation, without any delay;
- 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.

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 altitude of 1000 to 2000 m;
- b) 700 km/h at altitude 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 failed engine landing or flight to an area where ejection would be accomplished).

2.5. Approach and Landing with a Dead (windmilling) Engine

Dead-engine landing (with the engine windmilling) can be performed only with the LG extended, on an airfield or some landing strip well-known beforehand and visible from an altitude ensuring proper landing estimation, either by reference to the check altitude or by reference to check points.

Landing by reference to the check altitude is accomplished 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.



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;
- set the throttle lever to SHUT-OFF;
- disengage the AFCS (PS4);
- turn on the PUMP UNIT switch (RV15) (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.

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 at minor increase of the angle of descent during the turn.

Note. Jettison all external stores and glide at an airspeed of 470- 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 system;

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 airspeed of 480 to 500 km/h.

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 airspeed of 480 to 500 km/h. Performing the turn, calculate the check altitude (in meters) as follows: $H_{check}=(H_{initial}/2)+800$

After performing an 180° turn, proceed gliding on the downwind leg at 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.

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 nose wheel 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.

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.

Approach the airfield so as to overfly one of the check points at the recommended altitude, making allowance for the angle of turn.

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 diminished 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.

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.

2.6. Cone failure to extend during aircraft acceleration at constant engine power setting or during decrease of engine speed

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 CU9), align the cone position indicator broad pointer with the slender one, then set the cone function switch to MAN. (LV7);
- 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 6.1](#),
- in the case of unsteady run of the powerplant, proceed as mentioned in Paragraph 2.2,
- fully retract the cone before extending the landing gear.

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 in given table.



2.7. Cone failure to retract during aircraft deceleration or engine acceleration

Symptoms:

- the cone position indicator fails to deflect in response to Mach number decrease or engine speed increase.

Actions to be taken:

- rotate the setting knob (CU9) to align the cone position indicator broad pointer with the slender one, then set the function switch to MAN (LV7);
- discontinue a training mission and fly to the landing airfield (when fulfilling a combat mission, proceed as laid down in further text after changing over to manual control of the cone);
- during airspeed reduction and when making landing approach, proceed in accordance with further instructions concerning landing.

When flying with the air intake cone fully extended, perform initial approach at 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 condition 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.



2.8. Failure of Jet Nozzle Control System

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 by 8 to 12%.

Actions to be taken: turn on the 2-PSN NOZZLE EMERG. CTL switch (LV12). If the nozzle fails to shift to the position corresponding to the FULL THROTTLE setting, turn off the FULL THROTTLE, REHEAT (LV33) circuit breaker and use power settings up to FULL THROTTLE.

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 (RV70).

Actions to be taken: turn on the 2-PSN NOZZLE EMERG. CTL (LV12). If the nozzle fails to shift to the position corresponding to the FULL THROTTLE setting, turn off the FULL THROTTLE, REHEAT (LV33) 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 (LV12) is turned on and the FULL THROTTLE, REHEAT (LV33) circuit breaker is turned off (the nozzle fails 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.

2.9. Second Reheat Failure to Cut In, or its Spontaneous Disengagement

Should second reheat fail to cut in (with the SECOND REHEAT switch (LH57) 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 (RV70) and no engine rpm increase up to 102 – 103,5% being observed), turn off the SECOND REHEAT switch (LH57) and, further, use power settings up to FULL REHEAT.



2.10. Drop of Fuel Pressure

Symptoms: The SORC (CM93) centralized warning system button light is flickering, and the SERVICE TANK light flashes up in the light panel (RV70).

Actions to be taken:

- turn off the afterburner and set the throttle lever to any non-reheat power setting required for flight continuation;
- push the SORC (CM93) 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.

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%.

3. Failures of hydraulic system

3.1. Failure of Both Hydraulic Systems with Engine Running

Symptoms:

- the SORC (CM93) centralized warning system button light is flickering;
- the WATCH MAIN SYST. PRES. and WATCH BSTR SYST. PRES. lights come on in the light panel (RV70);
- the pressure in both hydraulic systems keeps decreasing below 165 kgf/cm² (with the НП-27Т PUMP UNIT (RV15) switched on).

Actions to be taken:

- disengage the AFCS (PS4),
- 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.



3.2. Failure of Aileron Boosters

Symptoms: jerking, creeping or excessive loading of the stick in aileron control.

Actions to be taken:

- switch off the AFCS (RV23),
- 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.

3.3. Failure of ARU Controller

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 (CM57).

Actions to be taken:

(a) in the first case:

- 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 (PS4) (to prevent possible oscillations of the aircraft);
- flip the pitch-channel automatic transmission ratio controller switch (LV27) 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:

- disengage the AFCS (PS4),
- 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.

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.

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 (CM57). In this case no peculiar features will be involved in either landing estimation or landing proper.

4. Electrical power failures

4.1. DC Generator Failure

Symptoms:

- the SORC (CM93) system button light is flickering;
- the DC GEN. OFF light flashes up in the light panel (RV70);
- 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 PO-750 No. 2 and missile control system.

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 SORC (CM93) system button light;
- disengage the AFCS (PS4),
- establish an engine speed of not more than 95%;
- descend to an altitude of less than 6000 m at as high vertical speed as possible, to permit flight without the usage 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 Ah as read by the ICA 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 or 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.

4.2. Failure of Inverter ПO-750A No.1

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. CONVR circuit breaker (RH54) on the right-hand horizontal console. This will cause the above loads to be changed over to inverter ПO-750A 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.

5. Failures of flight and navigation systems

5.1. Failure of FDI Gyro Horizon

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 DA-200, the altimeter, compass system and radio compass).

Actions to be taken:



- disengage the AFCS (PS4);
- 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 service ability 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 DA-200 and watching the readings of the altimeter, airspeed indicator, compass system and radio compass.

5.2. Failure of RSBN Equipment

Symptoms:

- the displayed aircraft azimuth and/or distance from the navigational beacon do not comply with the actual position of the aircraft.
- 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 NPP have failed to close their windows, or they opened the windows in the course of the approach;
- the readings of the PPD distance indicator fail to comply to the aircraft actual distance to the runway.

Actions to be taken: stop using the navigational section of the RSBN equipment any longer.

Return to the airdrome and come in to land by the radio compass, having placed the RSBN -ARC switch (LV7) in the ARC position.

5.3. Failure of Compass System

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 (PS4);
- 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 RSBN system for approaching the airdrome;

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.

To perform initial approach to the landing airdrome with the use of the RSBN system, rotate the SC course setting knob of the NPP 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 PPD distance indicator: if its readings are ever increasing, turn the plane through 180° to fly to the navigational beacon.

5.4. Failure of Pressure-Actuated Instruments (Failure of Pitot-Static System)

Symptoms:

- the readings of the US-1600 airspeed indicator and UISM-I 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 DA-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 UISM-I 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 ARU controller and AFCS will be affected.

Simultaneous failures of the US-1600, UISM-I, VDI-30K and DA-200 instruments in supersonic flight will testify to failure of the first static system. Simultaneous failures of the VDI-30K, DA-200 and УВПД-20 instrument in subsonic flight will be indicative of failure of the third static system. Failure of the first static system also affects functioning of the ARU controller, AFCS and air intake anti-surge shutters (LV6) automatic control.

Actions to be taken:

Check to see that the PERISCOPE, AA XDRCR, P-S TUBE, CLOCK and SIDE P-S TUBE circuit breakers (CL74 and 75) 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.



6. Landing gear failures

6.1. Failure of LG to Extend Normally

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 signaling 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.

In case the signaling 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 signaling 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 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 Paragraph 6.2.

6.2. Emergency LG Extension

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).

Cut out the PRESET (LIMIT) ALT. switch (LV56) before landing with the main LG legs retracted.

Abandon the aircraft by ejection in case the nose leg or one of the main legs fails to extend.

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.

7. Off-field forced landing

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 favorable conditions for ejection and abandon the aircraft.

Proceed as follows on taking the decision to perform an off-field forced landing:

- 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;
- 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 signaling unit.

Cut out the PRESET (LIMIT) ALT. (LV56) switch before landing with the main LG legs retracted.

8. Bail-out procedures

8.1. Getting Ready to Bail Out

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 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;

In case of immediate danger, bail out without any delay.



Abbreviations

Abbreviation	Meaning	Note
AA	air to air	
AAG	altitude above ground	
AG	air to ground	
AGD	attitude indicator	
AGL	above ground level	
AoA	angle of attack	
ARC	automatic radio compass	
ARU	horizontal tail movement control system	
ASP	optical aiming device	
ATC	air traffic control	
CAS	close air support	
ERR	error (warning light on the radar screen)	
IAS	indicated airspeed	
ILS	instrumental landing system; often used as general reference to similar instrumental landing systems	
IR	infra red	
KPP	essentially, an attitude indicator (augmented with ILS needles and altitude and course/radial directional needles)	
KSI	course and ground navigation radio-station indicator	
LST	low speed target	
M	Mach number	



MHR	missile head ready	
MTBF	mean time between failures	
NDB	non-directional beacon	
NPP	essentially, course and ground navigation radio-station indicator (augmented with PRMG needles, polar coordinate system labels, landing pattern labels, and course-set needle)	
PO-750	DC → AC converter	
PRMG	instrumental landing system	
RP-22(SM)	radar	
RPM	rotations per minute	
RSBN	tactical radio navigation system	
SARPP	“black box”; records flight parameters	
SAU	autopilot, labeled by type (SAU-23)	
SOD	transponder	
SPO	radiation warning receiver	
SPS	flaps boundary layer blowing (control) system	
SRZO	identification friend/foe system	
SUA	dangerous AoA warning lights	
TAS	true air speed	
TDC	Target designation cue	
UAV	unmanned aerial vehicle or future of aviation	
UUA	angle of attack indicator	



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