

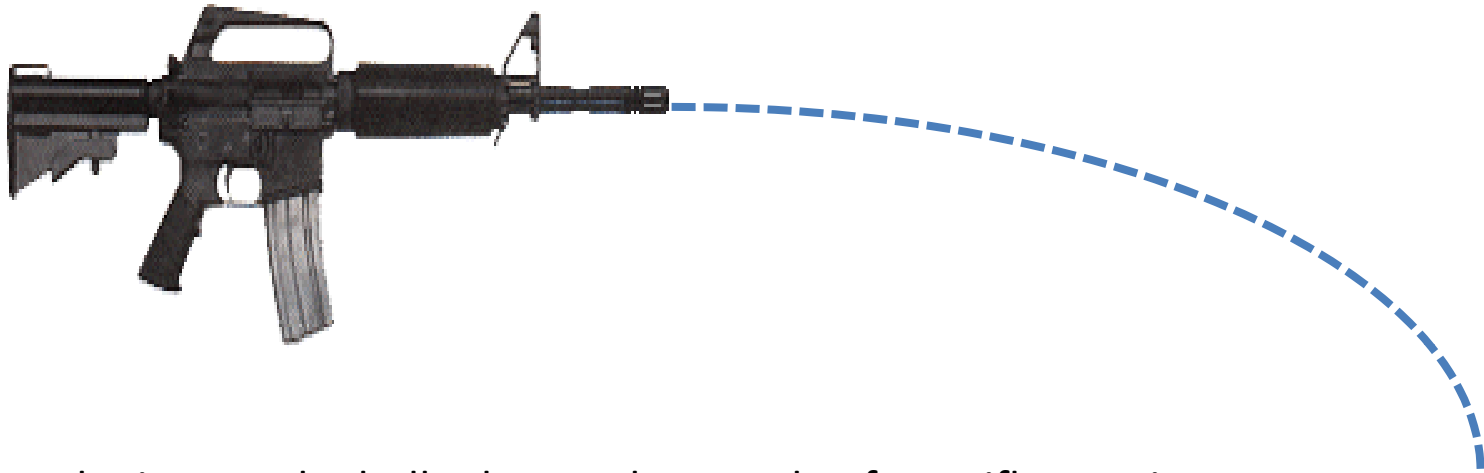


AFTS Basic Defensive Carbine

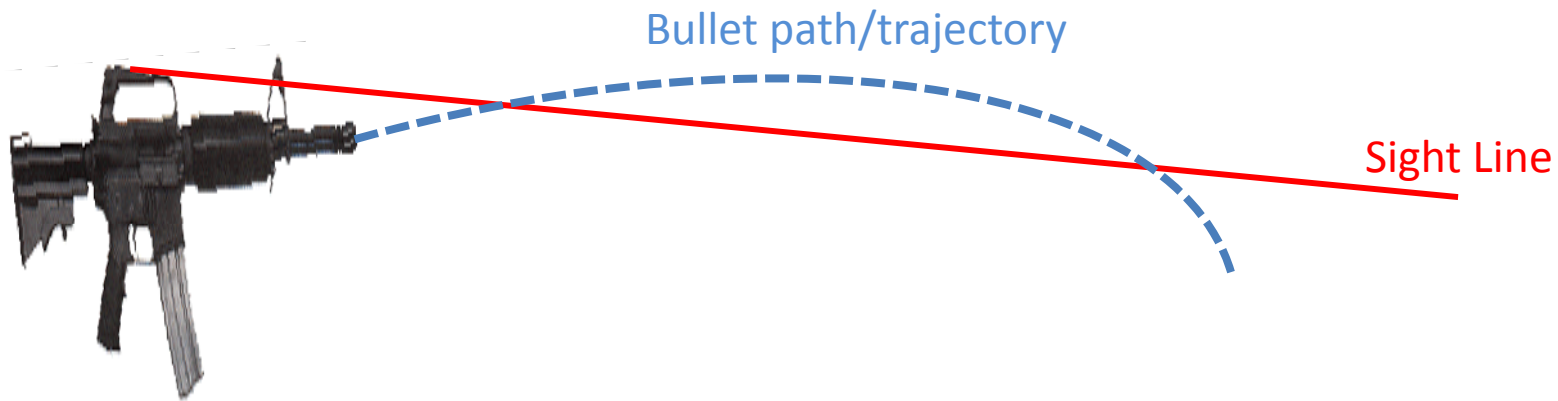
Chapter 4

Zero'ing your rifle and understanding holdovers

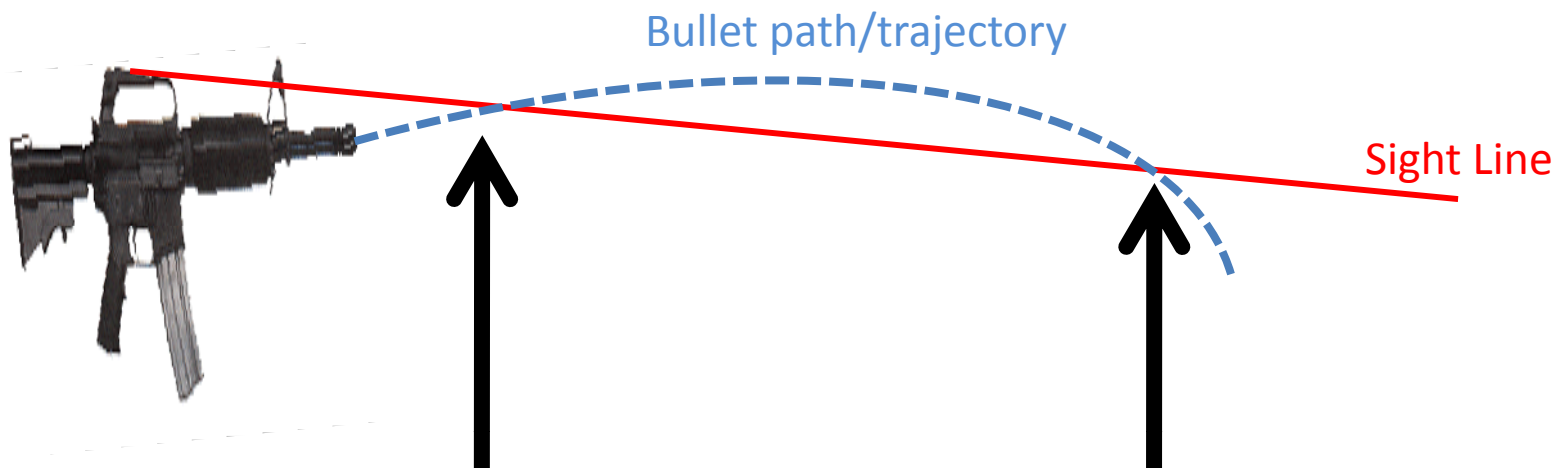
Bullet path/trajectory



The instant the bullet leaves the muzzle of our rifle, gravity begins to act on it in the vertical axis pulling it down as it travels forward.....until finally at some point it intersects with the ground....

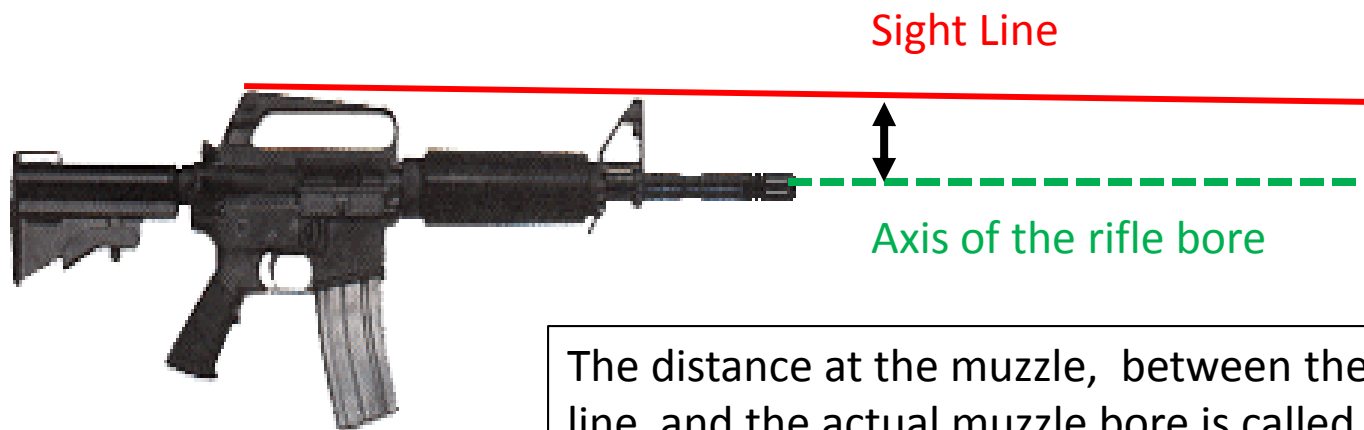


To make our sighting systems the most useful, we set them up at some vertical height above the bore axis of the rifle and effectively aim them downward at a steeper slope than the trajectory of the bullet so that the line of sight will in fact intersect that vertical path of the bullet twice during it's flight.....

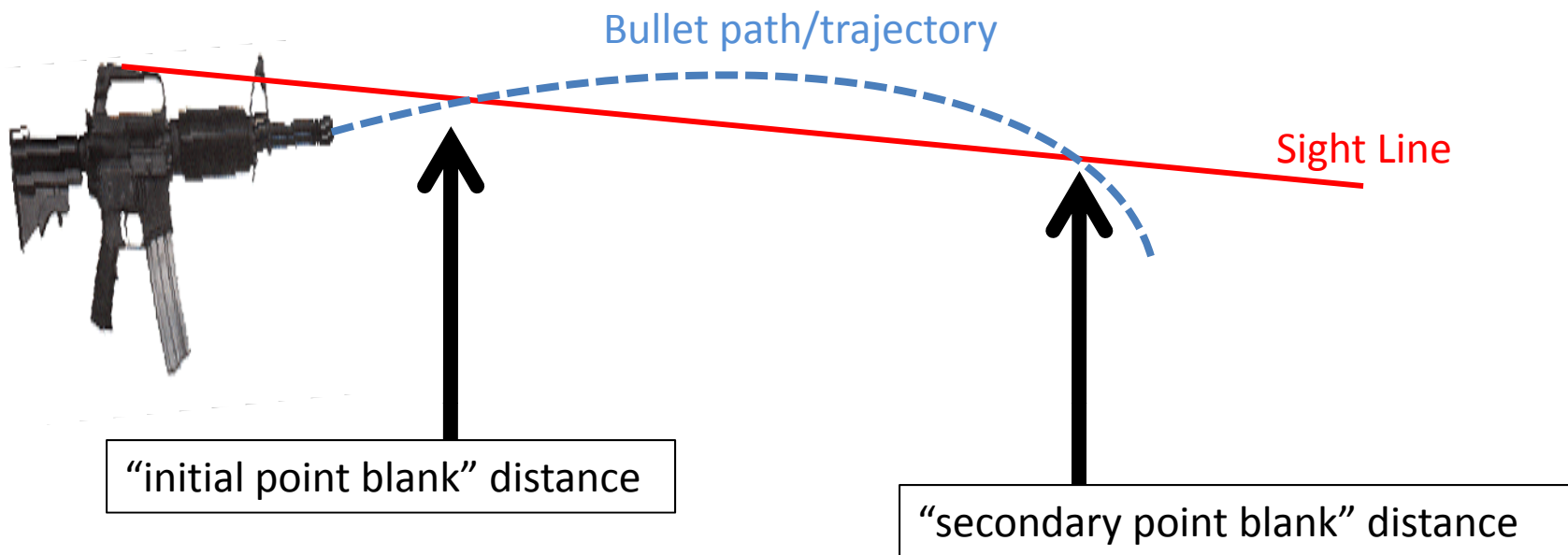


This first place the path of the bullet intersects the line of our sights is called the “initial point blank” distance

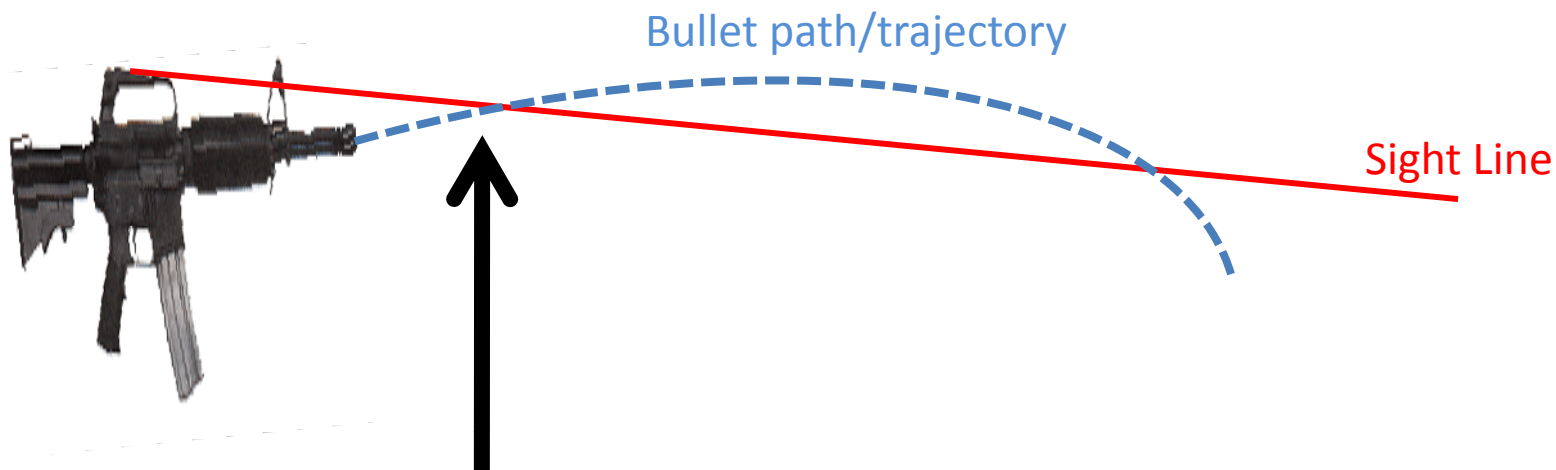
This second place the path of the bullet intersects the vertical axis of our sights is called the “secondary point blank” distance



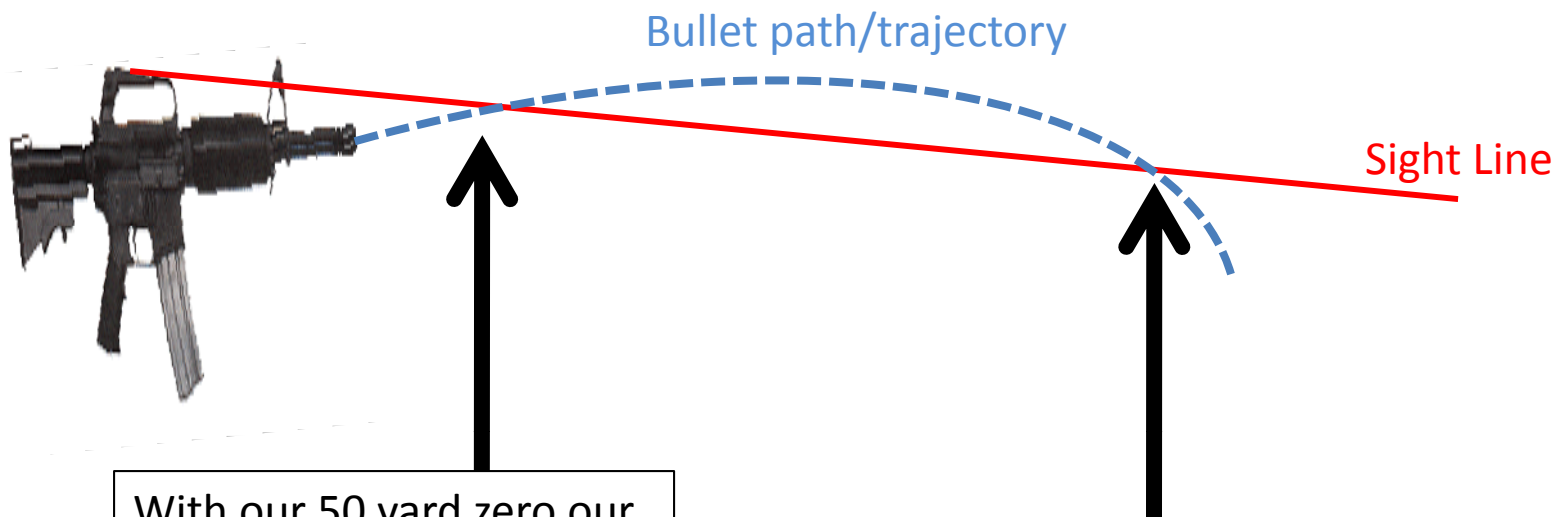
The distance at the muzzle, between the sight line and the actual muzzle bore is called **“height above bore”** and it tells us the vertical deviation between the line of sight and the path of the bullet as it exits the rifle’s barrel



When we zero our rifle, we adjust the vertical axis of the sight line to match either the initial or the secondary point blank point for our rifle at a specific distance....then when we aim the rifle we have to understand the ballistics and flight characteristics of our bullet's trajectory over the rest of the range of distances we might shoot at, so that we know where it is supposed to land at any specific distance....



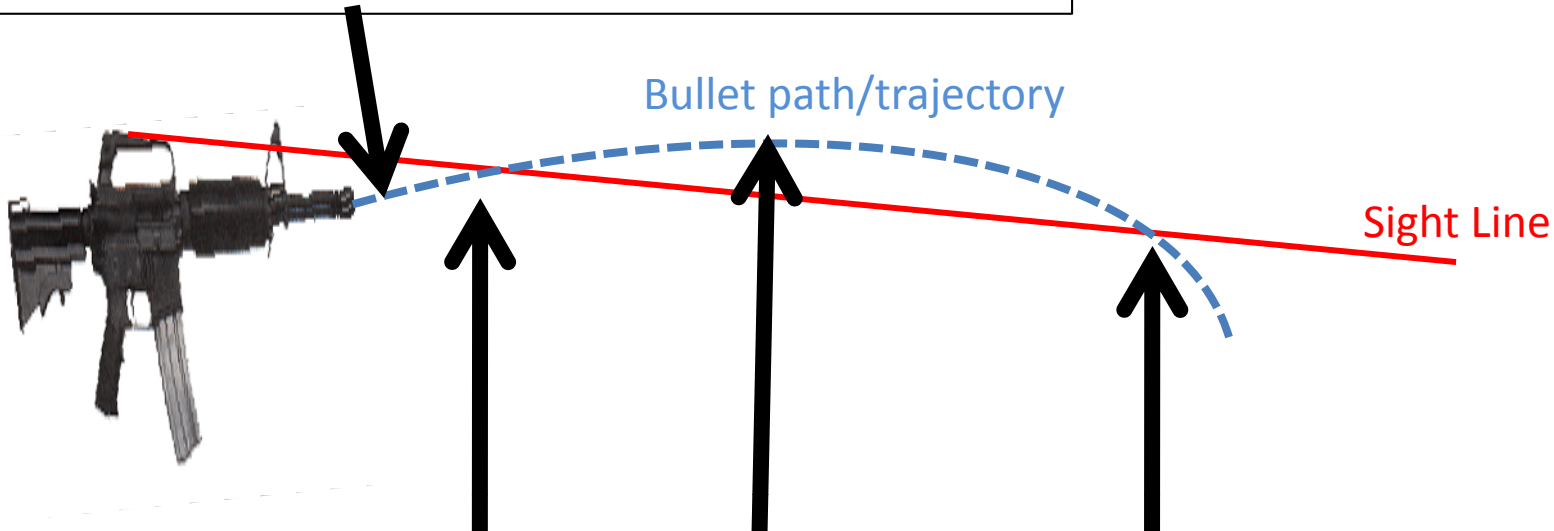
Today's zero'ing exercise, we will set our zero so that the sights are zero'ed for perfect point of aim (POA) equal to point of impact (POI) at exactly 50 yards for the initial point blank.....it is one of many zero'ing options that will work for your carbine/rifle, in the end which one is most appropriate is up to you if your choice...but for purposes of the class we will all use a 50 yard zero....



With our 50 yard zero our rifles will hit exactly where we aim at 50 yards

Based on the ballistics table or the ballistics calculator, and knowing our height above bore, our actual bullet muzzle velocity, and the ballistic coefficient of our bullet, we can calculate the second point blank and the trajectory of the bullet everywhere in between....

At close distances like 25 yards the bullet will be 2-3" below our point of aim



With our 50 yard zero our rifles will hit exactly where we aim at 50 yards

For typical M193 spec 55gr ball ammo at carbine barrel velocities, the second point blank will be at about 200 yards

For typical M193 spec 55gr ball ammo at carbine barrel velocities, at 100 yards the bullet will be 1.25 to 1.5" above our point of aim

To understand the zero and ballistics for our specific rifle/ammo combination we need to generate the correct ballistics table that tells us where the bullet is relative to our sight line at various distances...

Handloads.com has a free ballistics calculator on the web that can be used to generate these tables...it is currently at:

<http://www.handloads.com/calc/>

it will help you calculate ballistic coefficient for your bullet (small calculator on the left) and you enter data about temperature, zero distance, muzzle velocity, bullet weight, altitude, etc.....

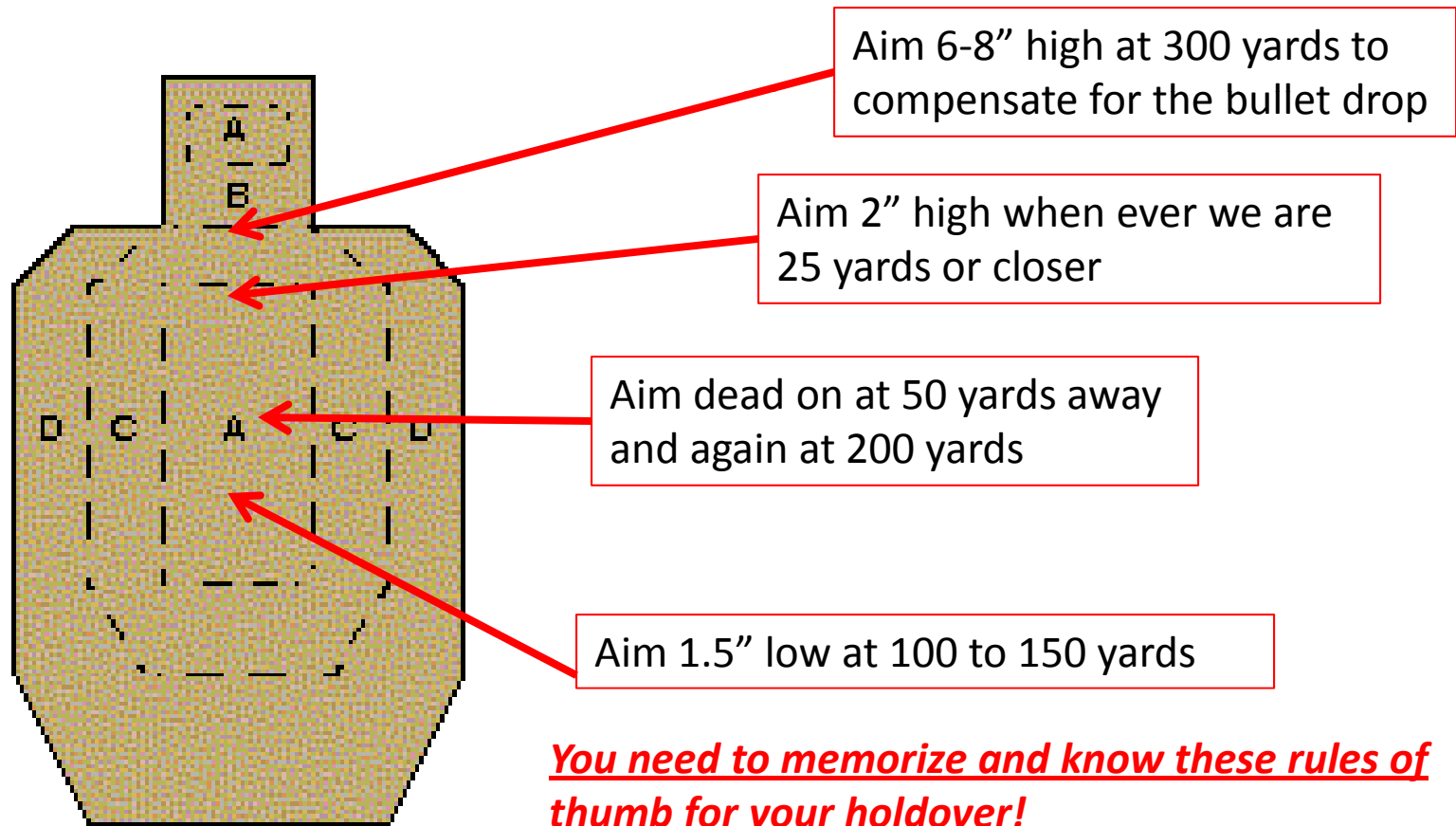
With our ballistic chart, we can chop out the part of the data that helps us determine the trajectory at various distances, then put it on a card and take it with us. This example table is for typical M193 spec 5.56 bullets fired out of a 16" M4 carbine barrel on at 80 degree day in Central Alabama

Range to Target in Yards	Point of Impact in (Inches)
0	-2.5
25	-1.12
50	0
75	0.83
100	1.36
125	1.56
150	1.41
175	0.9
200	-0.01
225	-1.34
250	-3.13
275	-5.41
300	-8.2

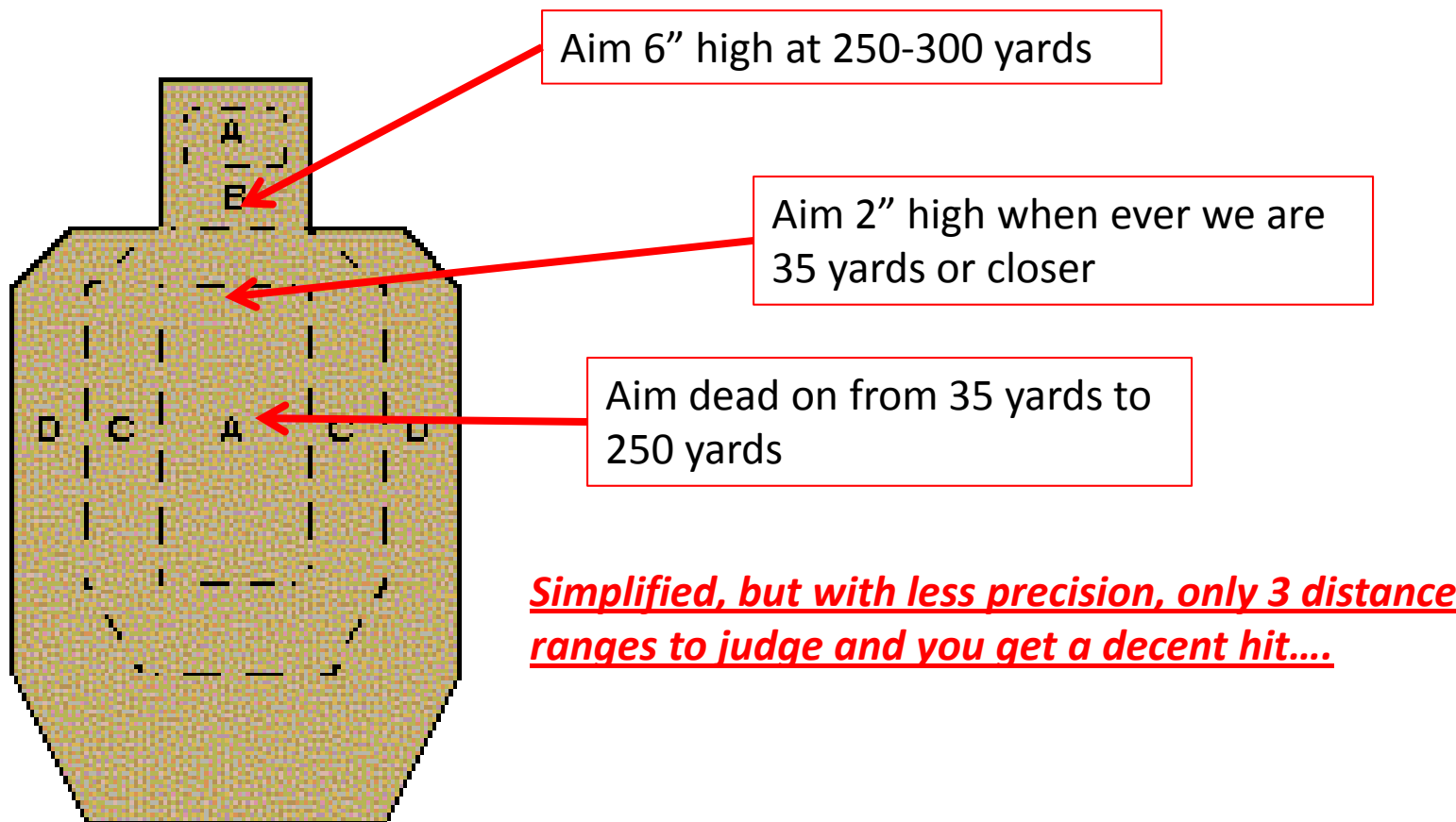
So what does all that mean in terms of aiming at our target???

We have to use “holdovers” or aim at a different point on the target from where we want the bullet to land in order to achieve the result we want....

It depends on the ammo, our barrel length, the bullet type....example, for M193 spec ball ammo out of a 16” carbine, using a 50 yard zero we can use the following simple rule of thumb to get good hits on a USPSA type target:



So what if you want a simplified hold over rule of thumb for this scenario?
One that assures we will get good hits but with less to remember and slightly less precision?



So why might my range results vary from the calculated values, why might they change over time? Some common reasons:

- Ammo velocity will vary based on the ambient temperature
- Ammo velocity can vary from lot to lot for any manufacturer
- Stated velocity by the manufacturer is often for different barrel lengths, and individual barrels exhibit different velocities even if they are the same length, barrels erode and velocity drops over time
- Light conditions will impact your zero, time of day, bright or cloudy, can change your POI especially with iron sights
- Changes in your cheek weld position impact your eye's relationship to the sights, especially on iron sights this can impact your zero if your eye is not exactly in the same place with relationship to the sights when you first zero'ed
- Any sight system can be knocked out of zero or experience drift for mechanical reasons, meaning your zero moved, which is why you need to verify it often and confirm it when every you make changes to your sights
- The calculated ballistic coefficient of your bullet is approximate, your actual bullets may vary slightly based on who make them and which lot, bullet weight can also vary slightly with some manufacturers of what is nominally the same type bullet.

Bottom line, there are lots of things that can impact your zero and holdovers, you are the one responsible for understanding these principles and verifying the zero and holdovers for your rifle with that ammo you are using, and you need to commit your basic holdovers to memory in case you loose your ballistics card....

So how do I figure all of this out for different rifles and ammo combinations?

- First, make an informed zero distance choice for your intended purposes, no matter what you choose for your zero, you are the one who has to know the holdovers and be able to use them...
- Do that by using the free on line ballistic calculator and the best information you have about your ammo in your rifle to create a calculated holdover chart for your zero and this combination of ammo and barrel...
- Go to the range and zero based on your initial decision, then verify what your actual holdovers are at various distances...when verifying you can use the calculated holdovers as your initial point of aim at various distances to insure you are on the paper at least...
- Correct your hold over chart to change the theoretical to your actual results
- Now you have to commit it to memory....establish your rules of thumb for appropriate distances....