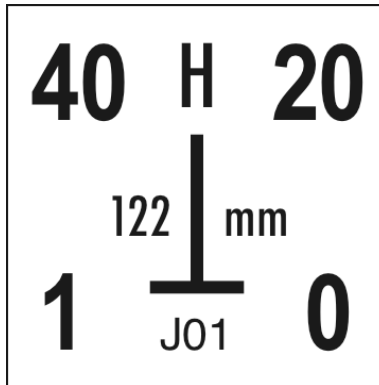## Artillery Factors in the Dunnigan System

By Alan R. Arvold

Way back when Panzer-Blitz was first being developed, Dunnigan and crew created a rather complex system of determining the counter values for H Class weapons. Later, when Reed and crew were developing Panzer Leader, they continued to use the same system, even expanding on it to deal with new weapons. Because of the complexity of the system, I will present the different counter values in sections, first dealing with indirect fire capable weapons, then moving on to direct fire only weapons in each section. Also, within each section I discuss both the towed and self-propelled varieties, which would include assault guns and support tanks. Mortars and rocket artillery will be covered in separate articles.

Attack Factors

Indirect Fire:

When Dunnigan determined the attack factors of indirect fire capable artillery units, he based them on the amount of high explosives that a six gun battery (the composition of a regular artillery counter) could deliver in a hex in one turn. The various factors that went into these calculations included the amount of high explosive in the HE round of a given gun or howitzer, the sustained rate of fire of the gun or howitzer in question, the lethal bursting radius of a shell from a given gun or howitzer, plus one or two more factors of which I am unaware. Each howitzer or gun came up with a different set of numbers, so they were lumped together in certain classes of artillery.

Light Artillery: 75mm to 76.2mm or below.
Medium Artillery: 105mm*
Heavy Artillery: 150mm, 152mm, and 155mm.
Super-Heavy Artillery: 170mm, 203mm, and above.
*the Russian 122mm was included in this group.

In each of these classes the resulting numbers were added together, then were divided by the number of different guns and howitzers in each group, to get an average number for the class. The resulting averages were divided by some numerical factor (which I do not know), to get the attack factors for each class of artillery (which

were rounded to the nearest 10). The resulting attack factors were as follows:

Light Artillery:	20
Medium Artillery:	40
Heavy Artillery:	60
Super-Heavy Artillery:	80

Guns presented a problem. A gun has a longer range than a howitzer of an equivalent caliber. Most of the time this is achieved by a longer barrel and a longer chamber into which more propellant can be crammed, thus their attack factors are the same as those for the howitzers. But for some guns with a super long range, the tradeoff was that they fired a lighter HE round with less explosives (usually 60 to 75 per cent) than that of an equivalent howitzer, thus making their attack factors less than those of an equivalent howitzer. The German 170mm gun was one such weapon. Its rate of fire was about the same as other howitzers in its class, but it put out less high explosive into a hex than the other weapons of its class. Thus it has an attack factor of 50, rather than 80, to account for this.

This brings up an interesting question, why are not more guns of the heavy and super heavy variety better represented in this game? Well first, with their longer range, they were usually reserved for counter battery fire. Yes, they could, and were, used for regular fire missions like the regular artillery units in PanzerBlitz and Panzer Leader, but since they had the additional mission of counter battery fire, they would be deployed well off the board to take advantage of their longer range and to present less of a target to counter-counter battery fire. Second, these guns were not capable of direct fire, having a minimum range of several thousand meters. Thus was due to the fact that they had a minimum barrel depression of about plus 10 degrees from the horizontal. This was caused by the structure of their mount or carriage that they were mounted on.
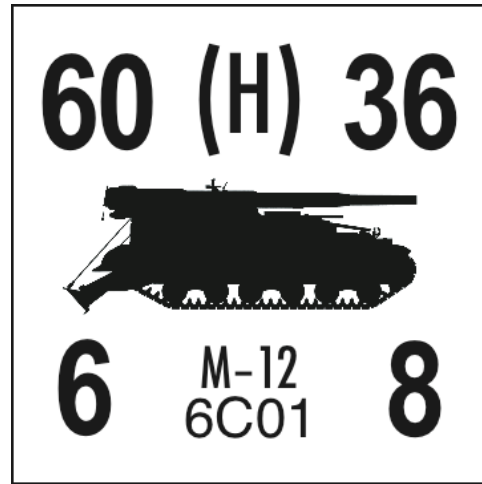

Third, they usually took so long to set up and take down for movement – usually 3 to 10 game turns – that it was not worth the effort to represent them in the games. Only those guns that were frequently found at divisional level (usually attached to the division) and could readily be moved quickly were deemed worthy of representation in the games. These guns were the German 170mm gun and the US M-12 self-propelled 155mm gun.

In Panzer Leader, Randall Reed took some short cuts when determining the attack factors for the counters. For one thing, since the German artillery units were already established in Panzer-Blitz, it was a simple thing to keep using them exactly as they were in Panzer Leader. Next, when he worked

out the factors for the American artillery, he found that they were close to, if not exactly on, the German attack factors for each class. So it was a simple enough task to simply put them into the appropriate artillery classes with the already established attack factors. The problem came with the British weapons. These weapons usually had calibers that fell in between the established classes. Thus Reed established classes for the British calibers as follows:

Light Artillery: 18 Pdr howitzer.	
Medium Artillery: 18/25 Pdr howitzer, 25 Pdr howitzer, 94/95mm guns.	
Heavy Artillery: 5.5 inch howitzer.	
Super-Heavy Artillery: 7.2 inch howitzer.	

Note: The 18 and 18/25 Pdrs. came from Panzer Leader 1940. The 94/95 mm guns were mounted on support tanks of the various British tank series. While there are no dismounted versions of these, their indirect fire artillery attack factor still had to be calculated as their direct fire attack factors were derived from these.

32 (H) 32	26 (H) 30
18/25 ┃┃┃ pdr	18 ┃┃┃ pdr
2 O01 **0**	**2** N01 **0**
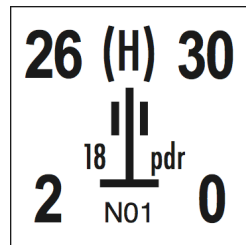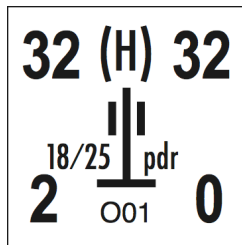
To establish the attack factors for the British weapons, Reed followed the system created by Dunnigan, with the exception of the last step (rounded off to the nearest 10) which he replaced by merely rounding off to the nearest whole integer. The resulting attack factors were as follows:

18 Pdr:	26
18/25 Pdr:	32
25 Pdr:	35
94/95mm guns:	38
5.5 inch howitzer:	48
7.2 inch howitzer:	70

In Panzer Leader 1940, Ramiro Cruz basically followed Reed's lead. He kept the German artillery units just the way they were, found that the attack factors for the French weapons were very close to the American and German values, and so used the same ones for the French in each artillery class, figuring out the British values using the Reed modified system.

Indirect fire self-propelled artillery units basically used the attack factors of the guns or howitzers of their artillery class. Since they were all six vehicle batteries, this worked out just fine.

There was only one modifier established for indirect fire artillery unit attack factors. If the counter contained less than six guns or howitzers, the attack factor was reduced appropriately to make number of the artillery pieces in the counter (i.e. 4 pieces reduced the attack factor by 1/3 and 3 pieces reduced the attack factor by half, fractions rounded up).

Direct Fire:
Direct fire artillery pieces, both self-propelled and towed, are those units that may engage only in direct fire. Self-propelled units would include assault guns, and tanks, halftracks, and armored cars mounting H class weapons. Anti-aircraft artillery is

covered in another article. The basic attack factors for direct fire artillery units were based on the unit's artillery class as listed earlier in this article. The indirect fire attack values would then be divided by three, with the exception of the light artillery class attack value which was divided by four, to get the basic direct fire artillery attack factors.

Direct Fire Light Artillery:	5
Direct Fire Medium Artillery:	14
Direct Fire Heavy Artillery:	20
Direct Fire Super-Heavy Artillery:	28

These were the basic direct fire attack factors that Dunnigan established for these artillery classes. The following modifiers were established for these attack factors.

Low Ammo:
The artillery unit has a low supply of ammo which meant that the guns were shot sparingly to conserve ammo. This modifier was applied to light infantry guns like the German 75mm and the Russian 76.2mm and to assault guns which had hulls which were based on light tanks and therefore had little space for ammo storage (a prime example would be the German GW 38t). The actual numerical effect of this modifier is to cut the basic direct fire artillery attack factor in half, rounding down any fractions.
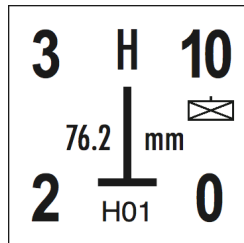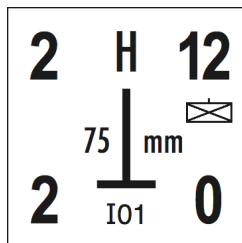
Double Batteries:
This modifier basically applies to the Russians. Because Russian assault gun batteries were 4 to 5 vehicle units, and the counter equals 10 vehicles which are 2 batteries, the counter was thus a double battery. Primary examples of this are found in the Russian SU-122, SU-152, JSU-152, and the KV-2 counters. These are actually battalion size units. The actual numerical effect of this modifier is to double the direct fire artillery attack factor for the unit in question.
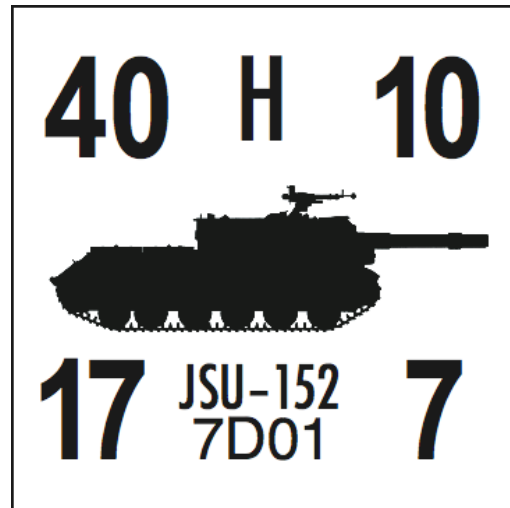
It should be noted that direct fire artillery attack factors are not affected by the number of guns or vehicles in the counter, be it 2 or 10, as the indirect fire artillery units are. This is because indirect fire artillery units rely on volume of fire to inundate the hex with high explosives in order to knock out or destroy the target and any reduction of the number of guns or vehicles will reduce that volume. Direct fire artillery units are firing directly at the target and thus would use far fewer rounds to hit their target as they could see it directly.

When Reed and crew were making Panzer Leader, they simply followed Dunnigan's lead in establishing the direct fire artillery factors. Since the Germans were already done they did not have to bother with them. On the Allied side, there was only one assault gun which had to be figured out using the system, that being the M4/105mm. All of the other assault guns that came afterwards had to be factored by their creators, including myself.
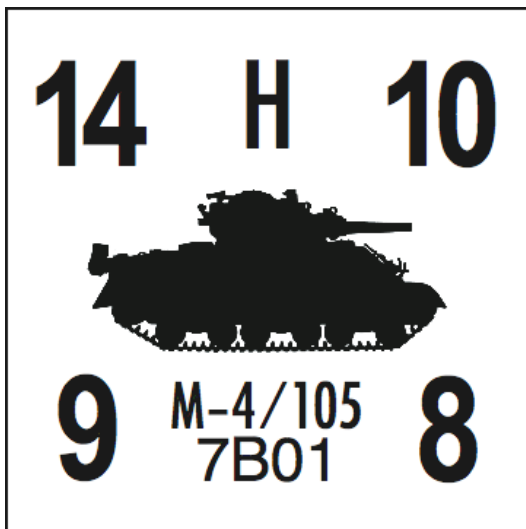
This brings up an interesting point. Ramiro Cruz, who probably con-tributed more variant counters to the system than most other authors in the 1970s, did not have a full under-standing of the Dunnigan system, especially when it came to H class weapons. His calculation of the attack factors was inconsistent and varied from counter to counter. This was especially true with the counters that came with the PanzerBlitz 1941 article that came in the General Vol.13, no.3. In Panzer Leader 1940, his calculations were more consistent although there were still a couple of oddities.

As one can see, direct fire artillery gets short changed when it comes to attack factors, especially the weapons of the Light Artillery Class. This in many cases makes them not very effective against non-armored targets such as infantry, though they are still very effective against other artillery units. However, their attack factors are based on their relative effectiveness against armored targets, not against non-armored targets, as anti-tank warfare is the basis of the combat system portrayed in the game

Range Factors

Indirect Fire Units:
In PanzerBlitz the range factors for indirect fire artillery counters were based on the following premise. The artillery unit was expected to be moved around and fired during the course of the scenario, given that PanzerBlitz deals mostly with mobile situations. The idea was that the artillery would set up, do a fire mission or two, then pack up and move to a new position. Thus the maximum effective range would be considerably shorter than the true maximum range. To get out to the true maximum range, the artillery had to be set in place for a while and had to have time to register their weapons out to their maximum ranges (which could take hours for most powers and days for the Russians). Granted, each artillery piece would have its own maximum effective range, but Dunnigan, for reasons of simplicity, merely established a set maximum effective range for each artillery class, to use as the range factor. These are as follows:

Light Artillery Class:	28 hexes
Medium Artillery Class:	32 hexes
Heavy Artillery Class:	36 hexes
Super-Heavy Artillery Class:	40 hexes

The Russian range factors were reduced to reflect their more primitive fire control system. Here they are:

Light Artillery Class:	16 hexes
Medium Artillery Class:	20 hexes
Heavy Artillery Class:	25 hexes
Super-Heavy Artillery Class:	30 hexes

In Panzer Leader, Reed kept to the established system when it came to American artillery, giving them the same ranges as their equivalent German counterparts. The British were a different matter though. Reed figured out the individual maximum effective range for each British artillery unit introduced in the original game and used that for the range factor for each piece. In Panzer Leader 1940, Ramiro Cruz also followed the system modified by Reed: he used the basic system to establish the ranges of the French artillery, essentially keeping the same in each class as the Americans and Germans, and figured out the individual maximum effective ranges of the British weapons and used those for the range factors for the British pieces.

One should note that the above listed ranges are for howitzers only. Guns have longer maximum ranges and thus their maximum effective ranges would longer as well. Thus, those artillery counters which have guns instead of howitzers, of which there are few, will

have a slightly longer range factor, such as the French 75mm, or a very long range factor, such as the German 170mm. Likewise, counters containing howitzers with cut down barrels had their range factors reduced a little to account for the lesser ranges that they had. Good examples of these are the American 75mm and the M-3 105mm.

Self-propelled artillery pieces usually kept the same range factors as the ground mounted versions. However, some of the bigger pieces had a much shorter range than what their weapon size would warrant. There were two reasons for this. One, these vehicles were using older WWI versions of the weapons, which had shorter ranges that their WWII counterparts. Two, the way the in which the weapons were mounted on the vehicles precluded the barrels from being elevated to their maximum ranges. The two vehicles that are affected by this are the German Hummel and the American M-12 SPA. Now, one might ask why the M-12 had its range factor reduced when it is the same as the ground mounted 155mm howitzer. Well, it must be remembered that the M-12 carried a 155mm gun, not a howitzer, and thus would have had a longer range factor, which in this case gets cut down to that of the 155mm howitzer.
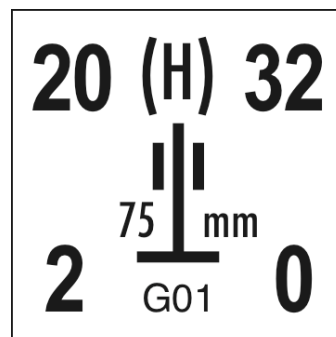
Direct Fire Units:

The ranges of the direct fire H class weapons, both ground mounted and self-propelled, were based on the maximum effective ranges of the weapons in question. These were dependent on the sights on the weapons themselves and on the tactical doctrine on the respective nation's direct support artillery. Generally the range factors established for the direct fire artillery, by unit class, were as follows:

> **Light Artillery Class**: 8 for most powers, 6 for the Russians
> **Medium Artillery Class**: 10 for most powers, 8 for the Russians
> **Heavy Artillery Class**: 12 for most powers, 10 for the Russians

Of course, there were individual exceptions. For example, the German 75mm IG and the StuH 42 AG each have a range factor of 12, whereas they should have a range factor of 8 and 10 respectively. Well, these guns had better sights which allowed them to reach out further. The same is true for the Russian 76.2mm IG, which has a range factor of 10 instead of the normal 8.

Defense Factors

For dismounted artillery units the defense factor was based on a special table established by Dunnigan. The factor was dependent on the artillery piece's size. These size classes were depended on the size of the weapon in question, its lowness to the ground (the lower the better, which is why small AT guns always have a defense factor of

3), and vulnerability of the gun/howitzer's ammo (which always had to be stacked nearly) and the crew (bigger guns and howitzers usually lacked gun shields, which were of dubious value anyway). H class anti-aircraft guns, which are covered in another article, always received an automatic defense factor of 1 because their primary mission required that they be more out in the open in order to get maximum visibility against aircraft. Russian medium and heavy artillery classes were classified as large size because of their tendency to park their guns close to each other (almost wheel hub to wheel hub) thus making the unit much easier to destroy as it was not so well spread out.

> **Small Size**:   3
> **Medium Size**:   2
> **Large Size**:   1

Reed followed these rules in Panzer Leader as did Ramiro Cruz in Panzer Leader 1940, however Cruz did introduce a fourth artillery size for us:

> **Very Small Size**:   4

Artillery units of this size had artillery pieces about the size of a machine gun. Fortunately only one artillery piece has this factor, that being the French 37mm IG.

Self-propelled artillery units, both direct and indirect fire types, have their defense factors based on the vehicle's armor and the tactical doctrine for the unit in question. This is covered in another article.

Movement Factors

The movement factor for dismounted artillery units, both direct and indirect fire types, is 0. This is due to the fact that most artillery pieces are too big to be moved very far by the crews. Yes, a crew can manhandle an artillery piece to get into position and to turn it around to fire in different direction. It is even conceivable that a crew push the artillery piece, especially a small one, a couple hexes during the course of a scenario. However it would take several turns to move the artillery counter one hex. It would be faster to just mount it up and transport it to the next hex, then dismount it. In addition, there would have to be some additional rules to account for this and Dunnigan decided that it would be simpler to just make the dismounted artillery unit non-movable, except through transport units. Reed and Cruz followed suit in Panzer Leader and Panzer Leader 1940 respectively.

There are two exceptions to this. The first is the Russian 203mm howitzer (actually gun/howitzer), which was given a movement factor of 2. This was due to the fact that the piece was

mounted on a motorized tracked carriage. This was necessary as the gun was so heavy that the crew could not manhandle or turn it or move it into position by themselves. However the carriage had a small supply of fuel and the gun could be move itself a few thousand meters in the course of a scenario. As there were many historical cases where the 203mm did just that, usually to get away from enemy units, it was thought best to give it a movement factor of 2 to account for this.

The second exception is the French 37mm infantry gun. This gun was so small and lightweight that it could be carried by its crew, thus it was given a movement factor of 1.

The movement factor for self-propelled artillery units was based on the movement factor of the vehicle which the piece was mounted on. This is covered in another article.

Dual Class Units

There are some H class artillery units which historically fell into more than one unit type category. In most cases these units were both an assault gun and a self-propelled artillery unit, although in one case (the SU-76) the vehicle was a tank destroyer, an assault gun, and on rare occasions, a self-propelled artillery piece. So how do we rate them in Dunnigan system? Since a unit can only be classified in one category, it is best to use the category that the vehicle was most used in during the war. The following units are examples of this:
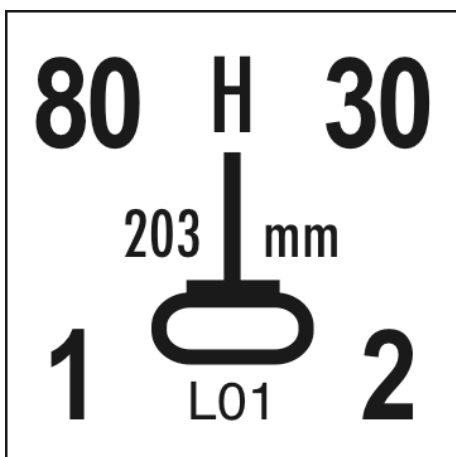
American M-4/105mm AG:
This vehicle was an assault tank which mounted a 105mm howitzer. Although primarily used in the direct fire mode most of the time, it had the ability to be use indirect fire, which is it did on several occasions. In Panzer Leader it was classified by Reed as an assault gun.

American M-8 HMC:
This vehicle was a self-propelled artillery vehicle that mounted the 75mm howitzer in the turret. It was used primarily as self-propelled artillery by the armored cavalry and primarily as an assault tank (gun) by the armored infantry. As I created this piece myself, I followed Reed's lead and classified and rated it was an assault gun.

Russian SU-76:
This vehicle was primarily used as an assault gun and as a mobile anti-tank gun. Dunnigan classified it as a tank destroyer, which was what it was used for the most during the first year of its service. As more tank destroyers came into service (the SU-85 and 100, and the JSU-122) the SU-76 was used less as a tank destroyer and more as an assault gun assigned to Rifle Divisions. On occasion it was used as self-propelled artillery, usually under the direction of an artillery officer, but this was at the opening bombardment of a major offensive, after which it would then move out and serve in one of its other roles.
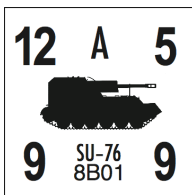
Given this information, how would these units be rated in the other categories? The following counter values should answer this question:

M-4/105mm SPA:	20-(H)-32-9-8
M-8 HMC SPA:	10-(H)-25-5-11
SU-76 AG:	10-H-6-9-9
SU-76 SPA:	34-H-16-9-9

Now, does this mean that these units are going to get counters with these values? Officially, no, but it does not mean that some private individual cannot make these alternate counters for their own private use. These values are here for their use as such.

Four Gun Batteries

Shortly after PanzerBlitz came out, someone wrote an article proposing four gun battery units instead of the usual six gun batteries that the indirect fire artillery units represent. The reason for this is that most of the artillery batteries in all of the armies were of the four gun variety. There were not that many six gun batteries as Dunnigan would have us believe. All that would change would be the attack factor on the counters. These were the suggested attack values for a four gun battery by class.

Light Artillery Class:	14
Medium Artillery Class:	28
Heavy Artillery Class:	40
Super-Heavy Artillery Class:	54

These values were arrived at by dividing the original attack factor of each class by six, then after dropping any fractions, multiply the result by

two, then subtractinf this new result from the original attack factors to get the attack factors above. (It seems that the author wanted to keep all of the fractions, including those for the missing guns, in the attack factor.) For the German 170mm gun, a four gun battery would have an attack value of 34.

For the British, who always seem to want to do things differently, the attack values for four gun batteries are as follows:

18 Pdr:	18
18/25 Pdr:	22
25 Pdr:	25
5.5 inch:	32
7.2 inch:	48

Although this section seems to violate the rules put forth in an earlier paragraph in this article, my purpose here is to presents the basic facts from that early article because I think that they have some merit. Again, there are not going to be any official counters with these attack factors. Instead, these values are for those players who want to construct four gun batteries for their own private use.

Odd Counters

H class counters, both direct and indirect fire types, have a rather large number of oddball counters, most of which were the creation of Ramiro Cruz, although a few of them are mine.

Russian T-28e Medium Tank:
This support tank, a Ramiro Cruz creation, has an attack value of 6 when

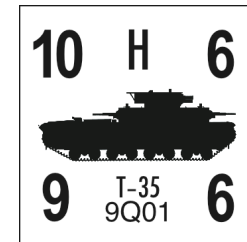it should have an attack factor of 10. What happened is that Cruz assumed that the main gun, a short 76.2mm, was the same weapon as the 76.2mm infantry gun, so he used the attack factor for that weapon, which was 3, as his basis. He then applied the double battery modifier since it was a company size counter to get his final attack factor of 6. In truth the T-28e did mount a gun similar to the 76.2mm infantry gun, but they were not the same weapon.

Russian T-35 Heavy Tank:
This heavy support tank (another Cruz creation) has the correct attack factor, but for the wrong reason. Cruz originally gave the tank an attack factor of 6, just like the T-28e, by virtue of them both having the same main gun. But the T-35 had multiple secondary guns (as in the two 45mm anti-tank guns) and he felt that he had to somehow account for them in the attack factor. So he looked at the combined attack factors of two 45mm anti-tank guns at the range of three hexes, which was the half range for the 76.2mm main gun. It equaled 10 so he used this number for overall attack factor (never mind that the two anti-tank guns pointed in opposite directions on the vehicle) while given the vehicle the weapons class and range factor of the 76.2mm main gun.

Russian BT-8 Light Tank:

This tank (still another Cruz creation), which is in reality the BT-7a (as shown), had the correct attack factor but the wrong weapons class. It had an A weapons class because Cruz thought that it was armed with the same gun as that on the T-34a and KV-1a. He was wrong as this tank was armed with the same short 76.2mm gun as the T-28e and the T-35.

I had Avalon Hill change the weapons class from A to H to correct this. I did not change the range factor to account for the poorer gun-sight that vehicle had for its gun compared to the gun-sights of the other two tanks.

Russian KV-2 AG:

This assault gun (still yet another Cruz creation) has an incorrect attack factor of 50 instead of 40 as it should be. What happened here was that Cruz took the actual battery size for the KV-2, which was four vehicles, and applied the attack factor of 20 to the battery. Then, since the counter represented a double battery, he applied that modifier to come up with an attack factor of 40. However, the counter represents ten vehicles while the actual double battery in question had only eight. Cruz now felt that he had to account for the other two vehicles represented by the counter. Since two vehicles equaled a half battery, he added 10 more to the attack factor to come up with a final 50. What he forgot when making this counter was that attack factors based on the number of vehicles represented by the counter is only used with indirect fire artillery units, not direct fire artillery units. But since the counter is considered to be canonical, we are stuck with it.
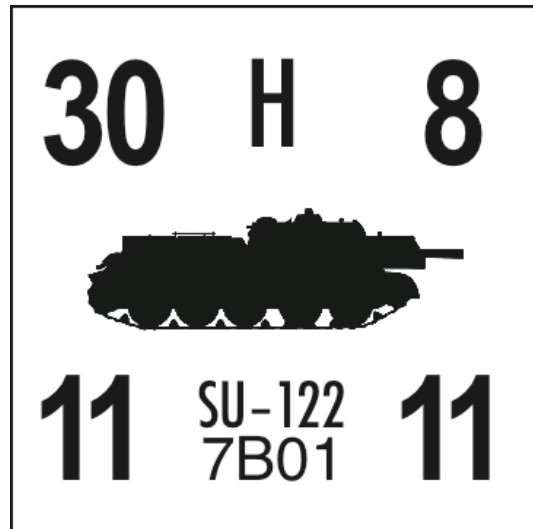
Russian SU-122 AG:

This assault gun, which I created, may seem to have a slightly inflated attack factor. According to the Dunnigan system, it should have an attack factor of 28, not 30. However what I did was to use the 122mm howitzer's true attack factor, which is 45 (before Dunnigan reduced it back to an attack factor of 40) in figuring out the attack factor for a single battery, which came out to 15. When I applied the double battery modifier the resulting attack factor was 30 which was what the counter has. I know that in stating that the 122mm howitzer true attack factor is 45 may create a demand to change it, but since the 122mm is one of the original counters from the game, it must considered canonical and so its attack factor remains at 40.
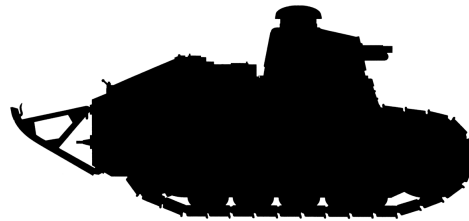
US M-3 105mm Infantry Howitzer:

This piece is a compromise counter. The M-3 was originally designed to be an infantry support weapon, much in the same line as the German 75mm and 150mm infantry guns. Though meant to be a direct fire weapon, it was also given indirect fire capability. In fact, it was rarely, if at all, used in the direct fire mode as American commanders preferred to use it exclusively in the indirect fire mode. What I did was start off in its direct fire mode, which would have yielded an attack factor of 14. I then gave it the indirect fire capability which it historically had. I then considered the size of the battery represented in the counter, which was 6 howitzers. In the direct fire mode the battery size was 3 guns, much the same as the M-4/105mm AG, which had three vehicles. I then doubled the attack factor to 28 to account for its 6 gun battery size. Now some people may think that I short changed the M-3 of the full attack factor of 40 that the regular 105mm howitzer has, and I probably did. But such are the sacrifices one must make when one has such a unique counter such as this one that was equally a direct and indirect fire weapon.
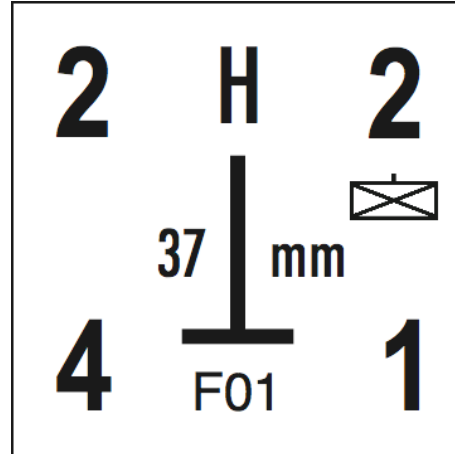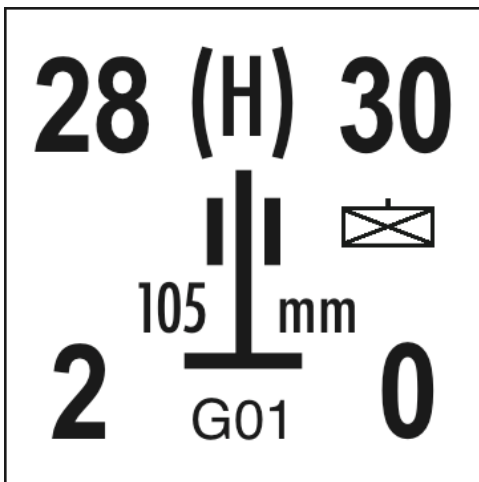
French 37mm Infantry Gun:

Another one of Cruz's creations (doesn't this guy ever quit?). As the defense and movement factors were previously discussed, they shall not be repeated here. The attack factor was based on that of the gun on the French FT-17 tank (the two guns were similar and both came out of the First World War). Cruz took the attack factor of the FT-17, which is 3, halved it for its effect against non-armored targets, which yielded 1 1/2, which he rounded up to 2 to get the attack factor. He then gave it the same range factor as the FT-17, which is 2. Not bad for a little infantry gun.

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