Section 5

Combat Use.

Using its own flight data and aerial weapons capability, this aircraft can perform the following tasks:

- Intercepting airborne targets at short and medium ranges in all weather conditions, both day and night, in look-up and look-down situations;
- Managing short-range high-maneuvering (WVR) combat;
- Attacking surface targets on land (and water).

The defeat of airborne targets is carried out:

- With medium-range R-27ER1 and R-27R1 radar guided missiles and R-27ET1 and R-27T1 thermal guided missiles;
- With short-range R-73E in close maneuvering combat with thermal guidance heads (ТГС);
- With the GSH-301 cannon.

ATTENTION: Missiles are indicated as follows on the HUD:

• R-27ER1	• R-27ER
• R-27R1	• R-27R
• R-27ET1	• R-27ET
• R-27T1	• R-27T
• R-73E	• R-73

Defeat of ground (surface) targets is provided by:

- Unguided S-25 rockets launched from S-25 pods; S-13 rockets from the B-13L launcher; S-8 rockets from the B8M-1 launcher;
- Aerial bombing: aerial bombs (caliber 50, 100, 250, and 500 Kg), incendiary tanks (ZB-500), and single-use cassette (cluster) bombs (RBK-500);
- The GSH-301 30-mm cannon with 150 rounds.

The firing of rockets and dropping of bombs is accomplished with the trigger marked PODV (further referred to as “P”), and the firing of the GSH-301 cannon is accomplished through the trigger marked FIRE (further referenced as “O”).

The employment of airborne weapons is accomplished through the armament control system (SUV-27E) (СУВ-27Э - системой управления вооружения) in conjunction with the onboard avionics (БРЭО- бортовым радиоэлектронным оборудованием).

5.1 An overview of the armament control system (SUV).

5.1.1. The fire control system includes the RLPK-27E (РЛПК - радиолокационного прицельного комплекса) radar targeting complex, the OEPS-27 (ОЭПС - оптико-электронной прицельной системы) optical-electronic targeting system, the “Nartsiss-M” unified graphical information complex (CEI) (СЕИ - системы единой индикации) [providing information to the HUD & HDD], the state identification system (IFF), and the SUO-27E2 weapon control system (СУО-27Э2 - системы управления оружием) to ensure:

- the employment of missiles against airborne targets in both long-range (ДРБ) and short-range (БМБ) combat;
- the ability to engage in long-range combat through the acquisition and tracking of targets with the radar (РЛС - радиолокационная станция) and optical/infrared (ОЛС - оптическая локационная станция) tracking stations (systems);
- the ability to effectively engage within-visual range, close air combat targets through the Vertical (ВЕРТИКАЛЬ), Helmet (ШЛЕМ), and Optical (ОПТИКА) (Boresight) modes;
- use of the built-in gun installation (cannon) (ВПУ);
- identification of nationality (IFF)
- application of unguided weapons against ground targets.

5.1.2. **The radar targeting complex (RLPK)** is part of the SUV-27E (СУВ-27Э) weapon management system and provides for:

- the detection of airborne targets flying at altitudes between 30 meters and 27 kilometers, acquiring and tracking their passage in all weather conditions, both day and night, in the presence of jamming and managing their destruction in both long-range and close-range combat;
- the computation of missile launch parameters and the generation and issuance of discrete commands in the SUO-27E2 (СУО-27Э2), as well as the illumination of the target under attack and the transmission of guidance commands to a launched, radar-guided missile (a missile with a radar seeker head [Радиолокационная Головка Самонаведения (РГС)]) via the radio correction channel;

- the formulation and display of both survey (search) and tactical data to the integrated display system screens (СЕИ) (HUD and HDD);
- the formulation and transmission of targeting data, as discrete commands, along with current range information in coordination with the optical-electrical targeting system (ОЭПС);
- the reception of the angular coordinates of a tracked target from the optical-electronic targeting system (ОЭПС), from the KU-31 (КУ-31) control lever in BORE(SIGHT) (ОПТ) mode and from the helmet mounted target designation system (Нашлемная Система Целеуказания - НСЦ) in HELMET (ШЛЕМ) mode;
- the creation and issuance of the appropriate prompts for managing the aircraft in various control modes;
- the formation and display of information on the integrated display system screens (СЕИ) (HUD and HDD) and in the K-DlAE when solving problems involving group operations;
- the solving of problems of group operations;
- the reception of data from the aircraft's onboard avionics (Бортовое РадиоЭлектронное Оборудование – БРЭО), ground (or air) control facilities, the identification of processed data with the detected coordinates and the tracked target;
- the output of control commands to the flight monitoring equipment, SOK-B (Средства Объективного Контроля учебно-Боевых действий - СОК-Б);
- the reception of weapon status information from the weapon control system (Система Управления Оружием – СУО).

RLPK (Radar) operates in the following modes:

- Tracking the Target Tracks (Passage), Сопровождение на Проходе (СНП): target detection and surveillance along with determining target coordinates and positions (tracking no more than 10 target tracks per scan)
- Continuous Bearing Mode (STT), Режим Непрерывной Пеленгации (РНП): determines the coordinates of the target with the accuracy required for launching missiles without saving the target tracks;
- Discrete-Continuous Illumination, Дискретно-Непрерывного Подсвета (ДНП): where the radar tracks and illuminates the target under attack and periodically sends single-use (guidance) command information [разовые команды (РК)] via the update link to the radar-guided missile (РГС);
- Quasi Survey (Search), КВази Обзора (КВО): where the Search and Track Radar System (Radar Aiming Complex) (РЛПК) is used as the slave channel. In Quasi Survey (Search) mode, after locking the target with the Optical Locating (Tracking) System

(ОЛС), the Search and Track Radar System is used to intermittently and briefly illuminate the target and provide range information (which is displayed on the HUD). This is accomplished by moving the EMIT switch from the DISABLED to the EMIT position. This slaved range support begins after a 5 second delay.

Either when the target range closes to less than 15 km or by pressing ENTER on the flightstick at ranges over 15 km, the Search and Track Radar System (Radar Aiming Complex) (РЛПК) automatically acquires the target and moves from KVO (КВО) to RNP (РНП) mode.

The range of the Search and Track Radar System (Radar Aiming Complex) (РЛПК) both in free space and against the background of the earth is practically identical and depends on the flight altitude of the aircraft, hemisphere of attack, and the composition and size on the fighters (σ = 3 m2):

a) when flying at high altitudes:

- Using Rear Hemisphere PRF (Задняя ПолуСфера – ЗПС) (M-PRF):

  if attacking looking down:

  Detection Range (Добн) = 30 – 40 km
  Lock Range (Дзахв) = 30 – 35 km;

  if attacking looking up:

  Detection Range (Добн) = 50 – 55 km
  Lock Range (Дзахв) = 45 – 50 km;

- in Front Hemisphere PRF (Передняя ПолуСфере – ППС) (H-PRF):

  Detection Range (Добн) = 80 – 100 km

  Lock Range (Дзахв) = 65 – 80 km;

b) when flying at medium altitudes (greater than 1000 m):

- Front H. PRF: Detection Range = 80-100 km; Lock Range = 65-80 km
- Rear H. PRF: Detection Range = 25-35 km; Lock Range = 20-30 km

c) when flying at low altitude (under 200 m):

- Front H. PRF: Detection Range = 35-40 km; Lock Range = 28-32 km
- Rear H. PRF: Detection Range = 20-25 km; Lock Range = 18-20 km

In Survey (Search) mode, with Front Hemisphere PRF selected, you might lose the target within the range span of 100-70 km for up to 5 cycles of the radar search (scan) (failure to provide range data).

The Radar Aiming Complex (RLPK) provides detection of aerial targets flying with a speed of more than 210 km/hr in both Front Hemisphere and Rear Hemisphere PRF. Targets flying at a lower speed (for example, a helicopter) are not detected. The Radar Aiming Complex supports the locking of slow moving objects like helicopters when locked using Front Hemisphere PRFs. The detection and locking of hovering helicopters and attacking using Rear Hemisphere PRFs is not guaranteed.

When attacking targets using Rear Hemisphere PRFs in a look-up situation at flight altitudes of more than 8500 m, the Radar Aiming Complex (РЛПК) provides the detection and capture of targets if the closure rate is greater than 300 km/hr. In the rest of the cases, when attacking with Rear Hemisphere PRFs, the RLPK supports the detection and capture of targets with closure rates of 180 km/h or more. This closure speed is reduced to 100 km/hr or more, when approaching from behind the target. In situations with little or no closure rate, detection isn't provided.

Tracking of targets is provided when closing with a speed differential of no less than 150 km/hr. In order to maintain a specified speed during an attack using Rear Hemisphere PRFs, it is necessary to keep the closure rate marker centered between the zero closure rate and "own speed" marks. If the closure rate scale starts flashing, increase your aircraft's airspeed.

The locking and tracking of a visually acquired target is guaranteed in the VERTICAL (close range combat) mode at ranges of less than 5 km at all aspects except 4/4 in the entire range of approaching (or receding) closure speeds. At equal speeds it is possible that the lock will be unstable. In order ensure a stable lock, a speed differential of no less than 150 km/hr must be maintained between the pursuer and the target.

The aspect angle of the target detectable by the RLPK is limited by the radial component of its velocity. At subsonic speeds, the aspect angle should not exceed 70° regardless of the hemisphere and circumstances of the attack.

When attacking a target, if maneuvering will alter the angles in a way that can change the target's hemisphere, set the PRF: FRONT (Hemisphere)-AUTO-REAR (Hemisphere) (ППС-АВТ-ЗПС) switch to the AUTO position.

In Continuous Bearing mode (STT), the RLPK ensures all aspect tracking of a maneuvering target against uncluttered backgrounds. Target maneuvers can include course reversals and turns with a target elevation (угле места цели) of more than 3° (at a range of under 30 km).

When attacking a maneuvering target which produces an aspect angle (ракурсу на углах) of less than 3° with the target in ground clutter, in either Front H. PRF or Rear H. PRF, tracking is ensured as long as your closure rate (either positive or negative) is 150 km/h or more. At subsonic speeds this corresponds to an angle of approximately 80°.

For either larger aspect angles or azimuths greater than 60°, the target will be dropped.

During the attack of a target using Front H. PRF, it is possible that multiple targets will propagate range and azimuth lines.

When attacking targets using the Rear H. PRF setting in Survey (Search) mode you may see phantom target marks along multiple azimuths and ranges, especially when flying at low altitude over forests or cities. You may also notice a brief (5-10 sec) appearance of the JAM (Активных Помеха – АП) (jamming) symbol. The true target mark will show itself along a specific azimuth with the decrease in range as you approach. At ranges of less than 20 km, the target mark "multiplies itself" along the azimuth. Additionally, in Survey (Search) mode, it is possible that there might also be false identification (IFF) above the target mark along with interference.

When operating the RLPK in Survey (Search) mode, you must adjust the expected target range (Друд) so that the time of the target's appearance coincides with the second or third line number.

In the absence of target range information from the Command Post (Командного Пункта – КП), set the expected target range (Друд) to 0.8 times the Detection Range (Добн) under these attack conditions: if, when attacking in a look up situation, the target is detected on the first line or, when attacking in a look down situation, it's detected on the fourth line, reduce the value of the expected target range (Друд).

When setting the ENTER RANGE (ВВОД ДАЛЬН) slider on the throttle to range values greater than 70 km, the size of the azimuth's field of view is ± 20°, with lesser range values ± 30°.

5.1.3. Optical-electro aiming system (OEPS) (ОЭПС).

The OEPS is a component of the Armament Control System (СУВ) and provides:

- detection, locking, and tracking of air targets against a background of clear sky, clouds, earth and water surfaces, both during the day and night, when conducting either close-air maneuvering or long-range missile aerial combat;
- measurement of target range with the help of a laser rangefinder;
- creation and issuance of the appropriate prompts for managing the aircraft in various control modes;
- formulation and display of information on the integrated display system screens (СЕИ) (HUD and HDD) in the OLS (ОЛС), OPTICAL (ОПТИКА), VERTICAL (ВЕРТИКАЛЬ) and HELMET (ШЛЕМ) A2A combat modes. It also provides targeting information when using heat seeking missiles (ТГС) against aerial targets, the onboard cannon (ВПУ) against both aerial and ground targets, and unguided weapons against ground targets;
- computation of missile launch parameters, target designation, and control commands for heat seeking missiles (ТГС);

- the computation of aiming solutions for the onboard cannon (ВПУ) against both aerial and ground targets;
- solving problems involved in aiming unguided weapons against ground targets;
- formulation and issuance of signals in the Weapon Management System (СУО), providing the means to prepare weapons depending on their combat use;
- issuance of the tracked target's angular coordinates to the RLPK, when the primary channel is the OLS (ОЛС) while in a Long-Range Aerial Combat mode;
- lock the visually acquired target when in either HELMET (ШЛЕМ), BORE (ОПТИКА), or VERTICAL (ВЕРТИКАЛЬ) mode;
- issuance of the visually acquired target's angular coordinates to the RLPK and to guided missiles with infrared homing heads (ТГС) when using the missile's guidance head in OPTICAL mode or with the helmet mounted target designation system (НСЦ) in HELMET (ШЛЕМ) mode;
- the output of control commands to the flight monitoring equipment (СОК-Б);
- reception of the angular coordinates and the current range of the tracked target from the RLPK;
- reception of weapon status information from the Weapon Management System (СУО);
- reception of information from the GCI (Ground Automatic Control System) (НАСУ) in order to direct the center of the IRST (ОЭПС) scanning area in Command Guidance (CG) (КН) mode;
- issuance to the Flight Navigation Complex (Пилотажно-Навигационный Комплекс - ПНК) both the bearing and range to the terrestrial waypoint in VISUAL CORRECTION (ВИЗУАЛЬНАЯ КОРРЕКЦИЯ) mode.

When using the Rear H. PRF mode, the maximum detection range of a low aspect (0/4-2/4) fighter flying at full military power against a clear sky background is approximately 50km; against a background of clouds, earth, and water, about 20-35 km; and in afterburner the range for aspects less than ¼ is 90-100 km in Front H. mode. Target lock range is approximately 70% of target detection range. The target lock range at full military power in Front H. mode at an aspect of less than 5° - 15° is approximately 10 km. To ensure the locking of a high-speed, long-range target in Front H. PRF, you must increase the attack angle to greater than 15°.

When using the OLS (ОЛС) along with the large or small area scan, remove extraneous noise on the HUD due to extraneous lighting (from clouds, land, water surfaces, and the sun) by adjusting the GAIN: INFRARED (УСИЛЕНИЕ ТП) dial.

Turning the GAIN: INFRARED (УСИЛЕНИЕ ТП) dial to the left reduces the sensitivity of the OLS (ОЛС) and removes inference from around the target marks. Target mark

positions are updated every 4-6 seconds, when using the wide area scan and every 1 second when in small field scan.

When locking a target using the OLS (ОЛС), it is advantageous to remove the background clutter from the HUD. Automatic locking is recommended when there is a single target mark within the IRST's scan zone.

In a case where the target is both designated and identified by the GCI (Ground Automatic Control System) (НАСУ), the IRST will itself automatically lock the designated target.

As long as the target remains unidentified, target lock is not possible.

In the absence of range information provided by either the RLPK or GCI (target range information from the GCI arrives as a discrete number) the range is entered manually into the optical-electrical targeting system (ОЭПС).

A failure to lock the target can occur:

- when the target leaves the tracking coverage zone;
- when either the target or you enter cloud cover;
- when there is a sudden decrease in the target's exhaust gas temperature (at long range);
- when your aircraft's nose comes between the target and the IRST.

When attacking a target using Partial Instrument Support (Неполном Приборном Обеспечении - НПО) (prior to entering the range), the default range of the scale is 10 km and the maximum allowed range symbol (ДР) is displayed. After entering the range, the range scale measurement changes.

The laser rangefinder (ЛД-Лазерный дальномер) operates in two modes:

- as primary (2 Hz emission frequency)
- as support (.25 Hz emission frequency)

Total operation time in primary mode is 3.5 minutes.

The laser rangefinder switch can be turned on beforehand (even from the ground).

Upon locking an aerial target in Rear Hemisphere, the laser rangefinder is engaged in the support mode when the target range is more than 1600 m and in primary mode when R < 1600m. When using the OEPS against ground targets, the laser rangefinder is always switched on in primary mode. When used in this way, it engages automatically when attacking a target in a dive greater than 10° or manually in level flight by pressing the P trigger on the flight stick (РУС).

The laser rangefinder shuts down automatically 30 sec after illumination begins or with the initial pressing of the P trigger or manually by pressing the RESET button on the throttle.

5.1.4. The Weapon Control System SUO-27E2.

The weapon control system (SUO-27E) is an integral part of the armament control system (SUV-27E2) and is designed for the preparation and use of all types of weapons and supports the following functions:

- indicates the presence of weapons on their hard points and their readiness state;

- selection of the both the type and variant of weapon to be used;

- indicates which weapon is selected and which remain in reserve;

- issues signals to the system for detecting and eliminating engine surge, when weapons are used;

- issuance of a signal for a tone of 400 Hz to be generated in the pilot's headset, when either a target is locked by a missile with a thermal seeker head or the readiness of a missile with a radar seeker head, when the MASTER ARM (ГЛАВ ВКЛ) switch is engaged;

-provides a safety lockout against weapon use when the landing gear are extended either in the air or on the ground by locking circuits and also switching the MASTER ARM switch to the off position.

SUO-27E2 can operate in the following modes:

- semi-automatic, where the preparation of the weapons for release, their tactical discharge and firing is done in accordance to commands issued automatically by either the Radar Aiming Complex or the Optical-Electronic Targeting System;

- manual, where the preparation of weapons for release, their tactical release, and firing is done in accordance with commands issued manually;

- emergency, where the emergency release of missiles from aerial (missile) launch pylons (АПУ - авиационное пусковое устройство) or the emergency ejection of weapons takes place using either the aerial (missile) ejector pylons or (АКУ - авиационное катапультное устройство) or bomb rails (БД - Балочный Держатель).

Upon receiving the target designation (ЦУ) and single-use commands, a heat-seeking missile (ТГС) issues a ready tone after the thermal head itself locks the target, while a radar-guided missile (РГС) takes at least 2 sec (for testing the target designation (ЦУ), fine tuning the frequency, and monitoring the radio correction channel) to announce its readiness.

In order to ensure the minimum amount of time to prepare a radar-guided missile, it is necessary to run the Integrated System Verification (ВСК - Встроенной Системе Контроля) routine as part of the SUV for R-27ER1 (R1) missiles prior to takeoff.

Should the target be locked simultaneously by R-73E missiles on every station, missile launching will occur according to the logic implemented within the SUV, i.e. 7 → 8 → 5 → 6 → 3 → 4 (5 → 6 → 3 → 4). However, if some missiles should not achieve target lock, the launch (release) sequence remains the same except that those which aren't ready are skipped.

If a single type of radar-guided missile is selected for use then, depending on their general state of readiness, they are launched according to the logic 3 → 4 → 9 → 10 → 2 → 1.

Different types of missiles (e.g., R-27ER1 or R27R1 and R-27ET1 or R-27T1) are launched according the same logic but launching begins with the missile class having been selected manually.

If during the missile launch the release mode switch is not set to the PAIRS (ЧАСТЬ) position but in any other position, then the missiles which are ready for launch will release one at a time with each P-trigger press.

If, when employing weapons against ground target, the selector switch remains in the PAIRS position, the weapons will be released in a series with an interval of 0.1 sec.

When Launch Authorized is illuminated, a missile is launched by depressing the P-trigger and does not depend on the length of time it is depressed. If the missile should fail to launch and the P-trigger remains depressed, then the LAUNCH (ПУСК) command passes to the next readied missile of the same type. Meanwhile the failed missile is de-energized and excluded from future counts of missiles available.

When launching either R-27ER1 or R-27R1 missiles in PAIRS mode and one or both of the missiles fails to launch, the launch command does not pass to a subsequent pair of readied missiles of the same type even when the P-trigger remains depressed.

In order to launch the subsequent pair (the next one in SINGLE (ОДИН) mode) release the P-trigger and depress it again.

When launching R-27R1 missiles, the Launch Authorized indication disappears while the P-trigger is depressed and reappears once the trigger is released (assuming the conditions for launch authorization still exist).

In all modes of R-73E employment, it is necessary to cool the thermal seeker head (ТГС) prior to launch by turning on either the MASTER ARM or 73-COOLING (73-ОХЛАЖД - 73-Охлаждение) switch at least 2 minutes prior to launch.

If it should be necessary to maintain the readiness of an R-73E missile while flying, switch off the MASTER ARM switch and turn on 73-COOLING for the remainder of the flight.

The O-trigger has two different positions (depressions):

- the first position selects the cannon as the priority weapon along with its aiming mode.

To select the onboard cannon, move the O-trigger with a light touch until it catches midway. In this first position the current aiming mode should display on the HUD;

- the second position fires the cannon. Finish pulling the O-trigger the remaining distance to its end limit (stop).

When using the cannon, Launch (Release) Authorized is not displayed on the HUD.

When firing the cannon without a cutoff selected, firing continues as long as the O-trigger is held in the second position until only 50 shells remain (НЗ). These are held in reserve.

When firing with a cutoff, 25 rounds are fired with each press (pull) of the O-trigger. When doing so, to stop firing, only release the trigger to the first stop so as not to disable the aiming mode. After each firing of the cannon, the remaining shells are indicated in a small box on the HUD (, 3 , 2 , 1 , A and O).

The indication of cannon rounds remaining is duplicated on the Input and Display Panel-10PE1(2) [ПВИ-10ПЭ1(2)] K, 3/4, 1/2, 1/4, НЗ, - respectively.

The remainder of the reserve rounds (НЗ) is expended either in CUTOFF (ОТСЕЧКА) mode in bursts of 25 rounds or, when firing without cutoff, for as long as the O-trigger is held in the second position. In the process, the reserve rounds (НЗ) indication is displayed on the HUD until the remaining rounds are expended. When necessary, the expenditure of the reserve rounds can be monitored on the Input and Display Panel () which counts in units of 10 (НЗ, 40, 30, 20, 10,).

WARNING: It is possible for the remaining rounds count to show 10 or 20 on the Input and Display Panel-10PE1(2) (ПВИ-10ПЭ1(2)) and A on the HUD when, in fact, there are no rounds left.

After firing the cannon, the O-trigger should be returned to its initial position.

The release of weapons upon ground targets is dependent on the Input and Display Panel-10PE2 (ПВИ-10ПЭ2) switch settings and the type of weapon selected as follows:

a) when set to the SINGLE position:

- the release of aerial bombs (АБ) occurs individually with each press of the P-trigger in sequence 9, 10, 2, 1, 3, 4, 5, 6 from the bomb mounts;

- the firing rockets from two symmetrical 80mm unguided rocket B-8M-1 (Б-8М-1) launchers occurs in volleys with a 0.8 sec interval, when you press and hold the P-trigger until the launchers are empty.

In order to fire the next two pods, the P-trigger must be released and, then, pressed again;

- 122mm unguided rockets B-13L (Б-13Л) are fired from their launcher pods in the same way as the 80mm rockets except that the interval is 0.16 sec;

- S-25 (С-25) rockets are fired one at a time with each press of the P-trigger.

b) when set to the PAIRS position:

- upon the first press of the P-trigger, four aerial bombs (АБ) are released at a fixed interval of 0.1 sec from stations 9, 10, 2, 1;

- on the second press, they are released in sequence from stations 3,4,3 (indicated on the PI-10P Weapon Status Panel by station 5), 4 (indicated by station 6);

- release of 88mm and 122mm () unguided rockets is identical to the SINGLE position;

- S-25 rockets are fired from two symmetrical stations with an interval of 0.16 sec with each press of the trigger;

c) when set to the SERIES position:

- all aerial bombs (АБ) are released according to the interval set on the PVI-10PE2 (ПВИ-10ПЭ2) when the P-trigger is pressed and held until all bombs are released from their suspension points in the sequence 9, 10, 2, 1, 3, 4, 5, 6;

- the entire pod of B-8M-1 and B-13L rockets are fired, when you press and hold the P-trigger until all are fired;

- S-25s are all fired one at a time from their suspension point in the sequence 3, 4, 3 (indicated on the PI-10P as station 5), 4 (indicated as station 6), when you press and hold the P-trigger.

When the TRAINING EMPLOYMENT (УЧЕБНАЯ РАБОТА) mode switch is engaged with the status “TRAINING (УЧЕБН)” displayed on the SHCHNP-10PM (ЩНП-10ПМ) panel and the release mode switch on the PVI-10E2 is set to the SINGLE position:

- four S-8 rockets are fired from their launchers, two by two, from symmetrical launchers with each press of the P-trigger;

- two S-13 rockets are fired from symmetrical launchers, one at a time, with each press of the P-trigger.

When the release mode switch is set to SERIAL:

- all launchers are used – up to eight S-8 rockets, two rockets from each launcher, with each press of the P-trigger;

- all launchers are used – four S-13 rockets, one per launcher, with each press of the P-trigger.

When the TRAINING EMPLOYMENT (УЧЕБНАЯ РАБОТА) mode switch is engaged with the status “TRAINING (УЧЕБН)” displayed and the cannon’s mode switch is set to CUTOFF on the PVI-10PE2 panel then, each time you pull the O-trigger (to the second position), 6 rounds are fired.

When the Integrated System Verification (ВСК) routine is run by the SUV (while the target is being locked by radar (РЛС)), at the same time that it monitors the Radar Aiming Complex (РЛПК), this routine simultaneously carries out a readiness check of the R-27(E)R1 or R-27(E)T1 missiles selected for use. Upon completion of this check by the Verification System (ВСК), the R-27(E)R or R-27(E)T missiles determined to be “ready” are indicated by a corresponding green light on the Weapon Readiness Panel (PI-10P) (ПИ-10П).

In all SUV modes, with the exception of NAVIGATION mode, the type of hanging weapon selected for use is indicated by the integrated display system screens (СЕИ) (HUD and HDD).

5.1.5. The SUV Panel and its control elements.

1. The seven position SUV mode switch has the following operational modes:

- **Pi0** (φ0): providing an ability to use infrared missiles (ТГС) against visible targets if the Radar Aiming Complex (РЛПК) and the Optical-Electronic Sighting System (ОЭПС) should fail;

- **NAVIGATION** (НАВИГ): displays navigational data received from the flight navigation system (ПНК - Пилотажно-Навигационный Комплекс) on the HUD;

- **IRST** (ОЛС): used to select the Optical-Electronic Sighting System (ОЭПС) as the master (leading) channel;

- **RADAR** (РЛС): used to select the Radar Aiming Complex (РЛПК) as the master channel;

- **VERTICAL** (ВЕРТ): provides the ability to lock a visible target in close-range combat through aircraft maneuvering;

- **BORE** (ОПТ): provides the ability to lock a visible target using the KU-31 (КУ-31) controller;

- **HELMET** (ШЛЕМ): provides the ability to lock a visible target by using the helmet mounted target designation system (НСЦ).

2. The TARGETING: AUTO-MANUAL (НАВЕД (Наведение) АВТ-РУЧН) selector switch has the following positions:

- **AUTO** (АВТ): Allows the automatic control of the survey (scan) zone's center of either the Radar Aiming Complex (РЛПК) or the IRST (ОЛС) as well as controlling radar emissions of the Radar Aiming Complex (РЛПК) during fighter operations in an area under the control of the Ground Automatic Control System (НАСУ) or when the target is designated by the flight leader's aircraft and target range is automatically provided by the Ground Automatic Control System after the target is locked either with incomplete instrument support (НПО) or the IRST (ОЛС).

- **MANUAL** (РУЧН): Allows the manual control of survey (scan) zone's center of either the Radar Aiming Complex (РЛПК) or the IRST (ОЛС) and manual entry of the range.

3. Three buttons: ←, ↑ , → : the mechanism for manually controlling the center of the survey (scan) zone of either the Radar Aiming Complex (РЛПК) or the IRST (ОЛС). When the button is clicked, the zone's center is offset in the arrow's direction by half the scanning area.

4. The altitude differential (ΔН) dial has 11 positions (0, 2, 4, 6, 8, 10, -2, -4, -6, -8, -10) allowing you to manually center the survey (scan) zone area of either the Radar Aiming Complex (РЛПК) or the IRST (ОЛС) along a particular elevation angle.

5. The EMIT-DUMMY-DISABLED (ИЗЛУЧ-ЭКВ-ОТКЛ) switch has the following positions:

- DUMMY: the transmitter operates as an antenna equivalent (artificial antenna) in the absence of a command to emit from the GCI (НАСУ) or as an ultra-high frequency (microwave) (СВЧ) antenna when passing commands from the GCI (НАСУ) in Command Guidance (КН - Командного Наведения) mode (in this mode the GCI controls the aircraft and sensor systems);

- EMIT: the transmitter uses the antenna to emit high-frequency energy into open space;

- DISABLED: the transmitter is disabled. The time it takes for it to come on line after the switch is moved from DISABLED to either the DUMMY or EMIT position is 1-2 sec.

6. The LASER RANGEFINDER (ЛД) switch turns on the laser rangefinder.

7. The LOCK: AUTO-MANUAL (ЗАХВ АВТ-РУЧН) switch has these positions:

- AUTO: set to automatically transition the RLPK (РЛПК) from survey (scan) mode to continuous direction finding mode (STT) and to automatically lock the first detected target with the IRST (ОЛС);

- MANUAL: set to lock the target manually by moving the radar cursor over the target with the KU-31 (КУ-31) control lever.

8. The COMPOSITE ACTIVE JAMMING-ACTIVE JAMMING-DISABLED (АПК-АП (Активная Помеха)-ОТКЛ) switch is used when operating the RLPK (РЛПК) in ECM conditions. The best switch position is selected after analyzing the radar situation (degree/type of interference) on the HUD.

9. The PRF: FRONT (Hemisphere)-AUTO-REAR (Hemisphere) (ППС-АВТ-ЗПС) switch has these positions:

- FRONT (ППС): specifies a high repetition rate (ВЧП - Высокая Частоты Повторения) of the sensing pulses and indicates a front hemisphere (target) aspect to a missile used with incomplete instrument support (НПО).

- REAR (ЗПС): specifies a medium repetition rate of the sensing pulses and indicates a rear hemisphere (target) aspect to a missile used in conditions of incomplete instrument support (НПО).

- AUTO (АВТ): the repetition rate of the sensing pulses is specified automatically with alternating high (НПО) and medium (СЧП - Средний Частоты Повторения) repetition rates. Used when information about target aspect is missing.

For the OEPS, target aspect is indicated either by the switch position under incomplete instrument support conditions or automatically based upon RLPK (РЛПК) data.

10. The AZIMUTH-RANGE/REFRESH?/AZIMUTH-VELOCITY (АЗ-Д-ОБН-АЗ-V) switch has these positions:

- AZIMUTH-RANGE (АЗ-Д - азимут-дальность): RLPK (РЛПК) survey (scan) information is displayed as azimuth and range coordinates on the HUD and HDD (СЕИ);

- AZIMUTH-SPEED (АЗ-V - азимут-скорость): RLPK scan information is displayed as azimuth-closure rate between the fighter and its target;

- REFRESH? (ОБН – обновление?): this setting is not used.

The following controls are located on the RLPK panel on the left side of the cockpit:

1. The five position PROGRAM (ПРОГРАММА) dial (1, 2, 3, 4, 5) for selecting the frequency channel band (range) of the RLPK transmitter's guidance frequencies.

2. The six position CHANNEL: RADAR (ЛИТЕРА РЛС) dial (1, 2, 3, 4, 5, 6) for selecting the carrier frequency of the transmitter within the selected guidance frequency band.

CHANNEL: RADAR Switch Positions	PROGRAM Switch Positions	Frequency channel numbers				
		1	2	3	4	5
1		1	7	13	19	25
2		2	8	14	20	26
3		3	9	15	21	27
4		4	10	16	22	28
5		5	11	17	23	-
6		6	12	18	24	-

3. The CHANNEL 27 (ЛИТЕРА 27) dial for selecting the transmitter frequency when guiding missiles with radar seeking heads (РТС).

4. The RANGE MEASUREMENT: GROUP-INDIVIDUAL-SOLO-OFF dial isn't used in flight.

The following elements are located on the target assignment and group operations support panels located on the right side of the cockpit:

1. Ten TARGET annunciator buttons (1-10) to select a target to be transferred and assigned for attack.

2. Five FIGHTER (ИСТРЕБИТЕЛИ) annunciator buttons (1-4 plus Group (ГР)) for selecting either the number of the recipient wingman or the number of the recipient associated group (by pressing the GROUP (ГР) button).

3. The ENTER (ВВОД) button for entering the selected button numbers.

4. The DISCARD (СБРОС) button used to remove the target designated either for transfer or attack. The functions and procedures for using the datalink system used in group operations is described in the section "System Operation" (book 2 of the FLIGHT MANUAL (РЛЭ)).

5. The PHOTO/TAPE STORAGE DEVICE: AUTO-DISABLED-MANUAL (ФКП МЛП - Прибор Фотоконтрольный /Механизм Лентопротяжны: АВТ-ОТКЛ-РУЧН) switch has the following positions:

- AUTO (АВТ): used to turn on photo and tape storage prior to an attack;

- DISABLED (ОТКЛ): to turn off the photo and tape storage between attacks;

- MANUAL (РУЧН): not used for control of ATC (УВД - Управления Воздушным Движением).

6. The INTEGRATED SYSTEMS MONITORING SH101 (БСК Ш101 - Встроенной Системе Контроля) switch to enable onboard testing of the SUV (СУВ).

The following controls and indicators are located on the PVI-10PE2 (ПВИ-10ПЭ2) panel located on the top left-hand side of the instrument panel:

- the EMPLOYED (РАБОТА) "window": indicates the type of weapon selected for use;

- the two RESERVE (РЕЗЕРВ) "windows": indicate the second and third type weapons in line for use;

- the REMAINING CANNON (ОСТАТОК ВПУ) "window": indicates the remaining rounds for the internal cannon (ВПУ);

- the EMPTY LAUNCHERS (ПУСТЫЕ БЛОКИ) "window": indicates when the unguided rocket (НРС) launchers are empty;

- the MASTER ARM (ГЛАВ ВКЛ) switch with detent: used to lockout launch circuits, to allow tactical reset and launch/firing, and also to initiate the cooling of the R-73E's thermal guidance head (ТГС);

- the weapon release mode switch has the following positions:

a) SINGLE (ОДИН): the launch of a guided missile (УР - Управляемые Ракети) is initiated one at a time for each press of the suspended-weapon trigger (P trigger), bombs are dropped or unguided rockets (НРС) are fired in accordance with established procedures;

b) PAIRS (ЧАСТЬ): two guided missiles (УР) are launched with each press of the suspended-weapon trigger;

c) SERIES (СЕРИЯ): bombs are dropped or unguided rockets (НРС) are fired in accordance with the selected interval (series);

- the AIR-GROUND (ВОЗДУХ-ЗЕМЛЯ) switch: set to the appropriate position when using weapons against either against air or ground targets;

- the LAUNCH AUTHORIZED: AUTO-MANUAL ((ПР - Пуск Разрешен) АВТ-РУЧ) switch: the position determines whether the SUO issues the RELEASE AUTHORIZED (ПР) instruction automatically based on data received from the SUV (AUTO) or is forced to do so (MANUAL). (The RELEASE AUTHORIZED (ПР) instruction for the internal cannon (ВПУ) is always issued irrespective of the switch position.)

- the UNCONTROLLED LAUNCH (НЕУПР ПУСК - Неуправлея Пуск) switch (with detent) (a pressure switch): used for the uncontrolled (emergency) launch of guided missiles (УР) from their launch pylons (АПУ);

- the EMERGENCY RELEASE (АВАР СБРОС - Аварийного Сброса) switch (with detent) (a pressure switch): used for the emergency release of weapons from either (missile) ejector pylons or (АКУ) or bomb rails (БД);

- the CUTOFF (ОТСЕЧКА) switch: used for firing bursts of approximately 1/4 (25 rounds) of the combat complement of shells with each pressure on the O trigger;

- the DISCARD (СБРОС) button: used to drop the empty unguided rockets (НРС) canisters;

-the DETONATION-NO DETONATION (ВЗРЫВ-НЕВЗРЫВ) switch (with detent): used to initialize the fuse of during the emergency release of a bomb if set to DETONATION.

On the Weapon Readiness Panel (PI-10P) (ПИ-10П) mounted on the instrument panel, there are two rows of lights to display the presence of suspended weapons (top row lights are yellow) and their availability for use (bottom row lights in green).

The 73-COOLING (73-ОХЛАЖД - 73-Охлаждение) switch is located on the left side of the instrument panel and is used to manage the cooling of the R-73E's thermal guidance head (ТГС).

The following are located on the flight stick (РУС):

- the CLOSE-RANGE COMBAT-LONG-RANGE COMBAT (Б.БОЙ-Д.БОЙ) switch: used to select the type of missile for close-range combat, given the presence of other weapons (long-range missiles, for example);

- the trigger for suspended weapons, P (П): used for the launching (releasing) all types of suspended weapons;

- the trigger O: for selecting the onboard cannon as the priority weapon (first position) and firing the cannon (second position);

- the radar cursor controller (УПР.СТРОБОМ - Управления Стробом): it is used to manually move the cursor on the HUD to lock the coordinates in AZIMUTH-RANGE (АЗ-Д) and AZIMUTH-SPEED (АЗ-V), when the RLPK is selected as the primary channel and, when the primary channel is the OEPS, to manually move it in AZIMUTH (АЗ) (**only**) and also to activate the laser rangefinder (ЛД) when attacking ground targets;

The following are located on the throttle (РУД):

- the ENTER (ВВОД) button: used to issue the command to lock the target in the RLPK, OEPS, and missiles with thermal guidance heads (ТГС), as well as for manually entering the range information of an aerial target in the RLPK and OEPS, and to enable the anticipated aim mark, when using the OEPS against ground targets;

- the ALTERNATIVE SUSPENSION (ВЫБОР ПОДВЕСОК) button: used to manually reselect weapons of varying types on stations 1, 2, 3, 4, 9, and 10;

- the DISCARD (СБРОС) button: used to cancel tracking of a target in OEPS, RLPK, cancel target tracking a missile's thermal guidance head (ТГС) in OPTICAL and HELMET mode, and to disable the laser rangefinder when in use against ground targets;

- the ENTER RANGE (ВВОД ДАЛЬН) slider: used to manually enter a target range value, while in SURVEY (ОБЗОР) mode, that has been provided verbally;

The indicator panel is found on the right-hand side of the instrument panel:

- EMIT (ИЗЛУЧ): indicates the presence of RPLK high frequency (ВЧ - Высокая Частоты) energy into space;

- RADAR LOCK (ЗАХВАТ РЛС): indicates that the RLPK has transitioned from scan to continuous bearing mode (РНП) (STT);

- IRST LOCK (ЗАХВАТ ОЛС): indicates that the target is locked by the IRST ()

- RANGE MEASUREMENT (ЗАМЕР ДАЛЬН): indicates that target range has been measured by the RLPK.

The following dials are located on the left-hand side of the instrument panel:

- GAIN: INFRARED (УСИЛЕНИЕ ТП): used to eliminate false targets on the HUD, when operating the OEPS in survey mode;

- TARGET BASE (БАЗА ЦЕЛИ (Б-С-М)): used for setting the target's base size when using the cannon (ВПУ) in the PREDICTED TRACK (ПРОГНОЗ-ДОРОЖКА) mode and for setting target size (V-large, S-medium, M-small) (Б – большая, С – средняя, М – малая) when using air-to-air missiles;

- HELMET MOUNTED SIGHT BRIGHTNESS (ЯРКОСТЬ НСЦ): used to alter the brightness of the helmet-mounted target designation system's (НСЦ) aiming ring.

On the power supply panel on the right side of the cabin is the SEARCH-TRACK SYSTEM (ОПС - Обзорно Поисковой Сыстемы) switch used to turn on the RLPK and OEPS.

5.1.6. Interaction of the Armament Control System (СУВ) subsystems.

I. Interaction of the Search and Track Radar Aiming Complex (РЛПК) and the Optical-Electronic Targeting System (ОЭПС) with the system of national identification (IFF).

The system of national recognition ensures the determination of the nationality of the target based on the principle of friend or foe.

With the Search and Track Radar Aiming Complex **(РЛПК)** as the leading channel while in SURVEY (similar to the West's RWS) mode the identification designation will appear over the target marker.

With the leading channel set to the Optical-Electronic Tracking System **(ОЭПС)**, while in SURVEY mode identification is not ensured, and in Target Tracking mode identification is ensured only after the transition of the Search and Track Radar Aiming Complex into Target Tracking (РНП) mode.

II. Interaction of the Search and Track Radar Aiming Complex (РЛПК) and the Optical-Electronic Targeting System (ОЭПС).

When the RLPK and OEPS are used in joint operation, the selection of the leading channel is achieved either manually or automatically according to the logic of the Armament Control System (SUV) and is determined by: the position of the SUV mode switch position, the positions of the (radar) Illumination (ИЗЛ) and Laser Rangefinder (ЛД) switches, and the type of missile selected.

When you press the O-trigger button (ВПУ О) (the first time), the leading channel of the IRST (ОЛС) is selected automatically and is independent of switch settings and missile selection. On the HUD, either the PREDICTED TRACK (ПРОГНОЗ-ДОРОЖКА) or NON-SYNCHRONOUS FIRING (НЕСИНХРОННАЯ СТРЕЛЬБА) mode for the cannon is displayed.

a) Interaction of the Search and Track Radar Aiming Complex (РЛПК) and the Optical-Electronic Targeting System (ОЭПС) while in SURVEY mode of Long-Range Missile Combat (ДРБ).

The selection of the leading channel in Long-Range Missile Combat with SURVEY mode selected is determined by the Armament Control System's mode switch position. When switched to the RADAR (РЛС) position, radar is selected as the primary channel of the Radar Aiming Complex (РЛПК); when the switch is set to IRST (ОЛС), the primary channel is the

Optical-Electronic Aiming System (ОЭПС). The centers of both channels' survey zones coincide.

b) Interaction of the Search and Track Radar Aiming Complex (РЛПК) and the Optical-Electronic Targeting System (ОЭПС) while in Long-Range Missile Combat (ДРБ) in passage mode (Passage Tracking (СНП) - similar to the West's TWS Mode).

With the Radar Aiming Complex (РЛПК) selected as the master channel (the Armament Control System mode switch is set to RADAR (РЛС)), the angular coordinates of the target as well as range are output from the Radar Aiming Complex (РЛПК) to the Optical-Electronic Targeting System (ОЭПС).

The Optical-Electronic Targeting System, in turn, executes a target lock on the target designated by the Radar Aiming Complex (РЛПК). As each step occurs, the corresponding Radar Lock (ЗАХВ РЛС), Optical Lock (ЗАХВ ОЛС) and Range Measurement (ЗАМЕР ДАЛЬН) lights illuminate on the warning display panel.

If during the locking of the target by the Radar Aiming Complex and IRST, a missile with a thermal guidance head (ТГС) is selected, the mode selector switch of the Armament Control System is moved from the Radar (РЛС) position to the Optical-Electronic (ОЭПС) position (regardless of the Laser Rangefinder (ЛД) switch position) and the leading channel becomes the Optical-Electronic Targeting System (ОЭПС).

When moving the Armament Control System mode switch from the Radar to the Optical-Electronic (ОЭПС) position, if the target is tracked by the Radar Aiming Complex but not by the Optical-Electronic Targeting System, the leading channel will not change. In this case, a transition to the Optical-Electronic Targeting System can only be made by dropping the Radar Aiming Complex's lock.

When the leading channel is controlled by the Optical-Electronic System (the mode switch of the Armament Control System is set to IRST) the Optical-Electronic Targeting System outputs the target's angular coordinates to the Search and Track Radar Aiming Complex.

At the same time, the Search and Track Radar Aiming Complex transitions into Quasi-Survey mode (КВО-КВази Обзора) and periodically outputs range information to the Optical-Electronic System, the Optical Lock (ЗАХВ ОЛС) indicator illuminates on the warning display panel, and the (radar) Illumination (ИЗЛ) symbol should be displayed on the HUD.

When the range becomes less than 15 km, the Search and Track Radar Aiming Complex transitions from Quasi-Survey mode to (Attack with) Continuous Direction Guidance (РНП) mode (the West's STT mode). The Optical-Electronic Targeting System receives range information, while on the display panel the Radar Lock, Optical Lock, and Range Measurement indicators illuminate. At the same time, the Illumination (ИЗЛ) symbol glows continuously on the HUD.

When fluctuations in the R-max, R-min, and RtR indicators occur on the HUD and a missile launch is required, you must press the ENTER (ВВОД) button. In doing so, the Radar

Aiming Complex switches to target tracking mode (the Radar Lock and Range Measurement indicators illuminate) and ensures the reliable use of missiles and reliable IFF.

If a target is locked by both the Optical-Electronic Targeting System and Radar Aiming Complex and if missiles with radar guidance heads (РГС) {note: the manual reads: "ТГС" but this may be a misprint. This paragraph only makes sense if the guidance heads are "РГС", radar guidance heads} are selected for use, the Armament Control System mode switch is moved from the IRST to the Radar position (regardless of the Laser Rangefinder switch position), and the master channel becomes the Search and Track Radar Aiming Complex.

Upon the re-selection of missiles moving from those with thermal homing heads to those with radar homing heads, the primary channel becomes the Radar Aiming Complex (РЛПК).

When the Armament Control System mode switch is moved from the IRST to the RADAR position, if the Optical-Electronic Tracking System is tracking the target but the Radar Aiming Complex is not, the master channel is not changed. In this case, the transition to the Radar Aiming Complex as the primary channel can only be made by dropping the Optical-Electronic Targeting System's lock.

III. Interaction during Close-Range Missile Combat (БМБ)

- In VERTICAL close-range combat mode, the IRST scans an area ≈3°x60°, while the Radar Aiming Complex scans a zone ≈5°x60°. If the (radar) Illumination HUD indication is on and the Laser Rangefinder is disabled as well as when radar-guided missiles (РГС) are selected, regardless of the Laser Rangefinder switch position, the master channel is assigned to the Radar Aiming Complex. In all other cases, the leading channel is assigned to the Optical-Electronic Tracking System.

  If the slaved channel is the first to lock the target, RADAR LOCK (OPTICAL LOCK) will illuminate on the warning panel and VERTICAL scan data will remain on the HUD. In a situation where the master channel is the first to lock the target, the targeting data of the master channel is displayed on the HUD (while the slaved channel is passed target information from the master channel) and the target is locked without having to press the ENTER button on the throttle.

- In HELMET mode, the Radar Aiming Complex is assigned as the leading channel after the target is locked when either (radar) Illumination is enabled and the Laser Rangefinder is disabled or when radar seeking missiles are selected regardless of the Laser Rangefinder switch position. In all other cases, the leading channel is assigned to the optical-Electronic Tracking System.

When the target is locked by either channel (master or slave), the targeting data concerning the locked target is displayed on the HUD and the corresponding RADAR LOCK or IRST LOCK indicator will illuminate on the warning panel and the remaining channel switches to following the target based on data sent from the capturing channel.

If the slave channel is the first to lock the target but the second channel is actually the master channel, then after master channel locks the target, the slaved channel switches to following the target based on information received from the master channel.

3. In OPTICS mode, the interactive logic is analogous to the HELMET mode logic.

IV. The interaction when using the onboard cannon (ВПУ).

Upon depressing the trigger O (the initial pull) the selection of the priority aiming mode is made, CANNON: NONSYNCHRONOUS FIRING (if there is an IRST lock and target range information from either the Laser Rangefinder or the Radar Aiming Complex) or PREDICTED TRACK (if either target range or IRST lock are not present).

If both the Radar Aiming Complex and IRST have the target locked and no range measurement is available from the Laser Rangefinder, then the IRST provides the angular coordinates, while the Radar Aiming Complex provides the range data to arrive at a firing solution. However, in this situation, the precision of Cannon is reduced.

5.1.7. Special operating features of the Armament Control System during complete (ППО) and incomplete (НПО) instrument support.

The Armament Control System supports the use of guided missiles (УР-Управляемая Ракета) and the onboard cannon (ВПУ) in the following modes:

- Full instrument support (PPO) when both the Radar Aiming Complex and the Optical-Electronic Targeting System have complete data on the parameters required for successfully completing the combat task, in which case the demarcations of the range scale take the following values:

a) 150, 100, 50, 25, 10, and 5 when the Radar Aiming Complex is the master channel;

b) 100, 50, and 10 when the IRST is the master channel.

When attacking the target in PPO mode, an index (arrow) indicates the current target range on the range scale:

- maximum allowable launch range mark against a target that is certain not to maneuver – R-max1 (ДРмакс1)

- maximum allowable launch range mark for a target that is certain to maneuver – R-max2 (ДРмакс2)

- minimum allowable launch range mark – R-min (ДРмин)

When CANNON: NON-SYNCHONOUS FIRING mode is selected, a 1200 m range scale is displayed encircling the aiming crosshair with each quarter equal to 300 m;

- NPO occurs when there is jamming of the Radar Aiming Complex (functioning as the primary channel) and no range-to-target measurement available from the Optical-Electronic Targeting System. With the Radar Aiming Complex as the primary channel, the extent of the range scale is set to 100 km in the Front Hemisphere PRF setting and 50 km in the Rear Hemisphere PRF setting. The current range marker is located inside the scale. With the IRST as the primary channel, the distance depicted on the scale is 10 km in the absence of range (data).

When attacking the target in conditions of NPO, in addition to the current target range on the range scale, there will be only one symbol indicating the maximum permitted launch range (ДР) displayed. No missile time-to-target is displayed.

While in NPO conditions during long-range missile combat, target range is given:

a) With the Radar Aiming Complex as the master channel: automatically by the KMOD (КМОД-кинематического метода определения дальности) algorithm or the Ground Automatic Control System (НАСУ), the latter of which is given priority. In the absence of range data from either NASU or KMOD, it can be entered manually. In order to input range data manually, set the TARGETING: AUTO-MANUAL switch to the MANUAL position on the Armament Control Panel and, using the INPUT: RANGE thumb slider on the throttle, alter the numbers displayed on the HUD (the underlined numbers) to reflect the range value transmitted by voice from the Command Post (КП), and press the ENTER button. After the range data is input either by hand, by the Ground Automatic Control System, or via KMOD, the extent of the range scale is set to what would be appropriate for the number input and, then, changes automatically from that point onward (extrapolates).

b) With the Optical-Electronic Targeting System set as the master channel: either automatically by the Ground Automatic Control System and the current range mark is set to the corresponding to it displayed as a number which is not underlined on the HUD. Or it is entered manually. To enter the range manually, set the TARGETING: AUTO-MANUAL switch to the MANUAL position, and using the INPUT: RANGE slider, set the range (underlined numbers) on the HUD and press the ENTER button. In NPO conditions, a mark indicating the maximum authorized missile launch range is displayed on the HUD range scale. After the range is input either manually or by Ground Automatic Control System, the extent of the range scale is set to what would be appropriate for the number input and, then, does not change.

The range can be updated manually by entering the new range data provided by the Command Post using the INPUT: RANGE slider to enter the new number and, then, pressing the ENTER button for each update. The current range indicator will move discretely on the scale according to the values entered either manually or by the Ground Automatic Control System.

Once the entered current range sets the range indicator below the maximum authorized missile launch range mark, the Launch Authorized (ПР) indication will illuminate on the HUD.

If it is not feasible to keep the range provided by ground control updated manually, then one can enter the range only once. To do this, set the range value at less than the value of the maximum authorized missile launch range and press the ENTER button. The current range index will be set below the R-max mark and, if missiles with thermal guidance seekers lock the target, Launch Authorized (ПР) will illuminate. If that's the case, continue flying until you reach the entered range confirmed by ground control.

When attacking a target using Forward Hemisphere target designation (ЦУ - целеуказания) (HPRF) and single-use command instructions (РК - разовые команды) in PPO conditions, launch preparation of R-27ER1 (R1), R-27ET1 (T1) occurs immediately upon target lock by either the Radar Aiming Complex or the Optical-Electronic Targeting System; using Rear Hemisphere (MPRF), about 5-7 sec. prior to maximum authorized launch range.

When using incomplete instrument support (НПО), target designation (ЦУ) and the single-use command instructions for launch preparation of the R-27ER1 (R1), R-27ET1 (T1) are issued immediately upon target lock by either the Radar Aiming System or the Optical-Electronic Targeting System when attacking in both Forward Hemisphere and Rear Hemisphere PRF.

When attacking targets with complete instrument support, the hemisphere of attack is issued automatically by the Optical Locating Station (OLS) and can match the FRONT-AUTO-REAR (PRF) switch position.

When there is no ongoing (automatic) or manually entered range for Long-Range Missile Combat, when the Master channel is the Optical-Electronic Targeting System and when the LAUNCH AUTHORIZATION: AUTO-MANUAL (ПР АВТ-РУЧ) switch is set to MANUAL, the probability of destroying the target is reduced.

[[[[[[FROM DCS Su-27 MANUAL:

The OEPS-27 electro-optical sighting system consist of the OLS-27 infrared/laser search-and-track system (IRST) and the Shchel-3UM helmet-mounted target designator and is controlled by the Ts-100 digital computer. The OLS-27 sensor is placed forward of the cockpit canopy in the center. The system acquires and tracks aerial targets by their thermal signatures. The helmet-mounted sight and the laser range finder of the IRST can also be used to visually acquire and determine coordinates of air and surface targets.

The SEI-31 integrated indication system provides flight, navigation and sighting data on the ILS-31 head-up display (HUD) and head down display.]]]]]]

Full instrument support in Close-Range Missile Combat is made possible by range measurements provided by either the Laser Rangefinder or the Radar Aiming Complex (with the appropriate switch setting-OLS or RADAR-selected).

When the Armament Control Panel is operating with incomplete instrument support in Close-Range Missile Combat (a situation in which the visually acquired target is locked with the OPTICAL, HELMET, or VERTICAL modes), a range of zero is automatically entered (the current range arrow points to zero), the missile is automatically issued R(ange)=0, and the Armament Control System is set to the allowed launch range.

When using the R-73E missile with incomplete instrument support in Close-Range Missile Combat, the Armament Control System may issue the instruction НОП (Invalid Targeting Error). When this occurs, the Launch Authorized symbol on the HUD will flash or, if using the Helmet Aiming System, its aiming rings and crosshairs will flash alternately. Fly the aircraft in a way which removes the error.

Given the presence of an invalid targeting error, an R-73E missile can still be launched. However, in doing so, the likelihood of hitting the target is reduced.

In Short-range Missile Combat you can also enter the range manually using the method stated above.

With incomplete weapon support and the onboard cannon selected, PREDICTED TRACK (ПРОГНОЗ-ДОРОЖКА) is the aiming method used.

In this mode, range can be estimated by comparing the size of the visible target to the gun funnel mouth; the widest (upper) part roughly corresponds to 200 m, while the narrowest (lower) part roughly corresponds to 600 m for target widths of less than 30 m. Increase the range by 100 m for every 10 m increase in target width. (For example, with a target base of 30-40 m the widest part of the funnel corresponds to 300 m, while the narrowest would correspond to 700 m.)

5.1.8. The Armament Control System supports the following operations against ground targets:

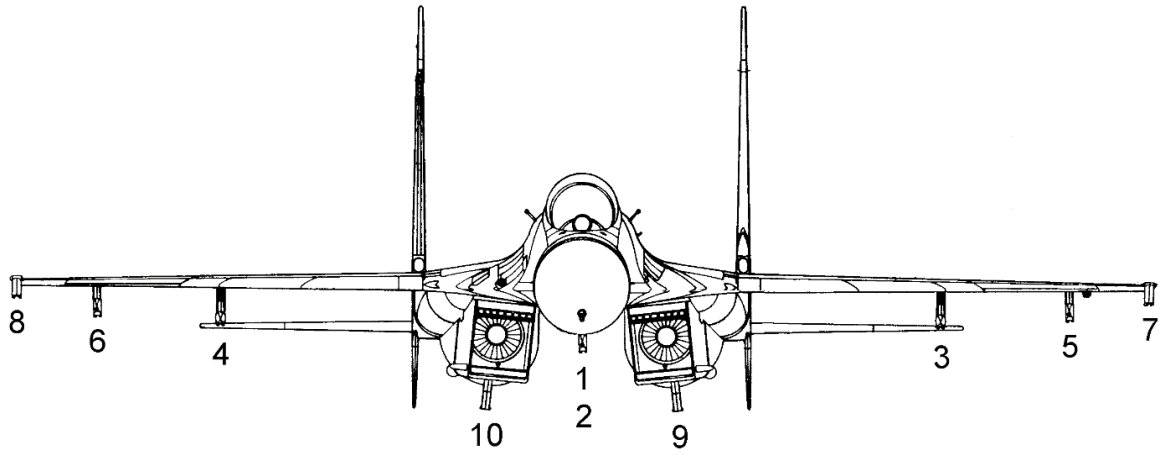
- the automatic utilization of bombs, canon fire, and unguided rockets (НРС) which is accomplished by setting the Armament Control System mode switch to the OPTICAL position and selecting these weapons for use. In addition, if using the onboard cannon against ground targets, you must set the GROUND-AIR switch on the Input/Display (Weapon Status) Panel-10PE1(2) [ПВИ-10ПЭ1(2)] to the GROUND position.

- the manual mode for delivery of aerial munitions/cannon fire (АБСП-авиационные бомбардировочные средства поражения) is accomplished by setting the FIXED RETICLE-

DAY-NIGHT switch to the FIXED RETICLE position in order to display the reticle on the HUD.

5.9.1. While in flight, the integrity of both the Armament Control System as a whole as well as its subsystems is assured through the issuance of fault signals to the “Ekran” system and the Universal Signal Panel (УСТ-универсальное сигнальное табло).

5.1.10 Placement options for air-to-air missiles:



Option Number	Suspension Point									
	8	6	4	10	1	2	9	3	5	7
1	**R-73E**	**R-73E**	**R-73E**					**R-73E**	**R-73E**	**R-73E**
2			**R-27ET1 (R-27T1)**					**R-27ET1 (R-27T1)**		
3			**R-27ER1 (R-27R1)**	**R-27ER1 (R-27R1)**	**R-27ER1 (R-27R1)**	**R-27ER1 (R-27R1)**	**R-27ER1 (R-27R1)**	**R-27ET1 (R-27T1)**		
4			**R-27ET1 (R-27T1)**	**R-27ER1 (R-27R1)**	**R-27ER1 (R-27R1)**	**R-27ER1 (R-27R1)**	**R-27ER1 (R-27R1)**	**R-27ET1 (R-27T1)**		
5	**R-73E**	**R-73E**	**R-73E**	**R-27ER1 (R-27R1)**	**R-27ER1 (R-27R1)**	**R-27ER1 (R-27R1)**	**R-27ER1 (R-27R1)**	**R-73E**	**R-73E**	**R-73E**
6	**R-73E**	**R-73E**	**R-27ER1 (R-27R1)**	**R-27ER1 (R-27R1)**	**R-27ER1 (R-27R1)**	**R-27ER1 (R-27R1)**	**R-27ER1 (R-27R1)**	**R-27ET1 (R-27T1)**	**R-73E**	**R-73E**
7	**R-73E**	**R-73E**	**R-27ET1 (R-27T1)**	**R-27ER1 (R-27R1)**	**R-27ER1 (R-27R1)**	**R-27ER1 (R-27R1)**	**R-27ER1 (R-27R1)**	**R-27ET1 (R-27T1)**	**R-73E**	**R-73E**

1. The speed limitations depending on the missile placement option selected:

- 1-2: not greater than 1300 km/hr;
- 3-7: not greater than 1200 km/hr.

2. For any variant of asymmetrical missile suspension, the maximum G-loading of the airframe is reduced by 2 (ΔПу=2), and application of negatives G's is forbidden.

3. The following variations of the basic placements carries no speed restriction: 2 x R-73E on points 7, 8 and 2 x R-27R1 on points 1, 2.

4. All load options can be adjusted for fewer missiles.

5. Variations of missile suspensions are allowed, with the exception of loading missiles all on one wing or variations that produce an imbalance of takeoff weight in excess of 450 kg.

6. Only same-type missiles are allowed on symmetrical suspension points.

7. The built in cannon can be used with all suspension variations and, also, with no suspensions.

8. With the exception of using IR homing head missiles in Fi0 mode, the R-27UT training missile, equipped with various homing heads (ТГС), is used for instructing and training the crew in the application of the R-27 type missile in all SUV modes. The missiles used are as follows: 470-1UTM with radar homing heads (РГС), 470-3UTM with thermal homing heads (ТГС). When preparing the missile, the homing mode is determined on the ground by repositioning the leads located at the rear of the missile. The missile is automatically readied for reuse in attack 1-2 minutes after the target is unlocked in the RLPK.

9. In training flights, R-73E missiles should only be used on either 5, 6 or 3, 4 suspension points (to prevent damage to the navigation lights (АНО - Аэронавигационных Огней).

10. The paired symmetrical suspension of R-27ER1 and R-27R1 missiles are allowed together on different pairs of points.

5.1.11 Conditions for Missile Launch

Parameters	Missile				
	R-73E	R-27T1	R-27ET1	R-27R1	R-27ER1
1. Allowable weather conditions and time of day.	Used day and night, when not inside a cloud, in conditions of clear skies, against backgrounds of clouds, ground, and water surfaces where the bearing of the sun or solar "tract" is not less than 15° and the bearing of the moon not less than 4° including terrestrial heat contrasting targets.			Day and night. All weather conditions.	

2. Span of launch ranges where the SUV initiates calculations for launch depending on launch conditions, in km Attacker=Target=0-10 km	In FRONT HEMI from 1.5 to 30 In REAR HEMI from 0.6 to 13	In FRONT HEMI from 2 to 33 In REAR HEMI from 0.7 to 5.5	In FRONT HEMI from 2 to 52.5 In REAR HEMI from 0.7 to 12.5	In FRONT HEMI from 2 to 42.5 In REAR HEMI from 0.7 to 7.5 In REAR HEMI mode, against the background of the earth with a small and Range < 3 km Dist ≤ 3 km	In FRONT HEMI from 2 to 65.5 In REAR HEMI from 0.7 to 16.5 Dist ≤ 6 km
3. The span of ranges visually estimated (with information provided by the CP) in km:	In FRONT HEMI from 1.5 to Launch Altitude+0.5 In REAR HEMI from 0.6 to (Launch Altitude/2)+2	In FRONT HEMI from 2 to 2Launch Altitude+10 In REAR HEMI from 0.7 to (Launch Altitude/2)+2	In FRONT HEMI from 2 to 3Launch Altitude+15 In REAR HEMI from 0.7 to Launch Altitude+3	In FRONT HEMI from 2 to 2Launch Altitude+10 In REAR HEMI from 0.7 to (Launch Altitude/2)+3	In FRONT HEMI from 2 to 3Launch Altitude+15 In REAR HEMI from 0.7 to Launch Altitude+3
4. The range of airborne target altitudes in m:	20 – 2000	20 – 25000	20 – 27000	20 – 25000	20 – 27000
5. The maximum allowable difference (separation) between target and interceptor in km:	± (1.5+0.2 Target Altitude)	± 10	± 12	± 10	± 12
6. Permissible G-load at launch	0 – 8 (7 when the slip is no greater than 2x the ball's diameter) (0 – 5 in BCY)	0 – 7 (6 when the slip is no greater than 2x the ball's diameter)		0 – 5 (angular velocity of a roll not more than 50°/sec	

Missile Type	Suspension Points	Missile Range
R-73E	3, 4	A ≤ 15000 m at V ≤ 300 – 1000 km/hr (up to M = 2.2)
R-72E	5, 6, 7, 8	A = 15000 – 18000 m at V ≥ 650 km/hr (up to M = 2.35) A < 15000 m at V = 300 – 1100 km/hr (up to M = 2.2)
R-27ER1	3,4	A = 15000 – 18000 m at V ≥ 650 km/hr

(R-27ET1, R-27R1, R-27T1)		(up to M = 2.2) A < 15000 m at V = 300 – 1100 km/hr (up to M = 0.6-2.2)
R-27ER1 (R-27R1)	9, 10, 2, 1	Within the entire range of combat employment at M ≥ 0.6

The launch of an R-73E missile at an LA-17 target drone can be accomplished in Rear Hemisphere (ЗПС) with a reduced target aspect of no more than 2/4 at a range of not less than 1000 m.

Firing the cannon at an altitude of 15,000 m is accomplished at airspeeds from 300-1100 km/hr, at altitudes of 15,000-16,000 m, at speeds from 450 km/hr to M=1.7 with G-forces of 0-6, and a slip of not more than two diameters of the ball in a modes of engine operation.

CAUTION: In order to ensure the thermal stability and durability of the GSH-301 gun, the cannon should only be fired in CUTOFF mode. After 50 rounds are fired, there should be a break in firing that lasts a minimum of 3 minutes.

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5.2. General procedure for a flight incorporating the use of weapons.

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5.3. Preparing for an intercept flight.

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5.4 Flight profiles for intercepting aerial targets.

5.4.1. When intercepting aerial targets, depending on the airspeed and altitude of their flight, the following typical flight profiles can be used, Fig. 18, 19:

- Afterburner, for short-range interception;
- Non-afterburning or combined – for long-range interception.

These flight profiles can be flown in automatic, flight-director, and manual control under guidance from the ground-based Automatic Control System. The specified profiles optimize both fuel consumption and time to target and are used to maximize the interception range of aerial targets. When the fighter is directed toward an aerial target by voice communication with Ground Control (**ПН**), the intercept flight profiles may differ from those indicated. (The previous sentence in Russian reads: При наведении истребителя на воздушную цель голосом с ПН профили полета на перехват могут отличаться от указанных.)

5.4.2. The **afterburner flight program** is executed at full afterburner until completion of the attack using one of the following profiles:

- Takeoff and climb to 11,000 m at Mach 0.9-0.95 (positions 1-2-3);
- Once at an altitude of 11,000 m, accelerate to Mach 1.3, 1.8, 2.0. M 2.0 is accomplished by accelerating to IAS (Vпр) = 1200 km/h, then by climbing at a constant IAS (Vпр) = 1200 km/h until reaching M = 2.0;
- Climb at Mach 0.9, 1.3, 1.8, 2.0 to position д-е, а-б, в-г, or 5-6 and fly until the command “Vertical” (climb/descend toward the target) is received [climb at Mach 0.9, if a climb at Full Military Power (МАКСИМАЛ) is preferred]
- Level out at the target attack altitude after fulfilling the “Vertical” command prior to the homing stage.

5.4.3. A **non-afterburning flight program** for intercepting aerial targets is used to maximize the intercept range and is performed according to the following profile:

- Take off at Full Military Power (MAXIMAL mode) and climb to 11,000 m at TAS (Vист) = 860 km/h
- Accelerate to Mach 0.9, then climb and cruise at Mach 0.9 (cruising-climb flight) until given the command “Vertical”.

5.4.4. The **combined flight program** provides for takeoff, climb, and climbing-cruise flight in the Full Military Thrust with the subsequent inclusion of the afterburner program.

5.4.5. Reduce altitude to the target's altitude from the point where the instruction "Vertical" is given until the assigned return flight altitude is entered. (Снижение на высоту атаки цели выполнять по разовой команде ВЕРТИКАЛЬ-1 при Нзад Нполета.)

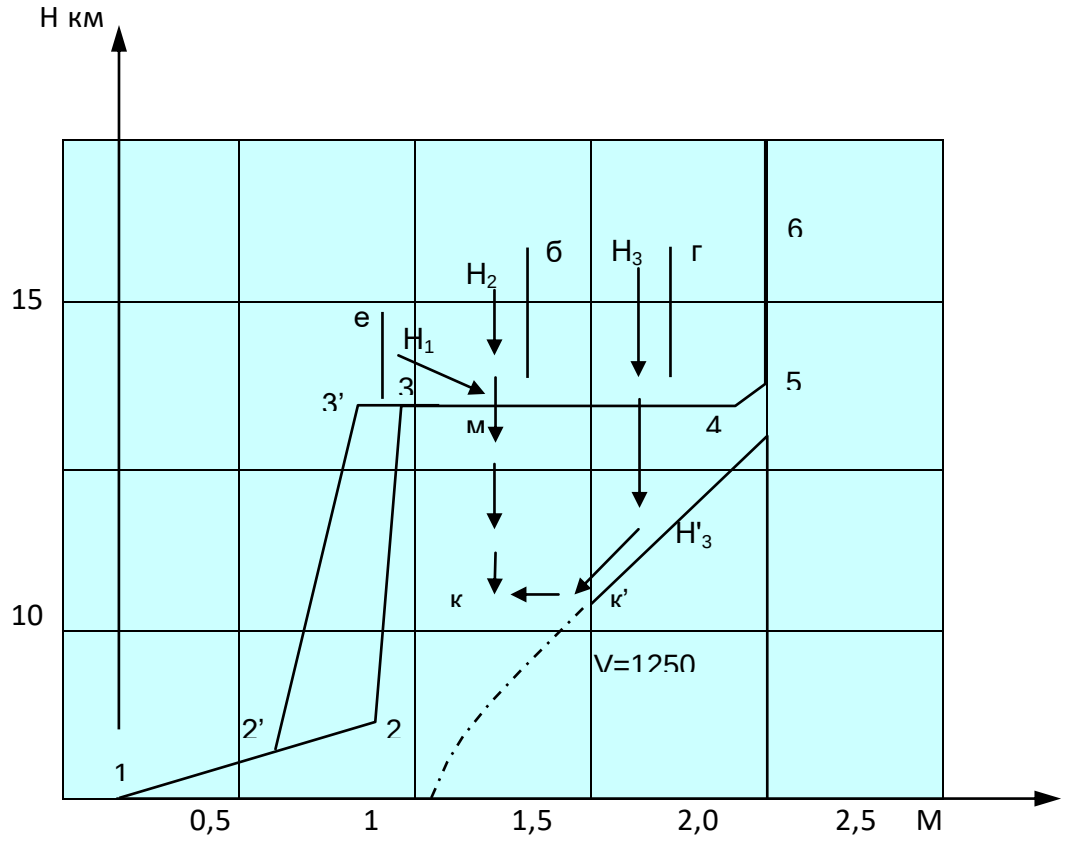

Рис. 18.

1-2-3-4-5-6 – Climb and airspeed profile at full afterburner for a short-range interception;

1-2’-3’-д-е – Climb to cruising flight at Full Military Power

1-2’-3’-4-5-6 – Climb and airspeed profile for long-range interception

д-е, а-б, в-г – deviations from the basic programs

H_1-м-к, H_2-м-к, H_3-$H’_3$-к’-к – altitude loss profiles.

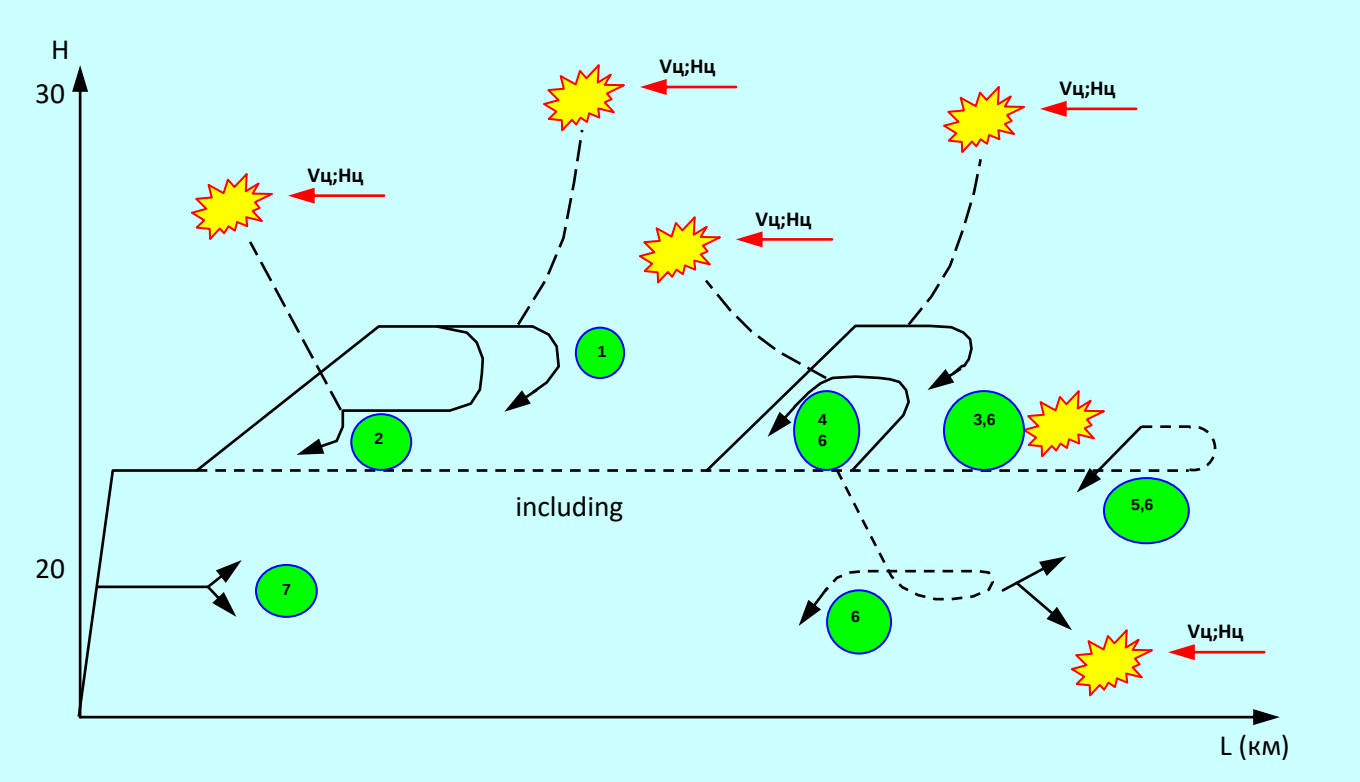

Рис. 19.

Typical flight profiles for intercepting air targets.

1, 2 –attacking targets in the stratosphere in HPRF and MPRF using one of the Short-Range Combat modes.

3, 4 –attacking targets in the stratosphere in HPRF and MPRF using a Long-Range Combat mode.

5, 6 –attacking targets in HPRF and MPRF at high, medium, and low altitudes with a Long-Range Combat mode.

7 –attacking targets subject to limited detection range in HPRF and MPRF.

[[[

$V^{ист}_{зад}$ = Assigned TAS? $TAS_{assigned}$

$V^{ист}_{пол}$= Absolute (full, whole)TAS? Required TAS? $TAS_{required}$

$V_{приб}$ or $V_{пр}$= Indicated Airspeed ?? IAS

]]]]

There are two possible scenarios:

1. $TAS_{assigned} \leq TAS_{current}$ ($V^{ист}_{зад} \leq V^{ист}_{пол}$) or 2. $TAS_{assigned} > TAS_{current}$ ($V^{ист}_{зад} > V^{ист}_{пол}$)

1. In a case where $TAS_{assigned} \leq TAS_{current}$ maintain your current Mach and reduce altitude until you are within 1-1.5 km of your assigned altitude and, then, smoothly transition to the assigned altitude (Нзад) (with $П^{изб}y \approx 1$).

If an IAS of 1150 km/hr is achieved prior to your altitude equaling the required altitude + (1-1.5) kilometers, stabilize at an altitude where the IAS = 1250 km/hr and TAS = $TAS_{assigned}$ when the $TAS_{assigned}$ = $TAS_{current}$.

If the $TAS_{assigned}$<$TAS_{current}$ – continue descending with a sustained IAS = 1250 km/hr. (To do this, set the throttle in a position somewhere between idle and half the distance to full military thrust until your altitude equals the assigned altitude + (1-1.5) km and then proceed as indicated.)

2. In a case where $TAS_{assigned}$>$TAS_{current}$, reduce altitude while accelerating to the $TAS_{assigned}$ (expressed as Mach), after which the decrease continues as before such that IAS= 1150 km/h.

Upon entering a region of stabilized Mach ($M_{current}$ in the first case or $M_{assigned}$ in the second case), reduce your speed as follows:

- at $M_{current}$= 0.9 set the throttle to Idle and gradually increase (from 30 m/sec at 12 km altitude to 50 m/sec at 10 km altitude and 90 m/sec at 5 km altitude.

Need to translate:

- [[[[[[при Мпол ≈ 0,9 установить режим МАЛЫЙ ГАЗ и постепенно увеличить (от ≈ 30 м/с на Н = 12 км до 50 м/с на Н = 10 км и 90 м/с на Н = 5 км);
- при Мпол ≈ 1,3 установить режим МАЛЫЙ ГАЗ и выйти на Vy = 100 м/с при Н > 12 км; при Н ≤ 12 км увеличить Vy до 140 – 150 м/с и дальше выдерживать её; при Н ≈ 10 км установить режим МАКСИМАЛ;
- при Мпол ≈ 1,8 установить режим МАКСИМАЛ, выйти на Vy 140 – 150 м/с и удерживать её;
- при Мпол ≈ 2,0 установить режим МИНИМАЛЬНЫЙ ФОРСАЖ, выйти на Vy ≈ 140 – 150 м/с и удерживать её;]]]]]

While in the process of decelerating, maintain the Mach (M) number.

When decelerating (more than 0.05), increase the throttle position by ¼ to ½ of the throttle travel possible.

During acceleration, decrease the throttle by ¼ of the full amount.

The transition to the assigned altitude begins at 1 km for M 0.9 and 1.5 km for M 1.3, 1.8, 2.0. At the same time, move the throttle to full military power for M 0.9 and to the Minimum Afterburner position for M 1.3, 1.8, & 2.0.

After the attack, if the landing airfield is a long distance away, the flight to the landing airfield is carried out at an altitude of 11,000-12,000 meters at M 0.8-0.85.

After attacking the target, reduce altitude to 12,000 meters with a velocity of 500 km/hr with the engines set to idle.

After attacking the target, if flying at an altitude of less than 11,000 m, climb to an altitude of 11,000-12,000 m at TAS 860 km/hr with the engines set at the maximum power setting.

The descent from an altitude of 12,000 m to the altitude required for landing is accomplished at an IAS of 500 km/hr.

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5.5 Disengaging from the target.

Exiting from combat contact with the target when guided by ground control is accomplished by performing maneuvers in both the vertical and horizontal planes in manual, director, or automatic control of the aircraft in conformance with information received via the radio link control channels in the modes of command guidance (CG) (KN), airborne guidance (AG) (BN) or airborne search (AS) (BP).

CG: the mode in which control commands are generated and transmitted by the Ground Controller via the Automatic Control System (ПН АСУ).

AG: the mode in which command management is generated by the Armament Control System (СУВ**)** using regular (continually updated) coordinate information about the target received from the Ground Control Automatic Control System (ПН АСУ).

AS: the mode in which control commands are generated by the Armament Control System (СУВ**)** using irregular (single point) coordinate information about the target received from the Ground Control Automatic Control System (ПН АСУ).

AS mode can be designated either by the Ground Controller via the Automatic Control System or automatically from CG mode (with coordinate support) or from AG mode when no information is received from the Automatic Control System for more than 60 seconds.

Guidance in both the AG and AS modes is provided only when the leading channel is the Search and Track Radar System (РЛПК) (the mode selector switch is set to Radar on the Armament Control Panel). If the Electro-Optical Tracking System is the leading channel (mode selector switch set to IRST (ОЛС) and the AG or AS symbol starts flashing, then it is essential that mode selector switch be changed to “Radar” on the Armament Control Panel.

5.5.1 Guidance to airborne targets with ACS-Automatic mode turned off is made with guidance from the GCI (Ground Automatic Control System) (НАСУ) as follows:

- contact the Ground Controller (ПН) during the climb;

- set the mode switch on the Armament Control Panel from Navigation to Radar (or IRST) and the EMIT-STANDBY (ЭКВ)-DISABLED switch to Standby (ЭКВ);
- set the Target Size potentiometer knob [L(arge)-M(edium)-S(mall)] (Б-С-М) to the position which corresponds to the type of target indicated either by Ground Control (ПН) or corresponding to the mission tasking (the extreme left is for a small target, extreme right for a large target, middle position for a medium-sized target) [I think the Russian source is incorrect in its reference. The right and left references should be reversed. Б stands for "Большая" (Largest) while М should stand for Малая (Smallest)];
- set the Guidance: Auto-Manual (НАВЕД АВТ-РУЧН) knob on the Armament Control System panel to the Auto(matic) position and fly the aircraft in manual control mode according to command guidance in the horizontal and vertical planes;
- following the course is accomplished either by superimposing the target marker (small circle) over the crosshair on the HUD or by aligning the deviation index from the preset heading (waypoint) with the fixed mark at the top of the HDD (fig. 20).
- Climb in accordance with the intercept flight program. After the indication "V" (Vertical) flashes on the HUD, the altitude for attacking the target is chosen independently taking data about the target's altitude into consideration.

The direction of the vertical maneuver is determined based on your own altitude and the target's altitude.

In the horizontal plane, continue following the course commands:

- When the indication "A" (Afterburner) is displayed on the HUD, engage the afterburners, execute the afterburner program, and accelerate to the assigned airspeed (on the HUD, both the true assigned airspeed and your own airspeed are displayed);
- After receiving the EMIT command from Ground Control (ПН), the symbol "IZL" (ИЗЛ) will appear on the HUD.

If the "IZL" symbol is flashing on the HUD, set the EMIT-STANDBY (ЭКВ)-DISABLED switch to the EMIT position and, in doing so, the "IZL" symbol will stop flashing. Whether emissions (radar) are turned on automatically or manually, the EMIT (ИЗЛУЧ) light will be illuminated on the Warning Panel.

When in TARGETING: AUTO mode, the "IZL" symbol on the HUD appears only if the Search and Track Radar System (РЛПК) is the primary channel.

Set the LOCK: AUTO-MANUAL (ЗАХВ АВТ-РУЧН) switch to the LOCK: AUTO position.

When the leading channel is the Electro-Optical Tracking System (ОЭПС), before setting the switch to the LOCK: AUTO position, make sure that there is no background interference (from clouds, ground, water, or sun) displayed on the HUD.

If interference is present, it should be removed using the GAIN: INFRARED (УСИЛЕНИЕ ТП) potentiometer.

The center of the tracking zone is managed automatically. When it detects a target, it superimposes a marker over the target (when the Search and Track Radar System (РЛПК) is primary).

In Command Guidance (CG) (КН) mode (with the Search and Track Radar as primary) the radar cursor is displayed on the HUD and moves on the screen in accordance with the range transferred from Ground Control (ПН) (the symbology in guidance mode is shown in Fig. 21). When the target marker enters the radar cursor, it automatically locks and transitions the Search and Track Radar System (РЛПК) into continuous bearing mode (РНП) (STT).

In both the on-board guidance and on-board search modes (with the Search and Track Radar System (РЛПК) as the primary channel), the designated target is automatically locked either when it enters the missile's DLZ or when the target range becomes less than 40km in Front Hemisphere PRF or less than 20km in Rear Hemisphere PRF.

If you wish to lock the target at a greater range, press the ENTER button on the throttle. If the target fails to lock automatically, lock it manually.

In CG (Command Guidance) mode (with the Electro-Optical Tracking System as the primary channel), the first target detected is automatically locked and automatically tracked.

When intercepting non-afterburning ($V \leq 700$-800 km/h), low-altitude ($H \leq 2.5$ km) aerial targets in CG mode with the primary channel set to the Electro-Optical Tracking System, maintain the guidance lock on its cooling rear by descending to an target's altitude +1.5 km (Assigned altitude=Target altitude+1.5km) (Нзад = Нц+1,5).

5.5.2. If your aircraft is redirected to another aerial target, the "!" (command redirection) symbol will appear on the HUD.

5.5.3. During guidance, it is possible to hand over guidance management from one Ground Controller (ПН) to another as well as change radio data. Once the radio data is reconstructed, the “Auto” lamp on the 11G6 control panel lights up and the indicators reflect the new radio data received from the new Ground Controller (ПН). And a signal is heard through the headset.

When manually changing the radio data according to information provided by the Ground Controller (ПН), it is necessary to set the WAVE (ВОЛНА), SPACING (РАЗНОС), and ENCRIPTION (ШИФР) switches to the values provided and press either the СПК or АЛМ mode button.

5.5.4. Interception of an aerial target via verbal guidance from the Ground Controller is accomplished as follows:

- select either the Search and Track Radar System or the Electro-Optical Tracking System as the primary channel;
- upon instruction from the Ground Controller, set the PRF: FRONT (Hemisphere)-AUTO-REAR (Hemisphere) (ППС-АВТ-ЗПС) switch to the appropriate position. When the correct hemisphere is unknown, set the switch to the AUTO position;
- pilot the aircraft manually maneuvering according to the Ground Controller’s commands in regard to course, altitude, and airspeed;
- using azimuth information provided by the Ground Controller, manually place the center position of the scan zone after pressing the required ЦЗ (central locking???) button;
- set the Altitude Differential (ΔН) selector to reflect the difference in altitude (either up or down) between the target and your aircraft (based on Ground Control (ПН) data regarding the target’s flight altitude). Since ΔН is set in discrete units of 2km, round to the closest higher value;
- using the ENTER RANGE (ВВОД ДАЛЬН) dial on the throttle, enter the range to the target provided by Ground Control (ПН). Monitor your input based on the figures displayed at the bottom of the HUD (numbers under the line);
- upon establishing the combat course under direction of the Ground Controller (ПН), enable the MAIN ON (ГЛАВ ВКЛ) switch;
- at the instruction of the Ground Controller, set the EMIT-STANDBY-DISABLED switch to the EMIT position. Upon doing this, the symbol EMITTING (ИЗЛ) will be displayed on the HUD and EMITTING (ИЗЛУЧ) will display on the warning panel. Target designation and target lock occurs either automatically or manually.

5.5.5. Should automatic lock-on of the target fail at a range of 40-35 km when attacking in FRONT (Hemisphere) PRF and 20-15 km in REAR (Hemisphere) PRF, lock the target manually.

It is possible that the auto-locking gate seen on the HUD/HDD complex (СЕИ) will jump chaotically from one target to the other, when attacking targets in REAR (Hemisphere) PRF against either complex backgrounds (such as mountains or major population centers) or aircraft flying in formation. In such happens, you should lock the target manually at a range of no more than 25km in order to avoid locking a false or incorrect target.

To lock the target manually, turn the LOCK: AUTO-MANUAL (ЗАХВ АВТ-РУЧН) switch to the LOCK: MANUAL position and proceed as follows:

- when instructed to do so verbally, and with the Search and Track Radar System selected as primary, use the hat switch to place the designator box over the target and press the ENTER (ВВОД) button on the throttle. After the target is locked with the Radar System, the HUD symbology will change (Fig 23) and, on the warning panel, the RADAR LOCK (ЗАХВАТ РЛС) and RANGE MEASUREMENT (ЗАМЕР ДАЛЬН) lamps will illuminate. After lock-on with the Radar System, it is possible that the target will also be locked by the IRST (ОЛС) (as the slaved channel) in which case the IRST LOCK (ЗАХВАТ ОЛС) lamp will illuminate as well.

If, at high convergence speeds, the azimuth and range coordinates of the target are difficult to establish, set the AZIMUTH-RANGE – UNUSED (Not Utilized) – AZIMUTH-VELOCITY (АЗ-Д--ОБН--АЗ-V) switch to the AZIMUTH-VELOCITY (АЗ-V) position and lock the target as outlined above.

If you have difficulty locking an overly duplicated target (multiple echoes), relock the target by moving the designator box within the margins of the target marker echoes;

- when instructed to do so verbally and, with the Electro-Optical Tracking System (ОЭПС) selected as the primary sensor, use the hat switch to center the wide field view target box over the target marker (Fig. 22) and press the ENTER (ВВОД) button on the throttle. At this time, the wide field view target box will be replaced by the narrow field view target box on the HUD (Fig. 24).

Using the hat switch, move the target box over the target marker which should be centered on the HUD and press the ENTER (ВВОД) button. If the target is locked by the

IRST (ОЛС), the HUD symbology will change to reflect what's seen in Fig 25 and the IRST LOCK (ЗАХВАТ ОЛС) lamp will illuminate on the warning panel.

If, when attempting to lock the target manually, if interference marks are displayed along with the target mark, remove them using the GAIN: INFRARED (УСИЛЕНИЕ ТП) dial.

While in survey (search) mode and using the small target box, instead of repeatedly attempting to lock a target, it is possible to switch to automatic locking by setting the switch to LOCK: AUTO ((ЗАХВ АВТ). In this way, the Electro-Optical Tracking System (ОЭПС) locks the first detected target.

In order to reset the small target search box to the large search box, press the RESET (СБРОС) button on the throttle. To switch from target lock mode in both the Electro-Optical Tracking System (ОЭПС) and the Search and Track Radar System (РЛПК) back to survey (search) mode, the RESET button on the throttle must be pressed as well.

5.5.6. Intercepting aerial targets in the presence of electronic jamming.

5.5.6.1 When attacking targets under conditions of active radar jamming, the situation must be analyzed:

- in survey (search) mode – the symbol АП appears on the HUD along with characteristic notches in the form of broken vertical lines (bands), "sowing" the display with false marks, confused hemisphere indications as well as readings (or failure to extract readings) for range or "spreading" the target across speed and range bands;
- in tracking mode - the symbol АП appears on the HUD, the aspect angle indicator, the hemisphere indicator, R-min, R-max, closure rate, range scale, the availability or absence of the estimated distance to target (Друд).

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5.6 Attacking aerial targets in long-range missile combat (ДРБ).

5.6.1. The attack of an aerial target begins from the moment of sustained target capture by the leading channel which can be either the radar or the OEPC, at which time the HUD displays a capture (lock) indication along with the indicator “A”.

After making sure that the leading channel has captured the target securely, turn on the MASTER ARM switch (for an attack lasting 3-5 minutes).

If the aircraft is in automatic control mode, turn ACS off and fly the aircraft manually as directed by the director circle, aligning it with the fixed crosshair on the HUD.

In the process, the aiming mark indicates the aiming error and gradually moves to the crosshair. Maintain the assigned speed by altering engines’ operating mode in accordance with the HUD indicators. When the leading channel is the OEPS, the throttle direction indicator is illuminated and the one-time command “F” to engage the afterburners is displayed on the HUD. When the leading channel is the RLPK, only the “F” command is displayed on the HUD recommending an increase in the engines’ operating mode.

If the director circle is held over the crosshair and the guidance mark is located above the crosshair and does not fall, the engine operating mode (thrust) must be increased. If the guidance mark is located below the crosshair and does not rise, the engine operating mode (thrust) must be decreased.

While attacking, it is possible for the required speed (as indicated on the HUD) to suddenly vary ±80 km/hr. Consequently, once close to the required speed, it is not necessary to chase these changes with changes in engine thrust.

The guidance provided by either leading channel has two stages:

1. Achieving a tactically advantageous position relative to the target being attacked.
2. Aiming at the airborne target.

The first stage begins with the initiation of the attack and continues until the “Hill” command appears (symbol G↑ or G↓). In this phase, horizontal flight is maintained at the altitude at which the attack is initiated followed by a subsequent climb or dive to the prescribed altitude. When the target is being attacked with the RLPK selected as leading channel, the prescribed altitude with Front Hemisphere PRF (ППС) selected is 3000 meters above the target. With Rear Hemisphere PRF (ЗПС) selected, the prescribed altitude will be 1600 m above the target.

When the leading channel is the OEPS, the prescribed altitude will be equal to the target’s altitude in both Front (ППС) and Rear (ЗПС) Hemisphere PRF.

Control of the course is determined by the targeting method, the selection of which is determined by the missile selected for use and the quality of the instrument support.

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5.14. Peculiar (Idiosyncratic) Operational Properties of SUV (СУВ).

5.14.1. Issues to consider when executing missions:

1. Missile launches from tandem points 2 and 1 are performed singly, regardless of the PAIRS-SINGLE switch position.

2. When launching R-27ER1 (P27P1) or R-27ET1 (R-27T1) missiles from points 3 and 4 at M < 2, the angle of attack shall not exceed 5°.

3. The launching of R-27R1 missiles in Rear Hemi (ЗПС) comes with the following range limitations:

- If the launch altitude is less than 3 km, then the launch distance is less than or equal to 3 km.
- If the launch altitude is greater than 3 km, then the launch distance is RMax (Др max 1) minus 2 km.

4. In order to prevent OLS failure when using the cannon in either FORECAST-TRACK or GRID mode, as well as when using weapons on ground targets in GRID mode, the armament control system (СУВ) mode switch should be set to the **BORE** (ОПТ) position.

5. The launching of R-27ER1 missiles in Rear Hemi comes with the following range limitations:

- If the launch altitude is less than 3 km, then the launch distance is ≤ 6 km.
- If the launch altitude is equal to or greater than 3 km, then the launch distance is RMax (Др max 1) minus 2 km.

When the AIMING switch is placed in the MANUAL position, the Command Guidance (КН) indication will remain on the HUD for a period of 40 seconds.

6. When fighter and target speeds are equal, the RLPK in VERTICAL mode will lock the target at ranges of less than 2 km. In order to lock the target at ranges of more than 2 km, the speed differential must be more than 90 km/hr.

7. When attacking targets in Rear Hemi (ЗПС) with the RLPK as the leading channel in Continuous Bearing Mode (STT) (РНП) with a launch range of less than 3.5 km, using the director's mark is allowed. In such cases, the aircraft is flown in accordance with the director's mark (however, in the event of good visibility, the aircraft can be flown in reference to the target mark).

8. Attacking targets in Search mode with the radar set to Front Hemi PRF (ППС) is allowed only if the target mark's IFF indication does not disappear for more than two consecutive scan cycles.

9. When aerial bombs (АБ), unguided rockets (НРС), or the cannon (ВПУ) are selected for use against ground targets, the current heading indication on the HUD can become "frozen" in which case the current heading indication should not be used.

10. When the radar is in Quasi-Search mode, IFF is not enabled. In order to determine the status of the target at a range greater than 15 km, the radar complex (РЛПК) must be forced into STT (РНП) mode by pressing the ENTER button on the throttle. The radar complex transitions from Quasi-Search to STT mode automatically, when either Front-Hemi or Rear-Hemi PRF mode is selected and the range to the target is less than 15 km.

11. When attacking a maneuvering target with a target elevation of less than 3° or in ground clutter in Front Hemi (Rear Hemi) PRF, tracking is ensured as long as the closure rate remains more or less 150 km/hr faster than your own airspeed. At subsonic speeds, this equates to a target aspect angle of around 80°. At greater aspect angles, target tracking is dropped.

12. When the laser rangefinder (ЛД) is activated, the "A" symbol does not illuminate.

13. It is possible to break away safely after attacking a target across the spectrum of allowable attack speeds as long as the minimum range remains above:

- for rocket type S-8 – 1600 m,
- for rocket type S-13 (T, OF), C-250 – 2000 m,
- for rocket type S-25 OF (OFM) – 2100 m.

14. Should the break off command, OTV (ОТВ), appear, only break off the attack when employing 250 kg bombs.

15. On occasion the digital computer (СЦВ-) will spontaneously reboot (when this occurs, the ENROUTE mode indication will appear for approximately 6 sec, even though it hasn't been selected).

16. When attacking a target with radar (РЛС - радиолокационная станция) set as the leading channel, in the event that search and targeting information disappears from the HUD (HDD), check the warning panel. If the IRST LOCK (ЗАХВАТ ОЛС) is displayed and there are missiles with thermal guidance heads (ТГС) available, set the selector switch to the Fi0 position and then, after 1 second, move it to the IRST (ОЛС) position. Next select the stations with thermal guided missiles (ТГС). After this the attack can be continued for the next 20-30 seconds with incomplete instrument support (НПО) and, then, with complete instrument support **(ППО).**

If either the IRST LOCK lamp is not lit or there are no thermal guided missiles available, set the mode switch to the Fi0 position and then, after 1 second, move it to the radar (РЛС) position. After 8-10 seconds, continue attacking the target.

In the event that search and targeting data is no longer being updated, the armament control system (СУВ) can be reinitialized by turning the SEARCH-TRACK SYSTEM (ОПС) switch to OFF and, then, ON. There should be a at least a two minute interval between the time the Search-Track System is turned off and, then, back on. After the Search-Track System is turned on, the warm-up time of the armament control system (СУВ) is 3 minutes.

17. When switching the armament control system from the radar (РЛС) to navigation (НАВИГ) mode, the information panels on the SAS-6 might illuminate briefly.

18. When attacking independently in Front Hemi PRF (ППС), the value given for target range in SURVEY (Search) mode can differ from the actual range by 3-6 km which can cause the IFF identifications to disappear during individual search cycles.

18. В отдельных атаках – в ППС значение дальности до цели, измеренной в режиме ОБЗОР, отличается от истинной на 3-6 км, что приводит к пропаданию меток госопознавания в отдельных циклах обзора.

19. When the radar is in KVO mode, there can be erratic fluctuations in RMax and RMin measurements, gaps in range measurement accompanied by the “D” warning symbol, fluctuations in the RMax and RMin values given, as well as changes in the hemisphere indication.

20. When radar (РЛС) is selected as the primary sensor and is in STT (РНП) mode, the HUD indications of “weapon type” and “launch authorization (ПР)” can disappear for brief periods of time.