

# Gunnery & Armor Penetration (WoT)

## Aiming

All about pointing your gun at the enemy and hitting them. Make sure to read the section about [Accuracy](#) and [Dispersion](#) as well.

### Automatic Aiming

Automatic Aiming, or auto-aim, aims slightly under the center of the tank: often the most armoured part. It does not lead your target at all. It is only useful for aiming at weaker armoured tanks very far from you or when you are both at close range and you need to focus on dodging incoming shots rather than carefully aiming at the enemy. In these occasions, auto-aim can save you some worry. By default, auto-aim is engaged by right-clicking on a target, and disengaged by pressing E or by right-clicking.

Note that auto-aim will keep aiming at the target as long as it remains visible to you, even if it is behind a rock, a house, or a friendly tank. That does not mean you should actually shoot at it in these situations - sounds like a stating the obvious, but it happens all the time, in particular with newer players.

### Manual Aiming

In most cases it is better to aim your gun manually rather than rely on auto-aim, but there are a few factors to consider. Every shell in the game has its own trajectory and flight speed, and you often need to consider them while manually aiming, but since the game does not tell you these parameters, they are best learned from experience.

### Arcade View

Arcade View is the default view mode that you load into battle with. It is a third person view mode that places the camera above and behind your turret. Your aim follows your view-point. This can be confusing to players in particular next to buildings, because the elevated view point causes the gun to point up the obstacle.

This can be mitigated by locking your gun in place. By default this is done by holding down the right mouse button. This enables free mouse look without losing your aim. Note that by default the right mouse button also enables Automatic Aiming, therefore it is recommended to assign a different mouse button or key to Automatic Aiming.

### Sniper View

Sniper View gives you a first person view basically through the gun. By default it is accessed by pressing the left Shift key or by zooming in on the target using the mouse wheel. Because of the different view point, this view mode does not cause any aiming problems in proximity to buildings or other elevations.

The other advantage of this view mode is the magnification of the target area, allowed for more precise aiming. Beware of "tunnel vision", however, and keep a close eye on your minimap so you do not get surprised by tanks sneaking up on you from behind while you are busy sniping.

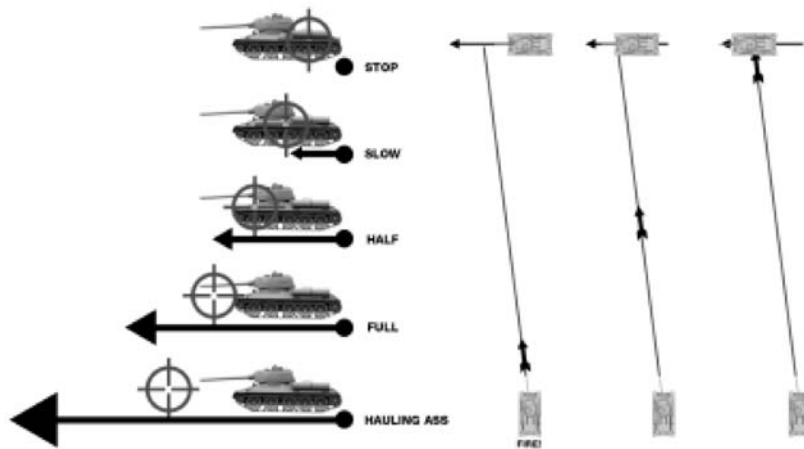
### Penetration Indicator

The penetration indicator is an option to the gun marker in your aiming reticle - enabled by default - which uses an easy colour code to help you evaluate whether you will be able to penetrate the target's armour in the location you are aiming at and with the shell you have loaded. A red indicator tells you that you will be

unable to penetrate the targeted tank in that location, a yellow indicator means that the target's armour thickness lies within the  $\pm 25\%$  range of your penetration rating, while a green indicator means that your shell's penetration rating will exceed the target's armour thickness in all cases.

While the penetration indicator is an invaluable tool in discovering a target's weak spots, always be aware of its limitations. It is a simple comparison of your penetration rating versus the target's armour thickness along the normal at the aim point and does not take into account the [impact angle](#), so even with a green penetration indicator your shot may still [ricochet](#) or fail to penetrate the target's effective armour thickness. Also, because of [dispersion](#) affecting every shot you take, you may not actually hit the weak spot you were aiming for.

## Leading the Target



### Leading the Target

If your target is moving perpendicular to you, you always have to adjust your aim manually. This is also called leading the target. Factoring in your shell's flight speed, you have to aim where you estimate the target your shell's trajectory intersects with the target's movement. For example, if your shell flies 1000 m/s on a flat trajectory (e.g. AP shells fired from the 8,8 cm KwK 43 L/71 "long 88" of the [Pz.Kpfw. VI Tiger](#)), and your target is 500m away, your shell takes little more than half a second to reach it. If your target is a [T-50-2](#) moving perpendicular to you at 72 km/h, i.e. 20m/s, theoretically you need to aim 10m in front of it to hit it.

However, since this is an online game and not reality, you also have to account for network latency, i.e. your *ping*. If you were playing with 500ms ping (an extremely high ping), then you would have to lead the target by an additional 0.5 seconds of movement. In the example that means you would have to double your lead and aim 20m in front of the target (see also [Latency Correction](#) below).

While all that is easy enough with a high velocity gun, it becomes much harder with a low velocity gun like the 105 mm AT Howitzer M3 of the aforementioned [T82](#). It fires HE shells which fly at a velocity of 311 m/s on a very high trajectory, i.e. they can take several seconds to reach a far away target. The amount you need to lead your target by with such a gun increases accordingly. Naturally, the more you need to lead the more will your aim be off if your target changes its course even slightly. That is something to keep in mind when trying to avoid incoming shots: never be predictable.

## Ballistic Trajectory

The reticle takes the ballistic trajectory into account, so it will automatically aim a little higher while you hover over a visible target (red outline). However, as soon as you move your aim away from the target, this automatic correction goes away. This is important to consider when leading a moving target as described

above, because then you will have to correct your aim for the trajectory yourself. An easy way to know by how much to correct is to first hover the reticle over the target, note how high it aims, and then aim to the same elevation while you lead. While doing that the reticle may adjust to terrain or objects your aim passes over, so you might need to compensate for that as well if the situation arises.

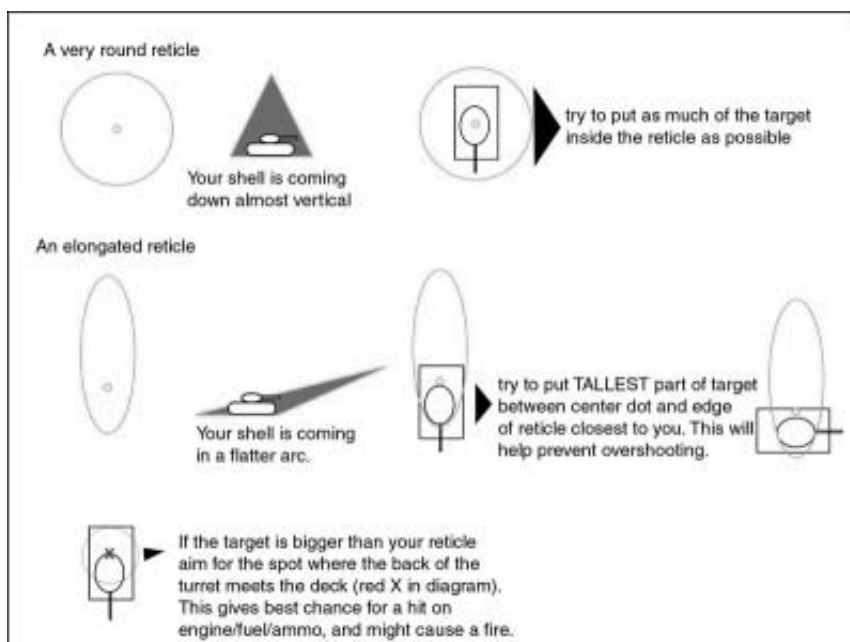
### Aiming and Line of Sight

Despite shells following a ballistic trajectory, aiming is strictly line of sight. That can lead to situations where you cannot place your reticle on a target, because it is hidden by a terrain feature, although the ballistic trajectory of your gun would actually allow you to hit the target. This is particularly pronounced with howitzer guns with high arcing trajectories, for example that on the T82. Due to the automatic correction of your aim it can be quite tricky to shoot the target in such situations, but there are a few considerations that can help you with:

- Sniper View has the lowest view point (gun mount), so do not use it if your target is behind an elevation and you have trouble placing your reticle on it.
- Arcade View has a higher view point for aiming purposes (Commander's cupola), so you may be able to aim at the target in this mode.
- Auto-aim does not actually rely on line of sight, so in situations where manual aiming fails, you can try to right click the target in arcade mode and see your reticle drop a little bit further, possibly just enough.
- If all of these fail, and if the target is far enough away, you can try to simply aim above the elevation, and hope for the best. It takes a lot of experience to get these fully manual howitzer shots right, however.

Regardless of elevation there can also be situations where you do have line of sight on the target and can place a shot, but you cannot see the target's red outline. This usually happens if another object is closer to you than the target and your reticle prioritizes the other target instead of the tank you clearly see and want to aim at. You can take the shot regardless, but aiming can be tricky if your reticle also tries to adjust the aim for the closer object. Be particularly careful if the closer object is a friendly tank - many have accidentally been shot in the back by their team mates in such situations.

### Strategic View (SPG)



## Strategic Aiming Basics

If your vehicle is a self-propelled gun, then Sniper View is not available to you, instead you have an SPG-specific aiming mode called Strategic View available. It is accessed in the same way as Sniper View. It gives you a top down view onto a section of the battlefield. You can use your mouse or the cursor keys to move the view around. You can also place the Strategic View directly onto a certain battlefield area by holding Ctrl and right clicking the desired location on the minimap.

Unlike in the other view modes, in strategic mode the aiming circle does adjust to terrain elevation and ballistic trajectory. Thus it will usually not be a perfect circle but an oval shape. This helps you judge both the angle of the terrain your target is positioned on and your shell trajectory to the target. The little dot within the aiming circle/oval represents the height adjusted center of your aim.

It takes a little getting used to perfect aiming with self-propelled guns, see the illustration to the right for the basics to get you started.

## Client vs Server

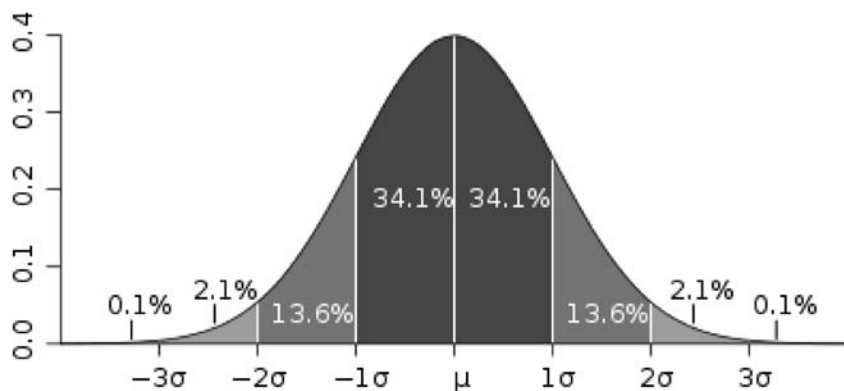
Shots that fall outside of your aim or go into a completely different direction are usually caused by network or server lag. This can happen because every movement of your aim on your client has to be transmitted to the server first and executed there as well. So regardless of your latency the server aim will always lag slightly behind your aiming on the client. If you press CapsLock + 0 during a battle, your client will show an additional blue reticle which shows the last information the client has received about where the server is currently placing your aim, as well as the size of the aiming circle on the server. Since this is subject to latency as well, it is not entirely accurate either, but if you are having latency related problems it can be a good idea to use the server reticle and wait until server and client reticles match before you fire a shot. The server reticle is not displayed while Automatic Aiming is engaged.

## Where to aim

When shooting at an enemy tank, it is always useful to aim for areas with less armour. All tanks have the strongest armour in the front, with the rear being the weakest. In addition, a tank's armour is not uniform. Use the Penetration Indicator to discover weakly armoured spot, so called weak-spots (typically hatches, machine gun mounts, etc.).

Often it can also be helpful to inflict critical damage, e.g. by destroying the tank's tracks and thus immobilizing it, by shooting it's fuel tank to set it on fire, etc. Follow the links for more details.

## Accuracy and Dispersion



### Standard Deviation Diagram

Every shot you take is dispersed randomly around the center of your aiming reticle, i.e. you will not necessarily hit exactly where you aimed. The actual dispersion amount is based on a Gaussian (normal) distribution curve and depends on your gun and the turret it is mounted to.

## Gun Accuracy

The accuracy value for a gun is given in meters at a range of 100m. The lower the value the more accurate your gun is. The value describes 2 standard deviations  $\sigma$  from the center of your aim. In other words, for a gun with 0.32m effective accuracy at 100m, 95.45% of all shots will land within 0.32m of the center of your aim at that distance. Dispersion amount increases linearly with distance, i.e. 0.32m effective accuracy at 100m translates to 0.64m at 200m and 1.28m at 400m

## Aiming Circle

The aiming circle, also called dispersion circle, dispersion indicator or reticle, describes the area of 2 standard deviations  $\sigma$  from the aim point. Based on a purely normal distribution that would mean that 4.2% of your shots would fall outside of the aiming circle. They are moved to the edge of the circle, so they don't fall outside. However, there is a minor amount of 0.2% of shots that lands outside the circle.

## Accuracy Penalties

The accuracy discussed above applies is the best case scenario. During actual game play several factors can come into play that result in a penalty to your accuracy:

- **Dead Gunner:** If your Gunner gets knocked out the Gunner's skill will be set to 0% for the purposes of calculating the accuracy stat. The effect is mitigated if the Commander has the *Jack of All Trades* skill. The effect is removed if the Gunner receives first aid via a consumable. See the Crew page for more information.
- **Gun Damage:** A damaged ("yellow") gun typically fires with halved accuracy for as long as it remains damaged.
- **Shooting:** With each shot you take your accuracy temporarily gets reduced dramatically depending on the vehicle type, but your Gunner will immediately start aiming again.
- **Turret Rotation:** Rotating the turret results in a temporary accuracy penalty. The exact amount depends on the installed gun and the speed you rotate the turret at.
- **Vehicle Movement:** Moving your vehicle forwards or backwards temporarily reduces accuracy. The exact amount depends on the installed suspension and the speed you are moving at.
- **Vehicle Rotation:** Rotating your vehicle left or right temporarily reduces accuracy. The exact amount

depends on the installed suspension and the speed you are rotating at.

With game version 0.7.2 several crew skills and perks have become available to reduce most of these penalties.

## Aiming Time

The aiming time listed for each gun (in a specific turret) describes the time it takes for the aiming circle to shrink to a third of its size. However, most of the penalties described above increase the aiming circle by a factor bigger than three, which is why fully aiming the gun typically takes longer than the listed amount of time.

## Client vs Server

When you fire a shot, your shell trajectory is first calculated based on the data the client has. It is later updated with the data confirmed by the server. If the difference was big, then you may see shell tracers leave your barrel at an angle or change flight path mid-trajectory.

It is unclear whether only the aiming point or also the dispersion of the trajectory around this center point is corrected based on server data. At least in v0.7.1, if you watch a replay, you can notice that each time you play it, your trajectory will be slightly different. This indicates that either dispersion is not synchronized between client and server, or that it is during a battle but that data is missing in the replay files. In any case, currently replays cannot be used to find out where your shot went exactly.

## Penetration Mechanics

Aiming properly and hitting the enemy tank are only the means to an end, and that is actually damaging and eventually disabling it. And that is not automatic. Once you have hit an enemy vehicle, the game then calculates where the shot hit the enemy, at what angle you struck the armour, the effective thickness of the armour (based on the impact angle), and thus ultimately whether your shell penetrates the armour.

## Impact Angle

The angle at which an Armour Piercing (AP), Armour Piercing Composite Rigid (APCR), High Explosive Anti Tank (HEAT) or High Explosive (HE) shell hits the target's armour is crucial for penetrating it. The ideal impact angle is along the normal, i.e. perpendicular to the armour plate. The actual impact angle is calculated as the deviation from the normal. For this, the ballistic flight path of the shell is taken into account, which can be particularly important for artillery guns and their high arcing trajectories if you fire AP or HEAT shells with them.

If the shell hits an external module (e.g. tracks, observation device, turret rotator), impact angle is not taken into account. The exception to this rule is the gun.

## Shell Normalization

The impact angle of AP and APCR shells onto a vehicle's armour is normalized, i.e. adjusted towards the armour's normal axis at the point of impact.

In case of spaced armour, shells are normalized at the point of impact on the spaced armour, and if they penetrate, continue along their normalized flight path into the vehicle. Once it impacts the hull armour, normalization occurs again and the remaining penetration potential (i.e. the original penetration potential minus the effective armour thickness of the spaced armour) is used to calculate whether the shell

penetrates the hull proper.

As of update 8.6, APCR shells are normalized at 2°. The normalization amount is a constant value depending on the shell; there is no randomization.

The impact angle of HEAT and HE shells is not normalized at all. Angle is used for armor line-of-sight thickness calculations, as normal.

### **Ricochet**

If the normalized impact angle of an AP or APCR shell on the target's armour exceeds 70° (80° for HEAT), a ricochet (a specific variant of a bounce) occurs regardless of its penetration value and the shell is deflected off the target without causing any damage. You may ricochet off of spaced armour as well, and even if you penetrate that your shell may still ricochet off the underlying hull armour.

As mentioned above, impact angle is not taken into account when hitting external modules except the gun, so a ricochet off those is impossible.

A ricochet off terrain features, buildings or wrecks is impossible.

### **Overmatch**

If the AP or APCR shell's **caliber** is 2 times or more than the nominal thickness of the armour (Such as a 120mm shell hitting a 60mm thick plate), projectile shell normalization is increased by the following formula: basic normalization \* 1.4 \* shell caliber / nominal armour thickness. Note that the shell is still capable of bouncing if it strikes the armor at an angle of 70° or more from normal.

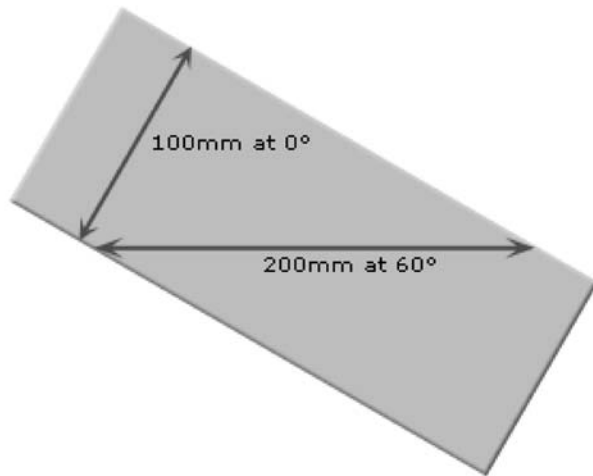
If the AP or APCR shell **caliber** is 3 times or more than the nominal thickness of the armour (such as a 120mm shell hitting a 40mm thick plate), no ricochet will happen even if the impact angle is more than 70° from normal. The increased shell normalization described above will also occur.

In cases involving HE shells or external module hits, overmatch does not occur.

### **Effective Armour Thickness**

Your tank is armoured with plates of varying thicknesses. The game only provides you with the nominal armour strength of the three main armour plates of your tank's hull and turret, respectively. However, the tanks are actually modeled in much greater detail. The penetration indicator can help you discover the actual nominal armour thickness of your target.

However, the nominal thickness of an armour plate is just the minimal amount of armour a shell impacting it must penetrate. As soon as the impact angle deviates from the normal, i.e. is not perfectly perpendicular to the armour plate's surface, the effective armour thickness that the shell needs to penetrate will be higher than the nominal armour thickness:



The effective armour thickness is calculated by dividing the nominal armour thickness with the cosine of the nominal impact angle. For example, in the diagram above we have a nominal armour thickness of 100mm and an impact angle of 30°, thus we have an effective armour thickness of  $100\text{mm}/\cos(30^\circ) = 115.47\text{mm}$  that the shell needs to be able to penetrate. In other words, at an impact angle of 30° the armour is effectively over 115.47% stronger than its nominal value.

The following table provides the coefficients for a number of normalized impact angles:

Impact Angle	Effective Armour Thickness
0°	100%
10°	101.54%
20°	106.42%
30°	115.47%
40°	130.54%
50°	155.57%
60°	200%
70°	292.38%
> 70°	Ricochet

As you can see, the effective armour thickness increases exponentially with the impact angle. For shells impacting you at 60° your armour is effectively twice as thick and at 70° nearly three times as thick. As explained above, for angles higher than 70° all AP and APCR shells will ricochet regardless of armour thickness.

As of 8.6, HEAT shells will start to ricochet if the impact angle equals or is greater than 80 degrees. The armor penetration after ricochet will remain the same.

The same applies to your targets, of course, so always take that into account when deciding if and where to shoot them. Reducing the impact angle to your target only slightly will exponentially reduce its effective armour thickness and a target that was previously impossible for you to penetrate may suddenly become easy prey. This is also the reason why you should always attack from two different angles at once. A target can only maximize their effective armour in one direction, as soon as they try to accommodate two possible



impact angles they suffer an exponential loss in effective armour thickness towards both of them (thus if you are the one getting flanked while in a strongly armoured tank it is best to maximize your effective armour towards one opponent while shooting the other one).

## Penetration Randomization

Penetration values displayed for a gun/shell combination are average values. The actual penetration value is randomized by up to +/- 25% around the average value. Randomization occurs on impact with the target, separately for each new shell you fire.

## Penetration Loss over Distance

Since shell speed decreases the longer a shell flies, the game models linear penetration loss over distance depending on the gun and shell type used:

- Armour Piercing (AP) shells experience low penetration loss over distance.
- Armour Piercing Composite Rigid (APCR) shells generally experience high penetration loss over distance (the exception are the APCR shells used by tier 10 mediums)
- High-Explosive (HE) and High-Explosive Anti-Tank shells (HEAT) shells experience no penetration loss at all.

The penetration values displayed in game indicate average penetration values at 0-100m distance (no penetration loss occurs within this range). Penetration values at higher distances are not displayed. As a rule of thumb, the higher the tier of the gun used, the lower the penetration loss over distance. For example, a Leichttraktor loses up to 17.5% penetration firing AP shells and 51.4% firing APCR shells with its default gun, whereas a Maus only loses about 2% with AP and 15.4% with APCR.

This Spreadsheet provides Maximum/minimum values for penetration and shell velocity; per gun per ammo type.

## Double Penetration

A shell can continue its flight path after the initial impact, either on the outside of the tank in case of ricochet or inside of the tank following penetration of spaced armour, hull armour or external modules. A shell will continue flying for ten times its caliber (a 100mm shell will continue for 1 meter). The remaining penetration potential is the initial penetration value, randomized at the point of impact +/- 25%, minus whatever effective armour thickness that was penetrated. This remaining penetration potential is then used to calculate whether any other armour plates that are hit can be penetrated. Internal modules or crew members have no armour and thus will always get hit if any penetration potential is left in the shell.

Note that the penetration model is simplified and after initially impacting a vehicle a shell is "bound" to this vehicle and cannot hit any other tank anymore. That means that a shell can neither ricochet off a tank to hit another tank within its deflected flight path, nor can a shell pass through a tank to hit another tank behind it. A shell's flight path also ends after impacting the ground or buildings.

## Damage Mechanics

If your shell penetrates the enemy tank's armour, its journey is not over, the enemy tank does not automatically take damage. It all depends on the path of your shell after penetrating the armour and what parts of the enemy tank it hits on that path. A shell can indeed pass clean through a tank without causing any damage.

## Shell Damage

Each shell has a specific damage potential. The game mechanics differentiate between armour damage and module and crew damage, but only the potential armour damage of a shell is actually displayed in game. The potential for module and crew damage exists in addition to the armour damage potential and is not shown in game.

The potential for module and crew damage is balanced individually for each shell - generally speaking low tier guns can cause more critical damage than armour damage, whereas the inverse is true for high tier guns. The reason is that low tier tanks have considerably more module hitpoints - another hidden property of your tank - than they have armour hitpoints. At high tiers the opposite is true.

## Damage Randomization

Just like shell penetration, all shell damage is randomized by up to +/- 25%, regardless of shell type. The gun properties display the average value. The shell properties display the damage range. Note, however, that the shell values are rounded to the nearest integer, whereas the damage amounts shown in game are truncated. This is a display issue, and both are incorrect: The server uses the exact values.

## Armour Damage

Each vehicle has hitpoints, displayed in the garage. Each vehicle enters the battle with 100% hitpoints because you must repair any damage taken by your vehicle in a previous battle before you are allowed to join the fight in it again. Each time the vehicle takes armour damage, its hitpoints get reduced. Once a vehicle's hitpoints reach zero, the vehicle is destroyed. During a battle, the remaining hitpoints of a vehicle are represented by the progress bars displayed over the targets you aim at.

Spaced armour is a special type of armour that exists to deflect a shell's flight path and to protect against the explosion blast from high-explosive (HE) shells. Spaced armour is special in that it is separate from the hull armour. Damage applied to spaced armour does not reduce the hitpoints of the vehicle itself.

## AP, APCR and HEAT Shells

AP, APCR and HEAT shells cause damage only if they manage to penetrate the target's hull armour. Once the hull armour is penetrated the target will take the full listed damage, +/- 25%. Other factors play no role to the damage calculation. For example, it makes no difference whether you barely penetrated or easily penetrated the target.

## HE Shells

# FIELD MANUAL

## Damaging vehicles with High-explosive rounds e.g. Matilda II tank COLLISION MODEL

Armour Groups is a set of polygons corresponding to a vehicle damage model.  
Inside of all these groups there is a single armour parameter.  
In terms of the game model, each "armour group" is a single object.  
Armour groups are shown in bright colours on the illustration.  
Trace rays are auxiliary vectors allowing to detect obstacles on a path of a blast wave propagation.

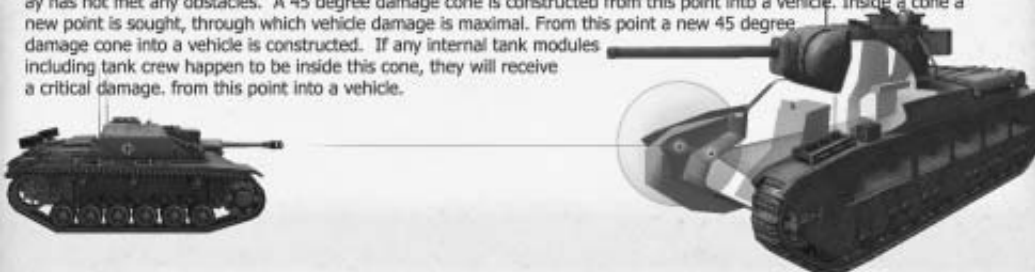
### The following occurs after an HE round contact with vehicle armour groups:

1. Armour penetration is calculated according to the algorithm common to all round types.
2. If the armour is penetrated, a damage sector around a penetration zone is constructed inside a vehicle. Critical damage is calculated of any internal tank modules including tank crew happen to be within a damage sector.
3. If the armour is not penetrated, near the point of contact a point is sought through which vehicle damage is maximal, and a trace ray through this point has not met any obstacles. A 45 degree damage cone is constructed from this point into a vehicle.



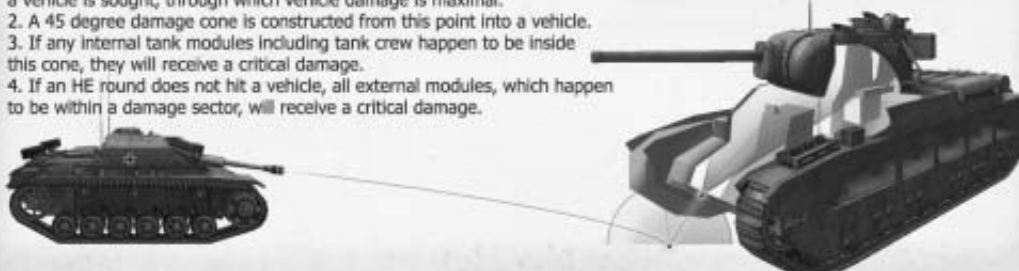
### The following happens when an HE round hits spaced armour:

1. Spaced armour penetration is calculated. If spaced armour is penetrated, a damage sector around a penetration zone is constructed with a centre at a point of penetration. Inside a damage sector a point is sought through which vehicle damage is maximal.
2. If spaced armour is not penetrated, near the point of contact the weakest point is sought, through which a trace ray has not met any obstacles. A 45 degree damage cone is constructed from this point into a vehicle. Inside a cone a new point is sought, through which vehicle damage is maximal. From this point a new 45 degree damage cone into a vehicle is constructed. If any internal tank modules including tank crew happen to be inside this cone, they will receive a critical damage, from this point into a vehicle.



### The following occurs when an HE round hits the ground or a building near a vehicle:

1. A damage sector is constructed at a point of an HE round explosion. Inside this sector a point of intersection with a vehicle is sought, through which vehicle damage is maximal.
2. A 45 degree damage cone is constructed from this point into a vehicle.
3. If any internal tank modules including tank crew happen to be inside this cone, they will receive a critical damage.
4. If an HE round does not hit a vehicle, all external modules, which happen to be within a damage sector, will receive a critical damage.



## High-Explosive shell damage model

The situation is more complex for HE shells because both penetrating and non-penetrating hits and even misses can cause damage.

If this type of shell penetrates the hull armour, the situation is identical to the one just described for the other types of shells, damage is done to the full listed potential, +/- 25%. Since the shell, as high-explosive ammunition, explodes inside of the vehicle after it passes through the armour, any internal modules or crew caught within the explosion radius risk taking damage/getting knocked out (see [Module and Crew Damage](#) below).

However, HE shells typically have low penetration values, so unless you aim carefully at a weakly

armoured area of your target, you will not penetrate and the shell explodes on the outside of the target vehicle at the point of impact. This also applies if a HE shell penetrates spaced armour, which causes it to explode before hitting the hull armour. Finally, even if you miss the target, the shell will implode on impact and may still cause damage to the target if that lies within the explosion radius, which depends on the shell used. In all these cases where hull armour is not penetrated by the shell itself, the amount of damage is lower and calculated according to the following formula:

$$\text{actualDamage} = 0.5 * \text{nominalDamage} * (1 - \text{ImpactDistance} / \text{SplashRadius}) - 1.1 * \text{nominalArmorThickness} * \text{SpallCoefficient}$$

SpallCoefficient may be 1.2, 1.25, 1.3, or 1.5 if a spall liner is installed and you calculate armour damage, otherwise 1 (i.e. a spall liner does not protect external modules). actualDamage results of zero or below mean you cause no damage.

ImpactDistance is the distance between the point of impact of the shell and the point of impact between the explosion's blast and the target along a straight, unobstructed line. Since the blast will cover an area of the target's surface, the game selects the spot that leads to maximum damage according to the above formula, i.e. it will be a trade-off between the spot with the lowest nominalArmorThickness and the closest spot that can be hit. Ideally your blast wave reaches an unarmoured area of your target, e.g. the open top and rear on certain tank destroyers or self-propelled guns.

Once the exact point of impact has been determined this way, the actual damage amount is determined as well as is the actual damage potential that the shell can now cause to the target. Whether this actual damage potential causes any damage to the vehicle follows the normal rules, but with the following limitation regarding internal modules and crew:

- If the shell exploded on the vehicle itself, then the propagation of the blast wave into the tank is simulated by calculating a cone-shaped area 45° wide originating from the point of impact of the shell along the normalized impact vector. Damage to internal modules and crew is possible within this area.
- If the shell exploded elsewhere and only the external blast wave impacted the vehicle, then no propagation of the blast into the vehicle itself takes place. Because of this no damage to internal modules and crew can occur.

If spaced armour is impacted by the blast wave first, the calculation above is conducted a second time for the underlying hull armour. Since this second calculation is based on the remaining reduced damage potential, its result is typically zero, i.e. no damage.

## Module and Crew Damage

As mentioned above, you can not only damage a vehicle's armour, but also its modules and crew. Armour damage and module/crew damage are distinct. That means hitting a module only affects that module, not the hitpoints of the tank, just like hitting the armour does not affect a module. However, the same shell can damage both hull armour and module(s) or crew since it travels through the tank after penetrating the hull armour.

## Damage States

Just like the vehicle's hull, also each of its modules and crew have hitpoints. During a battle, you only see a simplified display of the amount of hitpoints remaining on your modules and crew represented by one of three colour states in the damage panel at the bottom left of your screen. These states are:

- Default (i.e. no colour shading): Enough hitpoints for module and crew to be fully operational.
- Yellow: This state signifies that a module has taken considerable damage but is still operational. Tracks remain fully operational in this state, whereas every other module works at 50% efficiency. Crew members have no yellow state.

- Red: This state signifies that a module is in-operational/a crew member is knocked out. Crew members remain in this state unless a consumable is used to restore them to full health, whereas modules will automatically be repaired over time by your crew up to the "Yellow" state of being operational.

All module and crew state changes are accompanied by a voice message.

## Saving Throw

When a module or crew member is hit, they do not necessarily take damage from the hit. Instead, most modules have a specific chance not to take damage. This is also referred to as a *saving throw*. The base chances of damaging a specific module or crew member when hitting it are as follows:

- Suspension: 100%
- Engine: 45%
- Fuel Tank: 45%
- Observation Device: 45%
- Radio: 45%
- Turret Ring: 45%
- Gun: 33%
- Ammunition Rack: 27%

All crew members have the same chance to get knocked out when hit, however starting with game version 0.7.4 this chance depends on the damage type:

- Crew hit by AP/APCR/HEAT shell: 33%
- Crew hit by (internal) explosion: 10%

Each of these base chances to damage a module or knock out a crew member can be increased by 3 if the Deadeye perk is active for your Gunner at the time of a shot with an AP, APCR or HEAT shell.

No other factors influence these chances. The amount of ammunition you are carrying does not affect the chance of your ammunition rack taking damage.

## Complete Crew Death

Note that as soon as all crew members are knocked out, the tank becomes inoperable. Consumables to restore a crew member's health cannot be applied anymore at this point, i.e. there is no way to restore the tank to operating condition. It counts as destroyed, even though its hull stays on the battlefield with all its remaining hitpoints.

## Ammunition Rack Explosion

If the ammunition rack's hitpoints reach zero, it explodes, destroying the tank and its crew completely regardless of the remaining hitpoints on either of them. The only case the tank does not explode with a "red" ammo rack, is when the rack is empty. You can increase your ammo rack's hitpoints by installing "Wet" Ammo Rack equipment or by training the Safe Stowage perk on a crew member with the role of loader.

## Fire Damage

There are two ways the enemy can set your tank on fire.

- If your fuel tank's hitpoints reach zero, your tank automatically catches fire.
- Each time your engine gets hit, there is a chance that your tank catches fire. This chance depends on the engine and is displayed on the engine module's properties in game or here on the wiki. Note that the transmission counts as part of the engine.

While your tank is on fire, it constantly takes both hull as well as module and crew damage. The exact

damage rate depends on the tank but is not displayed in game. The duration of the fire also depends on the tank, on your crew's effective [Firefighting](#) skill level, and whether your Driver has the [Preventative Maintenance](#) perk active and whether you use [Automatic Fire Extinguishers](#) consumable. You can also extinguish a fire manually by using [Manual Fire Extinguishers](#) consumable.

## Ramming Damage

You can also damage a target by ramming it. The collision creates an explosion at the point of impact similar to that of a [high-explosive shell](#). The strength of the explosion, i.e. the damage potential, depends on the kinetic energy applied in the collision ( $0.5 * \text{combined weight} * \text{relative speed}^2$ ), or in other words the combined weight of you and your target as well as your relative speed. That means that the heavier both you and your target are and the faster you collide, the stronger the explosion caused by the collision will be.

However, that damage potential is distributed according to the weight of each of the two colliding vehicles relative to their combined weight ( $1 - \text{individual weight} / \text{combined weight}$ ). For example, if you weigh 75 tons and you ram a target weighing 25 tons, only 25% of the explosion will affect you.

Actual damage calculation then follows the same rules as for high-explosive shell explosions, thus ramming lightly armoured targets/areas of the target will cause more damage than strongly armoured parts. Damage taken can be reduced by having a [Spall Liner](#) equipped. You can further reduce damage taken and at the same time increase the damage inflicted to the target by having your vehicle's Driver trained in the [Controlled Impact](#) skill.

If you are about to be rammed, you can reduce the damage you will take by moving away from the approaching enemy, thus reducing your relative speed, and pointing your strongest armour at them. If your Driver has the Controlled Impact skill, you need to be moving to activate it, anyway.

## Zero Damage Hits

Hits that cause no damage, also called zero damage hits, are notorious among the player base, and various conspiracy theories abound in their respect. However, in most cases they are simply the result of the above described game mechanics in conjunction with poor and sometimes incorrect visual and audible feedback given to the player about what happened with their shell. Bounces and ricochets, hits to spaced armour or to external modules are difficult to distinguish for the player, yet they all have a chance of not resulting in any visible armour damage to the enemy tank (they might still cause module or crew damage, but that is not always immediately visible to the attacking player and thus dismissed).

Everybody experiences zero damage hits, just like everybody experiences misses. However, a thorough understanding of the game mechanics described above will help you minimize them. There is randomization in the game, but you will always hit what you aim for, namely the area covered by your dispersion circle, so aim wisely to maximize the chances of your shots to damage your target.

## Ghost Shells

Players also like to claim ghost shells, i.e. shells that either disappear straight out of the barrel or pass straight through a target as if it wasn't there.

The first type is typically due to the player missing the visual tracer effect - watching the battle's replay from a different angle will reveal it to you.

The second type can in rare cases be caused by heavy lag in the client/server connection that causes a synchronization loss - what you are seeing on the client is not actually what is happening on the server, and what's happening on the server is what counts. It may also be caused by a mistake in the collision model of the opponent's vehicle. The collision model is a simplified version of the visual model of the target vehicle, but separated into various hitboxes. If two hitboxes are not perfectly aligned, they may create a void between them that a shell can pass through if it flies through at just the right angle. Finally, for some vehicles there are parts of the visual vehicle model that are intentionally not reflected in the collision model and a shell can pass straight through them. This is often the case for elements fastened to a tank's external hull, e.g. boxes or fuel tanks. In many cases these are just decoration.

## Repair

If you take module damage during battle, your crew will instantly start repairing it by restoring a specific amount of hitpoints to the module every second. The actual amount that gets repaired every second depends on the specific module itself (not just its type) and the effective repair skill of your crew.

Your crew will only repair a damaged module just enough to make it operational again, i.e. it will remain in "yellow" or damaged state. The exact amount of hitpoints this state represents depends on the specific module as well.

To get a module fully operational again and restore all of its hitpoints to it during battle you must use a consumable. The Small Repair Kit is bought for credits and allows you to repair one module during the battle (starting from patch 0.7.4 both tracks can be repaired at once if they are both damaged). The Large Repair Kit costs either gold, or, starting from patch 0.8.5, credits, and fully repairs all modules that are damaged at the time you use it. It will also provide a bonus of 10% to the crew's repair speed unless consumed.