**3. ANTI-AIRCRAFT ARTILLERY SYSTEMS**

***Learning objectives:***

*- explain the basics construct of small arms and light weapons;*

*- identify and describe combat functions for SHORAD organization;*

*- describe the main requirements for successful operations.*

1. **Organization and classification of fire guns**

***Classification of fire guns***

a) **According to the degree of automation of the firing** (automatic execution of certain operations during the loading of the cannon):

- fire guns with automatic firing - the cannon works until the action of the firing pin mechanism is discontinued or until the projectiles are consumed; the cannon will execute fire in series or continuous fire;

- fire guns with semi-automatic firing - the cannon works automatically during recharging, but the fire is carried out manually; the cannon will execute fire cartridge-by-cartridge (fire with fire);

- non-automatic fire guns - the loading of the cannon, the reloading of the cannon and the fire are carried out manually.

b) **Depending on the size of the caliber:**

- machine guns: cal. < 20 mm;

- close caliber fire guns: 20 mm ≤ cal. ≤ 60 mm;

- medium caliber fire guns: 60 mm < cal. ≤ 100 mm;

- long caliber fire guns: cal. > l00 mm.

e) **Depending on the use in the battlefield**:

- artillery;

- anti-aircraft artillery;

- naval artillery:

* Ship-to-ship artillery system;
* Ship-to-aircraft artillery system;
* Ground-to-ship artillery system.

During the operation, the firing hammer strikes the firing pin of the artillery projectile, which lights up the propellant charge that will develop the necessary energy to throw the cartridge on the trajectory, but also to prepare and ensure the functioning of the mechanisms that make the recharging of the fire guns happen.

During automatic firing it is necessary to execute the following operations:

1. Programming the fuze;

2. Loading the cannon:

- opening the barrel at the backside;

- extraction of the shell;

- introduction of a new projectile into the loading chamber;

- closing of the barrel at the back by the breechblock;

3. Firing;

4. Evacuation of the shell;

5. Evacuation of drawn lanes.

A new cartridge can only be loaded after the shell has been extracted and evacuated.

**The main parts of anti-aircraft artillery fire gun are:**

1. The automatic device (the machine);
2. The carriage;
3. Gun sights;
4. Synchronous Transmission;
5. The platform with the bogie;
6. Ammunition;
7. Spare parts and accessories.

**A) The automatic device**

The automatic device is intended to support all mechanisms, to ensure automatic operation of the cannon during the shooting, and to allow the barrel to move in height at the desired angle. The automatic device is everything that moves in height. It consists of the following parts:

* Barrel;
* The breech;
* The automatic loading device;
* Cradle (mitralier's box)
* Firing mechanism;
* Manual loading mechanism of the breechblock;
* Recoil mechanism;
* Fuse adjustment device;
* The acceleration mechanism.

**B) The carriage**

It is intended to support and ensure the movement in direction of the automatic device, synchronous transmission, gun sights and other mechanisms that provide automatic operation of the cannon.

**C) Gun sights**

It ensures that the projectile meets the target in light-of-sight, for both ground and naval targets.

These can be anti-air corrector devices, for MR4 and A.A. 30, 57 mm, FERANTI, for the AA 35 mm cal. OERLIKON cannon or periscope for GEAPARD A.A. system.

**D) The synchronous transmission**

It is intended to automatically move the cannon in elevation and in azimuth to the position corresponding to the firing elements determined by the fire-control system (SCF).

**E) The platform with the bogie**

Supports the carriage with all the devices and mechanisms arranged on it, ensures that the cannon is placed in a march or battle position and allows the cannon to move.

**F) Ammunition**

Allows the destruction of air targets, checks the functioning of the automatic device, prepares the handouts during material training.

**G) Spare parts and accessories**

Provides the spare tools and parts necessary to keep the tunnel in functioning condition during maintenance operations.

**2. Basic characteristics of fire guns of A.A. artillery**

a) Power;

b) Mobility;

c) Shooting accuracy;

d) The reliability of the operation of weapons and ammunition;

e) The safety of the operation of weapons and ammunition.

**a) Power**

It is influenced by:

- isolated shot effect:

* the kinetic energy of the projectile
* angle of impact (optimum 90 degrees and decreases to 50% for 60 degrees);
* caliber – increases according to the thickness of the armor;
* weight and shape of the projectile;
* bursting explosive – stronger explosive and in larger quantities;
* type of detonator – it works at the right time.

- firing rate:

* theoretical - represents the number of projectiles that can be fired in a minute without time of loading, aiming or correcting the firing;
* practical - The rate of fire increases if the parts are smaller, less and for smaller caliber shots, but decreases for large and heavy projectiles and large parts of the mechanisms.

**b) Mobility**

Represents the possibility of easily moving the anti-aircraft artillery.

It depends on:

- weight of fire gun;

- type of displacement;

- the speed of moving from a fighting position to a moving position and vice versa.

**c) Precision**

It is the most complex technical and tactical characteristic because:

* depends on different factors;
* influences the effect on the target;
* ensures a rational consumption of ammunition.

**d) Accuracy**

The factors that influence the accuracy of shooting are:

- The recoil force directly influences the angle of jump;

- The vibrations of the cannon barrel influence the scattering of the trajectories;

- Manufacturing conditions (degree of processing and finishing of the mechanisms);

- Cannon barrel attrition – width of the loading chamber leads to a decrease in the muzzle velocity of the projectile, so the scattering increases and the accuracy decreases;

- Gun sights must be made and installed correctly;

- Position of the center of gravity - involves checking the recoil mechanism;

- Ammunition - homogeneity of the throwing charge, the difference in humidity and temperature, deviations from the normal weight of projectiles and powder charges influence the accuracy of firing.

- Atmospheric conditions and acknowledge their influence in the calculation of firing elements (air density and temperature, wind direction and speed, atmospheric pressure).

- The calculation of the firing elements is influenced by the quality of the check ups before firing and by the precision of determining the elements of the current target position (the quality of the servants' training);

- The execution of the fire should be done at the maximum effective distance, and the shooting by direct aiming should be corrected.

**d) Reliability of weapons and ammunition operation**

Represents the ability of a system to correctly perform the functions for which it was created, for a predetermined period of time, while maintaining the values of the main parameters and within normal limits.

The factors that influence the reliability of fire guns are:

- work at large temperature variations;

- subjecting the AA. artillery systems to large and prolonged efforts;

- different attrition of parts and mechanisms,

- different reliability of mechanical, electrical, electronic, hydraulic and pneumatic elements;

- shooting incidents;

- the existence of duplicated mechanisms (the firing mechanism);

- correct operation of artillery systems.

**e) Safety of using the anti-aircraft artillery system and ammunition**

The factors that influence safety are:

- simplicity of weapons and ammunition construction;

- type of fire guns: automatic, semi-automatic and non-automatic;

- compliance with the rules of operation and maintenance;

- convenience of using fire guns.

It is done by:

- doubling the mechanisms;

- the existence of safety mechanisms and devices;

- rational arrangement of mechanisms, ammunition, spare parts, servants;

- the existence of inscriptions, indicators, work orders;

- the existence of locking devices, protective covers etc.

**3. Requirements for VSHORAD artillery systems**

Anti-aircraft artillery (A.A.A.) units are organized into battalions/ battery with 6 cannons and radar short airspace research (SRR). Each battalion consists of 3 batteries (platoons), fire units (FU) with 2 cannons.

* General requirements for this kind of units consist of:

- the systems should be integrated in a large air defence architecture;

- the fire entity must act autonomously;

- the system components must be auto-propelled;

- technical measures for the crew protection must be applied.

* The main requirements for radar short airspace research are:

- the discovery distance of targets (more than 30 km for a target with 0,1 m2 cross radar section);

- circular and sector horizontally searching;

- the number of targets that can be simultaneously tracked must be more than 40;

- the number of targets witch can provide the necessary parameters for calculating the drag elements must be more than 10;

- protection for anti-radar missile;

- summary information display about aviation situation;

- compatible IFF system with the ally system and civil codes system.

* The main requirements for the cannon are:

- small caliber (20-40 mm);

- several barrels (2-4);

- combat probability more than 0,9 to 10 strokes;

- high rate of fire (more than 500 projectiles/min. for each barrel);

- use all kinds of projectiles and proximity warheads.