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   MIG-21F-13 Aircraft, Pilot's Instructions

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   b. Engine Running on Ground
   c. Checking Aircraft Systems after Engine Starting
   d. Engine
   e. Flight
   f. Flight Limits
   g. Service Instructions on KKO-3 Oxygen Equipment and
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   h. Flying Aircraft under Difficult Meteorological Conditions,
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      Landing Systems

i. Night Flights

j. Firing in Flight

k. Rocket Equipment Carried Aboard Aircraft MIG-21F-13

l. Emergency Situations in Flight

m. Maximum Flight Values of Indicated Air Speed, Mach Number, and Load Factor

n. Time and Range of Flight
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I. AIRCRAFT MAINTENANCE

1. Pre-flight Inspection
   1. Before the take-off have the aircraft technician check the aircraft
      readiness for flight, the quantity of fuel, oil, cargo, duf, alcohol,
      gas loading, rocket pods and bomb suspension, as well as on the
      maintenance or repair operations performed on the aircraft since the
      last flight day.

2. Aircraft Inspection
   2. Prior to taking seat in the cockpit:
      - Check condition of tires of L.O. wheels;
      - Make sure the D.I. airspeed tube and TD-156 Pitot tube are free of
        protective caps and covers;
      - Make sure safety locks are inserted into the hole in the energy recovery
        gun rod;
      - Make sure the armement circuit breakers are cut off except those which
        should be cut in on the ground prior to take-off;
      - Make sure the seat ejection gun is charged;
      - Make sure the harness release mechanism box is fastened to the right-hand
        belt strap and the pull-out cord is attached to the harness box;
      - See that no foreign objects are left in the cockpit or on the seat;
      - Check that ground locks are inserted into the seat firing mechanism
        safety pin and into the energy recovery lever;
      - Check that the fan curtain, triggers on seat armrests, energy
        automatic ignition lever and harness lock emergency release handles are locked
        with wire;
      - Make sure the AP-1 safety harness lock and seat clamp opening automatic
        mechanism is correct and adjusted for 1.5 sec.;
      - Check that the flexible pin of the AP-1 automatic mechanism is linked
        and the pull-out cord is fastened to the aircraft side by means of the spring
        hook.

3. Inspection of Cockpit
   In the cockpit safety measures being preserved:
   - Make sure the storage battery is charged and in switch-on; all circuit
     breakers are also on;
   - Check whether the circuit breakers on the right-hand panel are closed.
   (To be switched on prior to take-off or on;
If pilots of different height are expected to fly the aircraft, the aircraft technician should check the seat adjustment to fit the pilots' height after the pilots have entered the cabin. In this event:
- the pilot should press his head to the headrest;
- the seat should be brought all the way up by means of the bottom switch (part of the side of the seat), the technician must check the clearance between the top of the pressurized helmet (PBM) and the canopy glass panel, seeing that it is about 50 cm. In this position, the necessary degree of safety is ensured in case the pilot's balling-out. In case the clearance is below 50 cm, pull the seat down to get the required clearance and adjust the actuated cylinder switch off mechanism.
- Connect the hose of the filling helmet (or oxygen mask) and of the pressure suit to the PBM pressure regulator.
- Couple the electric plug connector and switch on the meter of the pressurized helmet transparent face plate.
- Check the oxygen equipment set for proper operation with and without automatic pressure applied.
- Command: "Remove seat and canopy ground locks" (ground locks from the seat triggers to be removed before the pilot takes his seat in the cabin). Check whether the locks are removed from the canopy recovery gear operating rods. The brake system for operation with the front wheel brake applied and released. The pressure in the brake system must equal 10 - 11 kg/cm². (Be pressure gauge in the cabin). Then the pedals are actuated with the brake lever pressed; the pressure in the wheel released of the brake pressure must drop down to 0.
- Check the engine control lever for easy movement and proper fitting to positions CUT OFF (CUT-Off), LOW SPEED (LOW SPEED), NORMAL (NORMAAL), MAXIMUM (MAXIMAAL), UACATION (ODER).

CAUTION: To avoid overfilling, perform checking with the circuit breaker of tank No.2 (service tanks) cut off.

Check the control stick for smooth travel when controlling the airplane (with the airflow boosters off).

CAUTION: Don't discharge the aircraft storage batteries, employ only ground power sources for checking the aircraft instruments and units.

Cut in the storage battery. By reading off the aircraft voltmeter, note sure the ground source of power is connected (the voltmeter must show 12 or 24 V). With the ground power source cut in, check the lamps on the D.C. signal panel and on the P4 and P6 light panel by pressing to turn their CHECK buttons.

Check the operation of the fuel feed and fuel transfer pumps by their signal lamps.

Press the PILOT EXTRACTED push-button to make sure the corresponding lamp flashes on.

Set the altimeter pointer to the scales zero and check whether the barometric pressure scales read the pressure of the day.

Check whether the clock indications are correct and prepare the clock for flight.

Cut in the airflow boosters.

Make sure the air duct inlet valve control and anti-surge shutters switches are in proper positions:
- Inlet duct control switch must be in the position EXTRACTED (FICHER).
- Inlet duct control selector switch must be set in the AUTO (AUTOMATIC) position and locked.
- Anti-surge shutoff switch must be set in the AUTO (AUTOMATIC) position and locked.

Check operation of the trimmer effect mechanisms:
- Press the push-button on the trimmer switch FORWARD and BACKWARD, the released control stick must accurately deflect either forward or backward. The illuminated inscription TRIMMER EFFECT FORWARD on the 8-light panel must go out immediately on pressing the trimmer effect button (provided the trimmer effect mechanism has been central prior to pressing the push-button);
- After checking, set the trimmer effect mechanism to the central position according to the signal lamp on the 8-light panel. The central position of the trimmer effect mechanism is adjusted with the push-button pressed in the backward direction (from the position FORWARD);
- After setting the trimmer effect mechanism in the central position, deflect the control stick to extreme positions to make sure the signal lamp remains burning.

Check whether the AFX-15 stabilizer control system is ready for operation:
- Check whether the selector switch is set in the AUTO position and locked;
- Make sure the pressure switch LOW SPEED-HIGH SPEED (HIGH SPEED-OFF) is in the neutral position;
- The signal lamp on the 8-light panel (TAILKINDED OFF 0 BRESS ) must be on the 8-light panel;
- Make sure the pointer of the gear position indicator is in the extreme left position.

Check whether the inlet duct control system is ready for operation:
- The manual control switch must be set in the AUTO position, aligned with a stop in the BACKWARD position and locked;
- The manual control switch must be in the RESTRICTED position (full BACKWARD position).
- Set it in and check the AFX-15 aircraft binder, ESS gyro induction compass, RDF-55 type indicator, FG-57 radio set, AFX-10 automatic radio compass, CYG-3 aircraft transponder.

9. Checking FG-57 Radio Set
To check operation of the FG-57 radio set:
- Adjust the plug connector in the head-piece cord;
- Switch on the channel and zero it up during 3 or 4 min.;
- Monitor the radio set operating, when changed over to RECEIVING (INFORMATION) by listening to the receiver noise in the head-piece;
- Switch on the FUZE DIS permission (GARRISON’S FORCE ) and check its operation with radio set operating for RECEIVING; the noise must be suppressed;
- Check over the radio set for transmission, check it for self-monitoring and establish a two-way communication with the airfield radio station.

Switch on the chosen channel after checking the radio set for proper operation on other channels.

Then flying with the T-56 inlet on set the FY-28 amplifier switches located on the left side of the cockpit into the SELECT (W/H) and SELECT-FM (FM) positions; when using the head-phones with the oxygen mask set, these switches into the SELECT-HEAD (W/H) and SELECT-MICROPHONE (FM) positions (this will switch off the FY-28 amplifier).

Note: To ensure a maximum communication range at all altitudes:
- (a) switch on the FULL POWER (FULL DFV) switch;
- (b) switch on the MOTOR DFV switch.

6. Gyro Induction Compass, Type ESS
The gyro induction compass, type ESS, installed aboard the aircraft is intended for determining:
- The aircraft course;
- The landing course angles;
- The bearing of radio stations.

It has the following advantages as compared to compasses EKN-3 and UXK-1:
- It ensures adequate precision of the course determination (2° being the maximum error) on the straight level flight;
- It offers high degree of accuracy while determining the course during non-steady flight.

7. Preparation of Gyro Induction Compass for Flight
Set the selector of central panel GP-7 to NONE (COMP) when the flights are carried out in the northern hemisphere.

Set the latitude scale of the control panel GP-7 to the latitude of the starting point; there is no necessity to change the scale setting when the route of flight does not exceed 400-500 km.

When the flight distance is greater (latitude changing by more than 4-5°), set the latitude scale on the control panel to the mean latitude of flight.

8. Switching On and Checking Gyro Induction Compass Before Starting
Start the engine and then put in the aircraft binder of remote-indicating gyro horizon AFX. Cut in the ESS aircraft binder after the pump on the AFX indicator has gone out.

Press the fast-sailing button 2-1.5 min. after shutting-off the supply and keep it pressed until the course indicator scale has come to a step. This done, read the magnetic course and make sure the indicator shows approximately correct course.

If necessary, manipulate the knob to adjust the specific course in the course indicator.

9. Checking Gyro Induction Compasses Before Take-off
Prior to the take-off while the aircraft is on the runway, press the fast-sailing button and keep it pressed until the scale of the course indicator has come to a step.

The readings of the magnetic compass must correspond to the magnetic compass of the aircraft on the runway.

Note: While checking the gyro induction compass, type ESS, for proper functioning, it is recommended that the change of indicator readings should be verified against the magnetic compass before and after pressing the button. The change should not exceed 3-4° if after matching the magnetic compass has justified correct readings before testing to the runway.
10. Operating Gyro Induction Compass

In Flight

Do not press the fast-acting button of the gyro induction compass and the cargo-engage switch of the AIB in flight.

Note: It is ABSOLUTELY PROHIBITED to press the cargo-engage switch of the gyro vertical of the AIB-1 during normal operation in flight.

When the button is pressed while performing aerobatics, increased pitch or diving with angles of bank exceeding 60°, at great angles of bank and pitch (more than 15° or 20°), gyroscope 1-G2 fails to fail due to improper sensor wiring or the gyro induction compass used as the directional gyro.

When it becomes necessary to precisely determine the magnetic course under the conditions of normal operation of gyro induction compass AIB-1, or when the reference gyro of the AIB or gyroscope 1-G2 fails to function, proceed as follows: over a straight level flight at constant speed some 20 - 30 seconds before pressing the gyro induction compass fast-acting button and at the moment of pressing the button. Then read the magnetic course off the indicator with the fast-acting button pressed around the moment the scale comes to a stop. If it uniformly swings in both directions, the readings should be taken relative to the middle position of the scale.

11. AIB-1 Gyro Error

The gyro error of the AIB-1 has the following advantages as compared to the gyro error of earlier models:

1. The pilot need not reposition the aircraft when changing course to
   ungrounded flight.

2. The instrument indicates correct indications of the aircraft attitude at diving angles up to 30° for the 750°-1 and 300°-1, 240°-2 angles.

The gyro error of the AIB-1 is ready for employment 1 - 2 minutes after engaging the AIB-1, while the take-off set the best index at zero with the aid of the beam levelling mast.

12. Level Flight

Set the rate-of-climb indicator pointer at zero for the level flight. When the bank centring pointer is at zero, the aircraft silhouette shows the angle of bank, i.e., the angle between the aircraft forward axis and the horizon plane.

If the levelled aircraft flies at steady speed with the air density being constant, the compass card has constant shifting valve relative to the zero back index through the magnitude corresponding to the angle of attack. The variation of the attack angle due to the change of the flight speed, air density and the aircraft levelling causes the change of the bank scale on the compass card relative to the position of the silhouette plane.

The positive or negative angle of the aircraft bank is determined by the position of the central point of the aircraft silhouette plane.

After obtaining the steady speed of the aircraft having constant angle of attack, the level flight should be carried out by reference to the silhouette plane to be maintained at the positive angle by the bank scale.

13. Flies and Desert

During the level flight, the stationary silhouette plane must stand against the blue background above the artificial horizon line which goes down. The bank angle should be indicated in this instance by reference to the position of the silhouette plane on the bank scale.

During the level flight, the fixed silhouette plane must be kept against the green background below the artificial horizon line which goes up. The angle of bank should be maintained by reference to the central point of the silhouette plane on the bank scale.

14. Performance of Aerobatic Movements

While performing aerobatic movements, the position of the aircraft is in space (i.e., its bank) should be governed by the position of the silhouette plane relative to the line of the artificial horizon. The pitch of the aircraft should be determined by the position of the central point of the silhouette plane on the pitch scale.

The airframe maneuvers must be performed within the range of angles from 0° to 90° with the silhouette plane standing against the blue background.

While performing the descending maneuver within the angle of 0° to 45°, the silhouette plane must be seen against the blue background.

The silhouette plane turns again down when the aircraft performs the ascending and descending maneuvers passing through the pitch increase of 90° to 180°.

CAUTION: 1. The instrument yields erroneous indications which might be caused by accidental disconnection of the power supply, then the aircraft should be brought to the level flight with simultaneous pressing of the switch mounted to be carried in level flight only (approximate, fixed on INDICATOR DESIGN). After that, the cargo-engage button on the indicator mast is placed to (engaging the lever being 3 seconds). The indicating lamp goes out upon the formation of the angle of roll. The cargo-engage switch must be used only when the bank angle has been within 15°.

2. It is PROHIBITED to use the cargo-engage switch if the AIB-1 function properly upon switching on the ground due to flight.
15. Automatic Radio Compass ARC-10

The control panel contains additional switches for varying the illumination intensity of the radio compass (marked EU) for night flights.

The aircraft is provided with a special equipment for automatic changing from the inner routing circuit (if the aircraft is new) to the outer routing circuit (if the aircraft is not new). The ARC-10 automatic radio compass automatically switches over to the outer home radio beacon when the aircraft is in flight over the outer home radio beacon. The equipment is automatically switched over to the inner home radio beacon when the aircraft is in flight over the inner home radio beacon. The ARC-10 automatic radio compass automatically switches over to the outer home radio beacon again as soon as the compass needle has travelled through 360° to either direction. When the outer home radio beacon is reached, the ARC-10 equipment automatically switches over to the inner home radio beacon (MARKER) position. The equipment is switched over as soon as the aircraft is again in flight over the inner home radio beacon.

16. Aircraft Engine Starting

When taking off from the aerodrome, start the aircraft engines after the power units are in operation and the oxygen is properly supplied.

17. Preparation for Starting

The engine is started from the ground or from the air when the aircraft is moving. When the aircraft is moving on the grons, the engines must be started from the air when the aircraft is moving on the grons. When starting engines from the ground, the aircraft must be equipped with all fire-fighting equipment. When starting engines from the ground, all foreign objects must be removed from the aircraft engines.

18. Engine Starting

Command: "Clear the engine!" and start the engine on opening: "Engine cleared!"

Start the engine as follows:
- Shift the engine control lever to the LOW SPEED position.
- Depress the starting button for 1 or 2 sec. and then release it.
- After the push-button is pressed, the engine s.p.m. must automatically settle at low speed within a time period of not over 60 sec.
- When the starting cycle is over, the STARTING light on the 7-5 light panel goes out.
- The exhaust gas temperature at the turbine outlet must not exceed 250°C during the process of starting.

The low pressure turbine s.p.m. must not exceed 25.4-28.6 at the low speed rating.

Fault: 1. The high pressure turbine s.p.m. is in the end of the starting cycle must not be less than 100 and not over 150, at the low speed rating the s.p.m. must equal 44.5-52.
- As soon as the high pressure turbine s.p.m. reach 9 or 100, the pressure gauge pointer must indicate oil pressure in the engine system.
- To avoid pressure surge over shift the engine control levers beyond the low speed position during the starting process.
- After the engine is started, cut all the circuit breakers located on the right engine panel (generator, pump unit, remote-control artificial horizon, radio set, trimmer effect, etc.).

CAUTION: If the engine fails to start or if the permissible values are exceeded during the starting, discontinue starting immediately by bringing the engine control levers to the OFF position.

When the engine is stopped before the STARTING lamp goes out, cut out the starting units and keep them switched on for not less than 40 sec. to complete the interrupted cycle of automatic starting cycle. A repeated starting cycle can be performed only after the cause of the failures has been found and eliminated.

19. Engine Starting with Fuel Feed Manual Control

The starting with the fuel feed manual control is permissible to assure the automatic starting cannot be performed due to some reason or other.

The starting is performed as follows:
- Place the engine control lever in the OFF position.
- Depress the push-button STARTING and keep it pressed for 1 or 2 sec. After this begin feeding fuel to the engine by slowly sliding the engine control lever towards the LOW SPEED position.
- The exhaust gas temperature at the turbine outlet must not exceed 250°C.

The end of the starting cycle is indicated by the moment the STARTING lamp on the 7-5 light panel goes out.

20. Automatic Starting

For automatic starting:
- Set in the appropriate circuit breakers (as in the case of starting from the ground control).
- set the engine control lever to the LOW SPEED (MAINT 3A) position;
- press the START (START) button and release it 2 - 3 seconds later.

1. If the engine r.p.m. to reach the low speed in 30 seconds after starting.
2. The number of starting attempts may be repeated three times at maximum, with the storage battery completely charged and two minutes at maximum if the storage battery integrating time above 60 kVh expectation.

With introduction of autonomous starting of the engine, to ensure the engine starting on the ground air bypass valves are installed on the engine and the flap open position is brought in.

In the process of starting, the flaps should be opened to keep the position corresponding to the full expected condition until the engine speed has reached 60% of the high-pressure turbine r.p.m. after which they automatically assume the position corresponding to the maximum duty.

When the engine control lever is pulled back, the flaps automatically leave the MAXIMUM DUTY (MAXIMUM) position to come to the STILL AIRPOWER CONDITION (STILL AIRPOWER) corresponding to 60% of the high-pressure turbine r.p.m.

The difference in the r.p.m. of 60% and 63% is provided to prevent spontaneous opening and closing of the flaps when the flight speed of the engine approximates 69%.

CAUTION: Should the engine fail to obtain the speeds corresponding to 60% of the high-pressure turbine r.p.m. (no starting took place), shut off the electric breaker marked STARTING UNITS (STARTING UNITS 1) after bringing the engine control lever to the STOP (STOP) position.

Engine Limitations

- Maximum permissible r.p.m. of the high-pressure turbine on the ground and in flight should be within ±103.7%.

- Maximum permissible variation of the low-pressure turbine r.p.m. under the maximum duty and adjusted conditions should not go beyond ±103.7%.

3. Engine Warming Up and Testing

After the engine is started at the LOW SPEED rating is established, allow the engine to run at the maximum rating for 0.5 or 1 min. and check the readings which must be:

- n - PNE (low-pressure turbine r.p.m.) = 29,529 rpm;
- exhaust gas - at least 16 kPa/cm,
- FAL - at least 14 kPa/cm.

CAUTION: If the engine continues operation is permissible for not over 10 min.

Check the engine for operation at 60% and 90% ratings.
- Check the engine speed at normal rating:

PNE (low-pressure turbine r.p.m.) = 39,078 rpm;

Time of continuous operation is unlimited.

CAUTION: 1. It ratings above normal the engine is tested on a site specifically intended for the purpose and furnished with special voices sounds and wire ropes.
2. During the engine testing the hose of the air inlet duct must be completely released. Never test the engine if the CORE EXHAUSTING pipe is burning.
3. It temperature below zero the engine operation at a speed of less than 50% is permissible for not over 2 min., after this the engine speed must be raised to the r.p.m. above 30% for at least 30 sec.

Check the engine operation at normal rating:

- Maximum rating the engine must indicate:

  - PNE (low-pressure turbine r.p.m.) = 100±9.99;
  - exhaust gas - not over 37 kPa/cm,
  - FAL - from 3.3 to 4 kPa/cm.

- Time of continuous operation is 10 or 15 sec.

Check the engine operation at augmented rating:

- Shift the engine control lever to the AUGMENTED position until it rests against the stop.

- The moment the augmented rating is switched on is indicated by the large AUGMENTATION flashing on the solid light panel and by a Jerk.

- When the augmented rating is switched on, the exhaust gas temperature must be dropped from 40 to 90°C as compared with the temperature of the maximum rating with the enhanced status. A short-time increase in the low-pressure turbine r.p.m. up to 103.7% during 5 sec. is permissible when the augmented rating is established, then the r.p.m. must settle at the actually adjusted maximum speed [low pressure turbine] during a period of not over 2 min.

CAUTION: 1. In case of the augmented rating change-over is accomplished by a pressure surge or exhaust gas temperature rises above the limit (700°C), shift the engine control lever to the MAXIMUM position or even lower. If pressure surge and temperature rise parallel, stop the engine by pressing the engine control lever to the OFF position. The engine may be started again only after the cause of troubles has been eliminated.

2. If the engine control lever shifting fails to take the augmentation, set it off by means of the switch AUGMENTED - MAXIMUM.

3. If with the engine change over to the augmented rating the fuel fails to burn in the afterburner (the exhaust gas temperature drops below 600°C), shift the engine control lever to the MAXIMUM position.

Instrument indications at the augmented rating must be as follows:

- Low-pressure turbine - ±100±7.99;
- exhaust gas - not over 100°C;
- FAL - from 5.3 to 4 kPa/cm.

- Time of continuous operation is not over 15 sec.

4. Engine Acceleration Test

Check the engine acceleration by shifting the engine control lever from low speed to maximum during 1.5 or 2 sec.

The acceleration up to PNE (low-pressure turbine r.p.m.) 90% must take...
from 9 to 32 sec. at ambient air temperature not below -75°C.

21. Maximum takeoff weight must be decided at low altitudes (less than 15,000 ft) and at full load conditions. The acceleration time must not exceed 5 sec. for a takeoff weight of 30,000 lb. or less. The acceleration time must not exceed 7 sec. for a takeoff weight of 30,000 lb. or more.

22. During takeoff, the thrust should be increased gradually to the full takeoff thrust. The acceleration time should be reduced to the minimum possible value.

23. During the climb, the thrust should be reduced gradually to the cruise thrust. The acceleration time should be increased gradually to the cruise acceleration time.

24. During the descent, the thrust should be reduced gradually to the landing thrust. The acceleration time should be reduced to the minimum possible value.

25. During the idle, the thrust should be reduced gradually to the idle thrust. The acceleration time should be reduced to the minimum possible value.

26. During the ascent, the thrust should be increased gradually to the takeoff thrust. The acceleration time should be reduced to the minimum possible value.

27. During the descent, the thrust should be reduced gradually to the idle thrust. The acceleration time should be reduced to the minimum possible value.

28. During the idle, the thrust should be reduced gradually to the idle thrust. The acceleration time should be reduced to the minimum possible value.

29. During the cruise, the thrust should be reduced gradually to the cruise thrust. The acceleration time should be increased gradually to the cruise acceleration time.

30. During the landing, the thrust should be reduced gradually to the landing thrust. The acceleration time should be reduced to the minimum possible value.

The F-15/20 engine has a thrust of 35,200 kg (77,500 lb) at takeoff. The engine is equipped with a variable exhaust nozzle that allows continuous setting of thrust from maximum to minimum. The engine is also equipped with a variable pitch propeller. The pitch of the propeller can be changed from maximum to minimum by the pilot. The engine is also equipped with a variable pitch propeller. The pitch of the propeller can be changed from maximum to minimum by the pilot.
### 20. Engine Ratings

<table>
<thead>
<tr>
<th>Item</th>
<th>Low pressure regulator r.p.m.</th>
<th>Exhaust gas temperature</th>
<th>Oil pressure</th>
<th>Continuous operation</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Maximum augmentation</td>
<td>100-8.5 during change-over, short-time</td>
<td>Not over 700°C</td>
<td>3.5</td>
</tr>
<tr>
<td>2</td>
<td>Minimum augmentation</td>
<td>100-8.5</td>
<td>Not over 700°C</td>
<td>3.5</td>
</tr>
<tr>
<td>3</td>
<td>Minimum rating</td>
<td>100-8.5 during change-over, short-time</td>
<td>Not over 700°C</td>
<td>3.5</td>
</tr>
<tr>
<td>4</td>
<td>Normal rating</td>
<td>90°C</td>
<td>Not over 700°C</td>
<td>3.5</td>
</tr>
<tr>
<td>5</td>
<td>0.8 of normal rating</td>
<td>80°C</td>
<td>Not over 700°C</td>
<td>3.5</td>
</tr>
<tr>
<td>6</td>
<td>Low speed</td>
<td>Not over 60°C</td>
<td>At least 1</td>
<td>Not over 10 min. on the ground, without limits in flight</td>
</tr>
<tr>
<td>7</td>
<td>Starting</td>
<td>Not over 60°C</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### 21. Engine Acceleration Time

The engine control lever shifting time during acceleration is 1.5 ± 0.5 sec.

(a) Acceleration time from low speed r.p.m. to 99% continuous rating (maximum, minimum, and intermediate). not over 20 sec.

(b) Acceleration time from 65% to 99% continuous rating (maximum, minimum, and intermediate). not over 9 sec.

### 22. Maximum Rating

The engine can be operated at maximum continuous rating within the range of 75°-100°C is limited similarly to operation at maximum rating.

1. Expected acceleration up to ratings over 99% (by the L.P. regulator) is permissible only after engine cooling at normal or lower ratings (at least for 1 min).
2. Increase in oil pressure from 0.5 to 3 kg/cm² at altitudes over 10,000 ft. is permissible.
3. Maximum r.p.m. of the R.P. regulator equals 103.64.
4. Short-time (not over 3 sec.) rapid increase of the L.P. regulator r.p.m., during augmented rating change-over and during acceleration, not over 10.94.
5. When the engine is started, check operation of spark plugs during 30 sec. at low speed rating.

### 23. Maximum Rating

In calm with the engine operating at a maximum rating exhaust gas temperature behind the turbine usually somewhat decreases.

At the altitude of 10,000 ft. gas temperature at the turbine outlet must not be lower than 750°C.

Simultaneously with the gas temperature reduction, the R.P. regulator r.p.m. decreases up to 76 due to a decrease in the ambient air temperature.

### 24. Augmented Rating

The maximum augmented rating can be set reliably at altitudes below 8,000 ft. when the indicated speed is not less than 450 km/h, at higher altitudes the indicated air speed at which the maximum augmented rating can be reliably increases, at altitude of 18,000 ft. it reaches 600 km/h, change-over time being up to 4 sec.

When changing over for the augmented rating, watch the augmented rating lamp, both after r.p.m. and exhaust gas temperature at the turbine outlet.

An increase in the exhaust gas temperature as measured at the turbine outlet may reach 800°C.

A short-time (not over 3 sec.) increase in the L.P. regulator r.p.m. must not exceed 10.94.

A decrease in the R.P. regulator r.p.m. can be registered during the augmented rating setting, but no limits are specified for the decrease.
The augmented rating must be introduced smoothly, without sharp increases and above-limit temperatures of exhaust gases.

In case the engine fails to return to the minimum rating, stop the augmented operation of the engine by switching off the AUGMENTED RATINGS (DUGLES) switch.

When the engine operates at the augmented rating or picks up speed, watch both pressure r.p.m. and exhaust gas temperature. When the engine picks up speed, the E.P. regulator r.p.m. increases.

Maximum speed of the E.P. regulator is 101.96, maximum temperature of exhaust gases as measured at the turbine exit is 500°C, at altitudes up to 13,000 m, and 720°C at altitudes up to 15,000 m.

In case the E.P. regulator speed is above 101.96 or the exhaust gas temperature exceeds 500°C, stop engine acceleration and find out the cause of the trouble as soon as the aircraft lands.

When the E.P. regulator r.p.m. reaches 102.9 or 103.54 with the engine still picking up speed, a reduction in the E.P. regulator r.p.m. may be registered.

The E.P. regulator r.p.m. reaches its maximum value when the E.P. number in the flight is close to the maximum value.

When the r.p.m. may be changed over for ratings below the maximum rating when the exhaust gas temperature exits 500°C (after the decrease).

When the engine operates at the MINIMUM ACCELERATION, the fuel pressure becomes less as compared to the pressure registered during the maximum augmentation, the fuel burning process becomes stable. This may result in thrust reduction (at high altitudes, and small indicated air pressure).

Indicated speed at which the engine operation becomes unstable (at minimum augmentation) are:
- 400 km/hr at altitude of 13,000 m;
- 480 km/hr at altitude of 15,000 m;
- 540 km/hr at altitude of 17,000 m.

In case artificial boosting is registered at the throttled augmented rating which is an evidence of the fuel unstable burning, place the engine control levers strictly in the FULL AUGMENTATION position in case the aircraft is flown with the engine operating at MINIMUM AUGMENTATION increase the indicated speed or decrease the altitude.

V. FLIGHT

34. TAKE-OFF

Perform the take-off with the L.O. automatic brake operating. On obtaining permission to take-off, gradually increase the engine r.p.m. up to maximum, make sure the engine operates normally, release the brake handle and begin the take-off run.

Perform the take-off with the engine operating at a maximum rating or at the MINIMUM ACCELERATION rating and the flaps extended.

If a reduction of the take-off distance is necessitated, the full augmented rating can be employed during the take-off.

35. AFTER TAKE-OFF

At the beginning of the take-off run the control stick must be kept in the neutral position.

As soon as the speed of 200 km/hr. is gained, raise the nose wheel from the ground by a smooth backward pull at the control stick.

During a normal take-off of the nose wheel the aircraft must also rise to the horizon and preserve this position till the take-off.

CAUTION: Never raise the aircraft nose above the horizon unless the aircraft fails below may bump against the runway.

The aircraft flies off the ground at a speed within 310 to 315 km/hr.

MAX: The take-off distance with the engine operating at the maximum rating, without the drop tank suspended and the flaps extended is from 900 to 1100 m, with the take-off performed at the augmented rating the distance constitutes 650 m.

The length of take-off run at maximum rating with two E-13 rockets is from 1300 to 1500 m.

The length of take-off run at augmented rating with drop tanks and two E-13 rockets is 900 to 1000 m, without drop tanks is 600 m.

Take-off with one rocket pod has no peculiarities.

The presence of the drop tank influences the take-off conditions but insignificantly.

After the take-off the aircraft must display a proper stability without a tendency for pitching or heaving.

NOTE: All the aircraft is equipped with highly effective ailerons, the wing-flapping roll during the take-off is damped with the aileron small-angle movements to avoid a large-amplitude rolling near the ground at small speed.

Retract the landing gear on reaching 10 or 15 m. above the ground, at speeds up to 300 km/hr the landing gear retraction time is 5 to 8 sec.; at higher speeds the retraction time increases, besides an incomplete retraction of the landing gear may be the result of higher speeds. Check whether the landing gear retraction is indicated by the signal light and by a pressure rise in the hydraulic system (up to 215 bhp/cm²).

When the landing gear is retracted and not the L.O. control valve to the neutral position.

Caution: In case one of the signal lamps does not burn with the landing gear retracted at high speeds, keep the L.O. control valve in the RETRACTED position and decrease the speed down to 200 km/hr. This must affect a complete retraction of the landing gear.

Retract flaps at altitudes within 100 - 150 m. The moment the flaps are retracted the aircraft slightly lowers.

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34. Rectangular Pattern Flight

Climbing to a flight altitude above the traffic flight above the airfield is advisable to avoid the traffic flight over the airfield with the landing gear retracted. Maintain a speed of 300 km/hr. The low pressure turbine r.p.m. will be 80%.

37. Fuel Consumption Control

Fuel consumption is limited by the instructions of the airfield and by the background of the signal lamps.

CAUTION: Do not use the respective circuit breaker on the left control panel; training and personnel training in the event that the fuel sensor in the fuel tank, ignition, or any other apparatus that has been damaged, and then disconnected from after 1-minute steady burning of the lamps of every pump.

38. Preparation for Landing

Prior to landing:
- Check whether the nose gear has been used in flight (if used this is rarely used in flight)
- Make sure the pressure in the hydraulic system equals 210 kg/cm².
- Check whether the air pressure equals 130 kg/cm² in the emergency system and 60 or 100 kg/cm² in the main air system.
- Reduce speed to 200 km/hr and extend the landing gear.
- Check the landing gear extension by the light of the green lamp.
- Keep the rudder in the neutral position and turn the aircraft to the ground plane.
- Keep the green light on. When the landing gear retracted, maintain a speed of 400 km/hr (the low pressure turbine r.p.m. will be 80%).
- Check whether the automatic brake system and the nose wheel brakes are engaged.
- Set the trimmer effect mechanism to the neutral position.

39. Landing Approach

Perform the horizontal flight and the 30° turn after the landing gear is extended, maintain a speed of 400 km/hr. Before the 30° turn make sure the nose wheel is extended and wing flap extended. Before the 30° turn extend the flap and check their movement by the light of the green lamp.

The extension of the flap ensures a slight tendency for pitching which is mostly removed by a deflection of the control stick.

Note: If the low pressure turbine r.p.m. exceeds 80% after the flap is extended, check that the landing gear extension has not been affected (or has been incomplete). If necessary, extend the landing gear completely and then perform landing.

Perform gliding after extending the flap at a speed of 400 km/hr. The final turn must be performed at a speed of at least 400 km/hr to be finished at an altitude of 300 m.

When gliding after the final turn with the flap extended maintain speed at 300 km/hr gradually reducing it to 300 km/hr at the beginning of landing off. When landing with rockets, the glide speed should be increased by 10 - 15 km/hr. Glide to the touchdown point calculating to apply power to reach it. All corrections must be performed either by changing the engine r.p.m. (in cases of misunderstanding) or by applying air brakes (in cases of overstretching).

Note: When landing with the landing gear and flaps extended the engine speed (low pressure turbine) must be maintained at 60 or 70%.

40. Landing

At an altitude of 10 or 15 m, reduce the angle of gliding by pulling the control stick backward so as to bring the aircraft to 1 m above the ground. Having landed off the aircraft, smoothly pull the landing gear lever to the LOW SPEED position to perform landing.

Plant with a gradual descent, for which purpose increases the angle of incidence by smoothly pulling the control stick backward to land the aircraft upon two main wheels (without powering) with the pitch pulled down to the extreme position.

During normal landing (fuel reserve of 300 - 500 litres), flaps extended the landing speed is 260 or 280 km/hr.

During landing with the control stick insufficiently pulled back, the landing speed and landing run increase respectively.

After landing, keep looking at 30° to the left and 40° to the right, forward upon the ground.

After the touchdown (upon two wheels) continue to land forward and to the left or when landing. Only after the nose is down, hold straight forward and begin braking.

Note: To reduce the landing run, do not hold the aircraft running with the nose stuck for a long time. If the aircraft is stable on the two main wheels, help the aircraft to lower the nose wheel by pushing slightly the control stick forward and begin braking.

The aircraft wheels are locked by pressing upon the brake lever to activate the automatic brake system.

Note: The automatic brake system allows to shift the engine control lever fully backward after the nose wheel is down (without giving rise to adding) and to immediately reduce the landing run.

The landing run is reduced, as a rule, by employing the drag parachute. The drag parachute is released at speeds not over 200 km/hr.

If the aircraft balance due to some mistake in the landing technique, the aircraft position is corrected as follows:

- When landing at higher speeds (the nose wheel is slightly above the ground), restrict further balancing as soon as the aircraft lowers the ground and then, as
25

the speed and altitude reduce, land the aircraft upon the two main wheels.
- When landing at normal or even lower speeds, arrest the control stick to
  the position it has occupied at the moment of leveling. As the aircraft approaches
  the ground, land the aircraft upon the main wheels by a smooth but energetic
  pull at the control stick.

In case of a high floting (lower than 1 m), stop pulling the control stick backward
and then land the aircraft upon the two wheels after the aircraft loses speed and
altitude.

When the main brake system fails, slow down the aircraft speed with the help of the
drag parachute; besides apply wheel brakes repeatedly by pulses using for
this purpose the emergency brake control valve.

After the landing run is over, extend the flaps, switch to the nose wheel steering mechanism, cut off the nose wheel brake and land the aircraft off the runway.

CAUTION: Never test the aircraft with the nose open.

47. Actions to Be Carried Out by Pilot During

Landing for Test Landing With (Current Procedure)

The parachute should not be released for correctly redressed landing run.
(1) After the main legs have touched the ground, the pilot must bring the
aircraft to arrested position at once.
(2) He must press the brake lever all the way down.
(3) After the aircraft has come to a stop, the landing flaps must be retracted
(4) The nose wheel brake must be disengaged.
(5) The automatic brake switch must be changed over to the NORMAL
(position) and perform the taxiing.

48. Actions to Be Carried Out When Flaking Down

Landing With Full Landing Gear

For reducing the landing run:
(1) After the main legs have touched the ground, the pilot must at once
bring the aircraft nose down by gently pushing the control stick forward during
1 - 2 seconds.
(2) The brakes parachute must be released immediately after bringing the
aircraft nose down.
(3) If necessary, stop the engine.
(4) After the aircraft has come to a stop, the nose wheel brakes should be
not set.
(5) The automatic brake switch must be set at the NORMAL (OFF) position after which the taxiing may be done.

49. Recommendations in Pilot When Automatic

Brake Systems Fail

If the automatic brake system fails, the pilot must:
(1) Release the brakes parachute and retract the landing flaps.
(2) Let go of the brake lever completely (to avoid abrding while changing
over to the manual control).
(3) Set the automatic brake lever to the MANUAL (OFF) position.
(4) Brake the aircraft by manually pressing the brake lever.
(5) Disconnect the brakes.

44. Recommendations to Pilot When Both Automatic

and Manual Brake Systems Fail

Should the automatic and manual brake system fail (due to air, break of
dope, etc.), the pilot must:
(1) Release the parachute.
(2) Change over to emergency brake by pulling forward the emergency brake
valve control in short pulls (to avoid tear of yokes).
(3) Retract the landing flaps.
(4) Stop the engines.

45. Landing with Side Wind

The landing with a side wind of up to 15 m/sec. blowing at 90o in relation
to the aircraft affords no great difficulty.

Compensate the aircraft drift by slipping in the opposite direction with a
haste of 10 or 15o.

In case of a stronger wind the drift must be compensated by slipping along-
side with changing the aircraft heading by.

The end of slipping, gradually reduce slipping so as to eliminate heading
completely. The pedals must be in the neutral position by the moment of
the touch-down. Land the aircraft upon one main wheel.

After landing gradually lower the nose wheel until it touches the ground
with the purpose of increasing the aircraft directional stability.

Maintain the direction of the run by deflecting the pedals towards the side
opposite to the turn (during the first half of the run) and by aligning the brake
(during the second half of the run).

50. Landing without Parachute Flaps

When landing with flaps totally retracted, keep the gliding speed at 360 -
370 km/hr gradually reducing it by the beginning of the running-out to 320 or
310 km/hr.

The aircraft speed at gliding must be maintained at 60 or 70 km/hr (in pressure
turbine).

51. Re-Approach

The re-approach is possible from any altitude (up to running-off altitude),

After taking the decision to go around, decrease the engines rpm up to MAX. IN.

On reaching the speed of 370 - 375 km/hr, begin slipping and retract the
landing gear.

Retract flaps at an altitude of 150 - 200 m.

52. Starting Engines at Parking

After placing the aircraft for parking, de-energizes all electric consumers
(except pump No.3) and stop the engine by placing the engine control lever in
the CUTOFF position.
29.

**Maximum Indicated Speed without Flap**

The limit value for the indicated speed (larger pointer) during flights without suspended loads is 1200 kn/hr from the ground to 12,500 ft.

During the aircraft acceleration with the trimmer effect mechanism, certain efforts appear on the control stick at the indicated speed of 750 kn/hr; at the speed of 950 or 990 kn/hr the efforts decrease until they are almost zero and remain practically constant at a further increase of the indicated speed up to 1200 kn/hr.

With the aircraft flying at limit values of indicated speed and N number, the efforts acting on the control stick are easily removed by the trimmer effect mechanism.

52. Flight with Flap Down

Prior to flight make sure the circuit breaker SWITCH RELEASE OF POWER, DROP TANKS, LIMITS FSD are cut-in on the right-hand instrument panel (under a transparent shield). Then taking-off with the present drop tank suspended cover flaps to extend flaps.

The takeoff with the tank suspended has no peculiarities save for the increased length of the take-off run.

The limits given below are established for the flight with the drop tank suspended:
- Final = 1000 kn/hr (larger pointer) at altitudes from 0 to 12,000 ft
- N = 1.4 at altitudes above 12,000 ft.

The growth of N number above 1.4 results in intensive slipping which cannot be compensated because of great efforts applied to the control pedals.

The flight with limit values of speed and N number has no peculiarities.

The aircraft is stable throughout the range of speeds and N number values.

The drop tank can be jettisoned in a level flight at speeds of 600 - 1000 kn/hr (larger pointer) and at N number of up to 1.3. The tank jettisoner is activated by activating the push-bottom.

To affect the drop tank jettisoner:
- lever must be pulled upwards to the safety stop on the left panel and press the bottom FIRE DROPPING.

- in case the tank is dropped, the long DROP TANK DISINTEGRAT (on the instrument panel lower part) goes out.

In case the tank is dropped in emergency with the fuel contained, the readings of the fuel meter remain false for the amount of fuel dropped in the tank.

53. Flight with F-22B Self-Defense Projectiles

Maximum indicated speed at altitudes from 0 to 12,000 ft

Maximum indicated speed at altitudes from 12,000 ft to 30,000 ft

- 1000 kn/hr
- 1200 kn/hr
54. Flight with Two L-13 Banthas and Drop Tank

Maximum speed: 
- At altitudes above 12,000 ft: 12,000 mph
- At altitudes below 12,000 ft: 10,000 mph
- At altitudes below 5,000 ft: 8,000 mph

55. Maneuvering

The aircraft is well controllable during simple, complicated, and advanced maneuvers.

CAUTION: Maneuvers with a roll angle greater than 30° may result in structural failure.

56. Aileron Turn

Aileron turns are recommended for all altitudes.

CAUTION: Aileron turns should be performed with a roll angle of not more than 30°.

57. Chordless

The chordless can be performed at normal, maximum, and minimum settings.

CAUTION: Chordless turns should be performed with a roll angle of not more than 30°.
The technique of performing a chandelle has its peculiarities as compared to other type aircraft.

Mr. Ballout

Half-turn can be performed at any altitude between 5000 m. and the ceiling. The half-turn entry speed (indicated) depends on the altitude and usually equals the following values:

- not over 450 km/hr at altitudes of 5000 m.
- from 400 to 600 km/hr at altitudes within 6000 - 10,000 m.
- from 350 to 450 km/hr at altitudes below 13,000 m.

The half-turn at the above speeds can be performed either with retracted or extended (at the entry) airbrakes.

When learning to perform the half-turn above the airfield begin the half-turn at altitudes within 5000 - 10,000 m. The loss of altitude will constitute from 2000 to 3000 m.

Prior to starting the half-turn establish the required speed (depending on the altitude) then slowly pull the control stick backwards to set the pitch angle within 10° to 15°. Deflect the control stick so the plane will break its glide and turn the aircraft with wheels upwards during 2 or 3 sec. at a speed of 700 km/hr.

In the wheel-up position, stop turning the aircraft and, without trying to preserve the position, gradually pull the control stick backwards to make the aircraft out of the dive into a level flight at an indicated speed within 500 to 700 km/hr. Once the aircraft is being reappeared from the dive, the wheel-down position will be felt on the control stick.

When preparing from the dive be careful to coordinate the control stick movement with the recovering procedure.

In case the control stick movement is too slow, the aircraft speed increases considerably thus ensuring a considerable loss of altitude. Recover the aircraft from the dive in this case with a more energetic pull at the control stick (without allowing the aircraft to roll from wing to wing).

Round

The aircraft should be able to perform snap and slow controlled rolls.

For training purposes a snap controlled roll is performed as follows: Bring the aircraft into a level flight at an indicated speed of 500 or 700 km/hr. Introduce a pitching with an angle of 10° or 15° and a snap to try to preserve the position attained, then with a smooth movement of the control stick towards the sides of rolling turn the aircraft around its longitudinal axis. The time needed for the snap roll is 2 or 3 sec.

To perform a snap roll at high speeds, the pitch angle is set within the limits of 20° to 30° (depending on the speed). In all other aspects the snap is the same. The roll performed at 600 or 700 km/hr.

A slow controlled roll takes 10 or 15 sec. It is performed with a variable angle of attack (for the moment the maneuver requires positive angles of attack, the other part of the maneuver - negative angles of attack), the pilot differing overload varying in signs.

To perform the slow roll, bring the aircraft to a level flight at an indicated speed of 600 or 700 km/hr to a pitch of 15° or 20°, keep it in the position and roll the aircraft around its longitudinal axis by a smooth deflection of control stick towards the sides of rolling.

During the roll, coordinate the movement of the control stick and pedals to keep the aircraft nose from lowering.

The horizontal rolls can be performed both in the horizontal and vertical planes at speeds of not below 400 km/hr (indicated speed).

Double (multi) rolls are two or more rolls performed one after another without intervals. The two (or multi) rolls may be either steep or slow horizontal ones. The entry speed in this case is not below 500 or even 700 km/hr.

The technique of performing a double (multi) roll is similar to single snap and slow controlled rolls.

60. Eckets' Loop

Enter Eckets' loop at altitudes not over 4000 - 5000 m. with the engine at the maximum rating or at altitudes of not over 6000 - 7000 m. with the engine at the augmented rating.

The entry speed at the maximum rating must be not less than 900 km/hr.

The loop is performed as follows:

- Check the required speed and deflect the control stick backwards so as to ensure an overload value of 4.5 or 5.5 when the aircraft attains 20° or 40° of pitch.
- Without releasing the pull, keep the aircraft on the trajectory curve in the vertical plane.
- The control stick backward movement is performed so as to keep the aircraft roll (angular speed) approximately constant and to ensure an indicated speed of not less than 250 km/hr (with an overload number of 1.5) by the moment the aircraft occupies a wheel-up position.
- In the loop, keep the aircraft free from banking as this will lead the aircraft away from the vertical plane.
- In the upper part of the loop, when the aircraft nose reaches the horizon, slowly reduce the engine r.p.m. up to the line speed rating. Enter the dive and then level off as when performing similar actions in a turned turn.
- The possibility of Eckets' loop at the maximum rating is a great loss of speed to the upper point which requires an accurate coordinated movement of the aircraft controlled surfaces.
- When the aircraft pitch is excessively deflected, the aircraft displays buffeting and a wing-lowering roll. A too slow movement of the control stick usually results in a loss of speed and aircraft 'heavering'. The overload is observed during the loop by the load factor indicator.

41. Oblique Loop

When the pilot creates a bank of 30 to 45° relative to the horizon prior to Eckets’ loop and then follows the loop preserving the present bank, the aircraft will describe a closed curve to a plane oblique to the horizon.

The oblique loop is performed similarly to Eckets’ loop.

The main difficulty in performing the oblique loop is to preserve the perfect banking while approaching or passing the upper point of the loop.

When in the wheel-up position, the pilot, whose convolution actions of the horizon-to-thorax position become reversed, must determine and preserve the...
aeroplane banking relative to the constant horizontal. Hence means that with the aeroplane in the upper part of the oblique loop and with the left-wing banking (provided left-wing banking has been chosen), the pilot must keep the left wing lowered and the right wing raised relative to the horizontal. Thus, as soon as the aeroplane enters a dive, the pilot must tread upon the pedal opposite to the bank to preserve the direction when levelling off.

As soon as the aeroplane is levelled off, the pilot must eliminate the bank and set the pedals into the neutral position by gradually reducing the deflection angle.

During the second part of the oblique loop the aeroplane must not pull around its longitudinal axis, especially towards the bank as this may result in a tight spin. This performing oblique loops for the first time, never set a bank exceeding 20°.

Altitude and speed limits for the oblique loop do not differ from those established for Fostester’s loops.

62. Fostester’s Half-Loop

The first half of the manoeuvre is similar in its character and technique to the first half of Fostester’s loop.

The half-loop entry speed must not be less than 800 or 950 km/hr at an altitude not above 7500 m. with the engine maximum or augmented rating. When entering the half-loop at an altitude of 7500 m. (at the maximum rating) the aircraft climbs through a distance of 4000 m.

The speed of the aircraft in the wheel-up position in the upper part must be at least 220 km/hr. When passing the upper point, smoothly deflect the control stick towards the chosen side of the roll and perform a half-loop by turning the aircraft through 180° around its longitudinal axis.

The movement of the controlled surfaces must ensure a complete half-loop during a period of 3 or 4 secs.

Simultaneously with the control stick deflection towards the roll side, slightly release the control stick to move it a little bit forward when the aircraft completes a roll through 90° in order to increase the aircraft directional stability and to reduce the angle of attack (as an aid to loose speed).

In case the aircraft speed in the upper point of the half-loop is less than 370 km/hr, convert the manoeuvre into Fostester’s full loop as small speed and large deflection angles of the controlled surfaces may lead to a stall.

63. Turns

The case can be performed with the engine operating at the normal, maximum, or augmented rating at an entry speed not exceeding the minimum speed value of the given altitude and angles of ascent up to 50°.

The case is in a turn following which the aircraft begins a level flight.

The speed in the beginning of levelling off must be not less than 600 – 900 km/hr at ascent angles within 60 – 80° or 450 – 650 km/hr at ascent angles less than 50°.

The climb during the case depends on the engine rating, entry speed, angle of ascent, and entry altitude.
46. Spin

The aircraft stalls into a spin only in case the pilot makes serious mistakes in the flying technique or acts at spinning for some reason or other.

The lowest indicated speed at which the aircraft loses its stability with the engine at the low speed rating and with the L.O.G. and flaps retracted in 215 knots. A slight buffeting appears when the speed is still further reduced from a value of 200 knots (with the pedals in the neutral position). The buffeting increases but slightly as the speed is gradually reduced to the minimum value.

The effectiveness of the ailerons decreases considerably at the speed of 100 knots (indicated) and then becomes reduced at heights of speeds of 350 or 400 knots. The stabilizer and the rudder are effective enough to keep the aircraft in a level flight without a bank and to bring the aircraft to a glide with the purpose of increasing the speed. The initial position of the control stick with the aircraft flying at the lowest speed is at the point which marks 2/3 of the control stick backward travel.

At the speed of 215 knots the aircraft drops in a wing which is accompanied by a nose-down condition. To restore the aircraft controllability and to reduce the angles of attack at this moment, release the control stick to shift it forward.

No difference is observed in the technique of the right and left ailerons safe for the fact that the right stick is charaterized with a greater amount of rotation.

The aircraft is rather stable when making the first 1.5 turns of the spin but the speed of rotation slows down at the end of the turn and the aircraft does not reach 30 or 30° above the horizon.

That the speed of rotation becomes still greater because 1/4 or 1/2 of a turn later the aircraft stalls, rolls from wing to wing, but continues spinning towards the given leg.

The angle between the aircraft longitudinal axis and the horizon changes from 50° above to 20 or 30° of pitch. These changes are characteristics of the aircraft only as compared to the performance of other type aircraft in the spin.

The effects applied to the pedals vary in the process of the spin. A variable buffeting accompanies the aircraft rotation and, especially, stalling.

In case the pilot fails to keep the aircraft from entering the spin, the pilot must shift the engine control lever to the low speed position, deflect the pitch along the spin, and pull the control stick all the way backward (with the ailerons in the neutral position). Then he must roll the aircraft through a turn and then everestionally push the pedals against the spin; 0.5 or 1 sec. later, the pilot must push the control stick forward beyond the equilibrium position.

When the pedals are deflected, the aircraft isom in its rotation and reverts to the spin as soon as the control stick is pushed forward (the reassuring period must last not more than one turn).

47. Prescribed Contingency

Irrespective of the altitude all flights must be performed with the canopy pressurized and the air feed system operating. The canopy is pressurized by setting the pressurization switch on the left side of the canopy to the front control position.

The canopy air supply line is set into operation by shifting the handle of the canopy air feed cock to the right control panel in the front control position. In flights the switch COCKPIT HEATING (GREEN BARREL 1 ) must be in the position AUTOMATIC (APPROVED).

If the canopy glazing dam during the flight, set the COCKPIT HEATING switch to the hot (TOWER) position. In case the dimming persists, increases the flight speed for a short time.

The canopy is de-pressurized on the ground when the aircraft reaches its parking place. This is performed automatically by opening the canopy as the canopy opening handle is interlocked with the canopy air feed cock. Besides, the canopy can be de-pressurized by moving the air feed cock handle to the extreme rear position (with the canopy closed).

The aircraft oxygen equipment must be necessarily operated and the 6D-77 pressure breathing apparatus present and connected during the flight.

It is permissible for the pilot to fly the aircraft at altitude up to 7000 m. and at speeds not over 750 knots (indicated speed) in the 6M-300 mask and the 6D-77 anti-g suit, the usage of the 6M-300 high-altitude pressure suit and VII-46 pressurized helmet being unnecessary in this case. The hose of the ICG pressure regulator feeding oxygen to the pressure suit must be plugged.

Flights up to the altitude of 10,000 m. at speeds up to 1200 knots one be performed with the equipment of the 6M-300 mask together with the 6D-77 pressure suit.

Flights at altitudes above 12,000 m. at speeds exceeding 750 knots (irrespective of the altitude in the last case), and also when fulfilling combat tasks, are permissible only with the high-altitude pressure suit and pressurized helmet on.

CAUTION: Prior to a flight in the 6M-300 pressure suit lock the head of the 6D-39 automatic suit overload regulator in the MINIMUM (MINIMUM) position.

48. Checking High-altitude Pressure Suit and Oxygen Equipment

Prior to Preparing for Flight

Prior to putting on the pressure suit (previously adjusted to the pilot’s size), check the suit fabric, seams, covers and tapes of the tightening device for intactness and the suit apparatus for proper condition. Besides, make sure the suit exists on tightly, seams or uniting levels.

Enamce the pressurized helmet and the oxygen mask paying attention to the following:

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- Intactness and proper condition of hoses, isolating and releasing valves, body, rubber gaskets of the hose by-pass joints.
- Intactness of the helmet transparent face-piece.
- Intactness of各个部件的连接以及阀门，导管，橡胶密封圈的完整性。

Body, rubber gaskets of the hose by-pass joints, and the face and mask are intact. The valves are properly closed and the pressure is set to zero. The helmet is securely fastened and the oxygen mask is attached. The oxygen supply line is set to the correct pressure.

Check the tightness of the mask-to-face tightening device. The mask is attached securely and the valves are closed. The pressure is set to zero. The helmet is securely fastened and the oxygen mask is attached. The oxygen supply line is set to the correct pressure.

Check the tightness of the mask-to-face tightening device. The mask is attached securely and the valves are closed. The pressure is set to zero. The helmet is securely fastened and the oxygen mask is attached. The oxygen supply line is set to the correct pressure.

Check the oxygen equipment as follows:

(a) at excessive pressures:
- Set the helmet transparent face-piece to the oxygen mask in the operating position.
- Open the suit oxygen supply line by setting the handle on the E-2 control panel to the suit (excessive) position.
- By fingers close the openings in the PSG-2 pressure regulator body.
- Slowly turning the excessive pressure knob counterclockwise create a pressure corresponding to 2000 mm or 1000 mm of water in the helmet or in the mask. Watch the pressure rise on the scale of the PS-2000 pressure gauge.

The oxygen equipment operation is considered normal if the suit increases the pressure upon the body with a pressure drop in the mask and helmet and the E-2000 pressure gauge displays a pressure drop during the inhalation and pressure rise during the exhalation.

After putting on the mask make sure it is properly fitted. With no pressure in the tightening device, the suit tightly fits the body without causing unpleasant sensations or blurring the pilot's movements. The suit is fitted securely and the pressure in the helmet is correct.

Check the suit tightening device for leakage by releasing the suit to the suit oxygen pressure and creating a pressure gradually rising to 2 atm. If the leakage is detected by the doctor or, if not detected by the doctor, by a technician in charge. During the check go over all seams, boxes, and areas to see they are in a proper condition, see also that the pressure is corrected by the suit upon the body is uniform.

Before flights in the pressurized helmet, check whether the helmet is air-tight (with the help of the suit) and is properly fitted.

Note: The selection and fitting of the pressurized suit, helmet, pressurized helmet and the oxygen mask with the mask-to-face tightening device are carried out by the doctor in accordance with instructions on employment of oxygen breathing equipment.

69. Checking E-2 Oxygen Equipment Before Flight

On taking seat in the cockpit, open slightly the oxygen apparatus valves to check its opening. Check the oxygen pressure in the system by reading off the pressure gauge of the E-2-30 indicator. The system pressure must be equal to 150 kg/cm². Set the ambient air temperature of +30°C.

Check the tightness of the pressurized helmet transparent face-piece (by the actuation of breathing). If the transparent face-piece is loose, it must be allowed to eliminate diagnosis by pressing the button RETRACTING MASK (SLIGHT CLOSING PRESSURE ) for 1 to 2 min.

Check position of the oxygen apparatus knob and on the E-2-30 control panel. The excessive pressure knob must be turned all the way clockwise, the air feed knob must rotate to the position MEDIUM (MEDE), while the handle controlling the oxygen feed to the pressure suit be in neutral (N) position.
In case the helmet transparent face-piece heater element fails (the transparent face-piece remains dessicated), periodically use the HEAT LENS DETACH button on the concept left side by pressing it for 1 to 2 sec. and lower to a safe altitude (4000 m).

If it is difficult to breathe due to a great resistance to breathing or due to the pilot's poor state, a continuous (overgang) oxygen supply line must be connected by setting the exit oxygen supply handle on the 11F-2 central panel (left-hand control panel) from the central (8) position to the 15F-2 position. This will inflate the exit bladders and will send oxygen into the pressurized helmet and the mask in a continuous stream.

As soon as the concept becomes depressurized (concept altitude being 13,000 and 12,000 m. or even more as shown by the concept altitude and differential pressure indicator), the aircraft system builds up pressure in the pressure suit 1 or 2 sec. later and, one more second later, in the mask or in the pressurized helmet. From this moment on the pilot is supplied with oxygen under pressure depending on the cabin "altitudes": the higher in the altitude, the more in the pressure in the mask (pressurized helmet) or EKE pressure suit. The pressure under the mask is checked in this phase by the scale of the B-2000 pressure gauge.

The flight is in a depressurized concept at "altitudes" above 12,000 m. may last 10 min. provided the 11F-2 oxygen equipment set is deployed.

In this case, to wait oxygen during a long-time flight in a depressurized concept at an altitude of 12,000 m. or below, disconnect manually the continuous oxygen supply line by setting the exit oxygen supply handle on the 11F-2 central panel to the central position to the OFF (:WEL ALTITUDE) : on this line can be automatically disconnected only at altitudes from 6000 to 10,000 m.

If a rise in the flight altitude (and concept "altitudes") above 12,000 m. is still necessary, set the exit oxygen supply handle to the central position before affecting the rise.

The flight in the air of atomic radiation, one only pure oxygen, for which pressure set the handle on the 11F-2 central panel to the 1600 gie position before entering the zone.

While having the oxygen mask on, make it fit more tightly to the face to eliminate the radioactive dust from the breathing organs.

As soon as the concept altitude in the end of the flight drops to 4000 m. remove the oxygen mask on the transparent face-piece of the pressurized helmet.

VIII. FLIGHTING AIRCRAFT UNDER DIFFICULT METEOROLOGICAL CONDITIONS, LANDING APPROACH AND LANDING WITH EMPLOYMENT OF INSTRUMENTS LANDING SYSTEMS

Landing approach and landing by using instruments and instrument landing systems may be performed as a straight-in landing with two 160°-type or a prolonged-pattern landing.

72. PRIOR IMPERIAL

Prior to beginning a flight under difficult meteorological conditions, make sure the AFK-1 artificial horizon, D-35 rate indicator, gyro induction compass, APK-10 direction finder, 185 low range radio altimeter, and flight control instruments operate normally.

Never forget to cut off in the circuit breaker ARTIFICIAL HORIZON (AHP ) on the right electric panel 1 or 2 min. before the take-off, to provide flights with the artificial horizon inoperability.

Cut off in the circuit breakers AIR SPEED TUBE-CLOCK (B-29D-TH) and ENCLOSED AIR SPEED TUBE (AOAP-TH) and give the command for the technician specialized in instruments to check operation of the instruments (by touch). The check may, cut out the circuit breakers.

Prior to starting the engine set the course setting pointer of the FIA-2 course indicator to the landing heading position and cut in the EKE compass circuit breaker on the right-hand electric panel.

Then still at parking, prior to taking off, or when on the runway, prior to the take-off, depress the synchronous button until the FIA-2 course indicator and magnetic course indicators become synchronized, i.e. until the magnetic course scale stops rotating.

After starting the engine check operation of the flight control instruments, radio communication, radio technical and radar equipment.

Prior to the take-off, cut in the breakers of the air speed tube and emergency air speed tube, check the AKSE-10 direction finder indicators (its radio station relative bearing must be equal to 180°), indications of the course setting unit (its pointer must rest against 0° – landing heading) and press the time counter button on the clock.

72. CLIMBING THROUGH OCEAN AND LOW FLIGHT BETWEEN-OCEAN FLOWING AIR RESISTANCE

After the take-off, retract the landing gear, check starter artificial horizon indications according to the true position of the aircraft in relation to the natural horizon, and then begin the climb.

A training climb must be performed with the engine operating at the normal or maximum ratings and the TAD smaller pointer at 900 or 750 kmph all the time while climbing through clouds. A trained pilot may employ the suggested rating (if forced necessary) during the climb.

When gaining altitude pay particular attention to preserving the aircraft lateral stability (by the indications of the artificial horizon), longitudinal stability (by the TAD velocity) and directional stability (by the indications of the gyro induction compass, type EKE).

Regularly check correctness of the artificial horizon indications by comparing them with those of the turn-and-slip indicator, rate-of-climb indicator and compass to detect possible errors in the indications in due time.

In case the EKE gyro induction compass fails, the flight may be performed by the indications of the artificial horizon constantly checked against indications of the turn-and-slip indicator. If the AFK-1 artificial horizon fails, check the flight by the indications of the turn-and-slip indicator in combination with those of other flight control instruments.

The flight conducted against the turn-and-slip indicator readings (without the artificial horizon) requires higher attention and skill on the part of the pilot.

Before finding the radio set, direction finder, flow meter, and transponder...
simultaneously imperative (which is due to the failure of the inverter feeding all these components, switch in the emergency supply circuit by cutting in the circuit breaker EMERGENCY INVERTER (ERREUR ACCESSIOIRIẢ) on the right electric panel.

1. The rear side of this section will cut off the right and the radarg ranging unit.

2. The radio unit will become serviceable again after its valves get warmed up during 1 or 1.5 min.

As soon as the radar ranging unit is found once again in working order, set the right switch bearing the inscription MARKER - OPTICS (PILLOW-OPTICS) in the position OPTICS and observe its influence on the KPR-10 direction finder when flying towards the distant boiling radio station during the instrumental landing, and to avoid the enemy detection.

To exclude errors in indications of the EGR gyro induction compass after flight unstable conditions, synchronize the EGR gyro induction compass indications prior to appreciating for the instrumental landing by pressing the synchronizer push-button after 40 sec. of a straight level flight at a constant speed.

After the required altitude is reached or after the airplane is in level flight, set the aircraft to a level flight (by using ILS indications), keep the indicated speed at 300 km/hr, turn towards the distant boiling radio station checking the aircraft position after the turn and the direction of the further flight by indications of the EGR gyro induction compass and by sending transponder requests.

After the distant boiling radio station is left behind, perform maneuvers to enter the landing approach.

### XI. NIGHT FLIGHT

#### 73. Prior to landing

Check the lighting equipment of the aircraft:
- set in the circuit breaker MASTER LIGHTS (HUBN. ERFAW KONTRABLICHT) located on the front right-hand electric panel;
- switch in the circuit breaker SIGNAL LIGHTS OF GYROSTABILIZER, TURBO INDICATOR, COCKPIT LIGHTING, OIL PRESSURE (KONTRABLICHT GYROSTABILIZER, TURBO, ERFAW KONTRABLICHT) on the left electric panel;
- adjust cockpit lighting by re-setting the KPR-1424 compass;
- by using the PPO-655 compass light of the 700 ultra-violet lamps, adjust their light filters and set the lamp fittings in the working positions;
- switch on the frontlightings, set the switch to one of the required positions;
- set the aircraft lights switch to the TAXIING LIGHT (Pикиша) position to make sure the taxiing light functions properly and is correctly adjusted. Then set the switch to the LANDING LIGHT (ASCHERIKA) position to see that the landing light is in a proper condition and sends a light beam in the required direction. After this set the switch in the TAXIING LIGHT (Pикиша) position;
- set in the circuit breaker BBLEV LIGHT (ZUFAHÄHNIKZUFAHÄHNIKZUFAHÄHNIKZUFAHÄHNIK) and BLOX (ZUFAHÄHNIKZUFAHÄHNIK) arranged on the front right-hand electric panel and adjust the required brightness of the light attained, after which cut out the circuit breakers;
- fix the switches of the 9- and 24-volt warning light panels and of the flight control signalling unit in the position convenient for the flight light;
- close the shutters of the pilot lamps;
- a filter shutter intended to remove light patches and instrument reflections from the camera glass panel;
- adjust the lighting of the direction finder control panel scale with the help of the KPR-10 SCALE (HUBN. ERFAW) thus.

#### 74. Landing light equipment during flight

#### NIGHT

During the landing approach:
- set the LANDING LIGHT, LANDING, TAILING, ATTENTION (9939, ZUFAHÄHNIK, Pикиша, ATTENTION) switch to the LANDING (ASCHERIKA) position over the inner landing gear or at altitudes of 300 to 600 m, this switch, the base unit of the stroboscopic light, will flash forming covering 30° - 60° area at an altitude of 50 m. It will be directed some 13° off the forward-facing axle in front of the plane, facing the direction of the plane's axe. The lighting unit is in this instance directed to infinity. After landing and upon activation of the green wheel, the beam of the stroboscopic light will still under the aircraft, while the beam of the port side axe will illuminate the forward hemispheres some 30° - 60° ahead of the aircraft instead of the stroboscopic landing light.

At the end of the road:
- set the landing light switch to TAILING (Pикиша) position so that the left landing lamp should illuminate the track;
- after turning to the parking place:
- set the landing light switch to the ATTENTION (Pикиша) position, and then set the taxiing light switch to the ATTENTION (Pикиша) position.

#### 75. Aircraft control on flight and in case

Prior to the flight set in the aircraft breakers arranged under the glass cover on the aircraft standard EMERGENCY BREAKER, ROCKET FUSE, ROCKET FUSE.

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( ARMING DECOY, PC, DECOY CARRIERS, GUN, ROCKET POD, CAMERA GUN (SPYRA, PC, M40), DECOY, ROCKET POD (SAFETY, PC), ARMED = SAFE (ARMED = ARMED).)

ARMED:

On the ground the gun is loaded so that it requires only one charging which is performed by the pilot in the aircraft to load the gun ready for firing.

10 to 15 min. before the actual firing prepare the sight and radar ranging unit for firing by cutting in the aircraft breakers SIGHT (STEPLITE), SIGHT HEATER (SIGHT HEATER), RADAR RANGING UNIT (RANGING). If a possibility exists to employ the sight and the radar ranging unit immediately on taking-off, put to the above aircraft breakers on the ground, after starting the engine.

76. Prior to Employing Sight...
- Change over the sight to the SPYRA (TEPP) position.
- Set the switch on the sight control panel to the RADIO (PEDOT) position and check the high voltage (DIRECT HOMEFIRE) lamp lights up;
- Check the sight for proper functioning by performing scan; turns the moving reticles must deflect in the same direction to the turn;
- Adjust the brightness of the reticles.

The gun fire is effected by actuating the fire control push-button on the control stick.

To fire the gun:
- Set in the aircraft breakers GUN (DECOY);
- Reloading the gun by depressing the reloading push-button for 2 sec.;
- Check whether the gun is ready for firing by the light of the red lamp in the lower part of the instrument panel;
- Check whether the sight selector switch is in the HN-30 position;
- Swing off the trigger guard;
- Aim at the target;
- Press upon the trigger guard (the fire will be automatically controlled by the camera in case the CAMERA GUN circuit breaker is out).

77. To Fire Rockets Equipped in Rocket Pods:
- Set the sight selector switch to the ROCKET POD (PC) position;
- Set to the ROCKET POD (PC) circuit breaker and check the ROCKET POD KERO (SPYRA REMOTE) (PC) by the light of the afterburner signal lamp.

Depending on the task set the required rate of firing by actuating the switch AUTOMATIC SIGHT (AUTOMATIC-LOAD):
- Set the required angle of elevation (depending on the altitude);
- Swing the trigger guard forward;
- Aim at the target;
- Press upon the trigger guard (the fire will be controlled by the camera to the CAMERA CONTROL PANEL circuit breaker is cut off).

To provide engine static, fire the gun at TAI of not less than 660 m/sec. When 3 rocket pods of 78-166-P type are supposed, never exceed the speed of 1000 m/sec (estimated speed) at the value of the G number equal to 1.8. Permissible load factor must not exceed 2G.

To use the camera gun without firing;
- Note sure the circuit breakers GUN and ROCKET PODS are off, while the GUN.

CAMERA GUN circuit breaker is on:
- Set the sight selector switch to the HN-30 or ROCKET Pods (PC) position;
- Swing the trigger guard forward;
- Aim at the target;
- Press upon the trigger guard.

NOTE: It is forbidden to use the camera gun after the gun or rocket pod fire. The fire over, released the gun, swing back the trigger guard, set the sight to the FIXED (FIRE) position, cut out the aircraft breakers GUN (DECOY), ROCKET Pods (PC) , SAFETY (SPYRA), DECOY (DECOY).

During sighting and firing keep to mind the following:
- Use the damping push-button to reduce the time required to set the angle of lead when aligning with the aircraftSeeing up the target;
- Prior to maneuvering the aircraft to assume the attack position, set the outer base ranging unit to a range of 2000 m;
- To ensure a proper follow-up of the angle of lead, keep the sight reticle center upon the target center for 3 or 5 sec. Prior to firing.

NOTE: Slight deviations of the sight reticle relative to the target center with an amplitude of 2 or 3 diameters of the central pixel are permissible and require no further correction in aiming. Attempts at correcting the accuracy of aiming may lead to a negative result: increased error in aiming due to the aircraft wind-tunnel walls;
- The plane-to-target distance during aiming is allowed for the range indicator (the accuracy is ±150 m.);
- Aiming with the radar ranging unit employed and the G2 altitude unit switched on (search distance limited) must be conducted at altitudes not lower than 800 - 1300 m;
- In case the radar ranging unit fails (the TARGET LOCATOR ON (ELITE) lamp remains dead and the pointer of the range indicator on the sight head is stationary), set the target base and manually introduce the range values as indicated by the outer base range finder;
- The radar ranging unit cannot be employed for aiming at ground targets, therefore the range values in this case must be introduced manually with the help of the outer base range finder;
- When the automatic system of the sight fails (at turns the reticle remains immovable), set the sight switch to the FIXED position and use the fixed reticles for aiming.

78. To affect the dropping of the rocket pods together with the rocket pods carrier, swing off the DECOY REMOTE REMOTE, ROCKET Pods safety arm and press the push-button (two green lamp must go out).

To drop signal flares, turn on the signal flare switch and press upon the push-button of the needed color.

XI. ROCKET EQUIPMENT CARRIED ABOARD AIRCRAFT B-17E-13

91. General Information

The rocket equipment system carried aboard the aircraft and designated B-17 is intended to hit air targets under the combat flight conditions.
The equipment is used:
- at speeds of 0.8 Mach to the maximum value;
- at altitudes of 5,000 m to the upper limit;
- at range of aiming time of 1.5 to 2.5 km;
- target aspect angle of 15° to 3/4.

The employment of the equipment carried aboard the aircraft XN-2-13 is limited at altitudes exceeding 18,000 m due to beam-lead visual attention of the target and sighting.

The rocket equipment of the aircraft XN-2-13 includes:
1. (a) optical sight WTP-58-1;
2. (b) aircraft distance-measuring equipment DPM ensuring the target look-on at distances up to 3 km;
3. (c) rocket portable launching range computer PRA-24;
4. (d) aircraft overload transmitters EMT-28A operating, in conjunction with altitude warning unit M-1400;
5. (e) two starting units MA-13;

Note: The E-13 type rockets are used with the equipment only temporarily.
Later, rockets E-13 having increased period of powered flight (up to 21 seconds) and hence, increased firing range will be used.

**Description of Rocket E-13**

The E-13 rocket is divided into four compartments:
- control compartment with boost motor (170) and motor compartment accommodating two pairs of redox and solid-rocket gas generator (5,6);
- search engine to produce blast effect;
- preceding optical fuse;
- solid-propellant engine.

The housing of the rocket is 9737-mm long cylinder having 127-mm diameter. Attached to the housing are four control surfaces - wings with cilia (moving surfaces which stabilize the rocket in flight obviating the roll effect and apply the principle of gyro) attached to the wing edges. The rocket has a streamlined shape and weighs 75 kg.

The control compartment serves to house the rocket on the target after the launch with the necessary degree of precision affecting the functioning of the fuse.

While sighting, the optical axis of the boost motor keeps aligned with the sight axis (accurate within 0.5°). When the target is seen within the field of vision of the boost motor, the pilot hears sound waves caused by the boost motor as an indication of its correct operation.

As the target located at a distance of 5 - 10 km, (depending on the type of the target and the rating of its engines) comes within the field of vision of the boost motor, the latter sends an acoustic signal (characteristic rumble) to the pilot's headset. The acoustic signal indicates that the boost motor has locked on the target.

Solid-propellant gas generator is intended for generating power necessary for driving the payoffs and charging the supply unit of the control compartment. The powered flight of the rocket lasts as long as 11 seconds, the time the solid-rocket gas generator is functioning.

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Previously optical fuse ensures explosion of the warhead in the rocket flies by the target not more than 11 metres off its, and the destruction of the rocket near 20 - 30 seconds after launching, if it fails to hit the target. The fuse is armed (ready for functioning) 0.5 - 2.5 seconds after the solid-propellant engine of the rocket has stopped. In this instance, the rocket has already covered at least 0.5 km. range from the carrier aircraft.

Solid-propellant engine is used to accelerate the rocket to the necessary speed. The time of the engine operation is within 0.2 - 2.5 seconds. During this time the rocket proceeds to acquire some additional speed of 2000 km/hr relative to the carrier aircraft.

After the engine has stopped, the rocket flies on by the inertia decelerating and continuing to home to the target.

**Employment of Rocket E-13**

Putting rocket E-13 in effective against the targets having limited radiation when launched from the side of the rear helicopter at aspect angles up to 2/4.

The maximum permissible launching range depends upon the altitude and speed of the aircraft and upon the closing rate. The greater are the altitude and closing rate the greater is the maximum launching range. Thus, when flying at 745 km/hr without exceeding the target speed (firing does at equalized speeds), the maximum permissible launching range is 3.5 km. at altitudes of 2,000 - 2,000 meters, and 3.5 km. at altitudes of 15,000 meters. 350 km/hr closing rate increases the maximum composite range of launching by another 1 km.

Data: When rockets E-13 having solid-rocket gas generator (5,6) with 10-sec. operating time are launched from aircraft equipped with computer PRA-24, the maximum launching range must not exceed 3.8 km., as computer PRA-24 solves the problems of computing the launching range for rockets E-13 having solid-rocket gas generator with 10-sec. operating time and hence greater range of the launching. In this event, the maximum range of launching must be controlled by means of the range indicator of radar ranging unit TR-1.

Maximum launching range exceeding 1 km. is ensured by correctly aiming the fuse. The rocket is provided with heat-seeking guidance system, therefore the carrier aircraft is free to perform any movements upon launching of the rocket.

When sighting, it should be borne in mind that the boost motor sends an acoustic (rumbling) signal to the pilot's headset if it is directed toward the gun, missile, fuselage, artillery, and the like.

The rocket may be launched at targets flying above and below the aircraft at aspect angles up to 2/4 in the vertical plane from the permissible ranges of the pilot has a visual control of the target even against the background of the clouds or earth.

The target control is as easy as keeping the beams of the rocket.

The launching becomes impossible if a slowed plane between the fighter and the target and if the gun is even at bearing angles of 50 - 30°. Then attaching the target toward the rear under angles of 40 - 55°, the acoustic signal is difficult to hear as the boost motor is not activated in the zone.

It is prohibited to launch the rockets if the lead factor of the carrier aircraft exceeds 2 at altitudes within 0 to 10,000 meters, or 1.6 at altitudes exceeding 16,000 meters as the rocket is liable to escape the initial error than failing to hit the target.
The rocket is normally based on the target if the initial rules of launching are observed, i.e., 17:
- the pilot has superimposed to central point of the sight reticle upon the target and separate the maximum level of the aerial signal sent out by the heat horizon;
- the red overheated warning lamp is on and the distance to the target does not exceed 3.3 km.

Data: Then the rockets are launched from the aircraft in level flight at altitudes below 1000 meters, it is PROHIBITORY to make use of the indications of the distance measuring equipment and the computed permissible range lamp due to the effects of the ground. In such cases, the rocket may be launched for 1 - 1.5 km. range to be determined separately.

The surface of the ground affects the indications of the distance measuring equipment when the rockets are launched at altitudes below 2000 meters from aircraft diving through 30° angles.

4G. 

Air and Ground Control of Rocket K-12

(1) The left console of the aircraft within reach:
- switch LEUCHTHER (OUTLINE MARKS) switch serving on a volume control of the aerial signal sent out by the heat horizon to the pilot's headset;
- ROCKETS for CANON - EMERGENCY ROCKETS (PC, EGD, CC) and emergency service selector for distance measuring equipment and firing circuits;
- ROCKETS LAUNCHES - LEFT, RIGHT (DUAL CC-R/lpp-DEPANG) selector for individual launching of the rockets and individual monitoring of the aerial signals sent out by their horizon;
- ROCKETS LAUNCHES - DUAL - SEPARATE (DUAL CC-DEPANG) selector, when the selector is set at DUAL (REAR), two rockets are launched upon pressing the firing button (in this instance, the position of the ROCKETS LAUNCHER - LEFT, RIGHT selector is immaterial; it is used for monitoring the aerial signals only);
- ONE DUAL - TWO SALVOS - ATTACHMENTS (PC 1, DUAL-GAP-APART) rocket selector.

(2) The upper left portion of the instrument panel carries:
- EMERGENCY RELEASE OF ROCKETS, ROCKETS NOSS (ARMS.DEROG PC,EDP) button serves for emergency release of both rocket sets ASP-ZF together with the rockets if they have already been launched;
- TAP GESCHENK (ARM.UP/DEROG) selector;
- STANDARD CANNON (RECHNL. (SUPPLEMENTARY SPARK) button.

(c) Mounted on the left portion of the bracket of sight ASP-ZF are:
- range indicator of distance measuring equipment EZ-1 with 0 to 6 km. scale showing the present range-to-target data determined by the distance measuring equipment at the moment of launching;
- CONTACT SIGHTS (RECHNL. SPARK) red warning lamp showing that the aircraft starts at a break-away starting distance from the target (1 km.);
- OVERLOAD (CAPSULE SPEAR) red warning lamp goes on under overload conditions when the rocket cannot be launched;

4H. PERMISSIBLE RANGE (PERMISSIBLE DISTANCE) green warning lamp showing that the aircraft is in the permissible range of the target (the signal being sent out by computer ASP-ZF);
- angle range indicator with 0 - 2000 km. scale showing the present range data to the target as determined by the optical range finder or distance measuring equipment when firing rockets or launching rockets;
- selector marked D-CC intended for switching over the sight and firing circuits to the rockets;
- selector marked D-EDP (ROCKETS - CANNON SP-30) and intended for switching over the sight and firing circuits to the rockets or cannon;
- selector marked D-EDP and intended to connect the altitude transmitter or attack; and altitude transmitters to the sight;
- selector mounted in the right portion of the bracket of sight ASP-ZF are:

- OPTICAL - RADIO (ANTenna-SPARK) selector used for supplying the data to the sight either from the optical range finder or from the distance measuring equipment;
- RADIO VOLTAGE (SPARK) green warning lamp indicating the readiness of the distance measuring equipment for operation.

(4) Arranged in the right upward portion of the instrument panel are:
- two green warning lamps labelled EMERGENCY ROCKETS (DEPANG CC) and LEFT-RIGHT (DEROG SPARK) serve to show that the rockets are available in launchers ASP-ZF, as soon as the rockets clear the launcher the lamps go out;
- EMERGENCY LAUNCHING OF EMERGENCY ROCKETS (DEROG, CC) button for supplying voltage to the glow plugs of the solid-propellant rocket engines of both rockets in case of emergency launching.

(5) The middle board under the instrument panel carries:
- ROCKETS WILL LAUNCH (DEROG CC) green warning lamps (two lamps) showing that rocket sets are composed from the following rocket systems. The lamps go out upon the emergency launching;
- CANNON (DEROG) red indicating lamp lighting up to show that the access is free for filling;
- FIRE TAPE SUSPENDED (DEROG CC) green indicating lamp showing that the fuel tank is suspended.

(6) The right console in the middle is provided with:
- two green warning lamps marked ZERO POSITION - ROCKETS - LEFT, RIGHT (DUAL. ROCKETS, PC, EGD, CC) and showing that the rocket launchers controllers are brought to the original position.

(7) Arranged in the upper row of the right console in the middle is:
- COMPUTER CONVERTER aircraft breaker supplying voltage to converter ST-1 2K that supplies power to computer ASP-ZF;

- the second row of controls (left to right) includes:
- STP SPARK (DEROG) aircraft breaker;
- STP SPARK (DEROG SPARK) aircraft breaker;
- DISTANCE MEASURING EQUIPMENT (DEROGSPARK) aircraft breaker. It applies the voltage to inverter EQ-750K, supplying power to the SPARK and to the control panel;

- EMERGENCY SPARK (DEROG CC) aircraft breaker;
- ROCKETS (PC) aircraft breaker.
(d) After the take-off, the pilot should:
- Listen to the noises produced by the startboard and pinot board (by moving over the SUCK ROCKET LAUNCH - RIGHT - RIGHT selector) to ensure they are normal. If necessary, the motion volume should be adjusted by GEAR-UP/GEAR DOWN.
- For safety, the SUCK ROCKET LAUNCHER (SURF CC) circuit breaker should be cut in 3-5 minutes before firing.

(e) For launching the rocket, the pilot must:
- Launch the target with the centre point of the right rear side. In this event the aircraft assumes an attitude necessary for the heat header to lock on the target. The heat header produces characteristic sound. Gently holding the aircraft control stick, be sure that the maximum volume point which can stand, somewhat off the centre point, is switched.
- Switch on the heat header using the range of the time indicator range and the right rear side.
- Press the firing button and keep it pressed until the rocket has cleared the launch and the heat header direction.
- If the heat header does not lock on the target, adjust the heat header with the heat header selector to lock on the target, and note that the heat header selector may be out of the selected position.
- Press the firing button and keep it pressed until the rocket has cleared the launch and the heat header direction.

(f) Before launching the rocket, the selector should be brought to the position LEFT or RIGHT as required.
- If the rocket is to be used, press the button to fire the rocket.
- After the rocket is launched, lock on the target and adjust the heat header direction.
- If the rocket is to be used, press the button to fire the rocket.

* The aircraft usually leaves the launcher 0.5-1.0 seconds after pressing the firing button.

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* For launching the rocket, the selector should be brought to the position LEFT or RIGHT as required.

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69. In-Flight Starting of Engines

NOTE: It is prohibited to keep the IN-FLIGHT STARTING (SNUFFER B NOZZLE) solution engaged more than 30 sec per engine due to the small size of the siphon. If the engine fails to start within the specified period, the engine control lever should be returned to the OFF position.

60. Booster-OFF Starting Procedure

Start the engine with the booster OFF only if an airfield is available. The booster OFF starting can be performed safely only when the booster hydraulic system functions normally (the afterburners are disconnected).

Prior to starting:
- Set the engine control lever to the CUTOFF (CTOP) position;
- Shut OFF pump No.2 and close the fuel cut-off valve;
- Set the power controller unless further supply is absolutely necessary;
- Check if the afterburners are OFF;
- Check if PUMP (PANSER CARBON) circuit breaker is ON;
- Check the pressure in the hydraulic system.

After the aircraft has reached the altitude of 2000 m, make sure the booster hydraulic system operates normally by watching the pressure drop warning lamp and left pointer of the pressure gauge in the booster hydraulic system.

NOTE: The booster hydraulic system is considered to be functioning properly in the following cases:
- In case of normal liberation of the engine, the pressure in the booster hydraulic system is maintained within 180 - 210 kg/cm², as indicated by the pressure gauge, and the yellow warning lamp is OFF.
- In this instance, the connection of hydraulic systems necessary to control the stabilizer (afterburners) is compensated by the EC-IA main pump of the booster hydraulic system;
- If pump E-14 of the booster hydraulic system fails to ensure the specified pressures (due to faults of the system or decrease of the automatic revolution) and the pressure in the hydraulic system comes down to 165 kg/cm², emergency pump unit E-77 is engaged in operation and the yellow warning lamp lights up. After that, the pressure in the hydraulic system will be safely maintained within 180 - 210 kg/cm². The yellow warning lamp will then go up to the loading.

If the altitude is 200 m, the aircraft should glide at a speed of 23 - 450 km/h by the wide nacle to the point of the first levelling-off (the first barrier bouncer) at an altitude of 700 metres off the runway.

The vertical speed of descent approximates 35 - 60 metres per second. Proceed the loading gear as prescribed for the emergency cases having made the landing judgement has been done correctly.

Do not extend the flap of the brake flap.

The aircraft having come down to the altitude of 200 metres, every act the first levelling-off of the plane, and decrease the glide angle to the value typical of the landing procedures done with the engine operating.

The vertical speed of descent must come down to 4 - 6 metres per second by the altitude of 20 - 40 metres. By the initial stage of the landing, the aircraft becomes the attitude of the plane and the vertical speed of descent are concentrated provided the speed along the trajectory is adequate. 

\[ v = 350 - 360 \text{ km/hr} \]

Perform the second levelling-off at an altitude of 15 - 20 m, exactly as it done during the normal landing with the engine operating, bring the aircraft to the ground at an altitude not exceeding 5 m and land it.
Pilot's Actions in Case of Failure of Hydraulics System

In case both hydraulic systems fail in flight (which is evidenced by flashing of the pressure drop warning lamps and steady drop of pressure in the two hydraulic systems below 105 kg/cm², the latter being checked with the aid of the pressure gauge), the crew must leave the aircraft by extinguishing irrespective of whether the engine is operating or not.

If one (main or booster) hydraulic system fails which is evidenced by flashing of the pressure drop warning lamps and by the pressure gauge indications, the flight should be stopped. It is forbidden to use the brake flaps during the landing approach, the landing gear should be extended as prescribed for the emergency procedure, the flaps being kept in.

If pump 1-2 of the booster hydraulic system fails and pump unit 1-27 is engaged with the aircraft in fifteen minutes after the flight, it is necessary:
- to use the machine 1-27 and to shut it out of operation (in normal overhauling);
- when approaching the airfield, to use pump unit 1-27 into operation to build up pressure in the booster hydraulic system.

The engine-off landing of the aircraft with the main hydraulic system failed can be carried out safely only when the booster hydraulic system functions normally.

To switch the aircraft with the engine inoperative and the booster hydraulic system failed, the pressure dropping below 105 kg/cm², but leaves the aircraft by opening the main flaps.

Pilot's Actions in Case of Fuel Pressure Drop

The pressure drop of fuel behind the fuel supply pump is indicated by lightening up of the LITFUEL LAMP (HYDRAULIC SYSTEM) indicator of light panel 9-6. In this instance set the engine r.p.m. in the normal rating or lighter duty, bring the aircraft down to the altitude of 7000 m. and discontinue the mission.

Avoid using prolonged periods of smallest of the engine.

Pilot's Actions in Case of Oil Pressure Drop in Engine

When the pressure of oil has come down to zero, discontinue the mission, decreases the engine r.p.m. and immediately land the aircraft.

Pilot's Actions in Case of Engine Fire

The fire is indicated by:
- lighting up of the FUEL (HYDRAULIC) label on light panel 9-6;
- smoke trail behind the aircraft trail (even during the takeoff);
- extinguish the fire:
  - at the engine control lever in the STOP (STOP) position;
  - press the FLIGHT-OFF V/I (HYDRAULIC) button;
  - decrease the speed of flight to 450 - 500 km/hr, bring the aircraft ceiling;
  - press the FIRE-Extinction (HYDRAULIC) button of the fire system;
  - hold down the aircraft.

Pilot's Actions in Case of Failure of Pitot-Static Tube E1-5 and Pitot Tube E1-16

The failure of the static pressure unit of the static and impact pressure of the Pitot-static tube is indicated by erroneous readings of the speed indicator, rate of climb indicator and manometer, variable ratio boost control unit 8734-A, and one automatic control indicator. The failure of the impact pressure system only supplied by Pitot-static tube E1-5 is evidenced by readings of the speed indicator, manometer, variable ratio boost control unit and one automatic control indicator.

In case of simultaneous failure of speed indicator, manometer, variable ratio boost control unit and one automatic control indicators, switch the auxiliary system of the above instruments from the main Pitot-static tube E1-5 over to emergency Pitot tube TD-16, discontinue the mission and land the aircraft.

In case all instruments fail at a time and remain inoperative after switch- ing over to emergency Pitot tube TD-16, discontinue the mission and fly the air- craft until it can be landed. Canceling the indications of the gyro horizon, turn indicator, engine r.p.m. indicator; indicating downspeed down to the altitude below 100 m. above the radio altimeter, navigate the aircraft referring to the data supplied by the ground radio aids.

Notes:
1. Static Pitot tube E1-5 and Pitot tube TD-16 must be heated, when required for, otherwise they are liable to get food which brings about failure of the instruments connected to the above tubes. In this instance, the indications of the instruments must read actual values measured some 2 - 3 minutes after extending the electronic heaters on.
2. If the instruments fail when the aircraft flies with afterburner on, disengage the latter and immediately get retrievable cone to the original position after heating the aircraft.
3. If all or part of instruments fail in flight, change the variable ratio boost control unit from 2100 (HYDRAULIC) to 1600 (AIR, HYDRAULIC) prior landing approach. When doing this, keep in mind that the end of the nose mechanization takes 10 - 20 sec. to shift.

Pilot's Actions under Engine Conditions

When the aircraft is flying through the overcast under landing conditions, break through the clouds and after having stabilized the aircraft in the level flight with its nose level, and, after the temperature changes; the speed of flight to 600 km/hr.

If one or more engines lose power, start to use the speed of flight, the de-icer system being used from the altitude of 2000 m. and upward.

The loss is best powered from the aircraft when it flies at high speed (if it is practicable under the flight conditions) of up to 700 km/hr for E1-5 at altitude altitudes and up to 600 - 500 km/hr for E1-5 at high altitudes.
33. Pilot's Actions after Breakdown of Aircraft Oxygen System

The breakdown of the aircraft oxygen system is indicated by:
- Drop in oxygen pressure in the system (as shown by the pressure gages);
- Drop in oxygen pressure to the pressurized helmet or mask (usually the indicator on the control box remains in the closed position);
- Failure of the aircraft's oxygen breathing apparatus to supply air to the pilot in the case of an emergency.

While the oxygen system is intact, make sure the air-dilution valve is set at the correct position. If the system fails, set it at the emergency position to ensure that the oxygen supply is sufficient for the crew.

97. Pilot’s Actions in Case of Aiming of Canopy Glass Panels

In case of aiming of the canopy glass panels, make sure the valve supplying the air to the cockpit is opened as soon as the oxygen is pressurized, and the pilot's emergency oxygen supply line is connected.

When the aircraft is in flight, supply oxygen to the cockpit as soon as possible.

99. Pilot’s Actions in Re-Pressurized Cockpit

At high altitudes, the pressure inside the cockpit is lower than the pressure outside. To maintain a comfortable cabin atmosphere, supply oxygen to the cockpit as soon as possible.

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Face: The pilot must concentrate his attention on the consumption of oxygen breathing in mind. If it sharply increases reaching the value of 40 – 50 l/min, then the pressure in the oxygen system reaches 30 kgf/cm². He must decrease the aircraft down to an altitude of 4000 m.

2. Upon engagement of the oxygen emergency supply system, the actuating unit first alights the pilot’s body, and then the pressure is relieved.

99. Pilot’s actions during emergency 

Failure of landing gear

If the landing gear will not come out by the usual method (no pressure in the main hydraulic system), the pilot must resort to the emergency measures prescribed for the purpose. To this end:

- Set the landing gear emergency control valve to the neutral (10/10) position;
- Open the landing gear emergency control valve;
- Make sure the landing gear has come out catching the green warning lamps which must light up after that pressure to landing the aircraft.

99. Pilot’s actions in case of generator failure

The failure of the generator in flight may be detected by flashing of the GENERATOR OFF (GENERATOR SHUTDOWN) indication on the RCD panel 1-4 and by the indications of the voltmeter (the voltage coming from 28 – 29 V down to 22 – 23 V of the storage battery).

When the generator fails:

- Discontinue the flight mission;
- Report the accident to the flight control officer using the radio set;
- Set the following consumers: pump No.2 (at altitudes below 7000 m.); pump No.1; emergency gas, radio altimeter, meter receiver 7F5-560, automatic radio compass 1PR-10 and transponder CPD-1. The radio compass, transponder and transceiver of radio station P197-47 should be set up for a short time and in turns, if necessary.

The time of safe flight of the aircraft with the generator failed and the power consumers being supplied from the aircraft storage batteries in the procedure outlined above both to the day and night reaches 15 – 20 minutes.

Note: 1. Breakdowns of the generator in flight automatically disconnect the flight with the heater, distance measuring equipment, infrared sight CR-52, radio altimeter, meter receiver 7F5-560, and pump Nos 1, 4 and 5.

2. To increase the time of safe flight, it is permissible to cut out other consumers of power the pilot can do without under the flight conditions.

3. When the voltage in the aircraft mains goes below 20 V the landing gears following the emergency procedure. In this instance, the pilot should bear in mind that the brakes parachute cannot be used.

100. Failure of inverter D-750A

Breakdown of inverter D-750A supplying the voltage to radio station P197-47, radio compass 1PR-10, IFR transponder, remote-reading indication pressure gauge 1PR-7, fuel flowmeter P195-100P, and radiomagnet flying unit 5LO in flight by disconnection of the radio communication (all channels), failure of the radio compass to respond to the departure of the aircraft from the radial relative bearing of the radio station, failure of the fuel flow gauge indicator (cables standing still).

Having observed the above indications of the inverter breakdown, the pilot must not to the INVETER DIRECT CONTROL PANEL (UNPERP.INDICATOR.DISP.) aircraft breakers mounted on the right side electric panel in the cockpit.

All the above consumers should be switched over to the secondary inverter D-750A, and the pilot will determine whether they are set into operation after heating of the radio valves (1 min – 1.5 min).

101. Pilot’s actions after breakdowns of variable-ratio automatic boost control unit AYF-13

In case of failure of variable-ratio automatic boost control unit AYF-13, change over to the manual control of servo mechanism of the AYF-13, after having decreased the speed of flight.

For changing over to the manual control, set the selector on the left console from the AUTOMATIC (AUTOMAT.) to the MANUAL (MANU.) position, and make use of the manual push button variable-ratio boost control unit governor (FPEM177) setting it to the LOW SPEED (MALA CHETKOS) position. Bear in mind that LOW SPEED (MALA CHETKOS) corresponds to the smaller one of the variable-ratio boost control unit red, and the LOW SPEED (MALA CHETKOS) to the bigger one.

While manipulating the variable-ratio boost control unit by hand, pay more than ordinary attention to the indications of the variable-ratio boost control unit gauges and compare the latter with the readings yielded by the speed indicator and the altimeter. The I.A.S. must not exceed the speed to which the position of the variable-ratio boost control unit corresponds by more than 100 – 150 km/h, otherwise the aircraft is liable to some oscillating on the position of the unit red does not correspond to the speed of flight.

While a servo mechanism is being controlled manually, the level flight also oscillations and landing procedure only can be performed.

Should the unit red fail, in the same one position (electric motor failure) so that the servo mechanism cannot be changed over to the take-off and landing position (to bigger one), decrease I.A.S. and land the aircraft with the unit red arranged at the smaller one.

Landing with the unit red at smaller one requires more than ordinary attention and accurate actions on the part of the pilot. He should keep in mind that in this instance the travel of the stabilizer is almost twice decreased, the efforts applied to the central unit increases 2 – 2.5 times (about 120 – 150 kg), and the speed of landing goes up. Therefore, the gliding speed must be reduced by 20 – 30 km/h, the gliding being done at a smaller angle of the flight trajectory slope.

When using one of the two mechanisms, remember that the time of the mechanism travel from one extreme position to the other takes 12 sec. irrespective of the flight procedure.
105. Pilot's actions after Breakdown of Anti-Surge Shutter Automatic System

The failure of anti-surge shutters is indicated by the appearance of flutter when the flight is carried out with N + 1.5 and over after pulling the control stick forward through the length exceeding half of the travel.

In this instance, the pilot must open the shutters manually. For this purpose he must bring the shutters control from the AUTOOMATIC (AUTOMATIC) to the OPENED (OPENED) position, after that the fluttering must disappear.

Decreases the speed, cut out the afterburner and after decreasing N below 1.5 close the shutters by bringing the control to the CLOSED (CLOSED) position. Further flight should be done with N not exceeding 1.5.

106. Pilot's actions after Breakdown of Retractable Cone Control System

The failure of the cone automatic control system is indicated by:

- cone-rotation of the cone when the aircraft flies at speeds involving N < 1.3 or 1.5 (even on light metal due to insufficient and sound in the intake channel due not closed);
- cone-rotation of the cone when the aircraft speed involves N > 1.5 or 1.7 and lower.

In this instance:

- the pilot must not stop the aircraft at speeds involving N exceeding 1.5 if the cone fails to be extended. In case the flight must be continued, the cone should be extended manually;
- retract the cone manually if it fails to be retracted with N > 1.3 or 1.5;
- set the cone-operation selector to MANUAL (MANUAL);
- set the manual control switch to the position corresponding to N of the flight speed.

In case the cone failed to be retracted manually, disconnect the flight controls while flying, keep the r.p.m. within 630.

107. Failure of Jet Needle Shutter Control Follow-Up System

In case the jet needle shutter control follow-up system fails (airframe throttle does not change with the engine control lever shifted from MINIMUM ADJUSTMENT to FULL ADJUSTMENT, a rapid increase or decrease of engine thrust during flight under the ADJUSTED RATE), switch on the PULSE RESISTANT CONTROL switch allowing to effect a temperature control of the shutters (the maximum augmentation position being secured).

108. Rapid Decrease in Engine R.P.M. (Below 600) Due to Pressure Surge in Engine

In case of a spontaneous decrease (below 600) in the r.p.m. due to pressure surge in the engine, immediately shift the engine control levers to the STOP position. If the pressure surge persists, throw over the tumbler switch ANTI-SURGE SWITCHES on the left control panel to open the shutters, as soon as the engine starts, start it once according to "Aircraft EAV-145, Pilot's Instructions".

109. Pilot's actions during Surge of Air Intake

Surge of the air intake is assisted by light knocks appearing in the air intake channel and felt by the pilot in the cockpit.

If the air intake surge is observed at the aircraft speeds involving N > 1.5 and above, proceed as follows:

- cut off the afterburner with the aid of ADVANCED CONDITION (ADVANCE) control;
- gradually reduce the aircraft altitude and decrease the speed of flight.

If the resources take effect to eliminate the surge, manually open the anti-surge shutters by changing the shutter control from the AUTOOMATIC (AUTOMATIC) to the CLOSED (CLOSED) position. After eliminating the surge and bringing the aircraft speed involving N below 1.5, return the shutter control to the original position marked AUTOOMATIC (AUTOMATIC).

110. Pilot's actions while Pulling Out

The pilot must be trained in the ground to acquire automatic habits required by the ejection procedure.

The nose-up-protected ejection seat, as compared with the seat having a seat curtian to protect the pilot's face, has the following advantages:

- the seat fully protects the pilot against the air stream during pull out.

This allows to increase the safe speed up to 300 km/hr (indicated speed);

- considerably reduces time necessary for preparations prior to pull out (from the moment the decision to take off still the heat triggers are pressed).

The special attitude is prescribed for the pilot, the pre-jettisoning time being necessary only for trigger pressing. The seat is equipped with an automatic jettisoning device which operates during the next objectives:

- the seat ensures a very energetic separation of the pilot from the seat, which reduces the minimum safe jettisoning altitude to 110 m.

The seat of the EAV-145L aircraft may be ejected either together with the canopy or with preliminary jettisoning of the canopy.

111. Ejection with Canopy

Prior to ejection:
- reduce the aircraft speed (conditions permitting);
- grip the seat armrests and press the trigger on one of the armrests, or both triggers on both armrests.

The consecutive stages of ejection develop automatically, no actions on the part of the pilot are necessary. Minimum altitude for ejection in a level flight is 110 m. Ejection safe speed (V_e) is 110 km/hr.

112. Ejection with Pre-Jettisoning of Canopy

Prior to ejection:
- swing back and pull the red handle on the right side of the instrument panel to effect the jettisoning of the canopy;
- grip the seat armrests and press upon the triggers (on both armrests, or both of them).
110. Failure of Seat Ejection Gun at High Altitudes

In case both triggers are pressed but this does not affect ejection, do as follows:
- Release firing speed (conditions permitting);
- Pull the E-37 oxygen apparatus opening handle to open oxygen emergency supply;
- Disengage the parts of the ME common connector by opening the lever of the upper black or the handle attached to the oxygen supply hose;
- Pull at the hand's attached to the seat bowl between the leg to operate the mechanisms releasing the seat straps (the handle will separate from the seat and remain in the pilot's hand);
- Place the strap by unlocking and pulling the emergency handle (painted red) on the strapping);
- Leave the aircraft;
- To reaching a safe height, take off the transparent face-plate of the helmet.

111. Canopy Fail is Separate from Seat after Ejection

In case the canopy does not separate from the seat 1.5 sec. after the operation, pull at the emergency handle of the seat bowl (between the leg to affect the seat strap release and to separate the canopy)

112. Emergency Egress from Aircraft on Ground

When an emergency escape from the aircraft on the ground is necessary, proceed as follows:
- Open the canopy (if it has not been removed) by pulling back the canopy operator handle (up the parking). If the canopy still remains in its place (due to the absence of air in the system or to the jamming of locks), pull the emergency opening handle on the stalkbase.
- After opening the canopy emergency opening system, the pilot must descend as low as possible in the vehicle.
- Take off the face shield of the flying helmet (if it has not been removed);
- Disconnect the ME common connector;
- Instantaneously pull the harness emergency release handle on the seat bowl front.

113. Limit Flight Values of Indicated Air Speed

I. Without suspended loads:
(a) Indicated air speed (larger pointer readings) at altitudes above 0 to 13,500 m. not must be over 1200 km/hr;
(b) 8 number at altitudes above 13,500 m. not must exceed 2.0;
(c) maximum load factor equals 8 with a fuel reserve of 1100 ltr. or 7 when the aircraft fuel quantity exceeds 1100 ltr.
2. With the drop tank suspended (but without other suspended loads):
(a) Indicated speed (larger pointer readings) at altitudes from 0 to 13,500 m. must not exceed 1000 km/hr;
(b) 8 number at altitudes above 13,500 m. must not be over 1.6;

3. Maximum load factor must be equal to 6 (with the drop tank either full or empty).
4. With the APC-57 rocket pod suspended (without the drop tank):
(a) Indicated air speed (larger pointer readings) at altitudes from 0 to 13,500 m. must not exceed 1000 km/hr;
(b) 8 number at altitudes above 13,500 m. must not be above 1.6;
(c) maximum load factor to 6.
5. With APC-57 rocket pod and drop tank suspended:
(a) Indicated air speed (larger pointer readings) at altitudes from 0 to 13,500 m. must not exceed 1000 km/hr;
(b) Maximum value of 8 number at altitudes exceeding 13,500 m. must be not over 1.6;
(c) maximum load factor is 6 (with the drop tank either full or empty).
6. Flight with the APC-53 rocket pods suspended:
(a) Without the drop tank:
   - at altitudes from 0 to 5000 m. the indicated speed is 1100 km/hr;
   - at altitudes from 5000 to 12,500 m. the indicated speed is 1200 km/hr;
   - at altitudes of 12,500 m. and higher with 8 number = 2.0 maximum permissible load factor equals 7;
(b) With the drop tank suspended:
   - at altitudes from 0 to 12000 m. the indicated speed is 1000 km/hr;
   - at altitudes of 12000 m. and higher with 8 number = 1.6 maximum permissible load factor (with the tank full or empty) is 6.

CAUTION: Augmented ratings of the engine allow to gain speed exceeding the above given values.
- Lowest indicated air speed (without suspended loads) is 213 km/hr.
- Aircraft stall speed at all altitudes equals 250 km/hr (larger pointer readings).
- Maximum air speed at which the drag parachute may be deployed equals 280 km/hr (larger pointer readings).
10. The drop tank may be ejected at all altitudes and engine settings at speeds from 200 to 1000 km/hr (larger pointer readings) with 8 number not exceeding 1.5.
11. The air brake can be extended within the whole range of air speed and 8 number values.
12. The flight with the canopy jettisoned is possible under the following conditions:
(a) at speeds up to 500 km/hr (larger pointer readings) when the pilot has the hand on the rudder and tugs the stick;
(b) at speeds up to 700 km/hr (larger pointer readings) when the pilot is in the pressurized helmet.

Loading Weight Limits
13. Normal loading limits:
(a) Airplane weight without wing suspension load with the total fuel reserve not exceeding 1100 ltr;
(b) Airplane weight with rocket pods with the total fuel reserve not exceeding 500 ltr.
14. An overloaded aircraft may land:
(a) without the wing suspension loads with the total fuel reserve not exceeding 2500 lit. (in immediate landing after the take-off with the drop tanks suspended);
(b) with rocket pods suspended and total fuel reserve not exceeding 1600 lit. (in immediate landing after the take-off with the rocket pods, the drop tanks to be obligatory disengaged prior to landing);
(c) With landing with the drop tanks and wing loads suspended, never exceed the speed of 100 m/hr.

IV. TIME AND RANGE OF FLIGHT

To fly the aircraft over the maximum distance during the maximum period of time (in a level flight), maintain the indicated air speed within the limits given in the Tables 1 to 5.

The flight distance and time increase with an increase in the flight altitude. The maximum flight distance and time can be obtained at altitudes within 10,000 – 15,000 m.

Table 1

<table>
<thead>
<tr>
<th>Flight Characteristics</th>
<th>Air Speed</th>
<th>Low Pressure Air Speed</th>
<th>Fuel Consumption</th>
<th>1 hr.</th>
<th>Distance</th>
<th>Duration of Flight (hr.)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Without suspension loads</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Initial flight weight</td>
<td>925</td>
<td>925</td>
<td>0.64</td>
<td>1200</td>
<td>1200</td>
<td>1-15</td>
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<tr>
<td>Total fuel reserve</td>
<td>1500</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Maximum dist. 520</td>
<td>925</td>
<td>925</td>
<td>0.78</td>
<td>1200</td>
<td>1200</td>
<td>1-42</td>
</tr>
<tr>
<td>Time Flight</td>
<td></td>
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<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Maximum dist. 400</td>
<td>795</td>
<td>795</td>
<td>0.57</td>
<td>1180</td>
<td>1200</td>
<td>1-51</td>
</tr>
<tr>
<td>Time Flight</td>
<td></td>
<td></td>
<td></td>
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<td></td>
</tr>
<tr>
<td>Maximum dist. 520</td>
<td>925</td>
<td>925</td>
<td>0.57</td>
<td>1180</td>
<td>1180</td>
<td>1-47</td>
</tr>
<tr>
<td>Time Flight</td>
<td></td>
<td></td>
<td></td>
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<td></td>
<td></td>
</tr>
</tbody>
</table>

The following points are taken into account:
(a) Fuel consumed by the engine on the ground (starting, engine testing, hauling) during 7 min. constitutes 60 kg.
(b) Fuel consumption, take-off distance and time for the take-off and climb correspond to the values given in Tables below.
(c) Fuel consumed by the aircraft following the landing pattern above the airfield of landing during 6 min. is 40 kg.
(d) Un-powered fuel reserve equals 30 kg.
(e) Fuel reserve (relative to the total fuel reserve) in 110 kg at g = 0.773 kg/m², or 115 kg at g = 0.83 g/m².
### Table 2
Fuel Consumption, Time and Distances with KAM-21P-15 Take-off and Climbing at Maximum Rating with T-11P-500 Engine

<table>
<thead>
<tr>
<th>Flight Altitude, m.</th>
<th>Without Drop Tank</th>
<th>With two E-13 Rockets</th>
<th>True Speed, km/hr</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Fuel Consump. kg.</td>
<td>Time, hrs.</td>
<td>Distance, km.</td>
</tr>
<tr>
<td>1000</td>
<td>10</td>
<td>5</td>
<td>1000</td>
</tr>
<tr>
<td>3000</td>
<td>150</td>
<td>30</td>
<td>3000</td>
</tr>
<tr>
<td>5000</td>
<td>210</td>
<td>50</td>
<td>5000</td>
</tr>
<tr>
<td>7500</td>
<td>210</td>
<td>75</td>
<td>7500</td>
</tr>
<tr>
<td>10,000</td>
<td>270</td>
<td>110</td>
<td>10,000</td>
</tr>
</tbody>
</table>

### Table 3
Fuel Consumption, Time and Distances with BMP-70-15 Aircraft Gliding with Drop Tank Suspended or without Drop Tank

<table>
<thead>
<tr>
<th>Flight Altitude, m.</th>
<th>Fuel Consump. kg.</th>
<th>Time, hrs.</th>
<th>Distance, km.</th>
</tr>
</thead>
<tbody>
<tr>
<td>1000</td>
<td>10</td>
<td>0.5</td>
<td>3</td>
</tr>
<tr>
<td>1500</td>
<td>20</td>
<td>3.0</td>
<td>30</td>
</tr>
<tr>
<td>2000</td>
<td>30</td>
<td>5.0</td>
<td>60</td>
</tr>
<tr>
<td>2500</td>
<td>40</td>
<td>7.0</td>
<td>90</td>
</tr>
<tr>
<td>3000</td>
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<td>100</td>
</tr>
<tr>
<td>3500</td>
<td>60</td>
<td>10.0</td>
<td>160</td>
</tr>
<tr>
<td>4000</td>
<td>70</td>
<td>12.0</td>
<td>180</td>
</tr>
</tbody>
</table>

Notes:
1. Glide is performed at a low speed.
2. The engine control lever must be at the low speed stop.
3. Air brakes must be retracted.