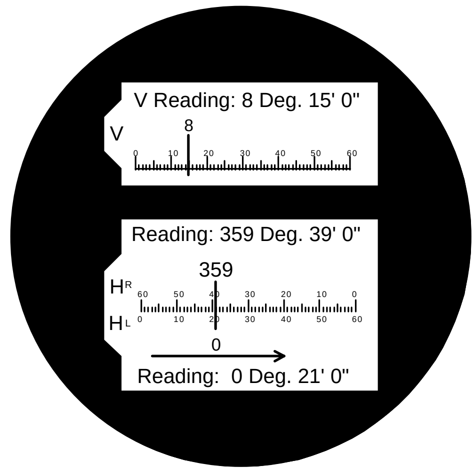
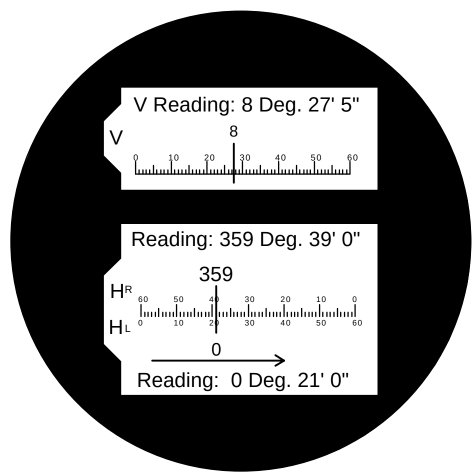
SPECIAL EXTRACT
RANGE FINDING PROCEDURES USING ANGULAR RELATION, TRIANGULATION AND THEODOLITE OPERATIONS

1. The operator places the reticle at the bottom of the target. This is the point on the target where he knows he has a solid real world measurement for height in meters and he can clearly see that point through his scope. He notes the reading for the vertical deflection. **In this case, the reading is 8 Deg. 15' 00".** Target height is 11 meters.

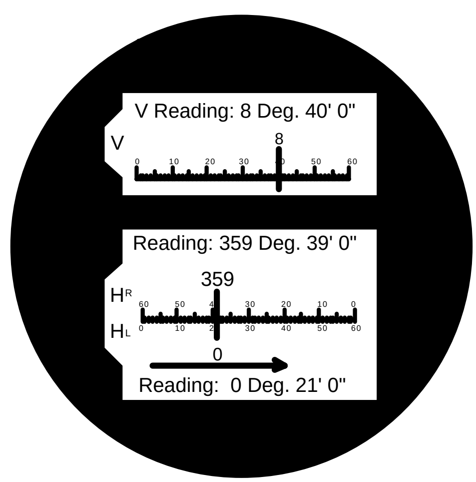


2. He will now slew the sight reticle to a point ***halfway*** up from the bottom. This is to take the slant angle setting to the target. This will also give him the angle that he needs to correct the target height's visual appearance to him based on the downhill angle to that target. The more severe this angle, the smaller the target is going to appear to him and this must be corrected for. **Mid-point reading is 8 Deg. 27' 50".** In this case, a 11-meter high target will appear to the eye to be 10.88 meters high for measurement. You can't tell this, but you know that target is 11 meters high. You can only slew the sight from the bottom to the top of the target based on what you can see of that target. There is no way to mentally project where the top of that target **would be** if the angle to the target were 0 degrees. So how do you correct for this misrepresented angle? You must take your 3rd and final reading to correct for this optical error.



3. The sight is now elevated to the top of the target and a reading is taken. The reading is 8 Deg. 40' 00". To obtain the deflection, subtract the bottom angle reading from the top angle reading. Remember to convert your angles to decimal format to subtract.

- 8 Deg. 40' 0" (8.66667 Deg) – 8 Deg. 15' 0" (8.25000) = .41667 or 0 Deg. 25' 00"



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- Angle C (Vertical) = 0 Deg. 25' 00"

4. Remember we said that because there is an 8+ degree angle to the target, that target is going to appear smaller to the operator. He can only take a reading on what he sees and cannot project where the top of the target would be on a horizontal plane (0 degree angle to target). Now is the time to correct the vertical deflection for that optical error. Here are the steps to correct the vertical deflection.

- Total height of target in Deg Min Sec = 0 Deg 25' 0"
- Angle to Target = 8 Deg. 27' 5"

CALCULATOR SEQUENCE

- Enter > .25
- Divide by
- Enter > 8.275
- COS key
- =
- **.25263 corrected Angle C (this is not in decimal format, don't change it)**

5. Now, how much does this minor correction affect the range to the target and the subsequent MOA elevation setting? Let's find out.

- Using an uncorrected 0 deg. 25' 0" / Range = 1513 meters / 79.75 MOA
- Using the corrected angle of 25' 26.3" / Range = 1487 meters / 77 MOA
- A difference of 2.75 minutes of angle at 1500 meters = a difference in the strike of the round by 47" on the target. Not too bad, but can you afford it? We haven't even corrected this data for slant angle to the target and the other MET and ENV conditions. The errors add up fast.

NOTE: Whenever you are reading the angle to target and you are shooting uphill or downhill, the target is going to appear farther away from you. When you correct the deflection for this angle, your range number should be smaller. If the range number is larger, you multiplied instead of divided. ***Remember you still must correct the True Range to target for the slant angle.***

The two effects are not the same. The first, the optical error due to angle corrects the apparent size of the target for range. The second, correcting the True Range for the Slant Angle, corrects the range for the effects of gravity.

This all sounds rather long and drawn out. The first couple of times it is. As you practice the use of the calculator and learn how to use the different memory capabilities, you will speed up. In the appendix for calculator operations, there are programs that are written for the Hewlett-Packard HP20S scientific calculator. This is the only (as far as I know) calculator that is easily programmed using keystroke programming. It's the best.

SAMPLE OF CALCFORM FOR VERTICAL ANGULAR DEFLECTION

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THEODOLITE RANGE FINDING

It is important to note that when obtaining a deflection on a target that is not 90 deg. to the position of the station, there will be an error in the range. In this case "Vertical Angular Deflection" will provide the best solution.

(Size of Target in Meters) X SIN of Angle B **(Big Angle)**
SIN of Angle C **(Small Angle, the deflection)**

VERTICAL ANGULAR DEFLECTION w/ Correction for ~~Slant Angle to Target~~

1. The vertical scale on theodolites cannot be "zeroed".
2. Pickup the bottom of the target to be ranged and enter the reading. **8 Deg 15' 0"**
3. Slew the reticle to the top of the target to be range and enter: **8 Deg 40' 0"**
4. Take a mid-point reading for your slant range **8 Deg 27' 30"**
5. Convert the first reading (1.) to decimal format: **8.25000**
6. Convert the second reading (2.) to decimal format: **8.6667**
7. Subtract smaller deflection from the larger deflection. Angle C = **0 Deg 25' 0"**
   Leave in decimal format and press the SIN key. Enter here. SIN Ang. C = **.00727**

CONTINUE WITH STEP 8 IF THERE IS SLANT ANGLE INVOLVED IN ANGLE C

8. Correct Angle C for Slant Angle Optical Error.
- **Enter > Angle C Reading =**
- **Divide by**
- **Enter > Angle to Target in decimal Degrees.**
- **COS key** **.42397 Deg.**
- **= Corrected Angle C Reading** **Corr SIN Angle C= .00740**

9. - Enter "90" on the calculator
- Hit the (-) key
- Enter the actual **corrected Angle C** deflection in decimal format. (i.e. .10' 22") to (.17278)
- Hit the (=) key
- This is the Angle B in decimal format. Convert to DMS.
- - Hit the (SIN) key and enter in the box SIN Ang. B= **.99997** 7

10. **Enter the size of the target in METERS** **11 METERS** 8

11. **EXECUTE THE FORMULA**

Data in Box 8. Data in Box 7.

11 Meters x **.99993**

DIVIDE BY

Data in Box 6 **.00740**

11. **RANGE TO TARGET =** **1487 Meters**

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SUMMARY

The shooting aspect of sniping is all about unknown distance shooting. They're a good number of target shooters out there that can put shots into the 10 and X ring all day long. That's there craft and they're the masters of it. Add the unknown distance factor to this and many of these shooters falls short. Who wouldn't? Determining the range to a target has long been one of the two major problems of military sniping. The other major problem, that being winds, affects any shooting discipline. We're all in that one together. In this chapter, you have been presented with the full spectrum of methods for determining a range to the target. Every method here is a passive method. Laser range finders and their use are covered in an Appendix. They are not given much credence here. When they do work, they are simple to operate, yet seem NOT to solve the problem of determining the distance to the target.

All of the methods presented; appearance of objects, Mil relation, Angular relation and finally triangulation have their place in sniping operations. Sure, Mil relation can work on hard targets of large size, using the optic on the rifle. Yet, frequently the target is not where you are at the same time. This requires that you determine the range to a point on the ground. Mil relation won't work in this instance. At times, you may be able to actually measure the distance to the target using a tape measure. Targets getting this kind of attention are special indeed. There are a couple of other methods that are addressed in Chapter 9, Mission Analysis for the Sniper. As with Chapter 3, constant practice with the scientific calculator and your special instruments are a key to success. Allowing yourself to get rusty using these advanced techniques only insures misses on first or second shots at these extreme ranges. On one hand that may be not too bad, on the other, well you know the rest. In sniper matches that I have attended, the biggest factor that separates the wheat

from the chaff on field shoots is determining the range to the target. However, there are tricks. For these, refer to Chapter 6, Application of Fire.