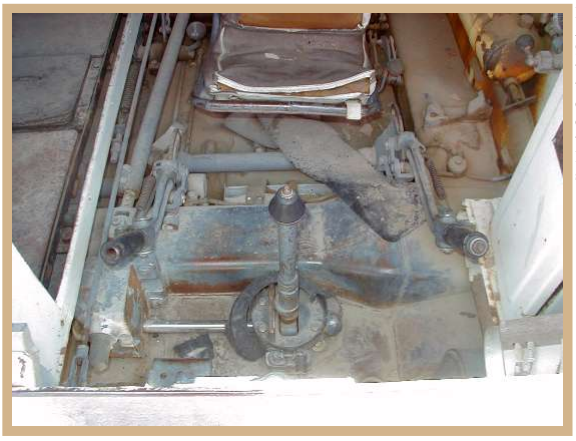
Soviet ZSU-23-4, "Shilka", Part 1

Picture 1:
The Soviet ZSU-23-4 Shilka (awl) was the anti-aircraft replacement for their earlier ZSU-57-2 vehicle, and was a complete redesign of the former AFV. Developed during the early 1960's, the ZSU-23-4 was the Soviet's first radar-directed, vehicle-mounted, AAA gun system, and was provided to the troops in 1964, making its first public appearance in 1965. The Shilka was built on a newly designed GM-575 chassis using PT-76 suspension components, with the driver seated to the left in the bow and three additional crewmembers up in the turret-- a commander, a gunner, and a range-finder.

Most of the color photographs in these pages were taken by David S. Speaks at the Threat Training Facility (TTF) maintained by the 547th Intelligence Squadron of the United States Air Force located at Nellis Air Force Base in Nevada. The TTF encourages military study of their collection, allowing visitors access to the collection vehicles and their interiors for examination. Due to the excellent quality of David Speaks' digital images of this particular ZSU-23-4M, we have produced them in large format and extended the series out to three pages. This first section will explore the history and general layout of the vehicle as well as components in the driver's compartment. Parts 2 and 3 will examine the turret components and crew assignments/duties.

Picture 2:
We will start our exploration of the ZSU-23-4 where we usually begin, in the driver's compartment that in this vehicle is located at the front-left of the vehicle. The front hatch is very large and provides the driver with a good view of the ground immediately in front of the vehicle. There are additional vision ports to either side of the driver's forward cab extension allowing limited views to the right and left. Inside the driver's area is a centrally located seat that is adjustable forward and back on support rails and also reclines-- the control levers for seat adjustments are located on either side of the seat bottom. The seat was originally outfitted with the thick black seat cushions that are typical in Soviet equipment, but the two junked cushions you see here with white edging are not original. There were two cushions originally, a contoured seat bottom and a seat back. Only the seat back cushion is still visible here, but it is ripped and torn.

The vehicle is steered with traditional steering levers, both of which have been pushed to their farthest forward position so the handles can't be seen in this picture. The gearshift lever is sticking up at the front of the seat but is missing its knob. The gearshift is located between the knees of the driver when he is in his seat. To his right (our left) would normally be a large panel cover over the opening you see; these shelves are normally filled with the vehicle batteries. To the driver's left are his primary instrument panel, the compressor and air tanks/controls for cold starting the main engine, and a white box (close to us) on the hull wall that is the stowage location for a night viewer periscope.



Picture 3:
A closer view of the floor in front of the driver's seat shows the gearshift base and the control rod that leads off to our left to a small 90-degree gearbox. From there, a shift control rod leads back along the floor under the turret to the transmission at the rear of the tank. The shifter is a simple double H pattern, as we will see shortly. The raised cowling on the floor on the other side of the shifter, that extends from side to side, is a torsion bar cover, and on the other side of the cover are the floor attachment brackets and connecting control rods for the two steering levers. All the control rods lead eventually to the rear of the Shilka and to the engine compartment or steering clutches and brakes. Unfortunately, we can't see the driver's foot pedals from this position except for the top of the accelerator at the lower-left corner of the picture. To our left is the battery shelf once again, and to our right are the locations for compressed air cylinders (one that would normally be mounted on the floor is missing) and the white night periscope storage box again.

Picture 4:
A closer view of the battery compartment shows the rubber pads on the shelves and a couple of the battery connecting cables, but the batteries are missing. At the upper left side of the picture are a green electrical connection box and the right vision port that I mentioned previously. At the top of the vision port mounting is a rubber forehead bump pad and on this side you can see one of the wingnuts that allows opening of the case and replacement of the glass block should it become damaged. A couple of replacement laminated glass blocks are stored in the white box with spring latches that you see above the battery box access panel opening.

Picture 5:
This is the outside view of the driver's right vision port. There was a cover provided for this port, although it is not mounted in place here, but you can see the wingnuts and bolts at each side that are used to secure it in

place. Just above the vision port frame is the washer sprayer, but the wiper blade is missing, although the mount is visible above the washer tubing. A combination rain/sunshade and blast protector is welded to the hull above the viewing port to protect it from weather and blast effects from the guns. The turret has been rotated forward and portions of the gun barrels and cooling pipes are visible at the top of the picture.

The ZSU-23-4 is powered by a V-6R 6-cylinder, in-line diesel powerplant mounted transversely under the rear deck. The transmission is a manual five-speed forward, one reverse unit connected directly to the engine. The mechanical steering is a simple clutch and brake design that requires a strong driver and the suspension is, as I mentioned previously, torsion bar, providing very reasonable ride control and comfort.

Picture 6:
The inside view of the vision port shows the forehead pad above and the electrical junction box below. Like most Soviet/Russian AFVs, these ports are electrically heated to reduce ice and fogging effects. Up above the port is a control valve for a windshield washer system. The valve that controls which sprayer will receive windshield washer fluid is located directly above the port and the tubes you see extend to each of the vision ports and to the windshield in the large front hatch. Just above the vision port is the windshield wiper motor, the wiper drive penetrating the armor at the upper-right edge of the port window. On the ceiling is a fresh air vent with an electric motor actuator that automatically closes the port when contaminants are discovered in the outside air, part of the automatic NBC system. The stowage box close to us at the right holds spare laminated vision blocks or other items. Above the front hatch (to the upper left) you can see part of the periscope mount used when the front hatch windshield covers are in place and there is no other way to see outside the Shilka. This is also the same periscope mount used for the night periscope.

Picture 7:
A view of the inside of the open driver's hatch illustrates a number of the components. The opening handle/brace is to our right and next to that is the folded handle that opens and closes the armored cover over the windshield. The windshield wiper and its motor are mounted at the bottom of the glass (at the top for us because the hatch is pivoted open) and the wiring to the motor has been disconnected, hanging near the motor. The defogger/defroster wiring is seen running around the perimeter of the windshield, attached to the wire at the top of the window (the bottom in this view). The long locking handle is at the very top of the picture. Notice the rubber seal around the large hatch. As with the turret, the driver's compartment is supposed to be close to airtight when closed up and under NBC attack. A filter cleans incoming air to the vehicle and a blower provides positive air pressure inside that keeps contaminated air out.

Picture 8:
The instrument panel is very large and takes most of the space on the left side of the driver's compartment. The large gage that is missing in the lower right corner of the panel is the clock. In the back corner of the compartment is a bracket for a fire extinguisher and a gas mask, and to the far right is the second side vision port, with the same detail we saw of the previous port. The long opening lever for the driver's large forward hatch is visible, as well as the mechanism for locking it open.

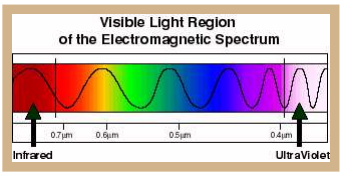
Below the instrument panel is a compressed air cylinder and compressor for cold starting the ZSU-23-4's diesel engine. There should be a second cylinder under this one, mounted to the floor, but it is missing in this vehicle. Underneath the pressure gage, next to the tank, you can see the actuating valve. An air line comes forward from the valve and loops up to run back under the instrument panel. Once again we can see the driver's storage bin for his TVN-2 infrared night vision periscope. The vehicle's FG-125 infrared headlights provide the IR light, and the commander also has a similar IR night vision periscope (a TKN-1T night periscopic with an effective viewing range of 220-275yds (200-250m)), and an IR spotlight that can be mounted on his rotating cupola.

Most Soviet vehicles have color-coded tubing and components that indicate the purpose of the equipment. Blue tubing is used for fresh air piping and ducting and you will see it in use around compressors and intake manifolds, for instance. Yellow colored tubing is used for fuel systems and piping, red for fire extinguisher systems, brown denotes oil lines and oil tanks, green for cooling systems, and black is reserved for compressed air cylinders like the one that is missing. Instrument panels, gages, and radio equipment boxes are generally painted silver for high visibility in a darkened interior. The floors of most Soviet-made AFVs are painted gray, along with all the equipment mounted on the floor or close to it (like the seat frame seen in Picture 3) while the walls and ceilings are predominately white. Most metal surfaces are primed in a brown primer coat before the finishing coat is added, so when paint wears off painted surfaces it appears brown until the primer wears off also.

Picture 9:
This shot shows the area around the TVN-2 passive IR night sight stowage box. Notice the shift pattern decal on the lid, just in case the driver needs a reminder. The pattern decal shows neutral is in the center of the pattern, 5th and 4th gear are at the left, 3rd and 2nd are in the middle on either side of neutral, and Reverse and 1st gears are at the right. What appears to be small crew heater (?) is mounted in front of the box, aimed down at the driver's feet, and the compressed air gage, valve and airline are at our far left. The left steering lever and handle are to the left of the jeans-clad leg, and the hole in the instrument panel where the clock is missing is at the upper-left corner of the picture.

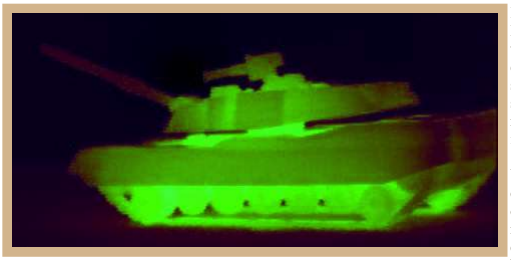
The TVN-2 is a common Russian IR night sight. Generally speaking, active IR devices operate on the principle of "illuminating" the target with infrared light rays that are invisible to humans and then converting the reflection off objects into a visible image. However, since the enemy has devices that can detect emissions from active devices, IR illuminating lights and active vision devices are typically used sparingly in combat. On the

other hand, if the IR receiver or sensor is very sensitive, it can record IR heat signatures without the use of an artificial IR light, and the resulting picture shows the effects of uneven environmental and man-made heat. And since passive IR sensors, or receivers, do not emit IR, they can not be detected by the enemy. The Soviet NSP-2 IR system and the IR night-driving device TVN-2 can both be used either actively or passively. And when used in complete darkness, these devices make it possible for the crew to identify local features, maintain observation of activities, conduct aimed fire, and drive without typical headlights. So what is IR and how do IR night vision devices work?



Picture 10:
In the early 1800s a German scientist by the name of Sir Frederick William Herschel (1738-1822) conducted some simple and elegant experiments with the light spectrum and heat. He used Sir Isaac Newton's well-know glass prism that you and I have played with as a child to separate the different components of white light into color bands (electromagnetic spectrum) and then measured the temperature of each of these visible light bands. As he measured the temperatures of the violet, blue, green, yellow, orange, and red light bands, he noticed that all of the colors had temperatures higher than the surroundings and that the temperature of the colors increased from the violet to the red end of the spectrum. This was an interesting discovery in its own right, but Sir William then went a step further. After noticing this pattern, he decided to measure the temperature just beyond the visible red portion of the spectrum in a region apparently devoid of any sunlight. And to his surprise, he found that this region had the highest temperature of all.

What Sir William had discovered was a form of light (or radiation) beyond visible red light. Later named infrared rays, or infrared radiation (the prefix infra- means "below"), Herschel's experiment was important not only because it led to the discovery of infrared electromagnetic radiation, but also because it was the first time that someone showed there were forms of light that we cannot see with our eyes. Today, infrared technology has a number of important applications. Infrared astronomy has helped answer a number of questions about the Universe and its formation and medical infrared imaging has become a useful diagnostic tool. Infrared cameras are available that detect heat loss in buildings and in testing electronic systems. Infrared satellites monitor the Earth's weather and are used to study vegetation patterns, geology, and ocean temperatures. In short, if you have access to an IR sensor, you can see heat and light in the part of the light spectrum that we normally can not see with our human eyes.



Picture 11:
Early military applications of IR night vision devices used additional IR light sources to illuminate objects directly because the optical sensors were not sensitive enough to pick up natural IR emissions. But as sensor quality improved, the later IR night vision models became sensitive enough to register heat emitted by sun heated sources, armored vehicles like this one, and even warm-blooded humans. This IR technology is sometimes called "infrared thermography"; the amplified image is then projected onto a phosphor screen, similar to a television or monitor screen. One critical problem with using any IR device for night vision is the fact that they are not effective in heavy rain or fog because water molecules absorb IR energy. This has led most of the richer nations' military away from IR technology and into the world of image intensification, an entirely different process.

Why are the images produced by most IR night vision devices typically shades of green (like this one)? Generally speaking, television and computer monitors use only three primary light colors to make visible images. A single pixel consists of a group of one red dot or phosphor, one green phosphor, and one blue phosphor, and these dots are used to generate the different colors you see on a television or monitor. But most night vision devices only use green phosphors for image production, so we see only shades of green in the night vision periscopes. You could just as easily use red or blue phosphors, but green is easier on the eyes and yet still easily visible in low light conditions. Also, the human eye can differentiate more shades of green than the other two phosphor colors.

The driver's TVN-2 night periscope in the Shilka provides a magnification of 1x with a field of view in both the horizontal and vertical planes of 30 degrees. Visibility in active mode depends on the IR source, either artificial or natural, but generally is good to around 30 meters. The MT-LB driver is also provided with this same TVN-2 night viewer, and other Soviet/Russian vehicles were provided with similar devices.

Picture 12:
Our last photo from inside the driver's compartment shows the pedals and surrounding components. The clutch, brake and accelerator pedals are in their traditional positions, and the gearshift knob rises from the floor. Off to the right is the right steering lever, next to the open battery shelf. Up forward is a storage bin for radio equipment and to the right is the red control panel for the engine fire extinguishing system back in the engine compartment. To the right of the small control panel is an auxiliary electrical outlet plug with protective screw cover. This outlet can be used for jumpstarting the vehicle, or for simply plugging in a night viewer.

Let's climb out again and take a look at the turret and its many components.

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