SLR.10
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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

ZEROING THE M16A2 SERVICE RIFLE

COURSE TITLE

SUSTAINMENT LEVEL RIFLE MARKSMANSHIP (PHASE I, II, III)

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

INSTRUCTOR PREPARATION CHECKLIST

ESSENTIAL DATA

LESSON DESIGNATOR	SLR.10
LESSON TITLE	Zeroing the M16A2 Service Rifle
DATE PREPARED	1 October 1999
TIME	1 hr 15 min
METHOD	Lecture
LOCATION	Indoor/outdoor classroom
INSTRUCTORS REQUIRED	One Primary Marksmanship Instructor (PMI)
REFERENCE	MCRP 3-01A
TRAINING AIDS/EQUIPMENT	Slides (sSLR.10-1 - sSLR.10-4)

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DETAILED OUTLINE

ZEROING THE M16A2 SERVICE RIFLE

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 the Marine to know how to zero his service rifle. Zeroing is the adjusting of the elevation and windage on the service rifle to cause the shots to impact where the Marine aims. Zeroing compensates for the effects of weather and other external influences upon where the bullet impacts. The ability to analyze a shot group and apply zeroing fundamentals is an essential skill required to shoot accurately.

2. OVERVIEW. This lesson will cover zeroing the M16A2 service rifle to include elements of zeroing; types of zeros; the M16A2 sighting system and the windage and elevation rules; steps to zeroing; factors affecting a battlesight zero (BZO)/causing a BZO to be reconfirmed; field expedient BZO; and zeroing during KD firing.

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

a. TERMINAL LEARNING OBJECTIVE. Given an M16A2 service rifle, sling, cartridge belt, magazines, magazine pouches, ammunition, target, and data book, without the aid of references, zero the rifle at 300 yards/meters so a seven minute of angle (MOA) group is achieved at the center of the target IAW MCRP 3-01A. (PVTX.11.4)

b. ENABLING LEARNING OBJECTIVES

1) Without the aid of references, identify the elements of zeroing IAW MCRP 3-01A. (PVTX.11.4a)

2) Without the aid of references, identify types of zeros IAW MCRP 3-01A. (PVTX.11.4b)

3) Without the aid of references, identify the windage and elevation rules IAW MCRP 3-01A. (PVTX.11.4c)

4) Given an M16A2 service rifle, without the aid of references, adjust the sights to compensate for the effects of weather while firing IAW MCRP 3-01A. (PVTX.11.4g)

5) Given an M16A2 service rifle, sling, cartridge belt, magazines, magazine pouches, 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. (PVTX.11.4h)

6) Given an M16A2 service rifle, sling, cartridge belt, magazines, magazine pouches, ammunition, target, and data book, without the aid of references, triangulate the shot group to find the center IAW MCRP 3-01A. (PVTX.11.4i)

7) Given an M16A2 service rifle, sling, cartridge belt, magazines, magazine pouches, ammunition, target, and data book, without the aid of references, adjust the rifle sights to establish a battlesight zero (BZO) IAW
MCRP 3-01A. (PVTX.11.4j)

8) Without the aid of references, identify the conditions that cause the battlesight zero (BZO) to be reconfirmed IAW MCRP 3-01A. (PVTX.11.4k)

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

5. EVALUATION. The Marine will be evaluated in a comprehensive written examination for Phase I of this course following completion of lessons SLR.1 - SLR.12. Performance will be evaluated via a performance checklist during the BZO Exercise, SLR.16.

TRANSITION: It is your responsibility to get consistent and accurate hits on the target with your rifle. This is accomplished by zeroing your rifle--determining and applying the sight settings (windage and elevation) on your rifle 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. (2 MIN) ELEMENTS OF ZEROING

Refer to slide sSLR.10-1.

To accurately engage targets, the strike of the bullet must coincide with your aiming point on the target. This must be done while compensating for the effects of weather and the range to the target. This is accomplished by adjusting the sights on your rifle to achieve point of aim/point of impact. 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 rear sight aperture, and then across the tip of the front sight post to the exact point of aim on the target.

b. Aiming Point. The aiming point is the precise point where the tip of the front sight post is placed in relationship to the target.

c. Centerline of the 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. This is accomplished 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 with the target. Therefore, the greater the distance to the target, the greater the elevation that must be applied to the sights.

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

the target.

Confirm by questions.

TRANSITION: There are three types of zeros which must be understood if you are to zero your rifle to place rounds on target.

2. (1 MIN) TYPES OF ZEROS

a. Battlesight Zero (BZO). A BZO is the elevation and windage settings required to place a single shot, or the center of a shot group, in a predesignated location on a target at 300 yards/meters, under ideal weather conditions (i.e., no wind). A BZO is the sight settings placed on your rifle for combat. In combat, your rifle's BZO setting will enable engagement of point targets from 0 – 300 yards/meters in a no wind condition. (Note that 8/3 is the rear sight elevation knob setting for BZO.)

b. Zero. A zero is the elevation and windage settings required to place a single shot, or the center of a shot group, in a predesignated location on a target at a specific range, from a specific firing position, under specific weather conditions.

c. True Zero. A true zero is the elevation and windage settings required to place a single shot, or the center of a shot group, in a predesignated location on a target at a specific range other than 300 yards/meters, from a specific firing position, under ideal weather conditions (i.e., no wind).

Confirm by questions.

TRANSITION: To zero the rifle, the first step is to determine the correct sight 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 sight adjustments.

3. (20 MIN) SIGHTING SYSTEM/WINDAGE AND ELEVATION RULES

Refer to slide sSLR.10-2.

a. Sighting System. The sighting system of the M16A2 service rifle consists of a front sight post, a rear sight windage knob, and a rear sight elevation knob. Moving each of these sights one graduation or notch is referred to as moving one "click" on the sight.

1) Front Sight. The front sight consists of a square, rotating sight post with a four-position, spring-loaded detent. The front sight post is moved up or down when zeroing the rifle. To adjust for elevation, depress the detent and rotate the post.

a) To raise the strike of the bullet, rotate the post clockwise (in the direction of the arrow marked UP) or to the right. When rotated clockwise, the front sight post moves down into the front sight housing, causing the shooter to have to raise the muzzle of the weapon to realign the tip of the front sight post in the center of the rear sight aperture.

b) To lower the strike of the bullet, rotate the post counterclockwise or to the left. When rotated counterclockwise, the front sight post moves up and out of the front sight housing, causing the shooter to have to lower the muzzle of the weapon to realign the tip of the front sight post in the center of the rear sight aperture.

2) Rear Sight. The rear sight consists of two sight apertures, a windage knob, and an elevation knob. Of the two apertures, one is for normal range and one is for short range limited visibility engagement. The normal range aperture is unmarked and used for zeroing and most firing situations. The limited visibility aperture is the larger aperture and may be used for engagement of targets closer than 200 yards and target engagement during limited visibility or when a greater field of view is desired. This large aperture is marked '0-2' and is used only in conjunction with your established BZO.

a) Windage Knob. The windage knob is moved left or right to move the strike of the round left or right.

(1) To move the shot group to the right, rotate the windage knob clockwise (in the direction of the arrow).

(2) To move the shot group to the left, rotate the windage knob counterclockwise.

b) Elevation Knob. The rear sight elevation knob is used to move the strike of the bullet up or down. To adjust for elevation or range to the target, rotate the elevation knob so the desired setting is aligned with the index on the left side of the receiver. Each number on the knob represents a distance from the target in 100 yard/meter increments.

(1) To raise the strike of the bullet, rotate the knob clockwise in the direction of the UP arrow.

(2) To lower the strike of the bullet, rotate the knob counterclockwise in the direction of the DN arrow.

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 front/rear sight elevation or rear sight windage for each 100 yards of range to the target.

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 rifle. If an adjustment needs to be made right or left to hit the center of the target, adjust the windage.

Refer to slide sSLR.10-3.

a) Front Sight Elevation Rule. One click of front sight elevation adjustment will move the strike of the bullet on the target approximately 1 1/4 inches for every 100 yards of range from the target.

b) Rear Sight Elevation Rule. One click of rear sight elevation adjustment will move the strike of the bullet on the target approximately 1 inch for every 100 yards of range from the target.

c) Windage Rule. One click of windage adjustment will move the strike of the bullet on the target approximately 1/2 inch for every 100 yards of range

from the target.

Confirm by questions.

TRANSITION: If a Marine is to place shots in the center of the target, correct sight adjustments must be made to the rifle. This is done by observing the location of the strike of the rounds, determining their distance from the center of the target, and making appropriate adjustments to the rifle sights. We will cover the basic zeroing steps that determine proper sight adjustments to enable shots to be placed in the center of the target.

4. (20 MIN) ZEROING THE M16A2 SERVICE RIFLE

Zeroing is conducted at a range of 300 yards/meters. The rifle's sights must be adjusted so the bullet's trajectory and line of sight intersect at a range of 300 yards/meters. Zeroing at 300 yards/meters accomplishes this.

a. Establishing Initial Sight Settings. To begin the zeroing process the rifle sights are placed on a known BZO previously established or on initial sight settings. To set the sights to initial sight settings:

1) Front Sight Post. To set the front sight post to initial sight setting, depress the front sight detent and rotate the front sight post until the base of the front sight post is flush with the front sight housing.

2) Rear Sight Elevation Knob. To set the elevation knob at the initial sight setting, perform the following:

a) Rotate the rear sight elevation knob counterclockwise until the rear sight assembly is bottomed out on the upper receiver.

NOTE

Once bottomed out, the rear sight elevation knob should be three clicks counterclockwise from 8/3. If the sight fails to move three clicks counterclockwise from 8/3, it must be adjusted by a qualified armorer.

b) Rotate the rear sight elevation knob clockwise until the number 8/3 aligns with the index mark located on the left side of the upper receiver.

3) Windage Knob. To set the windage knob to initial sight setting, rotate the windage knob until the index line located on the top of the large rear sight aperture aligns with the centerline on the windage index scale located on the moveable base of the rear sight assembly.

b. Steps to Zeroing the Rifle

1) When the target appears, fire a well-aimed 3-shot group in a one minute time limit.

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

3) When the 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.

Refer to slide sSLR.10-4.

5) Locate the center of the triangle and make elevation and windage adjustments on the rifle 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 center of the shot group and the center of the target.

b) Using the windage and elevation rules, make an elevation adjustment to the front sight post, moving the center of the shot group to the center of the target.

c) Using the windage and elevation rules, make a windage adjustment to the windage knob, moving the center of the shot group to the center of the target.

6) When the target appears, fire a well-aimed 3-shot group in a one minute time limit.

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

8) When the target is raised from the pits, plot the 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 in one minute to confirm the sight setting on your rifle. If necessary, make final elevation or windage adjustments on the rifle at this time.

12) When the target is raised from the pits, plot your 4-shot group in the data book.

13) Once the sight setting is confirmed, determine the value and direction of the wind (if wind was present), and remove the number of clicks added to the windage knob to compensate for current wind conditions. This setting becomes the BZO setting for your rifle.

14) Record your BZO setting in your data book and stow this page in your rifle's buttstock for future reference.

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. To maintain an accurate BZO, you must understand these factors and how to compensate for them. There are also factors that cause a BZO to be reconfirmed. When any of these factors are present, your BZO should be reconfirmed.

5. (10 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 (i.e., 20 degrees or more) will cause a change in the elevation BZO of the weapon. Changes in temperature cause chamber pressure to increase when hot and decrease when cold. This causes shots to impact the

target high in hot temperatures and low in cold temperatures.

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.

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.

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.*

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 (the data book will be discussed in detail in a later lesson, SLR.11). 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 seven factors (forward hand, grip, right elbow, stock weld, rifle butt in the shoulder, muscular relaxation/tension, breathing).

2) Stability of hold.

3) Sling tension.

4) Trigger control.

5) Sight picture.

Confirm by questions.

TRANSITION: Zeroing procedures remain the same regardless of the field situation. For example, there may not always be a 300-yard range available on which to zero. But there is an alternate, field expedient method for zeroing the rifle at 36

yards that can be used for BZO when a 300-yard range is not available.

6. (2 MIN) FIELD EXPEDIENT BZO

Refer to slide sSLR.10-5.

INSTRUCTOR'S NOTE: *Point out where the bullet crosses the line of sight twice.*

a. Purpose. When a rifle is zeroed at 300 yards, the bullet will cross the line of sight twice. The bullet will cross the line of sight first on its upward path of the trajectory at 36 yards, and again farther down range at 300 yards (point of aim/point of impact). When the bullet's trajectory intersects the line of sight at 36 yards and 300 yards, the rifle is considered to be zeroed to hit a target at the exact point of aim at both of these ranges. That is why there is an alternate, field expedient method for zeroing the rifle at 36 yards when a 300-yard range is not available.

b. Accuracy of a 36-yard Field Expedient BZO. A rifle zeroed using the field expedient BZO method at 36 yards can be taken into battle. Note, however, that a BZO established at 300 yards is considered to be more accurate than a BZO established at 36 yards. (This is due to the minor inconsistencies a Marine can apply at 36 yards that will, in turn, greatly multiply at 300 yards.)

Confirm by questions.

TRANSITION: Zeroing can be accomplished at a 36-yard line if a 300-yard line is not available. KD 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 sight settings used to begin that stage of fire will differ. We will walk through the objective sight settings used for various stages of fire during KD firing.

7. (15 MIN) ZEROING DURING KD FIRING

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

b. Objective Rear Sight Elevation Knob Settings. To maximize the design features of the M16A2 service rifle, objective rear sight elevation settings are used for each yard line in KD firing. To establish and maintain a BZO, the following settings should be maintained on the rear sight elevation knob:

1) 200 yards - 8/3-2 (hasty sight setting inside BZO).

a) When firing at 200 yards, the rifle's rear sight elevation knob is adjusted to 8/3-2, two clicks down from the BZO setting.

Refer to slide sSLR.10-5.

b) This is done because when a rifle is zeroed at 300 yards, the bullet exits the muzzle and travels upward to reach its maximum height, then downward until it intersects the line of sight to achieve point of aim/point of impact at 300 yards. The bullet is approximately 4 inches above the line of sight at 200 yards, requiring the rear sight elevation knob setting to be lowered 2 clicks at 200 yards for the bullet to impact the aiming point. This is done only on the KD Course of Fire because of the accuracy needed to get two-point hits on the “D” target at 200 yards.

2) 300 yards – 8/3. This setting is mandatory at 300 yards; there are no exceptions.

3) 500 yards – 5 (hasty sight setting outside BZO).

c. Elevation and Windage Sight Adjustments for Day 1 KD Firing. The purpose of KD firing is to practice and demonstrate fundamental marksmanship skills. KD firing is also used to establish and/or maintain a BZO on your rifle. Therefore, on Day 1 of training, all elevation sight adjustments will be made on the front sight post at 200 and 300 yards.

1) 200-yard Tri-fire. Tri-fire is fired from the sitting position at 200 yards to establish a sight setting to begin KD firing at the 200-yard line. Prior to firing, the rifle’s sights are placed on initial sight settings, a known BZO, or adjusted sight settings from the Grouping Exercise (with the rear sight set at the hasty sight setting of 8/3-2). During tri-fire, sight adjustments may be required to fine-tune your known BZO front sight post and windage

knob settings.

2) 200-yard Slow Fire Sitting. This stage of fire should be used to confirm your 200-yard true zero 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 KD firing, you should not move off of your sight 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 Kneeling. Use the same settings from 200-yard slow fire sitting, if possible. If an adjustment was made during 200 slow fire kneeling, you may use those settings.

5) 300-yard Slow Fire Kneeling. Use the same settings from 200-yard slow fire sitting, if possible, except apply 8/3 on the rear sight elevation knob. If an adjustment was made during 200 rapid fire kneeling, you may use those settings.

6) 300-yard Rapid Fire Prone. Use the same settings from 200-yard slow fire sitting, if possible, except apply 8/3 on the rear sight elevation knob. If an adjustment was made during 300 slow fire kneeling, you may use those settings.

7) 500-yard Slow Fire Prone. Use the same settings from 300-yard rapid fire prone except apply 5 on the rear sight elevation knob.

a) A primary objective of KD firing is to establish a BZO during the 300-yard rapid fire prone stage. Therefore, any front sight post adjustments made to the rifle at this stage should be retained at the 500-yard line so as not to come off of the BZO elevation setting.

b) At the 500-yard line, elevation adjustments are made to the rear sight elevation knob. However, an effort should be made to retain the objective rear sight elevation knob setting of 5.

f. Elevation Sight Adjustments for Days 2, 3, and 4 (Qualification).

1) 200 Yards. The rear sight elevation knob should be set at 8/3-2.

a) Assuming a BZO was established on Day 1, the front sight post setting should be that setting established at the 300-yard rapid fire stage on Day 1 minus the wind conditions (if present). This is done to maintain the BZO setting established. The Marine will not truly know if his BZO is off until he fires at the 300-yard line.

b) The rear sight windage knob setting should be that setting established at the 300-yard rapid fire stage on Day 1 minus the wind conditions (if present).

2) 300 Yards. The rear sight elevation knob should be set at 8/3.

a) The front sight post setting should be the BZO setting established at the 300-yard rapid fire stage on Day 1.

b) If an elevation adjustment must be made, it is made to the front sight post only. If an adjustment is needed, this means that a BZO has yet to be established on the rifle.

3) 500 Yards. The rear sight elevation knob should again be set at the sight setting established at the 500-yard line on Day 1.

e. Windage Adjustments for Days 2, 3, and 4. Windage adjustments are made to compensate for the effects of weather. Not counting wind conditions, regardless of the position or range to the target, every effort should be made to retain the windage knob BZO setting established during the 300-yard prone stage on Day 1.

f. Sight Adjustment Changes. If sight adjustments are needed after two days of training, chances are it is due to an inconsistency in the Marine’s application of the fundamentals and seven factors, rather than a necessary BZO adjustment. Use the following guidelines for making sight adjustments throughout KD firing:

1) Generally, major elevation adjustments from established sight settings are caused by poor application of the fundamentals, inconsistencies in firing positions, stability of hold across positions, inconsistencies in sight picture at different ranges and different positions, and inconsistent tension on the sling. Every effort should be made to correct shooting errors prior to making a sight adjustment on the rifle.

2) In addition, sight adjustments should be made off of a shot group, not a single shot.

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 rifleman.

OPPORTUNITY FOR QUESTIONS: (1 MIN)

1. Respond to questions from the class.

2. Prompt Marines with questions to the class.

a. QUESTION: How far will one click of front sight elevation adjustment move the strike of a round at 100 yards?

ANSWER: 1 1/4 inches.

b. QUESTION: What is a BZO?

ANSWER: A BZO is the elevation and windage settings required to place a single shot, or the center of a shot group, in a predesignated location on a target at 300 yards/meters, under ideal weather conditions (i.e., no wind). A BZO is the sight settings placed on your rifle for combat.

c. QUESTION: What are some of the factors that cause a BZO to be reconfirmed?

ANSWER: Rifle 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, apply the windage and elevation rules, and apply zeroing procedures to improve the accuracy of his shooting. To be successful in combat, the Marine must have a BZO on his rifle.

SLIDES

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