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UNITED STATES MARINE CORPS
WEAPONS TRAINING BATTALION
MARINE CORPS COMBAT DEVELOPMENT COMMAND
QUANTICO, VIRGINIA 22134-5040

DETAILED INSTRUCTOR GUIDE

LESSON TITLE

RIFLE ZEROING

COURSE TITLE

ANNUAL RIFLE TRAINING



UNITED STATES MARINE CORPS
Weapons Training Battalion
Marine Corps Combat Development Command
Quantico, Virginia 22134-5040

DETAILED OUTLINE

RIFLE ZEROING

INTRODUCTION

(3 MIN)

1. GAIN ATTENTION. The bottom line for the rifleman is to develop skills that will enable him to become combat effective. It is essential for an individual to know how to zero or adjust the elevation and windage settings of his RCO to cause the shots to impact where the individual aims. Zeroing the RCO allows for a starting point in which a shooter can engage targets from various distances under myriad of weather conditions. The ability to analyze a shot group and apply zeroing fundamentals is an essential skill that will ensure accuracy during training and in combat.

2. OVERVIEW. This lesson will cover zeroing the service rifle/carbine to include elements of zeroing; AN PVQ-31A/B, windage and elevation rules; elevation and windage adjuster; steps to zeroing; and factors affecting a battlesight zero (BZO)/causing a BZO to be reconfirmed.

3. INTRODUCE LEARNING OBJECTIVES. The Terminal Learning Objective and Enabling Learning Objectives pertaining to this lesson are as follows:

a. TERMINAL LEARNING OBJECTIVE. Given a service rifle/carbine, RCO, sling, magazines, cartridge belt, magazine retention device (pouches or load-bearing vest), ammunition, target, and data book, without the aid of references, zero the rifle/carbine IAW MCRP 3-01A. (0300.M16.1004)

b. ENABLING LEARNING OBJECTIVES

1) Given a service rifle/carbine, RCO, sling, magazines, cartridge belt, magazine retention device (pouches or load-bearing vest), ammunition, target, and data book, without the aid of references, employ the windage and elevation rules to establish a battlesight zero (BZO) IAW MCRP 3-01A. (0300.M16.1004b)

2) Given a service rifle/carbine, RCO, sling, magazines, cartridge belt, magazine retention device (pouches or load-bearing vest), ammunition, target, and data book, without the aid of references, triangulate the shot group to find the center IAW MCRP 3-01A. (0300.M16.1004c)



4. METHOD. This lesson will be taught in a classroom setting using lecture.

5. EVALUATION. The Marine will be evaluated during Table 1 Firing.

TRANSITION: There are five basic elements involved in zeroing a rifle; line of sight, aiming point, centerline of the bore, trajectory, and range. To zero the rifle, these elements must physically and mechanically coincide at a given point. It is your responsibility to get consistent hits on the target with your rifle. This is accomplished by zeroing your rifle at 100m, and determining and utilizing the BDC with your RCO to strike the center of the target at a particular range. But to do this, you must understand the elements of zeroing.

BODY

(1 HR 10 MIN)

1. (5 MIN) ELEMENTS OF ZEROING

(ON SLIDE #1)

To accurately engage targets, the strike of the bullet must coincide with your point of aim on the target. This must be done while compensating for the range to the target. This is accomplished by utilizing the BDC in the RCO to achieve point of aim/point of impact at different ranges. This process is called zeroing and it is a critical element of accurate target engagement.

- a. Line of Sight. Line of sight is a straight line beginning at the center of the eye, passing through the center of the ocular lens and then across the reticule to the exact point of aim on the target.
- b. Aiming Point. The aiming point is the precise point where the reticule is placed on the target while maintaining a full field of view with no scope shadow.
- c. Centerline of Bore. Centerline of the bore is an imaginary straight line beginning at the chamber end of the barrel, proceeding out of the muzzle, and continuing indefinitely.
- d. Trajectory. A bullet does not follow a straight line to the target. Instead, a bullet travels in a curved path, or arc, which is called the bullet trajectory.

1) This trajectory occurs because of the earth's gravity, which pulls the bullet down toward the ground as soon as the bullet leaves the rifle's barrel. The rate of this curvature increases as the bullet's speed



decreases.

2) To compensate for this effect so that the bullet will impact the target, the muzzle of the rifle must be elevated by applying elevation to the rifle sights.

3) The greater the distance to the target, the higher the bullet's trajectory must be to impact the target. Therefore, the greater the distance to the target, the BDC within the RCO must be used to accurately engage targets.

4) The RCO has a Bullet Drop Compensator to assist with the making adjustments in sight picture based on the trajectory of the bullet in its flight to the target.

e. Range. Range is the known distance from the rifle to the target.

Confirm by questions.

TRANSITION: Now that we understand the elements of zeroing we can discuss the type of zero we will use with the RCO.

2. BZO

a. Battlesight Zero (BZO). The RCO is designed to be used with both eyes open from muzzle to 300 meters for quick target acquisition and engagement. This allows the RCO to be used as a reflexive sight when SPEED is CRITICAL at these distances. In order to achieve this sighting ability the RCO should be zeroed at 100M. A field expedient BZO can be conducted at 25M or 36 yards but should only be used to get the shots on paper, so that BZO can be done from 100m.

Confirm by questions.

TRANSITION: To zero the rifle, the first step is to determine the correct adjustments to strike the center of the target. The windage and elevation rules define these adjustments and these rules must be used to make accurate adjustments on the RCO.

3. (23 MIN) SIGHTING SYSTEM/WINDAGE AND ELEVATION RULES

a. Sighting System. The RCO is capable of being adjusted to achieve POA/POI. The adjusters are set to move in 1/3 minute of angle (MOA) per click. Moving either the elevation or windage adjusters one graduation or notch is referred to as moving one "click" on the scope.



1) To raise the strike of the bullet, rotate the elevation adjuster clockwise or to the right. To lower the strike of the bullet, rotate the adjuster counterclockwise or to the left.

2) To move the strike of the bullet to the right, rotate the windage adjuster clockwise or to the right. To move the strike of the bullet to the left, rotate the adjuster counterclockwise or to the left.

b. Windage and Elevation Rules

1) Definition. The windage and elevation rules define how far the strike of the bullet will move on the target for each click of either the elevation or the windage adjusters each 100 yards of range to the target, with the RCO the 100m sets the BDC and the windage and elevation knobs shouldn't be changed, the offset aiming technique should be used after the 100m BZO.

2) Principles. The easiest way to understand the windage and elevation rules is to first analyze where the bullet struck the target. If an adjustment needs to be made up or down to hit the center of the target, adjust the elevation on your RCO. If an adjustment needs to be made right or left to hit the center of the target, adjust the windage.

a) Elevation Rule. One click on the elevation adjuster will move the strike of the bullet on the target approximately 1/3 inch at 100 meters.

b) Windage Rule. One click of windage adjustment will move the strike of the bullet on the target approximately 1/3 inch for every 100 meters.

c) Adjustment increments are approximately 1/3 inch per click at 100 meters. This means that three (3) clicks are required to move the bullet impact one inch on a target at 100 meters. One click is required to move the bullet impact one inch at 300m. At 36 yards field expedient zero, nine (9) clicks are required to move the bullet impact one inch or twelve (12) clicks move bullet strike one inch at 25 meters.

d) The AN/PVQ-31 (RCO) is internally adjustable. The adjuster screw need only position the internal roof prism. For this reason, the first shot will set the prism into its new position and follow up shots will be in the new adjusted position.

Confirm by questions.



TRANSITION: We will now cover the basic steps to determine proper adjustments to enable shots to be placed in the center of the target.

4. (20 MIN) STEPS TO ZERO THE RCO. Prior to any attempt at zeroing or live fire of the RCO the user must ensure proper mounting procedures are followed in accordance with the TM.

Although the RCO's are not dedicated sniper scopes, it is important to obtain a precise zero. If a Marine zeroing the weapon accepts a 25-meter zero that is off by only 1 inch, that angle grows to 32 inches at 800 meters. It is critical that the shooter obtain a precise zero. This will greatly enhance the shooter's ability to engage targets successfully.

a. Range. For a Field Expedient BZO, the optic may be zeroed at 25 meters or 36 yards using the tip of the 300 meters aiming post as POA/POI. A 25-meter or 36-yard field expedient zero is less precise than a 100-meter zero; therefore, the zeroing should be conducted at a range of 100 meters.

b. Establishing Initial Settings. The optic is shipped with a preset center from the manufacturer for the service rifle/ carbine. Normally this means that only small adjustments are necessary. **DO NOT** adjust the optic to the extremes. It is possible that over-adjustment will damage the alignment of the prism assembly inside the RCO.

c. Zeroing Process

1) When the target appears, fire a well-aimed 3-shot group at the sustained rate of fire.

2) The target will be lowered to the pits and marked indicating your 3-shot group.

3) When the spotted target is raised from the pits, plot the 3-shot group in the data book.

4) Triangulate the shot group by drawing a line to form a triangle connecting all 3 shots.

5) Locate the center of the triangle and make elevation and windage adjustments on the RCO to place the exact center of the triangle in the center of the target.

a) Determine the vertical and horizontal distances in inches between the shot group center and the center of the target.

b) Using the windage and elevation rules, make adjustments using the adjuster mechanisms located



inside the adjuster caps on the top and right-hand side of the scope. The adjustments can be made with a small screwdriver or with a bullet casing. The caps are tight to ensure a waterproof seal with the O-rings inside. The caps should only be off the scope when adjustments are being made. After an adjustment is made, screw the adjuster caps back on.

NOTE

The first round will be in about the same spot as the first group, but the recoil impulse of the rifle will cause the prism to shift with in the loctite and set to the new zero change.

- 6) When the target appears, fire 3 shots at the sustained rate of fire.
- 7) The target is lowered to the pits and marked indicating this 3-shot group.
- 8) When the spotted target is raised from the pits, plot your second 3-shot group in the data book.
- 9) Triangulate the shot group by drawing a line to form a triangle connecting all 3 shots.
- 10) Find the exact center of the triangle and make additional elevation and windage adjustments to the rifle if necessary. Again, these adjustments will be based on the distance between the center of the triangle and the center of the target.
- 11) When the target appears, fire 4 final shots to confirm the BZO on your rifle. If necessary, make final elevation or windage adjustments on the RCO at this time.
- 12) When the spotted target is raised from the pits, plot your 4-shot group in the data book.
- 13) Once the setting is confirmed this setting becomes the BZO setting for your rifle.

Confirm by questions.

TRANSITION: Table 1 firing provides the Marine with the opportunity to refine the accuracy of his sight settings from



different positions and ranges to the target. Depending on the stage of fire, the point of aim or holds used to begin that stage of fire will differ. We will walk through the objective point of aim or holds used for various stages of fire during Table 1 firing.

5. (15 MIN) ZEROING DURING TABLE 1 FIRING

a. Objective of Zeroing During Table 1 Firing. The objective of zeroing during Table 1 firing is to refine and maintain a BZO. The 300-yard rapid-fire prone stage provides the BZO setting for the rifle. Table 1 firing also enables the Marine to establish hasty points of aim or holds inside and outside his BZO range at the 200 and 500-yard lines, respectively.

b. Objective Points of Aim or Holds. To establish and maintain a BZO, the following holds should be maintained while engaging targets with the BDC:

- 1) 200 meters - use the crotch of the Chevron; but since the ranges are set up in yards use the tip of the chevron aimed higher on the able target because at 200 yards there is actually 182.88 meters, 200 meters is 218.8 yards the rise and fall of the round is only 2.1 inches from 100 -200 yards so the tip of the chevron works better as the aim point for 200 yards.
- 2) 300 meters - use the tip of the red aiming post
- 3) 500 meters - Reference point between the 4 and 6

c. Elevation and Windage Adjustments for Day 1 Table 1 Firing. The purpose of Table 1 firing is to practice and demonstrate fundamental marksmanship skills. If zero has not been established at 100 meters then Table 1 firing is also used to establish an initial zero for the rifle. Therefore, on Day 1 of training, all elevation and windage adjustments will be made at the 200 yd line, and everything after that would be done utilizing change of hold. Had an initial zero been accomplished at 100 meters the shooter will be able to begin firing at the two hundred yard line using the tip of the Chevron holding higher up on the able target without needing to make any adjustments.

- 1) 200-yard Tri-fire. Tri-fire is fired from the sitting position at 200 yards to establish an initial sight setting to begin Table 1 firing at the 200-yard line. During tri-fire, use it to find your offsets for that yard line, from the 100 meter line zeroing exercise. If there is no wind call you can adjust the sight to fine tune your zero for shooting yards.
- 2) 200-yard Slow Fire Sitting. This stage of fire



should be used to confirm your 200-yard hasty sight setting established in tri-fire.

3) 200-yard Slow Fire Kneeling and Standing. As you move from a stable firing position (sitting) to a less stable firing position (kneeling and standing), your stability of hold will decrease. This will affect shot placement because it may be difficult to obtain a stable sight picture. On Day 1 of Table 1 firing, you should not move off of your settings from 200-yard slow fire sitting, if possible, because it is a more stable position and a more accurate representation of your BZO.

4) 200-yard Rapid Fire Sitting. Use the same settings from 200-yard slow fire sitting.

5) 300-yard Slow Fire Sitting. Use the same settings from 200-yard slow fire sitting, except use the tip of the red aiming post.

6) 300-yard Rapid Fire Prone. Use the same settings from 300-yard slow fire sitting.

7) 500-yard Slow Fire Prone. Use the same settings from 300-yard rapid fire prone except you will use the reference point between the four and the six.

NOTE: You may find difficulty doing this because the aiming area is black, and the reference point on the BDC is black. You may want to hold just off to either side of the black at center mass and identify where the BDC stadia line is located in relation to the target.

d. Hold Adjustments for elevation Days 2 and 3(Qual.).
200-500 Yards. All adjustments to POI should be done using holds according to the proper use of the BDC or offset aiming techniques.

1) Offset aiming is determining where the strike of round impacts in relation to where the shooter originally aimed.

2) The shooter calculates the difference in POI from POA and holds an equal distance in the opposite direction or directions as the original shot.

3) An example would be if the shooter fires his shot and the POI is low and left, he would shift his POA higher and to the right so that his POI would be center mass.

c. Hold Adjustments for Wind for Days 2 and 3. Windage hold adjustments are made to compensate for the effects of weather. After determining the velocity, value, and direction of the wind the shooter must determine the range



to the target and the wind's impact on the bullet to determine how much of a hold into the wind the shooter must obtain. This adjustment is never permanent and is only valid for the specific wind condition and range to the target at that time.

Confirm by questions.

TRANSITION: There are factors which affect your ability to place accurate fire on a target and to maintain an accurate and stable BZO. These factors and how to compensate for them must be understood to zero accurately. There are also factors that cause a BZO to be reconfirmed. When any of these factors are present, your BZO should be reconfirmed.

6. (5 MIN) FACTORS CAUSING A BZO TO BE RECONFIRMED/AFFECTING A BZO

a. Factors Causing a BZO to be Reconfirmed

1) Maintenance. It is possible for the BZO to change if ordnance personnel perform maintenance on the rifle. If maintenance was performed, it is critical that the rifle be rezeroed as soon as possible.

2) Temperature. An extreme change in temperature will cause a change in the BZO of the weapon; the elevation will need to be adjusted.

3) Climate. Changing climates can mean changes in air density, moisture content, temperature, or barometric pressure. Any of these elements can affect the rifle's BZO. Reconfirm the BZO as soon as possible.

4) Ground Elevation. Drastic changes in ground altitude can create changes in air density, moisture content, temperature, or barometric pressure. Any of these elements can affect the rifle's BZO. Reconfirm the BZO as soon as possible.

5) Uniform. If your rifle is zeroed while in your utility uniform and fired in full battle gear, your BZO may change. A BZO must be established while wearing the uniform and equipment that will be worn while engaging targets.

INSTRUCTOR'S NOTE: *Elaborate on each of the factors affecting a BZO as necessary to assure student understanding.*

(ON SLIDE #7)



b. Factors Affecting the Accuracy of a BZO and/or Shot Placement. Anything the Marine changes from shot to shot affects the BZO on his rifle and/or shot placement. To ensure consistent shooting, complete notes should be kept in your data book analyzing your shots. These are some of the common factors that, when applied inconsistently, diminish the accuracy of your BZO and your shot groups:

- 1) Any of the five factors (forward hand, grip, right elbow, stock weld, rifle butt in the shoulder).
- 2) Stability of hold.
- 3) Sling tension.
- 4) Trigger control.
- 5) Hold.

Confirm by questions.

TRANSITION: If you understand and apply the proper procedures for zeroing your service rifle to compensate for the effects of weather and the range to the target, you will be a proficient marksman. The zeroing procedures remain the same regardless of the field situation and form the baseline for accurate target engagement.

OPPORTUNITY FOR QUESTIONS:

(1 MIN)

1. Respond to questions from the class.
2. Prompt students with questions to the class.
 - a. QUESTION: How far will one click adjustment on the elevation adjuster move the strike of a round at 100 yards?
ANSWER: 1/3 inch for every 100 yards of range from the target
 - b. QUESTION: What is offset aiming?
ANSWER: Offset aiming is adjusting your POA an equal distance from the error in POI in relation to the desired POI on the target.
 - c. QUESTION: What are some of the factors that cause a BZO to be reconfirmed?
ANSWER: Maintenance, temperature, climate, ground elevation, and uniform.



INSTRUCTOR'S NOTE: Ask Marines as many questions as necessary to ensure they fully understand the material presented in this class.

SUMMARY:

(1 MIN)

All the principles covered in this lesson are essential to becoming an effective marksman. The Marine must know how to analyze his shot groups and apply zeroing procedures to improve the accuracy of his shooting. Achieving a BZO is the starting point to developing into a combat-ready marksman. A Marine can work on the refinements of his shooting only after he has mastered the basics. Zeroing the rifle is a basic skill that the Marine must master to be successful.

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