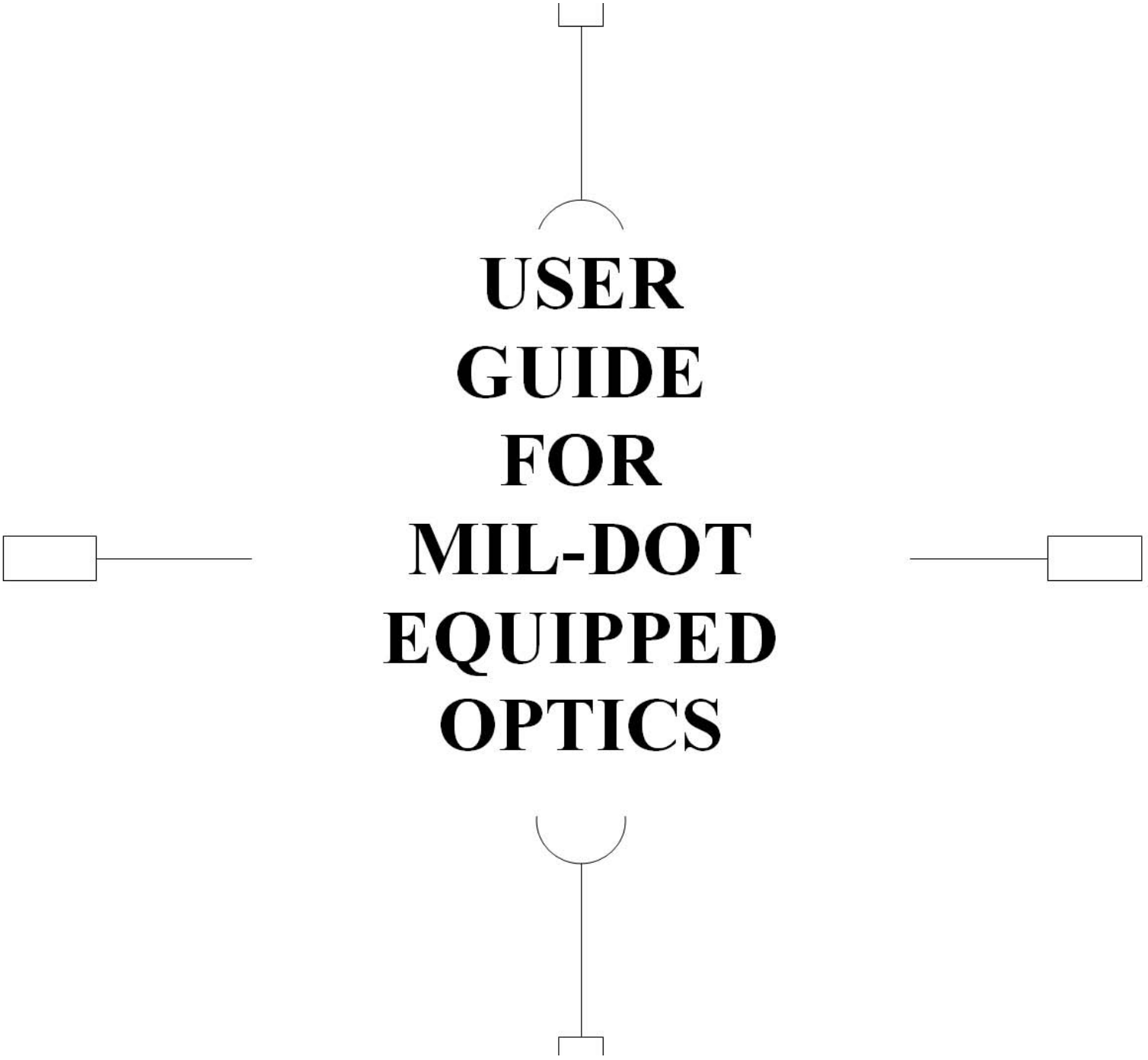
User Guide For Mil-Dot Equipped Optics

By: Michael Haugen



This guide is intended to provide the user of a Mil-Dot equipped optic with information on what the reticle is used for, the basics of its use and how to train yourself to better employ and realize the full potential of this reticle.

DISCLAIMER
THE INTENT OF THIS DOCUMENT IS TO PROVIDE SOME INFORMATION TO ENABLE USERS OF MIL DOT EQUIPPED OPTICS TO DEVELOP SKILL IN THEIR EMPLOYMENT. THE ACTUAL USE OF THIS INFORMATION IS THE RESPONSIBILITY OF THE USER. MISUSE OF THIS INFORMATION COULD RESULT IN LEGAL RAMIFICATIONS. TREAT ALL WEAPONS AS IF THEY ARE LOADED, NEVER ASSUME THIS AND BE DEADLY SERIOUS ABOUT IT. NEVER USE UNSUSPECTING OR UNAWARE INDIVIDUALS AS MIL PRACTICE OBJECTS.

THIS DOCUMENT IS NOT ALL INCLUSIVE; IT TAKES PATIENCE AND PRACTICE TO BECOME SKILLED AT ALL SHOOTING ASPECTS. NO AMOUNT OF MONEY OR DEVICE IS FOOL PROOF MEANING THAT YOU CANNOT ìBUY SKILLî. USERS SHOULD PRACTICE ANY AND ALL TECHNIQUES POSSIBLE TO DEVELOP APPLICABLE METHODS.

GENERAL INFORMATION

Congratulations on your recent purchase or interest in the use of an optical product that features the mil-dot reticle. Lets begin by issuing a disclaimer; some of you out there may find some controversial information contained in this manual, however this information has been verified and tested by a variety of professional sources. Whether you are a beginner or a seasoned user of mil-dot equipped optics, you will find something useful contained in this document.

There are three basic reasons that people purchase optics with this reticle; to estimate range, lead moving targets and/or to hold off for winds. The problem with this reticle is that it requires a little training and some practice. Having said this however, this reticle is extremely versatile and useful and when properly used will allow the shooter to accurately engage and hit targets at ranges previously thought impossible.

In the beginning, new shooters will doubt the accuracy of this system because ranges they previously thought were quite distant equate through the math to be significantly closer than expected. This is very typical because most shooters vastly over estimate range. As time goes on with more practice you will notice that your ability to estimate range by eye will dramatically increase which in turn will serve as a “check” against your “miling” allowing to quickly estimate the range and engage the target.

WHY USE MIL DOTS

This is probably the most asked question in reference to reticle patterns. The short answer is that the mil dot reticle once learned is not only a simple but extremely versatile tool. There are any number of “range finding” reticles on the market that promise any number of things, however they all are attempting to do the same thing but with less effort on the operators part. The largest difference between most of the “other” reticles and mil dots are in many cases the other reticles are built around a specific caliber and load; dramatically decreasing shooter versatility. Other reticles require the use of everything from “cheat sheets” to palm top computers in order to be functional. While there is nothing “technically” wrong with a cheat sheet or a palm top, it definitely makes for an interesting shooting experience when the cheat sheet gets lost and the batteries die in the computer. Point here is that mils dots are the standard by which everything else is measured, they are as ingenuous as they are simple and as I have said elsewhere in this document; once learned they will provide the tactical shooter and hunter with a tool that will allow him to do things he could not before. Most people who do not like them or badmouth them do not know how to correctly use them. Lastly, if you personally do not like mil dots do not use them. Use what makes you feel comfortable and assists you in hitting the target, but I challenge each and everyone who reads this to give them a chance; try to learn them and practice with them before you cast them out.

WHERE DID MIL DOTS COME FROM AND WHY ARE THEY USED?

The milliradian is an engineering term for a unit of trigonometric measurement; specifically a milliradian is used in the engineering community to measure angles as derived from a circle (verses right angles). The engineering community uses 6283 milliradians to a circle.

Earlier in the 20th century, the U.S. Infantry used “Mils” (see specifications for definition and value) to correct the trajectory for indirect fire and crew served weapons. This was done mainly because Mils are a finer measurement than degrees and enabled them to be more accurate. The Infantry divided a circle into 6280 parts or 1/6280th = 1 mil. This was a slight deviation from the truth but it was easier for them to compute, work with and provided even number results. The Artillery

also decided to use this system, but concluded that 6280 was not fine enough for accurate precision fire. They rounded the number to 6400, which equates to 1 mil or 17.8 mils = 1 degree. This system became institutionalized and remains widely used in all services today.

It should be noted that the term "mils" relates to the military variation whereas "milliradians" remains an engineering term.

The USMC was the first U.S. military service to in corporate a mil dot reticle in sniper optics by having it installed by J. Unertl for use on the M40 sniper weapons system. When the Army decided to incorporate a range estimation tool into it sniper optics it chose this system and had Leupold make the reticle accordingly. *I should clarify this point for those out there not familiar with the Leupold M3A Ultra currently used by the US Army. Many people believe that the Mark IV M3 that they see advertised by various retailers is the same as the optics on the Army M24. Although they are identical in appearance, they are not the same. Specifically the reticles are different; the M3 Ultra uses an etched glass reticle with* ***round or Army mil-dots****, whereas the available Mark IV M3s sport a wire reticle with the* ***USMC oblong dots****.* Since the U.S. military adopted mil dots for use by its snipers, this reticle pattern has become a favorite of law enforcement, varmint shooters and hunters.

Recently there has been a lot of discussion (read argument) around whether or not the Army and the USMC use different moa values on their reticles. A call to the Leupold engineers will result in their stating that all Leupold reticles (military or commercial) use 3.438 (same as the USMC), however every Army manual or reference states that 3.375 is the correct number. So what is the correct number? Research into the original Army requirements documents shows only the physical distance between dots and that it equate to 1 mil, however further discussions with the engineer reveal two things; a mil is a military term and that the Army only recognizes 6400 mils to a circle which in turn equates to 3.375moa to a mil. Why then did the USMC go with 6283 or 3.438. The answer probably lies in the fact that an engineer more than likely developed the reticle using the dots and because it was an engineering term stuck with the 6283 being unaware of the 6400 number. While all of this makes for a great argument, the last interesting part of the research revealed that the error acceptance on the Army reticle exceed the difference between the two (Army and USMC). Therefore the actual value could and probably is somewhere in between. The shooter using either reticle will never realize the difference in mil value (NOT dot size or measurement methods). The end result; use 3.5 moa to a mil and practice. It should also be noted that MG (ret) Julian Hatcher states in his book "Hatchers Notebook" first printing August 1947 on page 403 "one mil = 3.375 moa".

If you are a purest, use 3.375 for an Army type reticle and 3.438 for a USMC type reticle, otherwise use 3.5 for either.

The popularity of the mil dots has resulted in them being offered by virtually every optic manufacturer today. This interest has also resulted in numerous variations being developed by several companies at the request of users. Most of these variations come in the form of dot spacing and number of dots presented. The most exciting news in the mil dot reticle world is the recent development of the GEN II Mil Dot reticle offered by Premier Reticle, which dramatically increases the versatility of the reticle.

Regardless of which version of reticle you have purchased, I HIGHLY encourage you to read this manual and PRACTICE, PRACTICE and PRACTICE and you will have a system that is time and combat proven to deliver reliable and consistent hits to maximum effective range of the weapon it is used on.

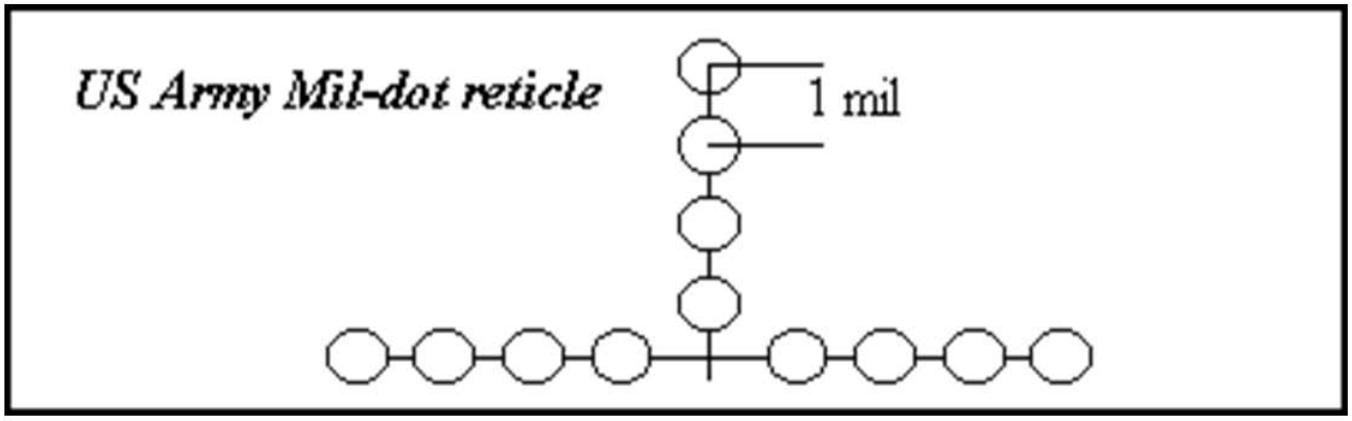
MIL-DOT SPECIFICATIONS

The term or measurement of Mils used to configure and use the Mil-dot [equipped optic] in estimating range. Here are the engineering (or true) specifications.

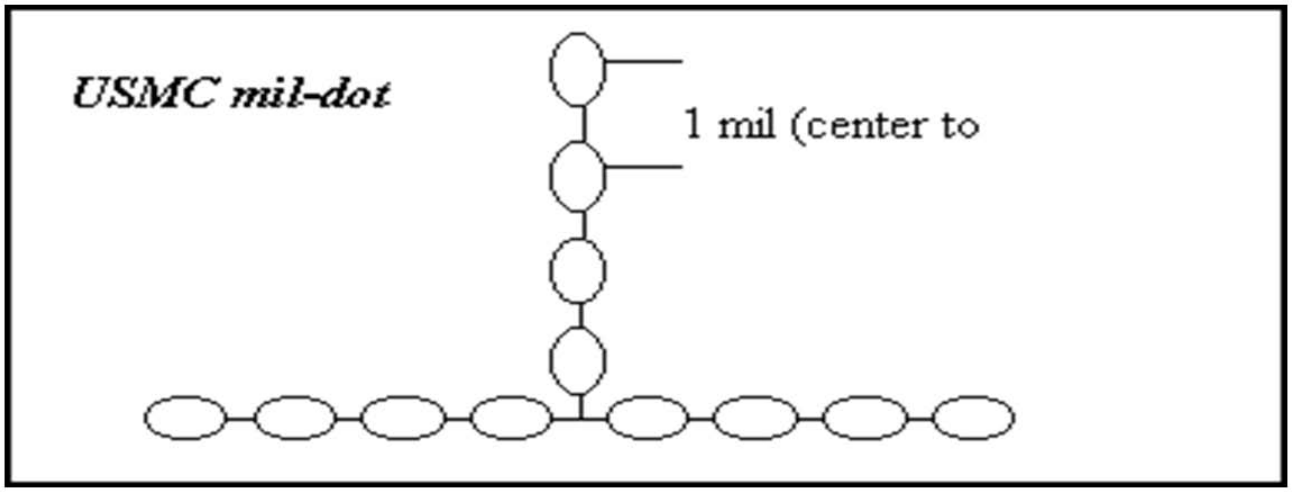
1 Milliradian = 1/1000th of a radian, 1 radian = 2 PI (6.283185306)
1 Milliradian = .0573 degrees or 6283 parts of a circle

As I mentioned in the previous section, the military changed the engineering measurement to suit their needs. In the arena of sniping the US Army and the USMC choice different paths; one opting for the military standard while the other choosing a pure or true path. Here are the related specifications:

ARMY: 360 degrees = 1 circle
6400 mils = 1 circle, 360
17.8 mils = 1 degree
360 degrees divided by 6400 = .05625 (number of mils in a degree) multiplied by 60 (60 minutes = 1 degree) = 3.375 MOA or ***1 mil = 3.375 moa***



USMC: 360 degrees = 1 circle
6283 mils = 1 circle
17.5 mils = 1 degree
360 degrees divided by 6283 = .0572974 (number of mils in a degree) multiplied by 60 (number of mils in a degree) = 3.437844 MOA or ***1 mil = 3.438 moa***



Therefore:

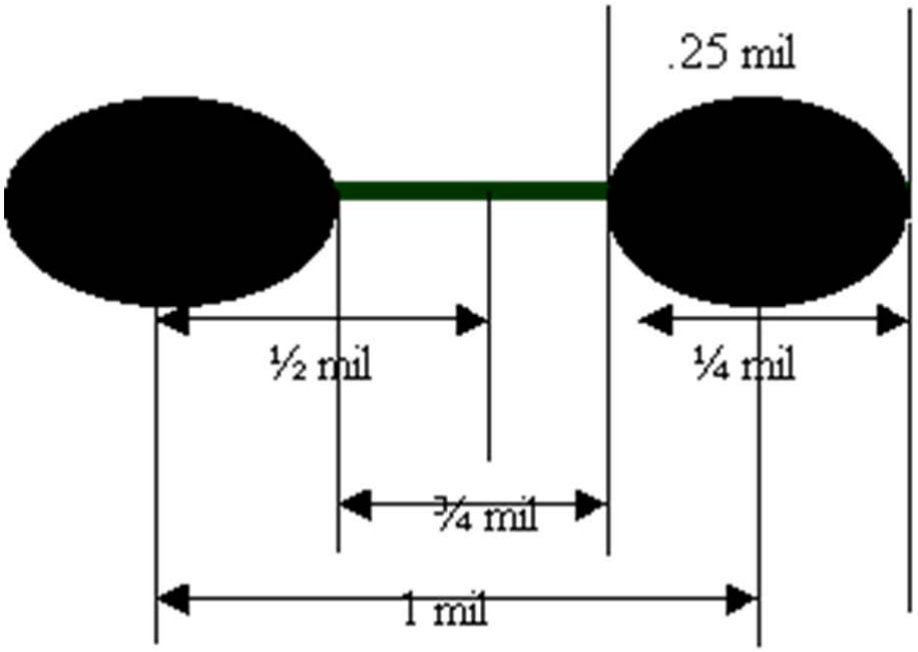
ARMY: 3.375 moa multiplied by 1.047" = 3.53" @ 100 yards
USMC: 3.438 moa multiplied by 1.047" = 3.6" @ 100 yards

Note: 1 Minute of Angle = 1.047" @ 100 yards (True)

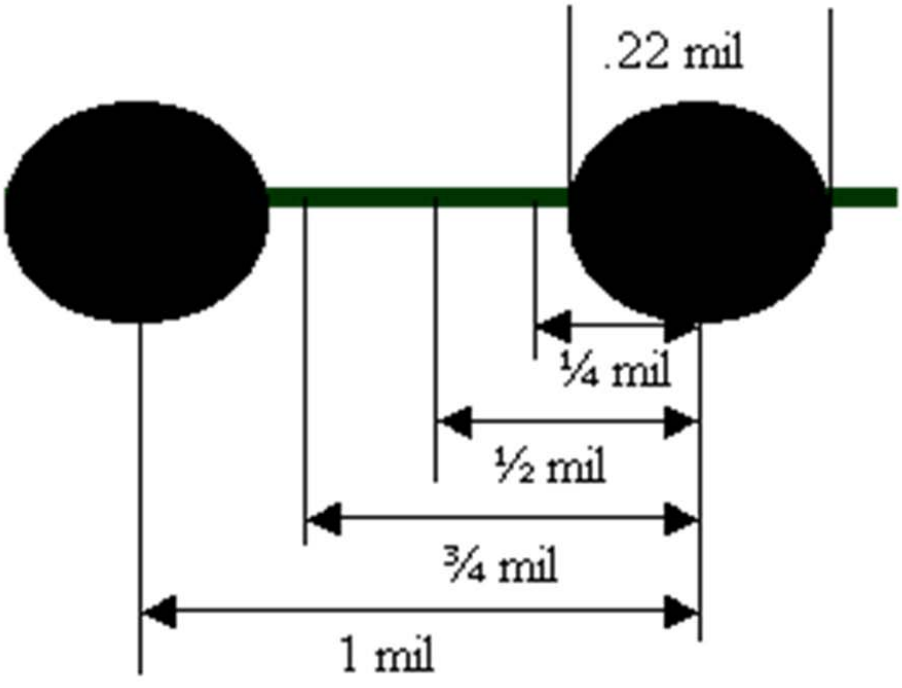
While we are distinguishing between Army and USMC reticles, I feel it is prudent to mention another difference. Not only are the mils themselves different but the value of the dots is also different. Army dots while commonly called 3/4 **mil** dots are in reality **3/4 MOA** dots (or .22 mil). This is to say that one dot subtends (covers) three quarters of a minute of angle

or .75 inch at 100 yards. The USMC dots are **1/4 mil** dots (or .86 moa) from edge to edge. Each USMC oblong dot subtends .86" at 100 yards. The new Premier Gen II reticle further adds to the mix by presenting a reticle that offers a dot that is .2 mil in diameter (.675 moa) or .675" @ 100 yards.

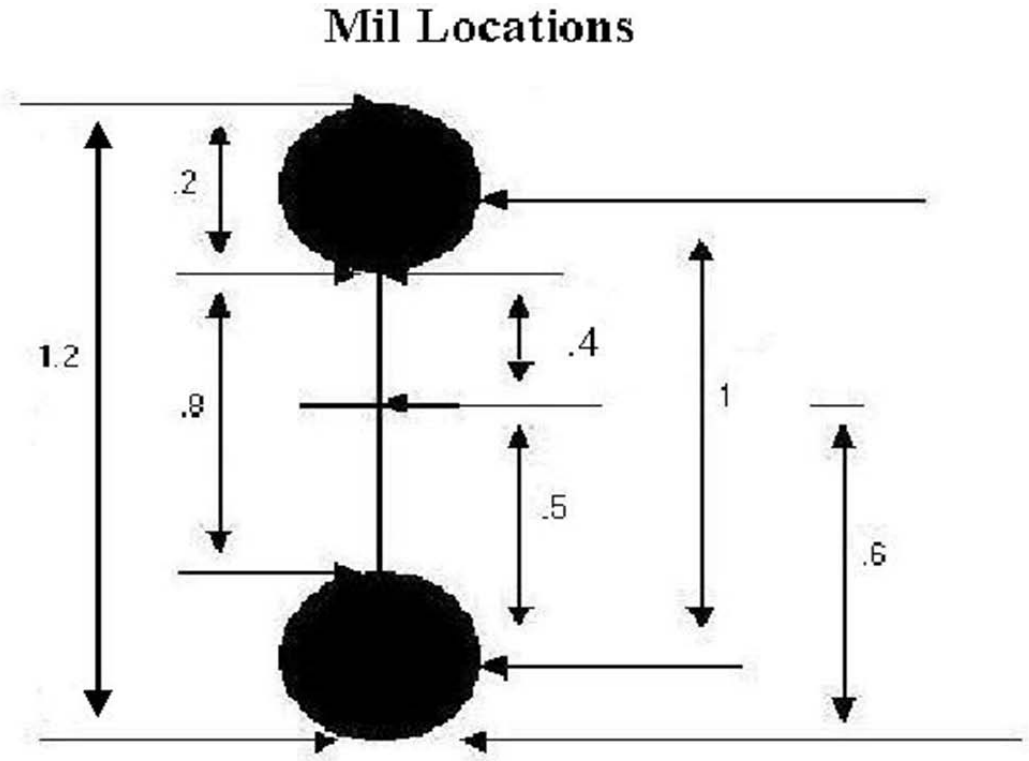
With Army dots, a quarter mil (1/4 mil) is the width of the dot from edge to edge plus the width of the line. As you can see from the diagram the 1/4 mil, 1/2 mil and 1-mil locations are depicted.



The commonly missed identified are the 1/4 mil and the 3/4 mil.



USMC dots, the measurements are easier to identify and remember.



The Gen II reticle has taken this further;

You will notice that there are differences in each reticle. None are truly better than the others, however depending on things like previous training and intended use, one reticle may appeal to you or be more useful than another. Keep in mind that all of the above do the same things; additionally there are variety of other custom mil dot reticles available that will give the shooter varying degrees of capability. The point here is you must know and practice with whatever reticle you have.

I am sure that all of the above is somewhat confusing but you have to remember that the mil-dot system merely provides aiming reference points and a range estimation tool. Where the actual locations of the 1/4, 1/2˝, 3/4 or 1 mil points are depends on where your starting point is. What I have drawn above gives you the quick reference points. If you are set on using center - center or edge - edge starting points then you will have to find those subsequent points. The bottom line is two fold. One, know what the values are of the reticle you are using. Two, use the same points all of the time. Do not get “wrapped around the axle” about what is best (edge to edge or center to center), just pick which ever one is easiest for you to remember and use.

One of the problems today is that all of the reference material available does not make the distinction between the two reticles and assumes the reader knows which system he has (and that there is a difference). The US Army manuals, TC 23-14, FM 23-10, and ST 31-20-4 all use the “round” dots, while the USMC manual FMFM 1-3B uses the oval dots. Civilian reference like John Plaster’s ”Ultimate Sniper” which plagiarizes several manuals use the Army dots as the example but use USMC math. Additionally, optic manufacturers do not always tell you how to use their reticle, many times because they themselves do not know how to use them.

HOW TO USE MIL DOTS

I am sure that most of you have skipped right to this page, as you want to jump ahead and get to using the optic. I have to HIGHLY recommend that you at least look at the diagrams and values associated with the reticle patterns listed under

specifications. All right then, lets get to it. The vast majority of users will employ the optic primarily to estimate range, some will also use it to hold for wind and some will use it to calculate and hold leads on moving targets. I will address the latter two uses further into this instruction.

RANGE ESTIMATION

There are two components to range estimation; the mechanics and the math. The mechanics encompass the physical methods of placing the reticle on the target and reading the reticle. The math is taking the "mils read" and converting it to a usable range.

THE MECHANICS

This is definitely the hardest part of range estimation using the mil dot reticle. It requires the shooter/use to place the reticle on the target (of known size), hold it long enough to accurately read it (depending how accurate you are trying to be to the nearest .1 mil).

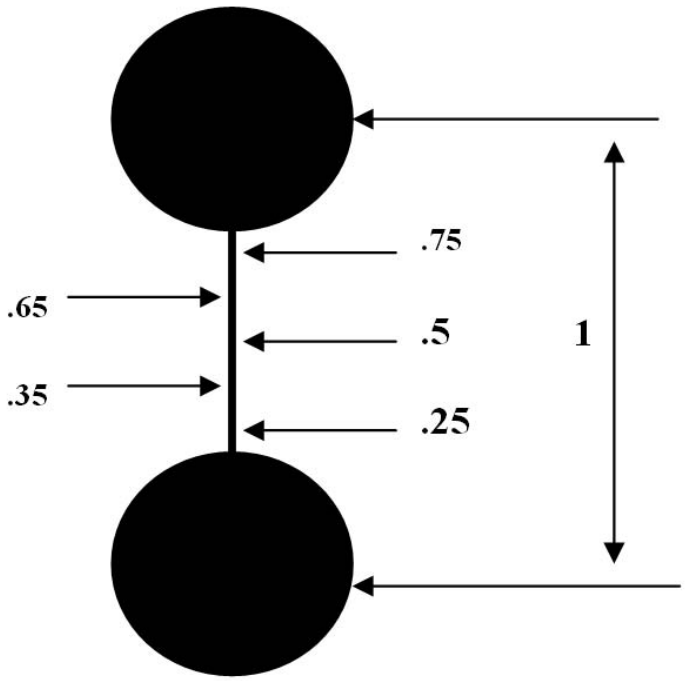
Whenever the majority of people think of a reticle on a target they envision the center of the cross hair placed on the desired point of impact (POI). In order to use a mil dot reticle to estimate range the shooter/user can use a variety of methods, all of which produce the same results. The main differences in the methods are what the shooter/user is most comfortable with and what the target is exposing.

The **MOST** important aspect of using the mil dot reticle for range estimation is a **STEADY HOLD** on the target. As you use the reticle, you will realize just how hard it really is to hold the reticle on the target. Most shooters will tend to move the reticle in the direction that they are reading, however many shooters will do the opposite. The shooter must practice shooting positions to determine what is best. All but the best shooters are able to hold a rifle/optic steady enough without a rest or support to accurately read the reticle. Shooters should **ALWAYS** seek to use some form of rest, bipod, sling etc. to develop a *STABLE, DURABLE*, and *SUSTAINABLE* shooting platform. When attempting to estimate range of living (for now) objects, it is imperative that the shooter be practiced and be able to read the scale quickly and accurately because they never stay in one place very long so. In order to develop this skill the shooter must practice, practice and practice (*we will cover practice techniques later*) using the reticle against targets at different ranges and of different sizes. Additionally the shooter should try all of the methods to determine which he/she prefers and the advantages/disadvantages of each.

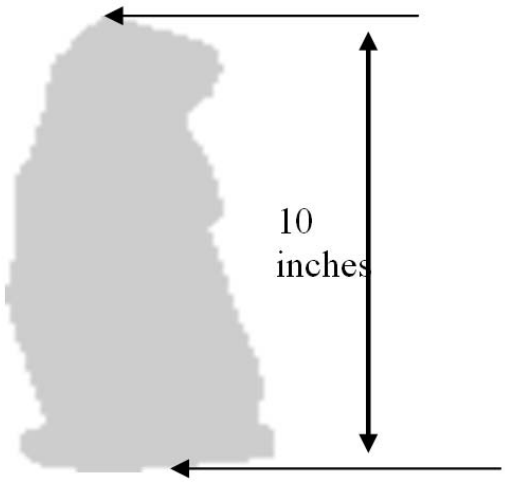
READING THE RETICLE

In order to use the reticle you must be able to read it. As mentioned elsewhere in this manual you must be able to read the reticle to the nearest .1 mil. Please refer to the diagrams depicted in SPECIFICATIONS for a break down of the specific reticles. Here is a generic break down of a mil dot reticle:

The picture is not to scale but provided to illuminate the discussion. Notice that what is depicted is not to the nearest .1 mil. To do so to scale the drawing would be too crowded to be useful. As depicted the .25, .5 and .75 mil are usually easy to find, the user must find the .3, .4, .6, etc locations. Keep in mind that although there is not an exact point annotated on the reticle, it behooves the shooter to learn to "guesstimate" where these points on the reticle are to lessen the range estimation error.



Regardless of which method you are going to use, you MUST know the target size (you will see this again). For the sake of this document, we will use the following;

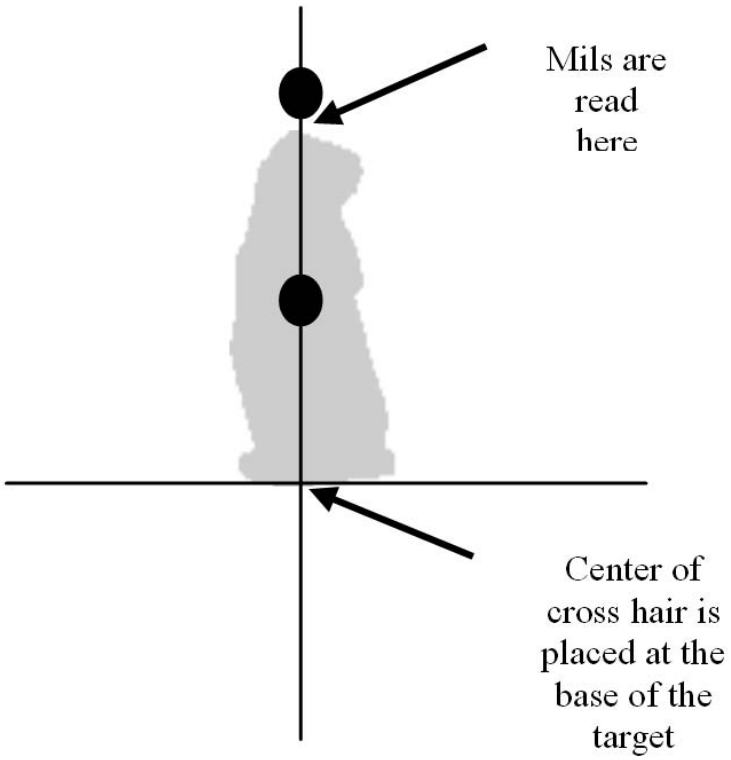


You will notice that Gordy the Ground Hog is 10 inches tall when he stands, which in your world is the average ground hog height.

Once you have the target size you have to decide on which method to use in order to obtain a mil reading. Here are some of the more popular methods;

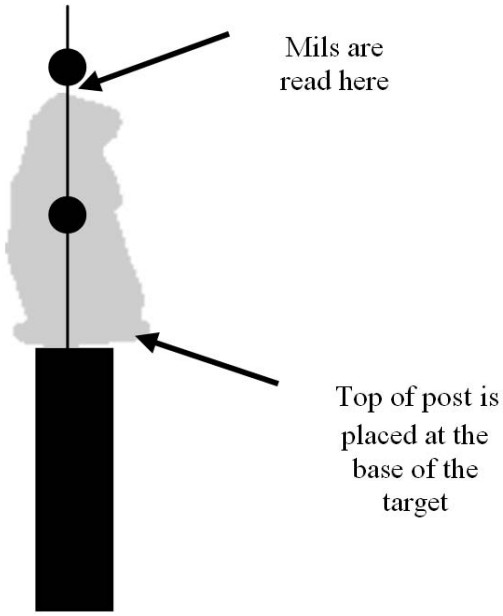
CROSS HAIR METHOD

As the name applies, this method uses the center of the cross hair placed at a point on the target then the reticle is read up, down, left or right. Keep in mind that the cross hair can be placed on any point and the target and mils read from there. This is the most widely used method because it is the most natural, placing the cross hairs on the target.



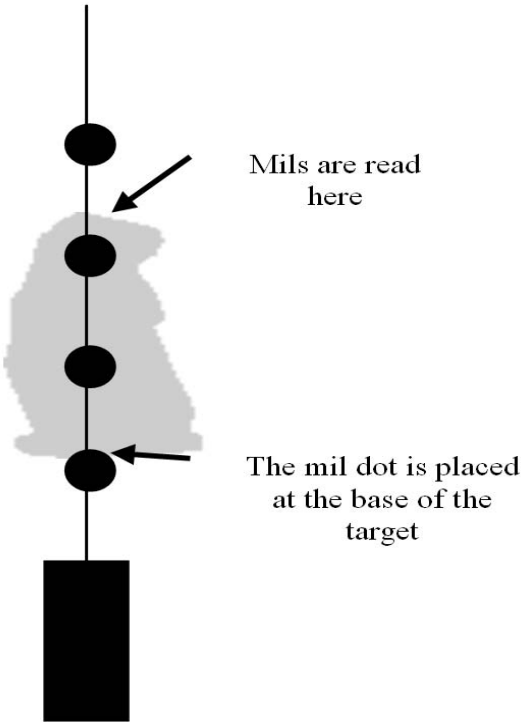
HEAVY POST METHOD

Similar to the cross hair method, the heavy post located on any of the four sides (top, bottom, left and right) is placed onto a base line and then mils read from there. The benefit of this method is that the heavy post is easier for most people to hold on a distant target (especially older shooters).



MIL DOT METHOD

Again, like the other two methods, a distinct aiming point is placed on the target and mils read from there. In this case, a dot is use verses the cross hair or a heavy post. This method is favored by some because the dots are easy to place on the target and for some easier to hold. One thing to keep in mind is that you are already into the mil scale when you place the reticle on the target and you must factor this into your calculations. Again remember, you MUST begin reading at the BASE DOT or factor its value is you begin elsewhere (i.e. if you begin reading from the top of the post as depicted above the reading would be 3.4 mils verses if you begin at the base dot which would be 2.4 mil and would be CORRECT).



THE MATH

There are two ways that you can derive range using a mil dot equipped optic, to manually compute it either by long hand or by using an electronic calculator OR to use one of several shooter aids that are on the market. The most notable shooter aid available is the Mil Dot Master; a slide rule type device, which provides the shooter with the ability to line up "mils read" with the target size in inches and gives you the range to the target. The other "device" is what is termed a "cheat sheet" and resembles a spreadsheet depicting mils read on normally the left side and target sizes across the top. By intersecting the two, you arrive at the range to the target.

While these devices are definitely handy, anyone using this reticle should know the math associated with it so that when they forget the device or cheat sheet they can still use the reticle to its maximum ability. Therefore, we will begin with the math (long way) of doing this.

CALCULATIONS

Using a mil dot reticle is a mathematical proposition requiring some calculating in order to arrive at a solution. For range estimation problems there are three components; target size (Tz), mils read (m) and range (R). You MUST have two of the three to arrive at the third component. Most commonly, the shooter will know the target size and by using the reticle will arrive at mils read, here are the formulas;

$$\frac{\text{Target size (in yards)} \times 1000}{\text{Mils read}} = \text{yards to target}$$

$$\frac{\text{Target size (in meters)} \times 1000}{\text{Mils read}} = \text{meters to target}$$

In short:

$$\frac{Tz}{m} = R$$

I am sure you notice that target size is required in yards or meters. Most of the time you know your target in inches (varmints), therefore the below formulas will help you convert and arrive at a usable range. The first formula for each is the easiest but not the most precise. Try them all out and decide for yourself what is best;

For Meters: **Object size (in) divided by 39 x 1000 divided by mils read**
Object size (in) x 25.4 divided by mils read

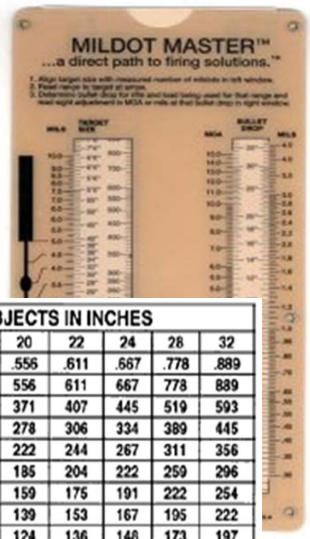
For Yards: **Object size (in) divided by 36 x 1000 divided by mils read**
Object size (in) x 27.77 divided by mils read

Lets try this out; You are a varmint hunter and looking down range you see a fat ground hog that happens to stand up looking around. You think he is 10 inches tall and place your reticle on him. You mil Mr. Ground hog at .6 mils, plugging what you now have into the formula this is the result;

10 inches divided by 36 x 1000 divided by .6 equals 462 yards OR
10 inches x 27.77 divided by .6 equals 462 yards OR
10 inches divided by 39 x 1000 divided by .6 equals 427 meters OR
10 inches x 25.4 divided by .6 equals 423 meters

SHOOTER AIDS

As mentioned above, you can also enlist the help of a shooter aid such as the Mil Dot Master (MDM) that will take the math out of this effort and provide you with an quick firing solution. The MDM is easy to use and will offer the shooter with more options than most will ever need (such as slant range corrections). For those interested in the MDM, I encourage you to visit their web site at www.mildot.com where you can use a virtual example. One lat word on the MDM, you MUST read the instructions and understand them for it to work, it is NOT magic and will not do all the work for you.



Another form of shooter aide is what is termed a "cheat sheet". This is a spreadsheet like form that shows mils read on one side and target size across the top. This is a simplified version of the MDM but does not require any sliding or moving of anything. Down side is that it only does one thing, provide range from target size and mils read. I will provide a larger version of this diagram at the end of this manual.

TABLE OF MILS FOR OBJECTS IN INCHES

INCHES		9	12	16	18	20	22	24	28	32
YARDS		.250	.333	.444	.500	.556	.611	.667	.778	.889
MIL	1	250	333	445	500	556	611	667	778	889
MIL	1.5	167	222	296	333	371	407	445	519	593
MIL	2	125	167	222	250	278	306	334	389	445
MIL	2.5	100	133	178	200	222	244	267	311	356
MIL	3	83	111	148	167	185	204	222	259	296
MIL	3.5	71	95	127	143	159	175	191	222	254
MIL	4	63	83	111	125	139	153	167	195	222
MIL	4.5	56	74	99	111	124	136	148	173	197
MIL	5	50	67	89	100	111	122	133	156	178
MIL	5.5	45	61	81	91	101	111	121	141	162
MIL	6	42	56	74	83	93	102	111	130	148
MIL	6.5	38	51	68	77	86	94	103	120	137
MIL	7	36	48	63	71	79	87	95	111	127

So you can see Mr. Ground Hog is about to have some problems if you can also call the wind and hold the target which brings us to the next subject, using the reticle to hold for wind.

HOW TO TRAIN AT RANGE ESTIMATION

Here are some pointers for increasing your range estimation skill.

- Construct several targets of known dimension such as 1-yard square (the more the better) and number so that the number can be seen from a distance (the number should be about the size of the target)
- Σ • Place these targets out at various ranges ensuring that they can be seen from the start point if possible across varied terrain. The targets should be placed in locations that are accessible by vehicle to allow using the odomter. Do not determine range as you are emplacing the targets, which will only jade your efforts.
- Σ • Return to the start point and with a note pad number, the left side with the number of targets you have put out.
- Now, without aid look at the targets you have put out and estimate the range by eye. Write down this figure on your pad next to the corresponding target number. This will help you develop your "by eye" skills and assist you in estimating range by optics.
- Σ • After you have finished the "by eye" method, take up a stable shooting position with your UNLOADED rifle or mill dot equipped spotting scope.
- Σ • Using the above techniques, mil the targets writing down the mil reading after each corresponding number.
- Σ • Do the math or use the shooter aid to determine the range.
- Σ • Using the odometer (or other method such as laser range finder, map, etc) determine the actual range to the targets.
- Compare this to what you determined by eye and using mils.
- Σ • You can also do the same as above by leaving the targets in place and moving your position.
- Σ • You can also vary target size and using the calculations or shooter aid determine the range/s.

Routine exercises as above will develop your ability to accurately and quickly estimate the range to any target.

WIND HOLD OFFS

Holding off for wind although simple sounding is an extremely difficult proposition and next to range estimation the most difficult of all shooter SKILLS to master. We could devote pages to this issue and describe a variety of methods to deter-

mine wind, however this manual is about mils not wind calling. We cannot however talk about using mils to hold off winds without at least discussing winds a little.

There are three components to calling wind, identifying the wind velocity in mph, identifying wind direction, and identifying wind value in minutes of angle or mils (derived from the speed). There are several ways to accomplish these three things;

WIND VELOCITY

Wind velocity is normally expressed in miles per hour (mph) or perhaps kilometers per hour (kph). Either way, wind has a speed that must be identified/recognized. There are two ways to determine wind; use of an instrument to measure it or by visual indicators. The next aspect is where to measure/read the wind; at the shooters position, mid range or at the target. Without getting too deep into this issue I will share how I do it and you can make up your own mind.

I use visual indicators (mirage and vegetation) to identify the wind velocity and direction. I do this because I am a tactical shooter and cannot afford to use an instrument at my position without compromising it. I look at the wind at mid range and at the target because this is where the bullet is under the most contact with the wind.

There are other sources that can give you what the value of mirage or waving vegetation is, therefore I will not go into it here suffice to say that like the rest of this issue PRACTICE, PRACTICE, PRACTICE are the keys to being able to identify and call the wind.

Once you have determined the wind speed and direction, you can give it a value in MOA or Mils. The moa or mil value is normally developed through the use of ballistic charts from a variety of sources (like Sierra Bullets www.sierrabullets.com). The value will be dependent of bullet weight, muzzle velocity, wind speed and range to target.

Most experienced shooters “SWAG” the wind and shoot, what they “feel” is right. By doing, this they develop experience in what a given wind is worth in mils or minutes (note: you need to build the experience from correct speeds and values, therefore you will have to measure it in the beginning). If you determine the wind in moa you must convert it to mils then hold that IN THE DIRECTION OF THE WIND. Of course, it is much easier to determine the wind in mils thus eliminating the need to convert. Wind in mils will normally be in quarters (1/4, 1/2, 3/4, etc) keeping in mind that one-mil equals 3.375 or 3.438 moa depending on the reticle you are using.

Lets recap; if you are looking down range at a target located 300 yards from you and you determine there to be an 8 mph left to right wind present at the target. Consulting a handy wind chart you see that the wind is worth 2 moa. In order to figure out the mil hold off you have to determine what 2 moa is equates to in mils. Since there is 3.375 moa in a mil, 2 moa is 59% of a mil or just over a 1/2 mil hold TO THE LEFT. That is you place the center of the reticle 1/2 mil to the left of the target to compensate for the wind.

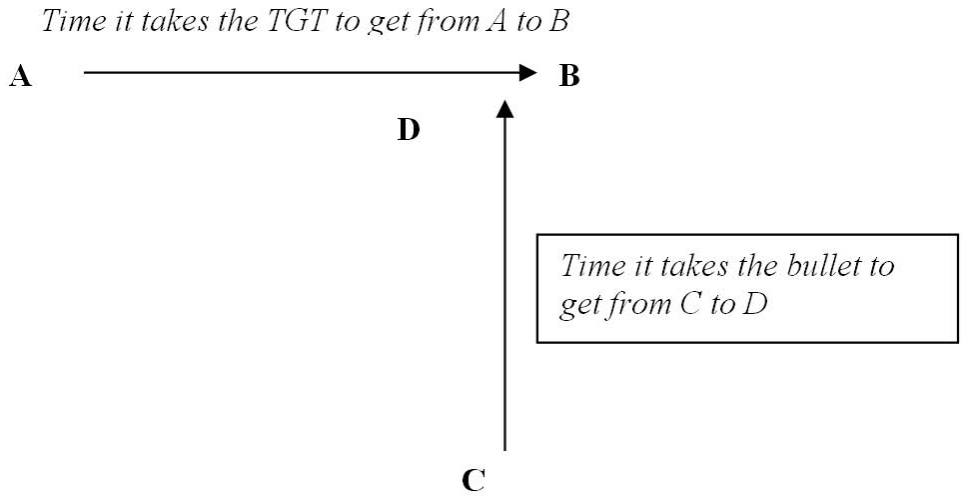
TRAINING ON CALLING WIND

Like everything else, this requires practice, practice and more practice. Unlike range estimation, wind calling will require you to also shoot to confirm or deny your call. One way to gain experience is to attend competitions even as an observer and watch experienced shooter deal with the wind. There you can see calls (you will have to make some friends there first) and the results on the target. I should mention the use of so-called “Kentucky” windage, which is usually firing multiple rounds until a hit is obtained. This may be applicable for some of you. In order to develop a skill at calling wind, you must start using known wind, for this an anemometer (wind meter) is needed. Look at the wind, make a guess and then measure it. Over time, your skill will increase to the point that you will become accurate.

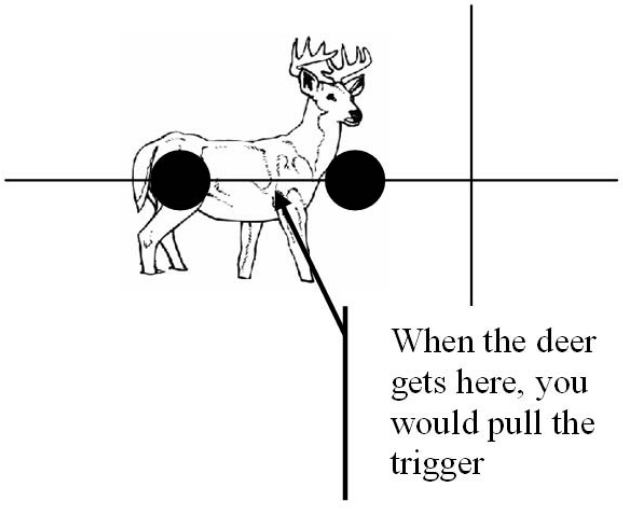
MOVING TARGETS

Some of you will use the mil dot reticle to engage moving targets. This is an extremely difficult task not to mention hard to practice. Professional shooters will use known distance ranges with moving targets to practice this skill.

There are three levels of movers; walkers, fast walk or slow run (trot) and run. You notice that I have not listed "dead sprint" or fast run, this is because engaging targets at these speeds is beyond the scope of most shooters and should not be attempted unless you are extremely skilled. Of the three speeds, you can of course further sub-divide them but you only make it harder to identify. Like wind, you must be able to determine target speed from which you can determine a "lead". A lead will be determined by not only target speed but also range to the target and caliber being used. You can mathematically calculate a lead by using a good ballistics program like that offered by Sierra Bullets to determine the "Time Of Flight" of a given projectile/caliber for a given distance. You might want to take a look at the delivered energy at that range to see where your limits should be with reference to the ability to drop the target. Once you have the TOF and range you then factor in rifle lock time and target speed to arrive at a lead.



The math that is involved here is pretty simple, but requires a little "computing". Say we are looking at a walking Deer. Lets say that the deer moves at 2 mph; seeing as how there are 5280 feet in 1 mile, therefore there are 10560 feet in 2 miles, divide this by 60 (60 minutes in an hour) and we arrive at 176 feet in a minute, divided by 60 (60 seconds in a minute) and we arrive at 2.93 feet per second. We are shooting a .308 Winchester from 300 yards using 168 grain Match King (I know it is not a preferred hunting bullet) with a muzzle velocity of 2650 feet per second and a TOF of .382677903 seconds (to travel the 300 yards). We are shooting a Remington 700 BDL with a lock time (time it takes the firing pin to hit and ignite the primer) of .003 seconds. Therefore, we add the lock time to the TOF to arrive at a total time from trigger being pulled until the bullet impacts at the target area equals .3856779 seconds (TOF plus lock time). We now have to figure out how far our target will move in the amount of time it takes for the bullet to get there. As we said the deer is moving at a speed of 2.93 fps divided by 12 gives us 35.16 inches per second. Taking this number we multiply the Total Time of Flight (TTOF) to arrive at a distance of 13.5 inches, or better said the deer will move 13.5 inches in the time it takes the bullet to reach him. 13.5 inches equals 4.5 minutes of angle at 300 yards (1 moa @ 300 yards equals 3 inches). With the given 3.375 minutes of angle to one Mil, we now arrive at a hold of 1.3 mils but since 1.3 Mil is not in the reticle, we have to use 1.25 or 1 1/4 Mils. Here it is graphically;



HOW TO TRAIN

As noted in the beginning of this section this skill is extremely difficult to train. However, if you have the means or devise some way of making a moving target in an area where you can train you should do so at every opportunity. Here are some pointers;

- Start with known target speed, preferably slow and build speed as skill increases. Do not increase target speed until you can hit them 90% or better all of the time.
- Use a target size that at a minimum replicates the kill zone of your intended target. In the beginning, a larger target should be used to show hits to allow you to adjust your leads/actions.
- Begin training at close ranges, i.e. 50 yards. Work your way back as your skill increases.
- You should use a partner positioned slightly behind your shoulder of your shooting side with a spotting scope that is as close to the line of bore as possible. He should look for bullet trace (vapor trail of the bullet) and provide you with feedback as to where the bullet is going.

QUICK MIL CHART

TABLE OF MILS FOR OBJECTS IN INCHES										
INCHES		9	12	16	18	20	22	24	28	32
YARDS		.250	.333	.444	.500	.556	.611	.667	.778	.889
MIL	1	250	333	445	500	556	611	667	778	889
MIL	1.5	167	222	296	333	371	407	445	519	593
MIL	2	125	167	222	250	278	306	334	389	445
MIL	2.5	100	133	178	200	222	244	267	311	356
MIL	3	83	111	148	167	185	204	222	259	296
MIL	3.5	71	95	127	143	159	175	191	222	254
MIL	4	63	83	111	125	139	153	167	195	222
MIL	4.5	56	74	99	111	124	136	148	173	197
MIL	5	50	67	89	100	111	122	133	156	178
MIL	5.5	45	61	81	91	101	111	121	141	162
MIL	6	42	56	74	83	93	102	111	130	148
MIL	6.5	38	51	68	77	86	94	103	120	137
MIL	7	36	48	63	71	79	87	95	111	127