# Teesside Rifle & Pistol Club

Home Office Approved Club CFP/10/1/7/4/1/2/1/2/3/72
National Rifle Association affiliated C1363
www.trpc.club

## SCC Precursor Training – External Ballistics

### *External ballistics exercise at 100m on selected Catterick ranges*

External ballistics is concerned with the bullet's behaviour between the barrel and the target.

This exercise requires you to undertake some online research, produce and understand trajectory tables, to shoot and make the necessary sight adjustments, compare the predicted trajectories *vs.* real world results, and maintain records of correct sight settings for a given rifle/ammunition combination over specified distances.

You will normally use one of the Club's rifles:

1. the CZ .223 with S&B ball ammunition (55g FMJ bullet)
2. the Remington .308 with S&B ball ammunition (147g FMJ bullet)
3. the Parker-Hale 7.62 with S&B ball ammunition (147g FMJ bullet).

Rifles 2 & 3 are essentially equivalents so we will treat them as a single entity.

You will use whichever rifle is available at the time so you must do this exercise for both rifles and ammunition[1].

The sights on these rifles have Zero-Stop devices. If you wind the elevation turret to the bottom of its adjustment it will be at (or very near) to a 100m zero with the specified ammunition. Adjustments on these scopes are ¼ MOA per click. Before you shoot, verify whether the scope in use rotates clockwise or *counter*-clockwise to lower the elevation to the Zero-Stop. If you do not know what MOA means, do some research.

**Task 1** – find muzzle velocities in feet-per-second for both types of S&B ammunition.

- .308 Win 147g FMJ =
- .223 Rem 55g FMJ =

The ballistic coefficient of a missile is the extent to which it is able to overcome air resistance. We are concerned with so-called G1 coefficients which have a value between 0.0 and 1.0.

**Task 2** – find out the G1 ballistic coefficients for the two S&B bullets.

- .308 Win 147g FMJ =
- .223 Rem 55g FMJ =

[1] You may use your own rifle and ammunition but you will have to go through the same process for your rifle <u>in addition to</u> completing the exercise for the .223 and .308 even if you use your own rifle.

**Task 3** – use a ballistics calculator to produce a trajectory table using the parameters below. The table must go from 100m to 600m in 100m intervals. Print a hard copy or download it to your phone/tablet.

Parameters you may need are (the CZ .223 first then the Remington .308/PH)

bullet diameter .224" or .308"

bullet mass 55g or 147g

ballistic coefficient – the numbers you found in Task 2

barrel length 25½" (65cm) or 24" (61cm)

right-hand twist 1:8" or 1:14"

sight height above bore 2" (both rifles)

zero distance is 100m

scope has ¼ MOA clicks

90° crosswind at 10mph

elevation 1,000 feet AMSL

temperature 15°C

Tip: you might not need all of these parameters.

Your trajectory table should show the elevation corrections to be made in MOA and clicks in 100m intervals from 100m to 600m. It should also include windage adjustments for the 'standard' 90° wind at 10mph.

**Task 4** – study your trajectory table and determine the point of impact change on a target which is 100m from the rifle when setting the sights for 200m, 300m ... 600m while maintaining the same point of aim on the target. That is, if your rifle is zeroed at 100m and your target is 100m from you, what should be the effect on the point of impact on the target of changing your sight setting to 200m, 300m ... 600m provided you always aim at the same point on the target?

You will need to write down or print on paper the elevation corrections and the points of impact on the target at 100 yards for the various sight settings 100, 200 ... 600m. Hand this to your instructor for review.

**Task 5** – study your trajectory table and undertake research as necessary. What is the effect of a 10mph cross wind coming from a 1 o'clock direction, compared to one from 2 or 3 o'clock? What about a 4, 5, 6 o'clock direction? What effect does a 3 o'clock wind have on your bullet's elevation? Clue: you have a rifle with a right-hand twist. Is this effect on your bullet's elevation of significance if shooting at 300m or less?

**Task 6** – putting it into practice. Show your data, calculations, and trajectory table to one of the Club's instructors. You can do this on the range or in advance. On a suitable range, meaning at 100m, use masking tape to secure a trajectory target to the screen/Fig 11 board. The lower edge of the paper is to be at least 12" from the bottom edge of the screen/board. The trajectory target will have a 2" (5cm) orange disc at the foot . This is the aiming mark. The vertical line from the centre of the aiming mark to the top of the paper must be installed vertically. A spirit level and/or plumb line will be available.

Using the selected rifle and ammunition, verify the sight is set to 100m and fire two rounds. The two bullets must strike the centre of the aiming mark. If they do not, make necessary adjustments and fire more shots to correct the sight but not on the trajectory target. It is absolutely critical that the rifle is properly zeroed at 100m. In this exercise, we are concerned exclusively with elevation. It is acceptable for someone else to spot for you and assist in confirming the rifle is zeroed at 100m. However, no one is to comment on where your shots strike the target while you undertake the trajectory exercise itself. Once the Club Instructor verifies the rifle is zeroed at 100m you will execute the following procedure. Throughout the exercise, you will aim only at the centre of the aiming mark (the orange disc).

Refer to your trajectory table and make the relevant adjustment to the sight for 200m and shoot three rounds. Next make the sight adjustment for 300m and shoot again. Repeat the process up to the 600m setting. When complete, you will have five sets of three bullet holes on the target representing your sight settings for 200, 300, 400, 500 and 600m.

Carefully, return the sight to your 400m setting and fire the three final rounds. If your data, your adjustments to the sight, the sight itself, the ammunition and your shooting are all reliable then these final three rounds should land at the same point of impact as the previous three shots at the 400m setting (i.e. on the way up). You should now have six bullet holes clustered at the 400m point.

Once you have fired all 20 rounds you may recover your target when the RCO gives permission. When you have recovered your target, refer to your trajectory tables and using a tape measure and Sharpie mark off your predicted points of impact for each sight setting, i.e. 100m, 200m, ... 600m. See Figure 1 below.

Now assess whether the mean points of impact of the rounds you fired *did* strike the target where predicted by your trajectory tables with respect to elevation only – ignore any effect of a side wind. If the bullets did not strike at the elevation expected, is there any consistency: did they all strike high/low? What could be the cause? Did your second set of three rounds at the 400m setting strike the same point of impact as the first set at 400m? If not, what could be the cause? Clue: it is unlikely to be any mechanical fault on the part of the scope or rifle and it won't be the ammunition. What does that leave?

Write your name, the date, the name of the range, details of the rifle and the ammunition on the target. Take a photograph of the target. Remove and hand the target to the Club Instructor as it will form documentation for your SCC training. Make a written record in your notebook of the predicted *vs*. actual mean points of impact. If the predictions and reality differ, make a note of what corrections would be necessary to the riflescope (e.g. your predicted adjustment is 20 MOA but it actually needs 22 MOA – write it down so that you know the correct setting for next time). If time permits you may place a fresh target on the board, make the sight corrections you think are now necessary and shoot further groups to determine whether you are correct. Do this for the 400 to 600m settings only as any errors will be more obvious than setting for 100-300m, say. Again, write down the results.

Figure 1 below shows the results of a trajectory test completed by Mathew Harrison on 18 May 24. The sheet was blank during the shooting phase and the distance marks were applied only *after* the target had been shot and the cross lines reflect Mathew's trajectory table (see Task 3). Note two different points of impact at 400m. All six bullets should be clustered together but they are not.

Having done this exercise and recorded the results, Mathew could go to a 600m range such as Peatfell, set his sight to the relevant setting and expect his first shot to be on the 4'x4' target. This illustrates why it is essential for everyone to understand trajectories, distances, minutes of angle, sight settings and record them in a notebook.

It is worth repeating: the crossing lines and distances are applied only after the shooting phase is complete.

This exercise is mandatory for those seeking the Shooter's Certificate of Competence and is to be completed prior to the classroom lessons. Liaise with the Training Officer or Secretary.

The exercise may be undertaken by any member – including those who already have the SCC – and, indeed, is recommended.

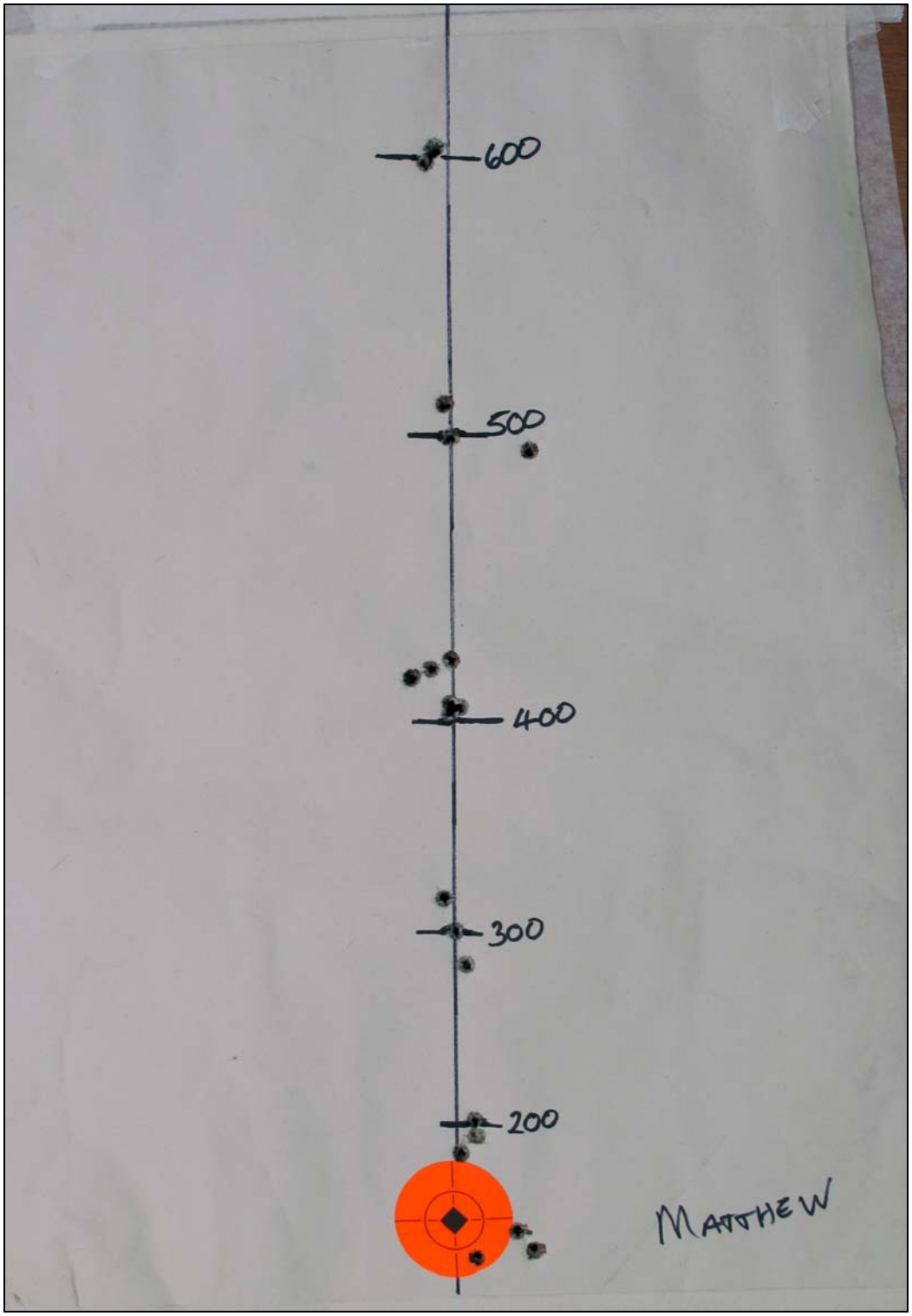


Figure 1 – Mathew Harrison's trajectory results