**4. NATO Anti-Aircraft Artillery System.**

**35 mm GEPARD**

***4.1. Introduction***

The Gepard (cheetah) Self-Ppropelled Anti-Aircraft Gun (SPAAG) was developed in the 1960s as a private venture. First prototypes were built in 1968. It entered service with the Bundeswehr in 1973 as the Flakpanzer-1 Gepard. A total of 420 of these vehicles were built for the German Army. Its role is to protect combat units, troops and key installations against air attacks. The Gepard is currently in service with Germany, Brazil, Chile, Jordan, Romania and the Netherlands.

Vehicle is fitted with twin Oerlikon GDF 35 mm guns. These guns are belt-fed. Maximum rate of fire for a single gun is 550 rounds per minute. Ammunition load of the Gepard consists of 640 armor-piercing-incendiary rounds for firing against air targets and 40 armor-piercing rounds against ground targets.

General search radar is located at the rear of the turret roof and tracking radar is located between the guns. Vehicle is fitted with friend-or-foe identification system. Radar of the Gepard has a range of 15 km. It provides all-round scanning with simultaneous target tracking. Vehicle has search on the move capability. This SPAAG is also fitted with fire control system.

Hull of the Gepard provides protection against small caliber cannons, while turret protection is only against small arms fire and artillery shell splinters. It is also fitted with NBC protection system.

The Gepard has a crew of three, including commander, gunner and driver.

Vehicle is based on the chassis of the Leopard 1 main battle tank. It is powered by the MTU MB Ca M500 diesel engine, developing 830 horsepower. The Gepard is fitted with auxiliary power unit, which powers all systems when the main engine is turned off. Engine and transmission of the Gepard can be replaced in 20 minutes in field conditions.

***4.2. Purpose***

B2L Gepard air defence system, armed with 2 35mm cannons is designed to destroy aerial and terrestrial targets. The GEPARD air defence system can carry out combat missions in any weather conditions, all day and night. For the surveillance of the airspace, the GEPARD system has a general search radar.

The tracking radar and the optical orientation system can discover the aerial and ground targets. It is equipped with a distance calculation system, which works due to a laser, with an action range of 5 km (Figure 1).



**Fig. 1** The Gepard self-propelled anti-aircraft gun

***4.3. GEPARD architecture***

**GAPI 01** Search Radar (SR) and the terrestrial recognition devices (IFF)

**GAPI 02**  Tracking Radar (TR)

**GAPI 03** Main distribution installation

**GAPI04** Main surveillance installation

**GAPI 05** Target coordinates measuring device

**GAPI 06** Central leading installation

**GAPI 07** Fire control computer

**GAPI 08**The sighting installation for the tracking radar (FR)

**GAPI 09** Optical sighting installation

**GAPI 10** Armament sighting installation

**GAPI 11** Armament system and the ammunition

**GAPI 12** Electrical energy installation

**GAPI 13** Hydraulic energy installation

**GAPI 14** Gear and turret venting installation

**GAPI 15** Lighting installation

**GAPI 16** The equipement of the turret and the combat chamber

**GAPI 17** Parts, tools and accessorises

*Specifications:*

Length: with the turret positioned at 12 o’clock, without the back bags \_\_\_ 7,86 m

with the turret positioned at 12 o’clock, with the back bags \_\_\_\_\_ 8,15 m

Width: between the end ties \_\_\_\_ 3,28 m

between the tracks defenders \_\_\_ 3,40 m

Hight: with periscope \_\_\_ 3,03 m

with beacon \_\_\_\_ 3,16 m

with search radar system \_\_\_ 4,16 m

with guns up to 85o\_\_\_6,44m

Weight: combat weight of the GEPARD system \_\_\_ 47 380 kg (MLC 52)

combat ready turret \_\_\_ 14 850 kg

bare turret \_\_\_ 13 550 kg

ammunition \_\_\_ 1 500 kg

Turret crew \_\_\_ 2 people

Main armament: 20 rounds anti-tank ammunition in the attached magazine

and 320 rounds anti-air ammunition in the main magazine

*GAPI 01 Search radar with the terrestrial recognition devices:* The purpose of the MPDR 12/4 radar and the MSR 400/4 terrestrial recognition devices is to oversee the airspace, to identify the discovered targets and to show them on the screen.

They are positioned at the retractable back portion of the turret; all the installations are bound to the venting installation.

*GAPI 02 Tracking radar with target coordinates measuring laser device:* The purpose of the tracking radar is to take over the targets discovered by the search radar or, with the help of the optical periscope, to follow the targets and to determinate the flying coordinates.

The distance up to the target can be measured with the laser installation. By turning on the distance switch, the value of the distance measured by the search radar, the tracking radar or the telemeter laser, is submitted to the firing mechanism. It is positioned in the combat chamber, in the turret and outside of it.

*GAPI 03 Main distribution installation:* It has the purpose to make the link between the electrical waves and supply voltage for every mechanism. It is positioned in the combat chamber and in the turret.

*GAPI 04 Main surveillance installation:* Its purpose is to control the supply and control voltage of the firing mechanism and of the armament and to show the flaws. It is positioned in the combat chamber, in the turret.

*GAPI 05 Target coordinates measuring device:* It sends to the computer of the firing mechanism system data about the location of the anti-air system. Moreover, it measures the muzzle velocity. They are placed in the combat chamber, on the chassis and on the armament.

*GAPI 06 Central leading installation:* It renders all the waves resulted from utilizing and functioning of the firing mechanism system and the armament, to check, interconnect and send them forward to be engineered. It is positioned in the framework of the left side pocket.

*GAPI 07 Fire control computer:* It is made of the main computer, the damage computer and the course data transformer. The main computer is an analogical one and, based on entry data (elevation, azimuth, distance) and on saved ballistic data, it continuously identifies the angles of correction for the armament. The shooting data and the compensation measurements, to reduce the tracking dynamic errors, are continuously being sent to the azimuth and elevation sighting mechanisms.

The damage computer system is independent of the main computer, which performs a simplified calculation of the corrections. It is positioned in the combat chamber, in the turret, behind the commander and the gunner.

*GAPI 08 The sighting installation for the tracking radar:* It ensures the tracking and the engagement of the targets, using the tracking radar antenna, sets the elevation angles and the azimuth and it sends them to the firing computer. It is positioned in the frontal part of the turret (the sighting device) and in the combat chamber, in the turret.

*GAPI 09 Optical sighting installation:* It ensures the optical capture of the target through the periscopes or thorough the telescope and tha tracking of the targets with the help of the periscopes. At the same time, it establishes the azimuth and the elevation angle and it sends them to the firing computer. Contrary to that,an orientation of the periscopes on the target is made with the help of the tracking radar (which engages targets), and so the surveillance and the engagement of the targets is obtained. It is position in the combat chamber, in the turret.

*GAPI 10 Azimuth sighting mechanism and the guns elevation angle:* Its purpose is to align the barrels with the future position of the target. The mechanisms which elevate the barrels in corespondance with the future position of the target and the turret, elevatet in the azimuth that corespondes to the future position of the target, are positioned in the combat chamber, in the turret, in the cahassis and outside the turret.

*GAPI 11 Armament system:* The two twin 35mm cannon’s function based on the borrowed gas principle. They have a rigid breechblock and are positioned outside the turret and can be rotated while elevated. The guns work from a normal functioning distance (electro-hydraulic). If failure appears, the functioning while damaged is possible (mechanical-hydraulic). The guns can execute shootings with different ammunition which they take from the main magazine (anti-air) or from the fixed magazine (terrestrial). The distribution of the ammunition from the magazine to each gun is supported, on each side, by a booster.

*GAPI 12 Electrical energy installation:* The necessary electrical energy for the functioning of the fire control system and of the armament is provided by the electricity installation. The electricity installation is on the chassis.

*GAPI 13 Hydraulic energy installation:* Hydraulic energy installation produces the necessary hydraulic energy for the functioning of the fire control system and of the armament, and to transmit the energy, through tubing and hoses, to the consumers.

It is positioned in the combat chamber, in the turret.

*GAPI 14 Turret venting installation:* The combat chamber ventilation mechanism ensures its fresh air, ventilates the magazine during the shooting and it provides the air circulation between the turret and the chassis. The heat from the running engines and devices is compensated by the ventilation mechanism. The wiring ensures the electrical bonding of all the parts from the venting installation.

It is positioned in the turret.

*GAPI 15 Lighting installation:* It includes complete distribution box, lamp for the “cos” turret (above the CCD), 3 lamps for lighting the combat chamber (white and red), beacon. It is positioned in the combat chamber, in the turret.

*GAPI 16 The equipement of the turret and the combat chamber:* It includes: complete shutter of the turret; diving mechanism; absorption items; pressure; measurement installation, graded from 0 to 4 millibars; chair support bar; crossing flooring without the magnetic valve; complete support flooring; complete chairs; knee protection cushions; crank supports; control panels framing; stand for the devices behind the chairs; stand for the optical target screen; stand for ARG 40 – 15 and for the digital – analogical transformer; stands for the antenna filters, radio stations and the board telephone; wiring for the radio station and for the board telephone; complete antenna assembly, left and right; smoke grenade thrower parts

- stand for the fire extinguisher; seatbelt; framework for ATR and the navigation system; ATR stand and receiver; accessories patch in the turret (outside and inside). They are positioned in the combat chamber, in the turret and on the exterior turret.

*GAPI 07 Parts, tools and accessorises:* for utilizing and repearing the component parts.

***4.4. Technical an tactical data***

|  |  |
| --- | --- |
| 4.4.1 Weights |  |
| Combat weights of the tank | 47330 kg (MLC 52) |
| Weight of the turret | 14800 kg |
| Weight of the empty turret | 13300 kg |
| Total ammunition weight | 1500 |
| The weight of a gun without ammunition | 890 kg |
| Weight of the barrel with optical sight | 175 kg |

4.4.2. Performance and functioning data

4.4.2.1. General data

* crew
  + turret ; 2 people (commander and gunner)
  + 1 driver
* fire unit (for one gun)
  + 320 AA ammunition
  + 20 anti-tank
* bounding time without functional inspection at 20o C:
  + EVA installation = ZM start and functioning in 5 minutes
  + switch to normal speed in 1 minute
  + fire control mechanism, bounding of the tracking radar in 5 minutes
  + getting them in functional state in 13 minutes
* allowed laterl tilt:
  + maximum rolling +/-550 thousandths (31 degrees)
  + maximum pitch +/-300 thousandths (17 degrees)
* working temperature range -30o......+46o C (dry air)
* maximum humidity 95% (-30o.......+46oC)
* crossing fords 75......225 centimeters

4.4.2.2.The search radar (SR) with the terrestrial search system

* discovery possibility:
  + in distance from 75m up to 15750m
  + in hight - maximum of 3000m
* speed of antenna – 60 rotations/minute
* frecuency changes possibility – 6
* functioning principle – doppler pulse
* frecuency range ,,S”
* frecuency domain 2,3....2,49 GHz
* pulse tracking frecuency 7,14 KHz

ATR

* functioning distances – in correlation the SR antenna (between 700 and 15000 m)
* functioning emision frecuency – 1030 mHz +-3 MHz
* receiving domain 1090 MHz +- 3MHz

4.4.2.3. The tracking radar

* doppler pulse (monoimpulse)
* minimum measure distance approx. 300m
* maximum measuring distance approx. 15000m
* frecuency range from 15,5 to 17,5GHz
* frecuency band (Ku)
* functioning frecuency – 2 interchangeable frecuencies
* pulse tracking frecuency, 3 automatic cuopled frecuency from 7137 to 8817Hz
* width of lobe45 thousandths (2.5 degrees)
* engagement angular range 135 thousandths (7.5 degrees)
* distance gap:
  + during engagement 9000m
  + during tracking 450m
  + wave evaluation video gate approx. 30m

4.4.2.4. Shooting data measurment device

* lateral incline measurment device
  + rolling approx +-625 thousandths (+-35.15 degrees)
  + pitch +-625 thousandths (+-35.15 degrees)
  + static precision +-36 thousandths (2.2 degrees)
  + stabilization time at 0 degrees – 2 seconds
* transmitter for the velocity of the tank: velocity transmission axiz 0.5m/s (1.8Km/h)
* initial velocity measurment device Vo: 1090......1225m/s

4.4.2.5. SCF computer

* distance range
  + main computer 300-15000m
  + damage computer 300-5500m
* target velocity 0-475m/s
* projectile detonation distance 0.4-11s
* correction of the elevation angle -85,5....+85,5 degrees
* coreection of the directional angle -85,5.....+85,5 degrees

4.4.2.6. Tracking radar system

* directional angle range +/-1700 thousandths (+/- 95,62 degrees)
* directional spinangle range n x 360 degrees
* elevation angle range -11,25.....85,25 degrees
* elevation spin angle range -11,25....85,25 degrees
* elevation search angle movement
  + beginning of search 15.02 degrees ( from this angle in starts to rotate downoard)
  + low limit 5 degrees
  + up limit 35,04 degrees
* directional spin velocity
  + engagement 140,62 degrees/sec
  + tracking 67,25 degrees/sec
* elevation spin angle velocity
  + engagement 67,5 degrees/sec
  + tracking 67,5 degrees/sec

4.4.2.7 Optical sighting system

Function of the sighting (periscopes)

* directional (considering the tanks lever level and the turrets longitudinal axis)
* measurement range n x 360 degrees
* spin range n x 360 degrees
* maximum spin velocity 140,62 degrees/second
* elevation (considering the tanks lever plan)
  + measurement range – 10.12....+85.5 degrees
  + spin range – 10.12...+85.5 degrees
  + spin velocity 67.5 degrees/second
* ZO sniper indication range
  + directional (the tanks lever plan considering the longitudinal axis) from – 39.27 degrees up to +39.7 degrees)
  + elvation from -6.75 degrees to +47.81 degrees
* monocular periscope -2 increse steps: 1,5 (50 degrees visual field) and 6 (12,48 degrees visual field) times
* posibility to adjust the dioptres from +4....-6

4.4.2.8. Sighting system of the armament

* directional n x 360 degrees
* elevation -5,06 degrees up to =85 degrees
* spin velocity of the turret 90 degrees/second
* spin elevation velocity 56,25 degrees/second

4.4.2.9.The armament system

* barrel length 3707.5 mm
* caliber 35mm
* firing rate 550 (+100 – 70) rounds/min (from -10 degrees to +30 degrees)
* Vo 1180m/s +-15m/sec (at 21oC gunpowder)
* right side riflings
* riflings number 24
* rebound 55 cm (after the first shot)
* exit striker (0,8-1,3mm)

4.4.2.10. EVA system

* second network DC generator
  + initial power 9 Kw
  + initial speed 6000+/-40 laps/min
  + initial voltage 27,6 V+- 0,2
* AC generators (network 3 and 4)
  + 2 initial power generators 20 KVA
  + initial voltage 3 x 200/115 V
  + frecuency 380 +6...-4HZ
  + speed 7600 laps/min
* rectifier (network 5)
  + initial voltage 115 V 380 Hz
  + exit voltage 115 V +-6V
  + exit power 0,6 KVA
  + frecuency 400Hz +...-0.4 Hz

4.4.2.11. Hydraulic energy system

* reservoir capacity 30 liters (C 635)
* damaged reservoir capacity 0,5 liters
* functioning pressure 147,09 bar
* flow 5,11/min
* drive engine voltage 24 V DC

4.4.2.12. Venting system of the turret

* combat chamber ventillation through air showers
* flow 14,4 m3/hour

4.4.2.13. Lighting system

* 3 24V lamps (GS 5 Watt)
* one 24V lamp (GS 18 V)

4.4.2.14. Combat chamber and turret endowment

* functioning diving pneumatic pressure 1,96 bar
* combat chamber suprapressure measurement system 0....40milibar

4.4.2.15. Parts, tools and accessorieses – for utilizing and repearing the component parts.