U.S. Army Research Institute
for the Behavioral and Social Sciences

Research Report 1947

Training Aids for Basic Combat Skills: Obtaining a 200 M Zero with M16 Rifle and M4 Carbine

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May 2011

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for the Behavioral and Social Sciences

Department of the Army
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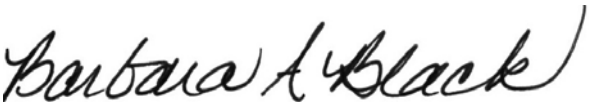

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Research accomplished under contract
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REPORT DOCUMENTATION PAGE

1. REPORT DATE (dd-mm-yy)	2. REPORT TYPE	3. DATES COVERED (from. . . to)
May 2011	Final	August 2009 to April 2010

4. TITLE AND SUBTITLE	5a. CONTRACT OR GRANT NUMBER
Training Aids for Basic Combat Skills: Obtaining a 200 M Zero with M16 Rifle and M4 Carbine	W74V8H-04-D-0045 (DO #0034)
	5b. PROGRAM ELEMENT NUMBER 633007
6. AUTHOR(S) Martin L. Bink (U. S. Army Research Institute); Michael D. Dlubac (Northrop Grumman Corporation); Evelyn Cage (Auburn University); and Richard L. Wampler (Northrop Grumman Corporation)	5c. PROJECT NUMBER A792
	5d. TASK NUMBER 359
	5e. WORK UNIT NUMBER

7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES)	8. PERFORMING ORGANIZATION REPORT NUMBER
US Army Research Institute for the Behavioral and Social Sciences ARI-Ft Benning Research Unit P. O. Box 52086 Fort Benning, GA 31995-2086 Northrop Grumman Corporation 3565 Macon Road Columbus, GA 31907	

9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES)	10. MONITOR ACRONYM
U. S. Army Research Institute for the Behavioral & Social Sciences ATTN: DAPE-ARI-IJ 2511 Jefferson Davis Highway Arlington, VA 22202-3926	ARI
	11. MONITOR REPORT NUMBER Research Report 1947

12. DISTRIBUTION/AVAILABILITY STATEMENT

Approved for public release; distribution is unlimited.

13. SUPPLEMENTARY NOTES

Contracting Officer's Representative and Subject Matter POC: Martin L. Bink

14. ABSTRACT: The overarching goal was to develop a training aid that could be used by Initial Entry Training companies to assist Soldiers to improve weapon-zeroing proficiency. More specifically, the research reported here addressed the need for targets and training aids for a 200 m zero. Training-aid development followed a five-phase process: Design, Development, Utilization, Assessment, and Revision. Ballistically-accurate targets for initial zeroing and confirm zero were developed as well as sight-adjustment practice flashcards and a marksmanship fundamentals coaching card. The training aids were designed to structure peer-learning contexts and support feedback in peer learning. Comparison of the developed targets to standard 300 m zero targets modified for 200 m zero showed that the new 200 m zero targets provided more consistent and accurate zeroing performance and supported the maintenance of skill across training events. Soldiers reported that the sight-adjustment and coaching cards were helpful. After minor modifications, the 200 m zero targets were transitioned to the U.S. Army Training and Doctrine Command Capabilities Manager for Live Training for distribution.

15. SUBJECT TERMS
training aids basic combat skills 200 m zero basic rifle marksmanship grouping and zeroing

SECURITY CLASSIFICATION OF			19. LIMITATION OF ABSTRACT	20. NUMBER OF PAGES	21. RESPONSIBLE PERSON
16. REPORT	17. ABSTRACT	18. THIS PAGE			
Unclassified	Unclassified	Unclassified	Unlimited	33	Ellen Kinzer Technical Publication Specialist 703-545-4225

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May 2011

Army Project Number
633007A792

Personnel Performance and Training

ACKNOWLEDGEMENT

The authors are grateful to the Drill Sergeants and leaders who generously provided input and feedback on the targets and training aids. These individuals relied on their training experiences to offer useful suggestions. They also made the training material available to their Soldiers to assess its value and offer suggestions for enhancement. In particular, the authors wish to thank COL (ret.) Daniel Kessler, CSM Richard Weik, LTC Kevin Butler, First Sergeant Craig Mussatti, CPT John Reinke, and First Sergeant Perry Meeks. The U.S. Army Armament Research, Development, and Engineering Center at Picatinny Arsenal is acknowledged for verifying ballistic information. The authors thank Dr. Jean Dyer for her comments on earlier drafts of this report and also thank Dr. Ken Evans and Mr. Bill Sanders for their expert review of the report.

TRAINING AIDS FOR BASIC COMBAT SKILLS: OBTAINING A 200 M ZERO WITH M16 RIFLE AND M4 CARBINE

EXECUTIVE SUMMARY

Research Requirement:

The overarching goal was to develop a set of training aids that could be used by Initial Entry Training (IET) companies to assist Soldiers to improve weapon-zeroing proficiency. More specifically, new targetry was needed for a 200 m zero. There also was a need to augment the training associated with the zeroing process. In order to better support training, the training aids were designed to structure peer-learning contexts and support feedback in peer learning. The present research report details the development, assessment, and revision of training aids that assist in obtaining a 200 m zero on rifles used in IET. More specifically, a set of 200 m zero targets, a graphical training aid for the zeroing process, and a graphical training aid for marksmanship fundamentals were produced and evaluated.

Procedure:

Training-aid development followed a five-phase process: Design, Development, Utilization, Assessment, and Revision. Ballistically-accurate 200 m zero targets for use at 25 m, 100 m, and 200 m were developed as well as sight-adjustment practice flashcards and a marksmanship fundamentals coaching card. An Infantry IET company was used to assess the targets. One group of Soldiers from the company used the developed 200 m zero targets and training aids during initial zeroing and confirm zero while another group of Soldiers used 300 m zero targets modified for a 200 m zero for the same training events. Performance on the zeroing events as well as weapon qualification was compared between the two groups of Soldiers.

Findings:

While the use of the targets and training aids did not decrease the total number of rounds required for Soldiers to zero their weapons and did not increase the weapon-qualification scores, the new targets did reduce the number of rounds required to confirm zero and predicted subsequent training performance and qualification scores. The relation of performance across weapon-zeroing events and qualification scores for the new targets training aids indicated that the targets and training aids can be used to provide an early diagnostic for qualification performance.

Utilization and Dissemination of Findings:

Results of this research were presented to the units who supported the project. The final versions of the targets and training aids were provided to selected IET units at Fort Benning, GA. The targets were also transitioned to Training and Doctrine Command Capabilities Manager for Live Training for distribution. The final versions of the targets and training aids are provided as a CD with this publication or can be obtained by contacting the ARI – Fort Benning Research Unit.

TRAINING AIDS FOR BASIC COMBAT SKILLS: OBTAINING A 200 M ZERO WITH M16 RIFLE AND M4 CARBINE

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Introduction

This research report supplements the description of the development of training aids for basic combat skills given in Bink, Wampler, Dlubac, and Cage (2011). The overarching goal of the training aids described in Bink et al. (2011) was to develop a set of aids that could be used by Initial Entry Training (IET) companies to assist Soldiers in improving skill proficiency. To this end, training-aid suggestions from approximately 150 Drill Sergeants (DSs) and training company leaders representing more than 25 IET companies were solicited. There were several criteria for selecting the specific types of training aids to develop from these suggestions. First, the training aids should address important basic combat skills. Second, the training aids should address tasks with which IET Soldiers have difficulty. Third, the training aids should be compact and portable enough to be used in field environments but could also be used in the barracks or a classroom. Finally, the training aids should address the need to tailor training to the background and proficiencies of Soldiers.

As outlined in Bink et al. (2011), training-aid development should follow a five-phase process: Design, Development, Utilization, Assessment, and Revision. Accordingly, a training aid is not fully developed until each phase has been applied to the aid, and these phases should be completed sequentially. The Design phase refers to the preliminary plans regarding the purpose and function of the aid, whereas the Development phase refers to the application of Design principles to the practicality of the training environment and resources available for the training aid (Bink et al., 2011). Stated differently, Design involves preparing the aspects of the aid that will drive its use, whereas Development involves participating in the construction of the aid and planning the practical aspects that might influence that construction. Following Design and Development, Utilization involves the use (physical or mental) of the training aid. Next, Assessment involves the empirical and practical review of the stages that precede it. Principles in the Assessment phase call for the evaluation of whether the aid was effectively utilized in its current design to meet the goals for which it was developed. Finally, Revision involves using the evaluation results to create a more effective and efficient training aid. The present research report details the development, assessment, and revision of training aids that assist in obtaining a 200 m zero on rifles used in IET. More specifically, a set of 200 m zero targets, a graphical training aid for the zeroing process, and a graphical training aid for marksmanship fundamentals were produced and evaluated.

The ability of a Soldier to qualify with the assigned weapon in basic combat training heavily relies on a properly zeroed weapon (Osborne, Morey, & Smith, 1980; Osborne, Schroeder, & Heller, 1984; Taylor, Dyer & Osborne, 1986). Zeroing is the process of adjusting a weapon's sight so that the point-of-aim corresponds to the point-of-impact of the round at a given distance (e.g., 300 m). The sight of a weapon assigned in basic combat training (i.e., M16 or M4) must be adjusted to a given Soldier's alignment to the weapon. A zero is obtained by consistently shooting a set number of rounds within a point-of-impact. The alignment of the point-of-impact and the point-of-aim depends on the distance of the target from the shooter.

Regardless of this alignment, the ability to obtain a satisfactorily zeroed weapon depends on several Soldier-related abilities. First and foremost among these factors is the ability to consistently place rounds in a tight cluster. Also known as "grouping," the ability to consistently shoot rounds in (nearly) the same place is a product of a Soldier's application of the fundamentals of marksmanship (i.e., steady position, aiming, breath control, and trigger control; e.g., Osborne et al., 1984). In addition to grouping, a Soldier should understand the principles and process of zeroing the weapon in order to properly obtain a zero (Osborne et al., 1984; Smith et al., 1980).

The Army's marksmanship doctrinal publication, Field Manual (FM) 3-22.9 (Department of the Army [DA], 2008)[1], provides information for zeroing rifle sights. Accordingly, zeroing occurs in two training events. The first event is fired at 25 m targets. In this event, Soldiers are first required to group so that at least a standard proportion of rounds in two consecutive firing strings impact the target within a 4 cm circle. The doctrinal grouping standard requires 5 out of 6 rounds in two consecutive three-shot groups to be within a 4 cm circle. Once "grouped," the Soldier again fires strings of rounds and adjusts the weapon's sights according to the placement of the shot group on the target. A zeroing target is used that has a marked point-of-impact circle. The target is also gridded so that a Soldier can determine how far a shot group is from the point-of-impact and can accordingly adjust the weapon (see Figure 1 for an example zeroing target). A weapon is considered zeroed once a Soldier can fire at least the standard number of the rounds from two consecutive shot groups in the point-of-impact (e.g., 5-out-of-6 rounds).

The second training event for weapon zeroing is to confirm the zero at distance. Generally, two distances are used to confirm zero: the actual zero distance (e.g., 300 m) and a closer distance (e.g., 100 m). The purposes of this event are (a) to assure that the zero achieved at 25 m is accurate at the actual zero distance, (b) to refine the zero, and (c) to demonstrate the effects of physical factors (e.g., wind and gravity) and firing fundamentals (e.g., steady position and trigger control) on marksmanship accuracy (see Osborne et al., 1984). To confirm zero, Soldiers again shoot iterations of groups at a target and accordingly adjust the sights after each iteration until the shot groups are consistently located in the specified point-of-impact. Generally, Soldiers confirm zero at the closer distance (e.g., 100 m) before moving to the zero distance (e.g., 300 m) to confirm. Once a Soldier has confirmed zero at distance, the weapon is considered zeroed.

Since 2003, Army doctrine has specified that weapons used in basic combat training (except the M16A1) be zeroed to 300 m (DA, 2003). As a result, current training materials for zeroing are specific to 300 m zero parameters (e.g., size of targets and location of point-of-impact on targets). However, an emerging Army philosophy was that Soldiers should use a 200 m zero (Currey, 2008). For example, the Army's Asymmetric Warfare Group developed the Combat Applications Training Course, which included having Soldiers zero their rifles to 200 m. The stated advantage of a 200 m zero is that the point-of-impact of the bullet is within three inches of the point-of-aim of the rifle out to about 250 m. With a 300 m zero, the point-of-

[1] At the time the research was conducted, FM 3-22.9 dated 2008 was current. However, at the time this report was published, Change 1of the basic rifle marksmanship FM 3-22.9 dated 2011 was current. The discussion in this report of grouping and zeroing procedures was still germane to the revised FM 3-22.9 (2011). Some of the results of the research reported here are reflected in the updated FM 3-22.9 (2011).

impact of the bullet is about seven inches above the point-of-aim at 200 m for the M4 carbine. As a consequence, Soldiers would need to aim low in order to hit center mass of mid-range targets (e.g., at about 170m). Some training units are moving toward adopting the 200 m zero as a standard. Although various techniques are being used by trainers to assist in obtaining a 200 m zero (Dyer et al., 2010), the Army has not yet developed nor provided specific guidance nor standardized targets for obtaining a 200 m zero.

The need for training materials for a 200 m zero presented an opportunity to develop training aids for basic combat skills. Not only was new targetry needed for the 200 m zero, but also there was a need to augment the training associated with the zeroing process. The need to improve zeroing training is especially important because marksmanship qualification is a graduation requirement for IET and because there is considerable variability in marksmanship performance during IET (e.g., Dyer et al., 2010). In addition, like most IET training, marksmanship training occurs in large groups with large Soldier-to-DS ratios. As a result, training aids that could leverage peer-learning techniques to facilitate weapon-zeroing training were needed.

Peer training occurs when an individual with the same status (e.g., a classmate) actively supports another's learning (Topping, 2005). Peer learning generally involves one individual in a peer group guiding the learning activities or "coaching" for the others in the group and is most effective in matched dyads or small groups, but can also be used with effect in large-group instruction (Topping, 2005; Costanza, Leibrecht, Cooper, & Sanders, 2009). Peer learning has also been shown to have effective applications in military training (e.g., Costanza et al., 2009; Woodie, 2005). Because marksmanship training in IET occurs in large groups with large Soldier-to-DS ratios, peer learning can be utilized as a way to augment the amount of training and feedback each individual receives. Peer groups can be used to practice fundamentals and techniques trained by DSs. To make such peer training effective, the training aids presented here were designed to guide Soldiers through critical weapon-zeroing procedures.

Because peer learning requires all individuals (i.e., peers) to be engaged in the learning process (Tomasello, 1999; Vygotsky, 1978), there should be a learning benefit to all individuals involved in peer learning (Tomasello, Capenter, Call, Behne, & Moll, 2005; Topping, 2005). By diagnosing impediments of others and by sharing demonstrations of their own skill, peer coaches not only provide feedback to other trainees (Festinger, 1954; Collision & Parcell, 2004) but also develop a deeper understanding of the skill for themselves (Tomasello et al., 2005). The individualized nature of peer training allows for the optimization of content and pace for a given learner (Costanza et al., 2009). Moreover, peer learning also impacts trainee motivation (McCombs, 2004; Tomasello, 1999) and can increase group cohesion (Aronson & Patnoe, 1997, Topping, 2005).

The 200 m zeroing training aids were designed to structure peer-learning contexts and support feedback in peer learning. However, the training aids were also designed to better assist DSs in leading Soldiers through the process of grouping and zeroing. The training aids provided technically accurate feedback tools that DSs could use to train weapon zeroing. In all, three training aids were developed. The first was a set of targets for the 200 m zero. The second was a set of guided-practice flash cards for determining weapon-sight adjustments. Finally, a

memory jogger for proper marksmanship fundamentals was developed to assist peer coaching. These training aids were developed and then evaluated in the field.

Training Aid Design and Development

Effective training materials must be designed to meet the needs of the intended target audience and the training outcome (Wampler, Dyer, Livingston, Blankenbeckler, & Dlubac, 2006). Moreover, effective training materials should have clear, measurable, and attainable objectives for the skills to be learned, should use a delivery modality that is appropriate to the skill to be learned, and should accommodate heterogeneous experience in the training audience (Wampler et al., 2006). These three characteristics of effective training materials served as the foundation for designing the weapon-zeroing training aids. While measurable objectives and delivery modality were important considerations in the design of the current training aids, particular attention was paid to designing a training aid that would have benefit across multiple levels of military and educational backgrounds as well as across heterogeneous levels of marksmanship skills and knowledge.

Four training mechanisms to assure accurate weapon zero were incorporated in the design of the training aids. First, training aids were to help provide an understanding of the process of weapon zeroing (Smith et al., 1980). Part of this understanding involves the logic of shot groupings, and part of this understanding involves the calculations required for accurate sight adjustments. Second, training aids were to provide appropriate and repeated practice of the zeroing process (Thompson, Smith, Morey, & Osborne, 1980). The most important aspects of the zeroing process for practice were marksmanship fundamentals (Osborne et al., 1984) and the calculations of sight adjustments (Thompson et al., 1980). Third, training aids were to provide frequent and accurate feedback on both the understanding of the zeroing process and on marksmanship performance (Smith et al., 1980; Thompson et al., 1980). Finally, training aids were to provide continuity across the zero-training events (Thompson et al., 1980). That is, the targetry and training materials used for train-up, grouping and zeroing, and confirm zero should have consistent appearance, terminology, and learning emphasis.

Targets to Obtain 200 m Zero

The primary training aid was a set of targets for 200 m zero. The set included a target for initial grouping and zeroing training at 25 m. The set also included two targets for downrange feedback and confirm zero at greater distances. One target was developed to be used at 200 m, and the other target was designed for 100 m. At a minimum, a zeroing target requires a point-of-aim, an indication of the appropriate point-of-impact, and some mechanism to determine sight adjustments. The mechanism typically used to indicate sight adjustments is a grid printed on the target that has correspondence to the weapon sight. The physical parameters of these target characteristics (i.e., point-of-aim, point-of-impact, and adjustment grid) and the relation of the characteristics (i.e., offsets) depend on ballistic properties of the weapon, the properties of the sight, the zeroing distance (e.g., 200 m) and the distance to the target (e.g., 25 m). Because the targets were designed for basic combat training, all the target parameters were based on the Army's common-issue small arms (i.e., M16 rifle and M4 carbine) with either an iron sight (i.e.,

either carry-handle sight and back up iron sight [BUIS]) or an M68 close-combat optic (CCO) sight. The technical parameters for each target characteristic mentioned in the following descriptions were calculated by the U.S. Army Armament Research, Development and Engineering Center [2] and are available in Appendix A.

The general design of the targets was guided by four characteristics that impact the training value of targetry. First, minute-of-angle (MOA) was used to determine the dimensions of all targets. For example, the point-of-aim on all targets was a four-MOA circle and the gridlines on the targets were one MOA. Basing target dimensions on angular units of measure (i.e., MOA) meant that even though the physical size of the targets changed from 25 m targets to 200 m targets, the targets were perceptually equivalent across the different target ranges. In addition, because Soldiers are taught the MOA concept in training, basing the targets on MOA should help reinforce that training and help transfer that training to advanced marksmanship concepts such as aiming adjustments for wind or firing at a moving target.

Second, the targets were designed to be used with multiple weapons (i.e., M16 and M4) and multiple sights (i.e., iron sights and CCO). Having targets with general applicability allows for savings in production costs and also provides continuity in training of multiple weapon systems (Osborne et al., 1984). For all targets, sight adjustment information was provided for both iron sights and CCO. In addition, separate versions of the targets were developed to be used with the M16A2/A3/A4 rifles and the M4 carbine.

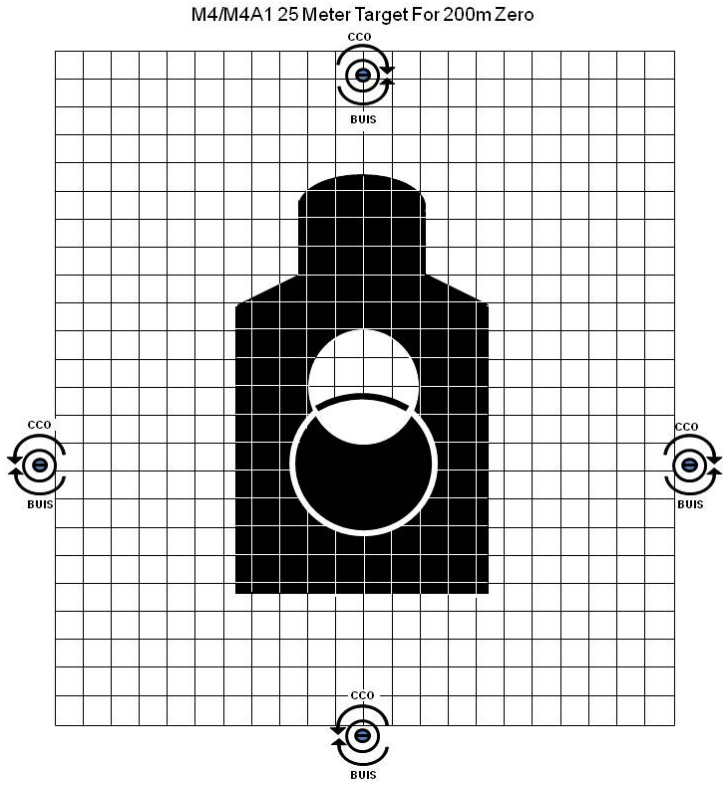
The third general design principle was the inclusion of clearly defined and accurate points-of-aim and points-of-impact. The point-of-aim on all targets was a four-MOA white circle on a black background. Four MOA was used because that was the size of the aiming dot in the CCO used by most Infantry one-station unit training (OSUT) Soldiers at the time the targets were developed. As a result, the OSUT Soldier merely had to cover the white point-of-aim with the aiming dot in order to have an accurate aim on the target. In addition, the visual contrast and size of the white dot provide an easily identifiable point-of-aim for iron sights. More importantly, the four-MOA white dot provided a way to easily identify the center of mass on the scaled silhouette 25 m target. Identifying center of mass is often cited as an impediment to efficient zeroing (Dyer et al., 2010; Smith et al., 1980). Likewise, having a clearly defined point-of-impact increases the accuracy of feedback on zeroing performance (Osborne et al., 1984; Smith et al., 1980). An accurate and clearly marked point-of-impact should assist DSs to determine when a Soldier's weapon is properly zeroed. The point-of-impact on all targets was indicated by an outline circle and was appropriately offset from the point-of-aim on the 25 m and the 100 m targets. The point-of-aim and point-of-impact are identical at 200 m and no offset was required for the 200 m target.

The fourth general design principle for the targets was to include information and guides for using the targets to zero the weapon. The more the target can help guide Soldiers and DSs through the process of zeroing, the more efficient that training becomes (Smith et al., 1980). To a certain extent, the gridlines included on zeroing targets that indicate the amount of sight adjustment required is an instance of target guides. In addition, the current 25 m target for 300 m

[2] The U.S. Army Armament Research, Development and Engineering Center at Picatinny Arsenal is the U. S. Army center responsible for verifying ballistics parameters for small arms.

zero contains guides that indicate the direction of sight adjustments and information about the amount of adjustment for a given weapon sight. This same information was included in the design of the 200 m zero targets but in a slightly different format. Sight adjustment information was also included on the 100 m and 200 m targets.

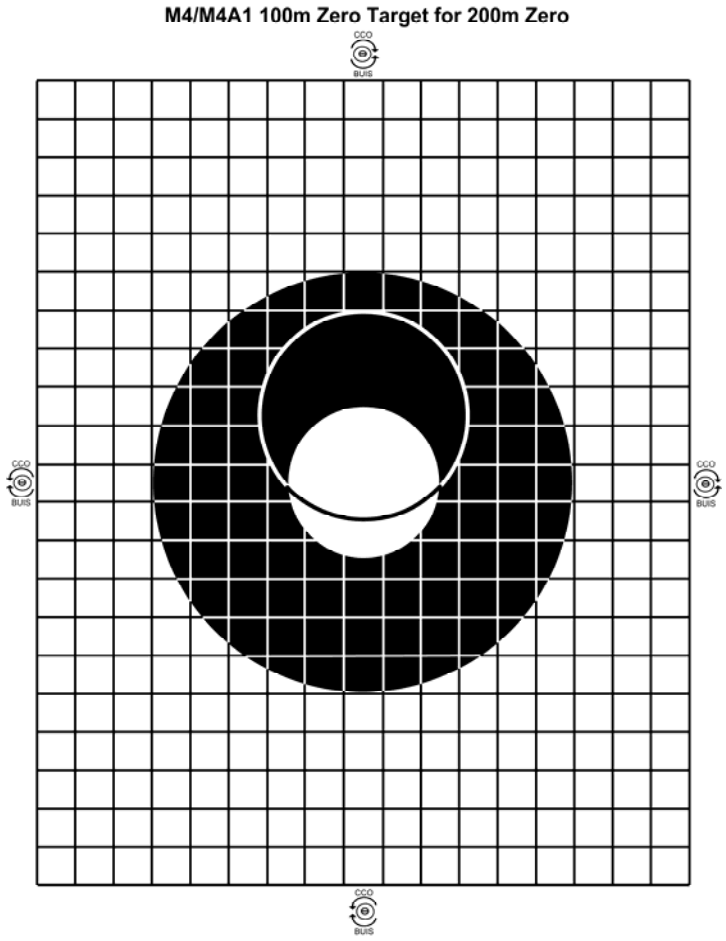
25 m target. The 25 m target was designed in a similar format as the existing 25 m target for 300 m zero. The designed target was printed on 8.5 in. x 11 in. cardstock and included a black scaled silhouette on a white background with a one-MOA grid covering the target area (see Figure 1). The target also included a four-MOA point-of-aim and an offset point-of-impact. The parameters for the size of the silhouette, of the point-of-aim, of the point-of-impact, and of the grid squares are given in Appendix A. On the target, the sight-adjustment guides indicated the direction the sight-correction knob must be turned in order to zero the sight given a shot group in a quadrant of the target (see Figure 1). The sight-adjustment guides at the top and bottom of the target indicted the direction the weapon's elevation knob must be turned to make a vertical adjustment, and the sight-adjustment guides on the left and right of the target indicted the direction the weapon's windage knob must be turned to make a horizontal adjustment. For example, for a shot group located in the upper left-hand quadrant of the target and using a CCO, a Soldier would make a vertical adjustment by moving the elevation knob clockwise and make a horizontal adjustment by moving the windage knob counterclockwise. The number of indents, or "clicks," the knobs would be moved is indicated in the table at the bottom of the target. So, for the CCO, the Soldier would move the sight adjustment knobs two clicks for each grid-square difference between the center of the shot group and the center of the point-of-impact. Separate versions of the target were developed for both the M16 rifle and the M4 carbine.



Value of ONE click in MOA for M4/M4A1 sights			
WEAPON	ELEVATION KNOB	WINDAGE KNOB	FRONT SIGHT POST
BUIS	N/A	1 MOA = 2 clicks	2 MOA = 1 click
CCO	1 MOA = 2 clicks	1 MOA = 2 clicks	N/A

Figure 1. 25 m target for 200 m zero using M4-series carbine (reduced scale).

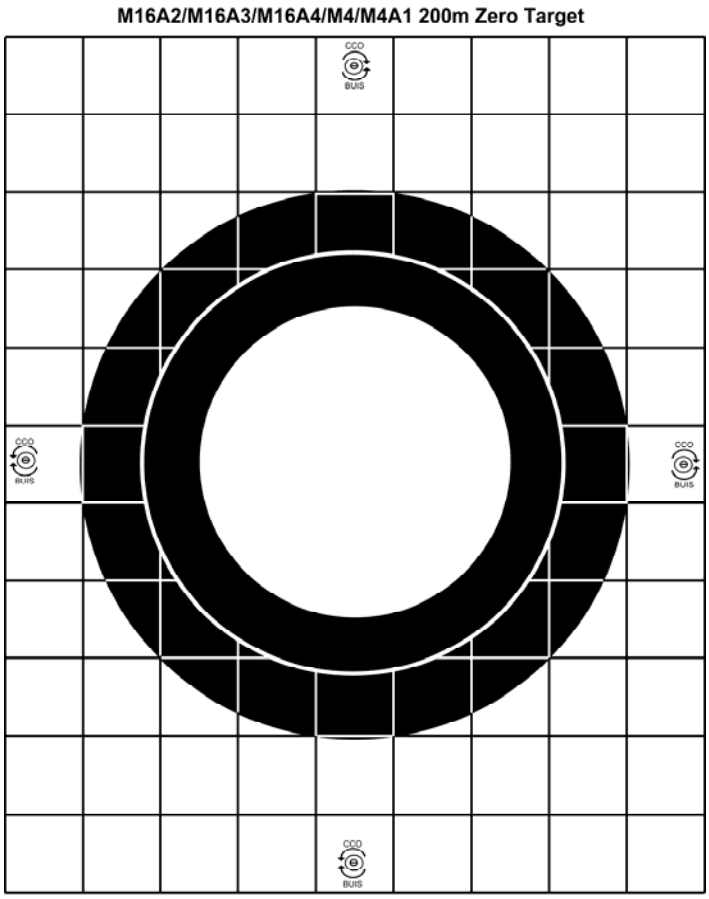
100 m target. Instead of using a scaled-silhouette target, the 100 m target was a black circle with the diameter of a scaled-silhouette (see Figure 2). The use of a circular target as opposed to a silhouette was intended to further focus the point-of-aim by eliminating competing visual cues (e.g., silhouette features) during confirm zero. It should be noted that circular targets were historically used in Army training, but the use of silhouettes was adopted as a way of transferring basic rifle marksmanship (BRM) training to battlefield application (see Osborne, et al., 1984). For the newly developed targets, the circular white four-MOA point-of-aim was again used, and the point-of-impact was offset above the point-of-aim per the ballistic characteristics of the weapon systems (see Appendix A). The 100 m target also included a one-MOA grid, and the width of the grid lines and point-of-impact circle line were sufficiently thick that they could be seen with the naked eye from the firing line. The parameters for the size of the target circle, of the point-of-aim, of the point-of-impact, and of the grid squares are given in Appendix A. The target was printed on 24 in. x 36 in. heavy-weight paper. As with the 25 m targets, the designed 100 m targets included sight-adjustment guides and information. Separate versions of the target were developed for both the M16 rifle and the M4 carbine.



Value of ONE click in MOA for M4 M4A1 iron sights			
WEAPON	ELEVATION KNOB	WINDAGE KNOB	FRONT SIGHT POST
BUIS	N/A	1 MOA = 2 clicks	2 MOA = 1 click
CCO	1 MOA = 2 clicks	1 MOA = 2 clicks	N/A

Figure 2. 100 m target for 200 m zero using M4-series carbine (reduced scale).

200 m target. The 200 m target (see Figure 3) was designed similar to the 100 m target. Again, the developed target used a black circle for the target area, and the target was printed on 24 in. x 36 in. heavy-weight paper. Because at the zero distance (i.e., 200 m) the point-of-aim and the point-of-impact are the same, there is no need for an offset for the point-of-impact. As a result, the same target can be used for both weapon systems (i.e., M16 and M4). The single version of the 200 m target contains sight-adjustment information for both weapon systems. The parameters for the size of the target circle, of the point-of-aim, of the point-of-impact, and of the grid squares are given in Appendix A.



Value of ONE click in MOA for M16A2/A3/A4/M4/M4A1 Sights			
WEAPON	ELEVATION KNOB	WINDAGE KNOB	FRONT SIGHT POST
M16A2 / A3	N/A	1 MOA = 0.5 click	1 MOA = 1 click
M16A4 w/carrying handle	N/A	1 MOA = 1 click	1 MOA = 1 click
BUIS	N/A	1 MOA = 2 click	N/A
CCO	2 click = 1 MOA	1 MOA = 2 click	N/A
M4	N/A	N/A	2 MOA = 1 click

Figure 3. 200 m target for 200 m zero (reduced scale).

Coaches Cards

The 200 m targets were designed to facilitate the weapon zeroing process. However, the most important aspect of zeroing is the Soldier's ability to properly align the sights with the target and then maintain the weapon pointing at the correct location while squeezing the trigger (i.e., firing fundamentals). While individual Soldiers may be able to self-assess their firing fundamentals, the Army recognizes that other Soldiers serving as "peer coaches" can be a valuable assist in this process (DA, 2008). The doctrinal publication includes information on the duties and benefits of the peer coach. In addition, the Army developed a BRM Coaches Checklist which is Graphic Training Aid (GTA) 07-01-043. While the GTA might be helpful to more experienced trainers, it is lengthy and could be confusing to Soldiers just learning to fire during the BRM periods. As stated in FM 3-22.9, a problem with peer coaching exists when "the new Soldier does not have adequate guidance, a 'blind leading the blind' situation may result, leading to negative training and safety violations" (DA, 2008, pp. 4-12).

As a result, one of the zeroing training aids was a simplified "coaches card" that could not only reinforce firing fundamentals but also facilitate peer interaction. The small coaches card presented information contained in FM 3-22.9 (DA, 2008), the existing GTA 07-01-043, and input provided by IET marksmanship trainers. In addition to basic firing fundamentals, the cards provided guidance on *how to coach* on one side of the card. The ability to be an effective coach does not originate from merely being an expert at the skill, rather effective coaching must be learned (see Costanza et al., 2009). The guidance was intended to provide the basics of marksmanship coaching and not a detailed explanation of effective coaching. The cards were printed on laminated 4.25 in. x 5.75 in. sheets in order to be carried in a Soldier's uniform pocket. An example of the Coaches Card is shown in Figure 4 and Figure 5.

Figure 4. Coaches card – Side 1.

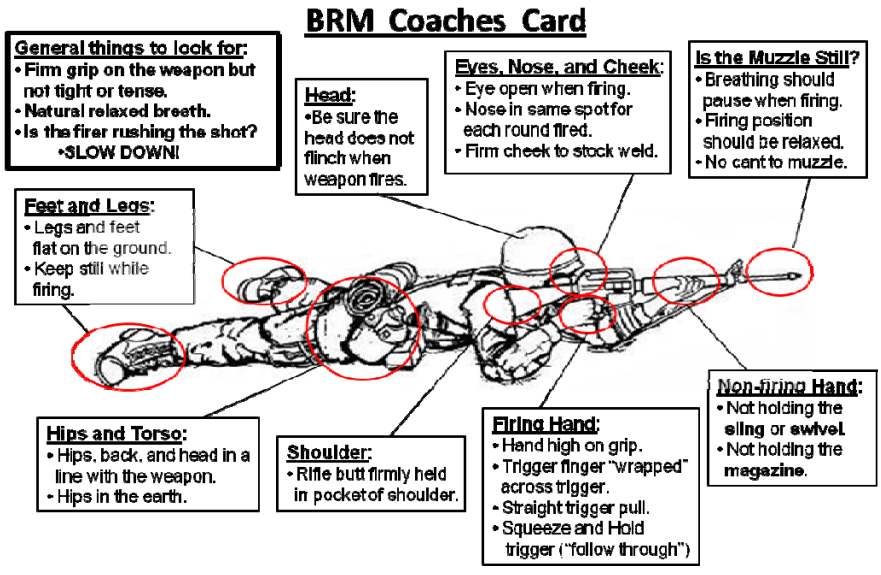


Figure 5. Coaches card – Side 2.

Sight-adjustment Flashcards

In order to better aid the understanding of the zeroing process, a set of flash cards to practice zero adjustments was developed based on the 200 m zero targets used at 25 m. The front of each flashcard portrayed the zero-target with an array of black dots representing a single shot group. Soldiers assess the shot group and use the information on the target to determine how the weapon sight should be adjusted to move the point-of-impact of the rounds to the desired location on the target (i.e., the marked point-of-impact). The reverse of the flashcard provided an explanation of the correct sight adjustment. A sample of the flashcards is shown in Figure 6. The 15 flashcards were printed on 5.5 in. x 8.5 in. laminated sheets and spiral-bound into a small booklet that could be carried in a Soldiers uniform pocket.

The sight-adjustment flashcards can be used by trainers to assist Soldiers in understanding how to determine sight adjustments. Soldiers having difficulty with the task can use the cards alone to practice their adjustment skills. Detailed drawings and explanations on the reverse of each card can help the less-skilled Soldiers understand how to assess the shot group and what sight adjustment is necessary. More-skilled Soldiers can use the cards to work with less-skilled Soldiers because the shot groups are provided along with the correct sight adjustments and supporting explanation.

In addition to a 200 m zero, another emerging rifle marksmanship concept in the Army is the use of 5-round shot groups to zero instead of 3-round shot groups. The logic for using 5-round shot groups is that more rounds give a more accurate estimation of the center of the shot group and that the estimation is less affected by an errant round. The grouping and zeroing standard most often used with 5-round shot groups was eight out of ten rounds in two consecutive 5-round groups. Because Infantry OSUT was currently using 5-round shot groups, the flashcards illustrated 5-round groupings.

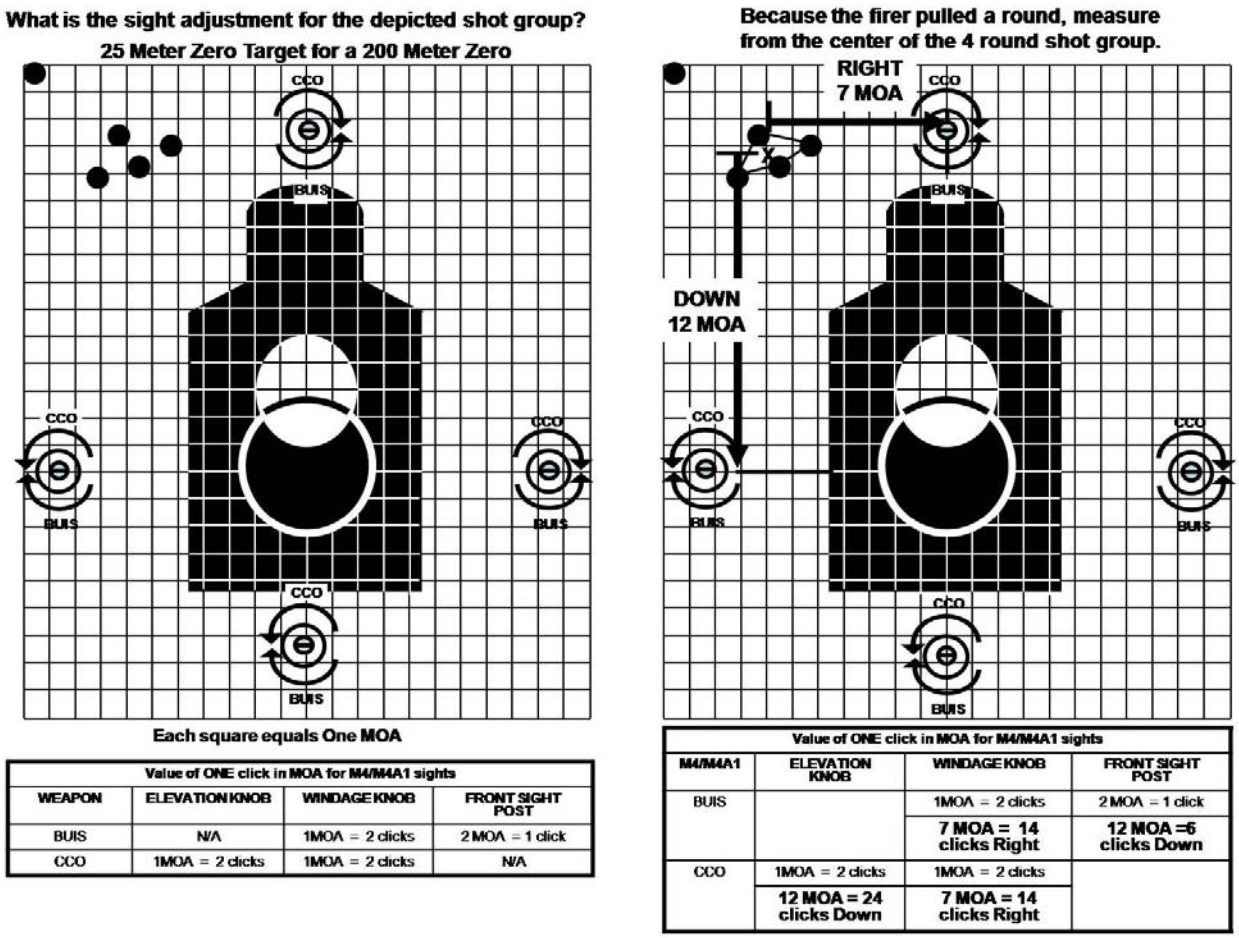


Figure 6. Sample sight-adjustment flashcard shown front and back

Training Aids Assessment and Revision

Following the development of the training aids, the effectiveness of the training aids was assessed in actual training. Because all training aids (i.e., targets, coaches cards, and sight-adjustment flashcards) were intended to be used in conjunction with one another and because the use of the training aids was confounded (i.e., used only in one assessment group), separate assessment of the effectiveness of individual training aids was not possible. As a consequence, the assessment data only addressed Soldiers' performance on the 200 m targets, and the inferences of these data are generalized to the *set* of training aids. However, the input from informal DS and Soldier interviews was used to inform inferences about the effectiveness of coaches cards and sight-adjustment flashcards. Informal input was also used to inform revisions to all of the training aids.

Method

Participants. One Infantry OSUT company participated in the assessment of the 200 m zeroing training aids. The company had a maximum fill of 177 Soldiers, but because of sick leave, other assignments, or other actions, only 115 Soldiers completed all parts of the training-aids assessment process.

Materials and procedure. The prototype targets, coaches cards, and sight-adjustment flashcards were assessed during BRM periods for the Infantry OSUT company. Half of the company (i.e., two platoons) used the prototype targets and other training aids during BRM periods for grouping, zeroing, and confirm-zero. The other half of the company (i.e., two platoons) used standard Army targets, which were designed for a 300 m zero but were modified by the DSs to obtain a 200 m zero by adding the appropriate point-of-impact. An example of the modified 300 m zero target is given in Figure 7 (25 m target). This half of the company also used the standard downrange feedback targets for confirm zero (see Figure 8). The half of the company that used the standard targets did not use the coaches cards or the sight-adjustment flashcards. A total of 57 Soldiers used the newly developed 200 m zero targets and training aids, and 58 Soldiers used the standard targets and no training aids.

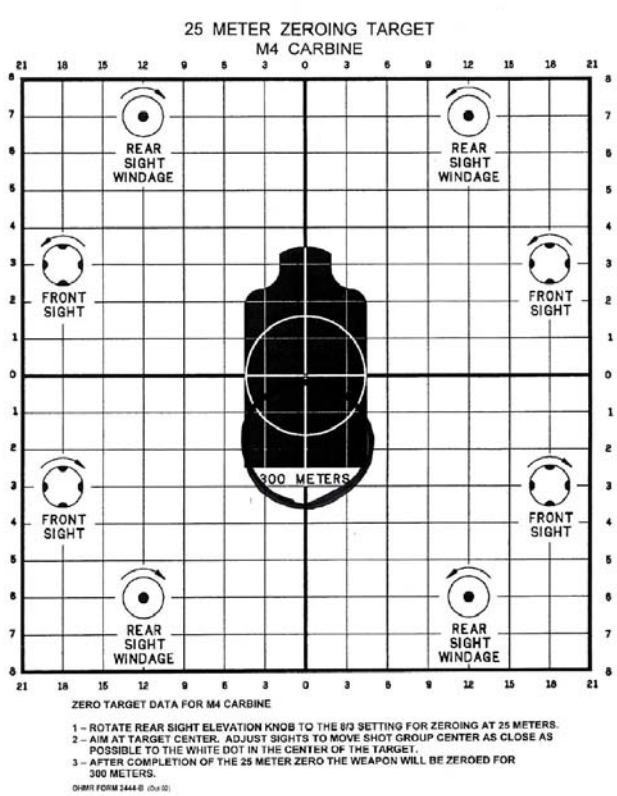


Figure 7. Example of standard 300 m zero target modified to obtain 200 m zero.

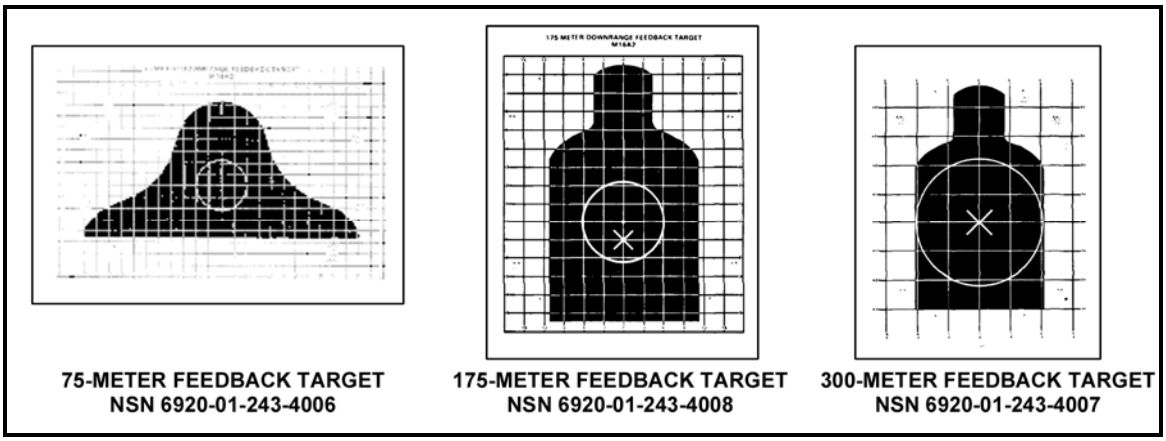


Figure 8. Standard downrange feedback zeroing targets as given in FM 3-22.9.

Four sets of flashcards were distributed to each assigned platoon after the initial session of BRM training. The initial BRM session was classroom lecture on the principles of marksmanship and weapons maintenance. The Soldiers circulated the flashcards within each platoon and worked in buddy teams to review the flashcards during "down time" such as guard duty, barracks fire watch, waiting to participate in a training event, etc. The flashcards were available to the Soldiers for about two weeks prior to grouping and zeroing their weapons. Coaches cards were distributed to each member of the assigned platoon prior to the BRM period for weapon grouping and zeroing. Soldiers reviewed the cards and were instructed to refer to the cards while buddy-coaching during this training period.

Other than firing at assigned targets, the BRM training periods for grouping and zeroing were conducted in a similar manner for both groups. DSs marked each shot group for each Soldier and assured that each Soldier grouped and zeroed his weapon. Each target for each Soldier was collected as the Soldier completed training and left the firing line. For research identification purposes, the Soldier's roster number was placed on his target by researchers as the targets were collected. Because DSs marked each shot group, it was possible to determine how many rounds each Soldier used in order to group and to zero. The same procedure was used for the BRM training period for confirm zero. That is, Soldiers fired the normal course of fire for the training period using assigned targets, DSs marked each shot group, and the targets were collected and marked with the roster number as each Soldier completed training. In addition to the total number of rounds fired for each BRM event, the total number of rounds for each Soldier in the correct point-of-impact was tallied. It is important to note the participating company used 5-round shot groups for grouping and zeroing. It is also important to note that due to range availability and time constraints, the participating company was not able to fire both distances (i.e., 100 m and 200 m) for confirm zero. As a consequence, the results for confirm zero are only based on performance at 200 m.

Data was also collected from the weapon-qualification event. As previously stated, each IET Soldier is required to meet a performance standard on marksmanship before being allowed to graduate. The qualification event is the concluding event of all BRM training and requires Soldiers to fire at 40 target exposures. A minimum score of 23 target hits qualifies the Soldier. All Soldiers make at least one attempt to qualify, and those who fail to qualify on the first

attempt re-fire until qualified. During the qualification period for the participating company, first-attempt qualification scores were collected and matched to the roster number of each Soldier. In addition, subjective feedback on the training aids was collected in informal interviews with DSs and Soldiers after the weapon qualification event.

Results

All comparisons were tested at the 5% error rate. Post-hoc differences in means were determined by pair-wise comparisons of 95% confidence intervals. Where appropriate, group means and standard errors of the means are provided in the text. Error bars on all data figures represent 95% confidence intervals.

Two sets of analyses were conducted on marksmanship-performance data. The first set of analyses compared group means between the platoons who used the newly developed targets, coaches cards, and sight-adjustment flashcards (subsequently termed "new training aids" group) and the platoons who used only standard targets (subsequently termed "standard targets only" group) on first-attempt weapon-qualification scores and on total rounds fired per Soldier in zeroing and confirm zero. The analysis of weapon qualification scores was conducted to determine if the developed training aids produced a direct impact on the most salient marksmanship assessment. The analysis of total rounds fired was intended to determine if using the developed training aids would produce a resource saving (i.e., fewer rounds to zero and confirm zero).

The second set of analyses compared correlations between the two groups in order to determine the degree to which the developed training aids produced a relation among marksmanship training events and qualification performance. Because marksmanship training is sequential, performance in one training event should impact subsequent marksmanship performance (Thompson et al., 1980). Thus, it is important to demonstrate the degree to which performance in one training event (e.g., zeroing) predicts the performance in another event (e.g., confirm zero). A simple two-stage analytical model was constructed to test the relation of performance among zeroing, confirm zero, and weapon qualification. In the first stage, the zero-order correlation between zeroing performance and confirm-zero performance was tested between groups. In the second stage, a stepwise multiple regression analysis was conducted for each group using weapon qualification scores as the criterion and, in order, confirm-zero performance and zeroing performance as predictors. The model was tested with proportion of rounds in the correct point-of-impact on targets as a measure of marksmanship performance because this measure reflects the overall accuracy of the Soldier and, as such, is a more sensitive measure of Soldier skill than total rounds fired.

Analyses of marksmanship performance were followed by an analysis of the types of targets used in the standard-targets-only group. As previously stated, the Army did not have a target for a 200 m zero at the time the present research was initiated. As a consequence, units wanting to adjust their weapon systems for a 200 m zero would have to modify existing 300 m zero targets. The process of modifying the 300 m zero targets is time consuming and requires that the exact point-of-impact is transcribed to the modified targets. However, using modified 300 m zero targets presented many issues for the accuracy and consistency of the training for 200

m zero. Chief among these training issues was the fact that many DSs had different interpretations of how to place the 200 m zero point-of-impact on the 300 m zero target. The point-of-impact issue was evident in the participating platoons that used the "standard" targets (i.e., not the new 200 m zero targets and training aids) as evidenced by modified 300 m zero targets including both circles and squares of varying sizes and at different locations on the target. As a consequence, an analysis of the types of modified standard targets used and the impact of the various types of targets on marksmanship performance was conducted.

Comparisons of group means. There was no difference in weapon-qualification scores ($t < 1$) between the new-training-aids group ($M = 28.98$, $SEM = .89$) and the standard-targets-only group ($M = 28.86$, $SEM = .68$). It was not surprising that no differences were found between weapon-qualification scores because many factors impact marksmanship performance and the ability to qualify with the weapon (Dyer et al., 2010; Osborne et al., 1984; Smith, et., al., 1980; Taylor et al., 1986) and because there is considerably more marksmanship training after weapon zeroing and before weapon qualification.

The comparison of total rounds used was analyzed in a 2 (new training aids vs. standard targets only) x 2 (zeroing vs. confirm zero) mixed-factors design. This analysis yielded a significant interaction ($F(1, 113) = 10.53$, $MSE = 206.77$) between the experimental group and the training event. The nature of the interaction is presented in Figure 8. Accordingly, the Soldiers using the new training aids ($M = 36.93$, $SEM = 2.49$) required more rounds to zero than did the Soldiers using standard targets only ($M = 30.09$, $SEM = 2.47$). However, the opposite was true during confirm zero. That is, Soldiers using the new training aids ($M = 22.98$, $SEM = 1.45$) required *fewer* rounds to confirm zero than did the Soldiers using standard targets only ($M = 28.45$, $SEM = 1.44$). So, even though both groups of Soldiers used almost the same number of rounds across the two training events ($F < 1$), the Soldiers who used the new training aids reduced the number of rounds used from zeroing to confirm zero ($t(56) = 4.74$, $SED = 2.94$) while the Soldiers who used standard targets only used the same number of rounds across training events ($t < 1$).

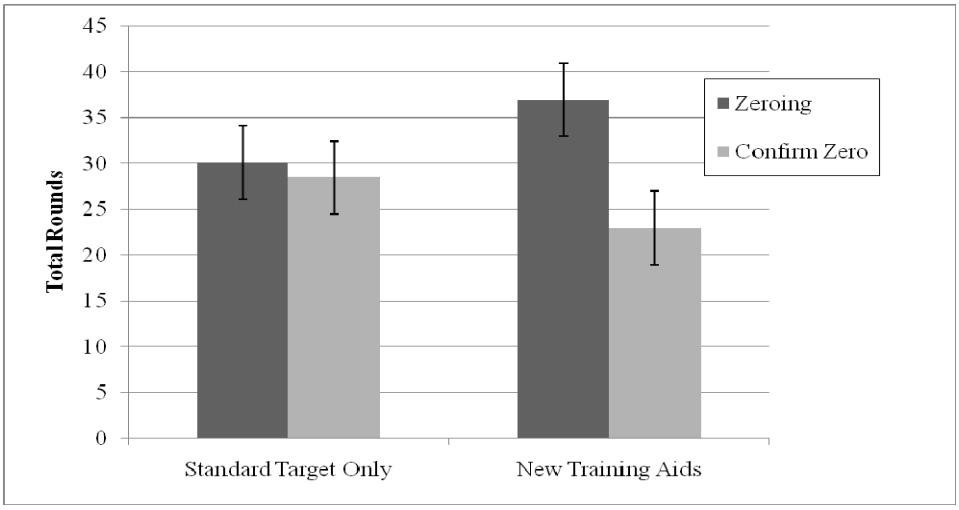


Figure 9. Number of rounds used in zeroing and confirm zero as a function of experimental group.

Correlation model. Comparison of the zero-order correlations for the first stage of the model revealed that, even though the correlation for the Soldiers who used the new training aids ($r(57) = .19$) was larger than the correlation for Soldiers who used standard targets only ($r(58) = .08$), there was no significant relation of the proportion of rounds in the correct point-of-impact between zeroing and confirm zero for either group. The stepwise multiple-regression analyses did reveal differences in the relations among marksmanship performance between Soldiers who used the new training aids and Soldiers who used the standard target only. More specifically, the combination of accuracy measures on zeroing and on confirm zero ($R = .41$) significantly predicted weapon-qualification scores ($F(2, 55) = 5.67$, $MSE = 32.76$) for Soldiers using the new training aids, but the combination of accuracy measures on zeroing and confirm zero ($R = .26$) did not significantly predict weapon-qualification scores ($F(2, 56) = 1.99$, $MSE = 23.46$) for Soldiers who used standard targets only.

Not only were the regression coefficients different between the two experimental groups, but also the characteristics of the regression models differed between the two groups. For the Soldiers who used the new training aids, accuracy during confirm zero (i.e., the first term entered in the stepwise regression) significantly predicted qualification scores ($R = .29$; $F_{change}(1, 56) = 4.53$), and accuracy during zeroing independently contributed to significant prediction of qualification scores ($R_{change} = .30$; $F_{change}(1, 55) = 5.40$). By contrast, for Soldiers who used the standard targets only, accuracy during confirm zero did not significantly predict qualification scores ($R < .01$; $F_{change} < 1$), but accuracy during zeroing did independently contribute to significant prediction of qualification scores ($R_{change} = .26$; $F_{change}(1, 56) = 3.76$).

The differences in the regression model parameters between the two experimental groups can be summarized as follows. On the one hand, for Soldiers using the new training aids, the combined effect of accuracy in zeroing and in confirm zero led to a significant prediction of weapon-qualification scores. Moreover, accuracy in both zeroing and confirm zero independently predicted qualification scores. The strong relation among the three marksmanship events suggested that the use of the new training aids contributes to the maintenance of skill exhibited during weapon qualification. On the other hand, for Soldiers using the standard targets only, accuracy during zeroing was a predictor of qualification scores, but there was no additive effect of accuracy during confirm zero. So, even though zeroing accuracy influenced qualification scores, using the standard target did not provide a strong relation among training events.

Analyses of modified 300 m targets. The targets used for initial zeroing (i.e., 25 m) in the standard-target-only group were classified based on the type of point-of-impact that was added to the 300 m target. The classifications were determined by the position of the modified point-of-impact and shape of the modified point-of-impact. An incorrect position or location of the point-of-impact during initial zeroing would affect the zero of the weapon and cause the Soldier to require more rounds to confirm zero. Incorrect or inconsistent points-of-impact on the modified 300 m zero targets would also make it more difficult for DSs to provide effective feedback to Soldiers during the training event.

The classifications of the modified 300 m zero targets and the percent of Soldiers in the standard-target group who used each type of target are given in Table 1. As can be seen in the table, only 57% of the Soldiers fired at targets that were modified in any way for a 200 m zero. However, less than 10% of the Soldiers in the entire group zeroed with targets that had the correct shape (i.e., circle) and location for the point-of-impact. An example of a correctly modified 300 m zero target is given in Figure 7. Almost 70% of the Soldiers in the standard-target group zeroed to a point-of-impact that was not appropriate for a 200 m zero, and 18% of the Soldiers in the group specifically zeroed for 300 m instead of 200 m.

Table 1.
Classification of Modified 300 M Zero Targets with the Percent of Soldiers Using Each Type.

Target Modified for 200 m Zero				Target Not Modified	
57%				43%	
Correct Position		Incorrect Position		"Eyeball"	300 m Zero
31%		26%		25%	18%
Square	Circle	Square	Circle		
22%	9%	25%	1%		

Note: The "eyeball" method represented the attempt by DSs to adjust sights to 200 m zero point-of-impact without marking the point-of-impact on the targets.

Any difficulties caused by zeroing with inaccurate targets would most likely manifest in the following marksmanship event (i.e., confirm zero). In order to demonstrate the impact of the inconsistent and inaccurate points-of-impact on subsequent marksmanship performance, comparisons were made on confirm-zero performance (i.e., rounds fired and accuracy) across Soldiers who used correctly modified 300 m zero targets at initial zeroing, Soldiers who used incorrectly modified 300 m zero targets at initial zeroing, and Soldiers who used unmodified 300 m zero targets at initial zeroing. One-way analysis-of-variance tests showed a significant difference in group means for both the number of rounds fired in confirm zero ($F(2, 55) = 3.25$, $MSE = 112.05$) and the proportion of rounds in the point-of-impact for confirm zero ($F(2, 55) = 3.15$, $MSE = .02$). Subsequent Tukey's Least Significant Difference tests revealed the nature of the group differences. For the total number of rounds fired, there was no difference between Soldiers who fired at unmarked targets ($M = 30.55$, $SEM = 1.82$) and those who fired at incorrectly-marked targets ($M = 31.62$, $SEM = 3.38$). However, Soldiers who fired at correctly-marked targets ($M = 23.6$, $SEM = 2.41$) fired significantly fewer rounds during confirm zero than each of the other groups. Likewise, Soldiers who fired at correctly-marked targets had a higher proportion of rounds in the point-of-impact ($M = .69$, $SEM = .04$) than Soldiers who fired at unmarked targets ($M = .59$, $SEM = .03$), but neither of these groups of Soldiers differed from Soldiers who shot at incorrectly-marked targets ($M = .64$, $SEM = .04$).

Interestingly, the number of rounds fired and the proportion of rounds in the point-of-impact did not differ between Soldiers who fired at correctly-modified 300 m zero targets and Soldiers who used the new 200 m zero targets (larger $t(75) = 1.58$). However, the proportion of rounds in the point-of-impact did not significantly correlate with weapon-qualification scores for Soldiers who used correctly-marked targets ($r = .05$), but that correlation was significant for Soldiers who used the new 200 m zero targets ($r(57) = .29$). In summary, it appeared that the

inconsistencies in modifying 300 m zero targets for a 200 m zero most likely resulted in the main differences noted in the prior analyses between the standard-target group and the new-training-aids group. Even correctly-modified 300 m zero targets did not provide maintenance of skill that was evident with the newly-developed 200 m zero targets. Using a target specifically designed for a 200 m zero alleviates extra responsibility, confusion, and subjective interpretation on the part of DSs, and should allow DSs to more easily train Soldiers.

Revisions to the Training Aids

The assessment results indicated that the new training aids benefitted marksmanship training by providing continuity among training events. In addition to the assessment data, information from about 12 informal interviews with DSs and Soldiers provided input to revise the training aids. In general, DSs and Soldiers who used the training aids understood the benefit of using such a training aid and were positive about the impact the training aid could have on marksmanship performance. As a result, no revisions were made to the coaches cards or the sight-adjustment flashcards. However, additional sight-adjustment flashcards were developed and added to the final version of the packet. A total of 20 sight-adjustment flashcards comprised the final version of the training aid.

Two major revisions were made to the targets after assessment. The first revision was made at the request of the Infantry OSUT training brigade. That request was to change the size of the point-of-aim of the targets to two MOA. Doing so would correspond to the smaller aiming dot of the newer generation M68 CCO while still useful for previous generation CCO, which have 4-MOA aiming dots. The smaller point-of-aim would also provide a more precise point-of-aim for iron sights. The other revision was to produce a version of the confirm-zero targets (i.e., 100 m and 200 m) with concentric rings within the point-of-impact. These rings can be used to further refine marksmanship performance by "scoring" shot groups. One minor revision was made to all targets. The contrast for the sight-adjustment information table at the bottom of the targets was reversed (i.e., from white background with black lettering to black background with white lettering) in order to be more visible in bright sunlight. After these revisions, the entire set of 200 m zero targets contained eight targets. A list of those targets is presented in Table 2, and the entire set of targets is shown in reduced scale in Appendix B. The final versions of the targets, coaches cards, and sight-adjustment flashcards are provided as a CD with this publication or can be obtained by contacting the ARI – Fort Benning Research Unit.

Table 2.
List of the Complete Set of 200 m Targets Developed.

Firing Distance	Weapon System	Modifications
25 m	M4 with M68 (CCO) or iron sights	None
	M16 with M68 (CCO) or iron sights	None
100 m	M4 with M68 (CCO) or iron sights	None
		Scoring Rings
	M16 with M68 (CCO) or iron sights	None
		Scoring Rings
200 m	M4 or M16 with M68 (CCO) or iron sights	None
		Scoring Rings

Discussion and Conclusions

As noted in prior research, a significant contributor to being able to shoot a qualifying score is to have the weapon properly zeroed (Taylor et al., 1986). Soldiers with an improperly zeroed weapon will not be able to hit the intended point even if all firing fundamentals are correctly performed. While Soldiers receive instruction on how to zero the weapon, it was noted that the quality and level of instruction varied significantly among training units (Cobb, Graves, James, Dlubac & Wampler, 2010; Dyer et al., 2010). The result is that Soldiers have difficulty learning and retaining the ability to properly zero their weapon, which impedes their ability to qualify with their weapon.

Because of the importance of weapon zeroing, the goal for developing the training aids reported here was to produce tools that could help Soldiers more efficiently zero their weapon system. In addition, the training aids were developed to leverage peer-learning principles to aid weapon-zeroing training. As a result, a set of training aids to achieve and to train a 200 m zero were developed. The primary training aid was a set of targets specific to the 200 m zero. These targets not only included clear and accurate point-of-aim and point-of impact for 200 m zero, but also were based on MOA so that they could be used with multiple weapon sights. The coaches cards were designed to facilitate peer interaction by providing guidelines for peer coaching.

Likewise, the sight-adjustment flashcards were designed to be used by interacting groups of Soldiers. The flashcards allowed Soldiers to practice the determination of sight adjustments and to get feedback on the process.

While the use of the training aids did not decrease the total number of rounds required for Soldiers to zero their weapons and did not increase the weapon-qualification scores, the training aids did reduce the number of rounds required to confirm zero as compared to zeroing and provided a positive relation among training events (i.e., zeroing, confirm zero, and weapon qualification). The efficiency in training provided by the training aids was not demonstrated by a savings in rounds fired during zeroing, but rather efficiency was demonstrated by the fact that rounds fired in one training event would impact subsequent training and qualification scores. The relation of performance across weapon-zeroing events and qualification scores for the new training aids also indicated that using the training aids can provide an early diagnostic for qualification performance. Most Soldiers who are inaccurate with the developed targets (especially during confirm zero) will not perform well on weapon qualification and can be identified for remediation during zeroing training.

It should be recognized that neither the coaches cards nor the sight-adjustment flashcards were independently assessed. In fact, only data on target performance were analyzed. The lack of specific assessment data was not an oversight, per se. Rather, the lack of assessment of the coaches cards and the flashcards reflects the reality of current BRM training. That is, currently, the vast majority of IET Soldiers are not responsible for determining sight adjustments during live fire events because of time pressure (Dyer, 2011). As a consequence, any benefit to sight-adjustment ability as a result of using the flashcards would have been inconsequential to BRM training. However, as Soldiers are given more responsibility in the training process (see Wilcox and Wickman, 2010), the coaches cards and sight-adjustment training aids should benefit training and further assessment would be possible.

Because the developed targets are based on MOA, apply to multiple weapon systems, are easily used, and provide an accurate 200 m zero, the targets are useful to Soldiers in any training or operational unit. In fact, the targets were transitioned to the Training and Doctrine Command Capabilities Manager for Live Training for wider distribution within the Army. The intent was to make the targets available to any Army unit wishing to obtain an accurate 200 m zero for the M4 or the M16. As a result, most Soldiers in the Army will have access to the targets and can use them for training or for preparation for weapon qualification.

At the conclusion of the research effort, all training aids were left with the participating company and used in subsequent training cycles. Results of this research were presented to the Infantry OSUT training brigade who supported the project. The final version of the 200 m zero training aids were provided to the Infantry OSUT training brigade at Fort Benning, GA. These units will continue to use the training aids and could form the foundation for future research concerning the benefit of these training aids or other related training aids for use in basic combat skills.

References

Aronson, E., & Patnoe, S. (1997). *The Jigsaw Classroom: Building cooperation in the classroom* (Second ed.). New York, NY: Longman Press.

Bink, M. L., Wampler, R. L., Dlubac, M. D., & Cage, E. A. (2011). *Training Aids for basic combat skills: A procedure for training-aid development.* (ARI Research Report 1939). Arlington, VA: U.S. Army Research Institute for the Behavioral and Social Sciences.

Cobb, M. G., Graves, T. R., James, D. R., Dlubac, M. D. & Wampler, R. L. (2010). *Marksmanship Skill retention in basic combat training (BCT): An initial assessment of integrating asymmetric warfare group training techniques within a 10-week BCT* (ARI Research Report 1920). Arlington, VA: U.S. Army Research Institute for the Behavioral and Social Sciences. (DTIC No AD A516970).

Collison, C. & Parcell, G. (2004). *Learning to fly: Practical knowledge management from leading and learning organizations*. West Sussex: Capstone Publishing Limited.

Costanza, M. N., Leibrecht, B. C., Cooper, W., & Sanders, W. R. (2009). *Peer-to-peer training facilitator's guide: Development and evaluation.* (ARI Research Report 1911). Alexandria, VA: U.S. Army Research Institute for the Behavioral and Social Sciences. (DTIC No AD A508309).

Currey, C. J. (2008). Outcomes-based training: What's next? *Initial Entry Training Journal*, 1-3. Fort Jackson, SC: Directorate of Basic Combat Training.

Department of the Army (2008). Rifle marksmanship M16-/M4-series weapons (FM 3-22.9). Washington DC: Author.

Department of the Army (2003). Rifle marksmanship M16A1, M16A2/3, M16A4, and M4 carbine (FM 3-22.9). Washington DC: Author.

Dyer, J. L. (2011). Assessment of new marksmanship strategies: 2010. Draft ARI report in preparation. ARI – Fort Benning Research Unit.

Dyer, J. L., Schaefer, P. S., Bink, M. L., James, D. R., Wampler, R. L., & Dlubac, M. D. (2010). *Soldier performance on a new marksmanship course of fire*. (ARI Research Report 1924). Arlington, VA: US Army Research Institute for the Behavioral and Social Sciences. (DTIC No AD A523973).

Festinger, L. (1954). A theory of social comparison processes. *Human Relations, 7*, 117-140.

McCombs, B. L. (2004). The learner-centered psychological principles: A framework for balancing a focus on academic achievement with a focus on social and emotional learning needs. In J. E. Zins, R. P. Weissberg, M. C. Wang, & H. J. Walberg (Eds.), *Building academic success on social and emotional learning: What does the research say?* (pp. 23-39). New York, NY: Teachers College Press.

Osborne, A. D., Morey, J. C., & Smith, S. (1980). *Adequacy of M16A1 rifle performance and its implications for marksmanship training*. (ARI Research Report 1265). Alexandria, VA: U.S. Army Research Institute for the Behavioral and Social Sciences. (DTIC No AD A100960).

Osborne, A. D., Schroeder, J. E., & Heller, F. H. (1984). *Evaluation of the basic rifle marksmanship program of instruction*. (ARI Research Report 1364). Alexandria, VA: U.S. Army Research Institute for the Behavioral and Social Sciences. (DTIC No AD A148315).

Smith, S. Thompson, T. J., Evans, K. L., Osborne, A. D., Maxey, J. L., & Morey, J. C. (1980). *Effects of down-range feedback and the ARI zeroing target in rifle marksmanship training.* (ARI Research Report 1251). Alexandria, VA: U.S. Army Research Institute for the Behavioral and Social Sciences. (DTIC No AD A100958).

Taylor, C. J., Dyer, F. N., & Osborne, A. D. (1986). *Effects of rifle zero and size of shot group on marksmanship scores* (ARI Research Note 86-15). Alexandria, VA: U.S. Army Research Institute for the Behavioral and Social Sciences. (DTIC No AD A164 659).

Thompson, T. J., Smith, S., Morey, J. C., & Osborne, A. D. (1980). *Effectiveness of improved basic rifle marksmanship training programs*. (ARI Research Report 1255). Alexandria, VA: U.S. Army Research Institute for the Behavioral and Social Sciences. (DTIC No AD A096954).

Tomasello, M. (1999). *Cultural origins of human cognition.* Cambridge, MA: Harvard University Press.

Tomasello, M., Carpenter, M., Call, J., Behne, T., & Moll, H. (2005). Understanding and sharing intentions: The origins of cultural cognition. *Behavioral and Brain Sciences, 28,* 675 – 735.

Topping, K. J. (2005). Trends in peer learning. *Educational Psychology, 25*, 631-645.

Vygotsky, L. S. (1978). *Mind in society: The development of higher psychological processes.* Cambridge, MA: Harvard University Press.

Wampler, R. L., Dyer, J. L., Livingston, S. C., Blankenbeckler, P. N., & Dlubac, M. D. (2006). *Training lessons learned and confirmed from military training research* (ARI Research Report 1850). Arlington, VA: U.S. Army Research Institute for the Behavioral and Social Sciences. (DTIC No AD A446697).

Wilcox, D., & Wickman, R. (2010). Smart training. *Initial Military Training Journal, July*, 2 – 9.

Woodie, T. E. (2005). *Learning together: The role of the online community in Army professional education*. Fort Leavenworth, KS: School of Advanced Military Studies. (DTIC No. AD A436308).

APPENDIX A

200 M ZERO TARGET DIMENSIONS AND OFFSETS

Dimensions and Offsets for 25 m Targets.

Sheet size	
Height	27.94 cm
Width	21.59 cm
Grid size	
Height	20.4 cm
Width	18.7 cm
Grid square	0.96X0.96 cm
Silhouette position	6.7
Bottom	4 cm
Left	5.4 cm
Silhouette size	
Height	12.7 cm
Width	7.6 cm
POA position	
Bottom	8.5 cm
Left	12.1 cm
POA circumference	5.15 cm
POI position (M-4 Carbine)	
Bottom	5.7 cm
Left	9.9 cm
POI position (M-16 Rifle)	
Bottom	5.1 cm
Left	11.8 cm
POI circumference	12.5 cm
Line Weights	
Grid	1 pt
POI	6 pt

Dimensions and Offsets for 100 m Targets.

Sheet size	
Height	91.4 cm
Width	55.8 cm
Grid size	
Height	61.9 cm
Width	50.3 cm
Grid square	2.7 x 2.7 cm
BG position	
Bottom	14.7 cm
Left	34 cm
BG circumference	101.7 cm
POA position	
Bottom	25 cm
Left	34 cm
POA circumference (2 MOA)	18.22 cm
POI position (M-4 Carbine)	
Bottom	28 cm
Left	36 cm
POI position (M-16 Rifle)	
Bottom	26 cm
Left	42 cm
POI circumference	49.6 cm
9-Ring circumference*	31.4 cm
10-Ring circumference*	13.1 cm
Line Weights	
Grid	5 pt
POI/Rings	5 pt

*9-Ring and 10-Ring have same center position as POI circle (8-Ring)

Dimensions and Offsets for 200 m Targets.

Sheet size	
Height	94.4 cm
Width	55.8 cm
Grid size	
Height	65 cm
Width	53.1 cm
Grid square	5.8 x 5.8 cm
BG position	
Bottom	11.5 cm
Left	20.8 cm
BG circumference	130.6 cm
POA position	
Bottom	20.9 cm
Left	30.3 cm
POA circumference (2 MOA)	37.05 cm
POI position	
Bottom	16.4 cm
Left	26 cm
POI circumference	100.4 cm
9-Ring circumference*	62.5 cm
10-Ring circumference*	25.1 cm
Line Weights	
Grid	5 pt
POI/Rings	9 pt

*9-Ring and 10-Ring have same center position as POI circle (8-Ring)

Dimension and offset key.

Sheet size	The size of the paper
Height	Long dimension
Width	Short dimension
Grid size	The size of the minute-of-angle grid area of target
Height	Long dimension
Width	Short dimension
Grid square	The dimension of one minute-of-angle grid square
BG position[1]	Distance of the center of the aiming background (black circle) from the bottom-left corner of the grid area
Bottom	Distance from the bottom of the grid area
Left	Distance from the left edge of the grid area
BG circumference	Circumference of the aiming background (black circle)
Silhouette position[1]	Distance of bottom-left corner of 25 m Target silhouette from the bottom-left corner of grid area
Bottom	Distance from the bottom of the grid area
Left	Distance from the left edge of the grid area
Silhouette size	Size of 25 m Target silhouette
Height	Long dimension
Width	Short dimension
POA position[1]	Distance to the center of the point-of-aim circle (white) from the bottom-left corner of grid area
Bottom	Distance from the bottom of the grid area
Left	Distance from the left edge of the grid area
POA circumference	Circumference of the point-of-aim circle (white)
POI position	Distance of the center of the point-of-impact circle (unfilled) from the bottom-left corner of grid area
Bottom	Distance from the bottom of the grid area
Left	Distance from the left edge of the grid area
POI circumference	Circumference of the point-of-impact circle (unfilled)
9-Ring circumference[2]	Circumference of concentric scored ring inside the point of impact (unfilled circle)
10-Ring circumference[2]	Circumference of concentric scored ring inside the point of impact (unfilled circle)
Line Weights	
Grid	Line weight of minute-of-angle grid
POI/Rings	Line weight of point-of-impact circle and scored rings (unfilled circles)

[1] Measured from the outside of the grid line

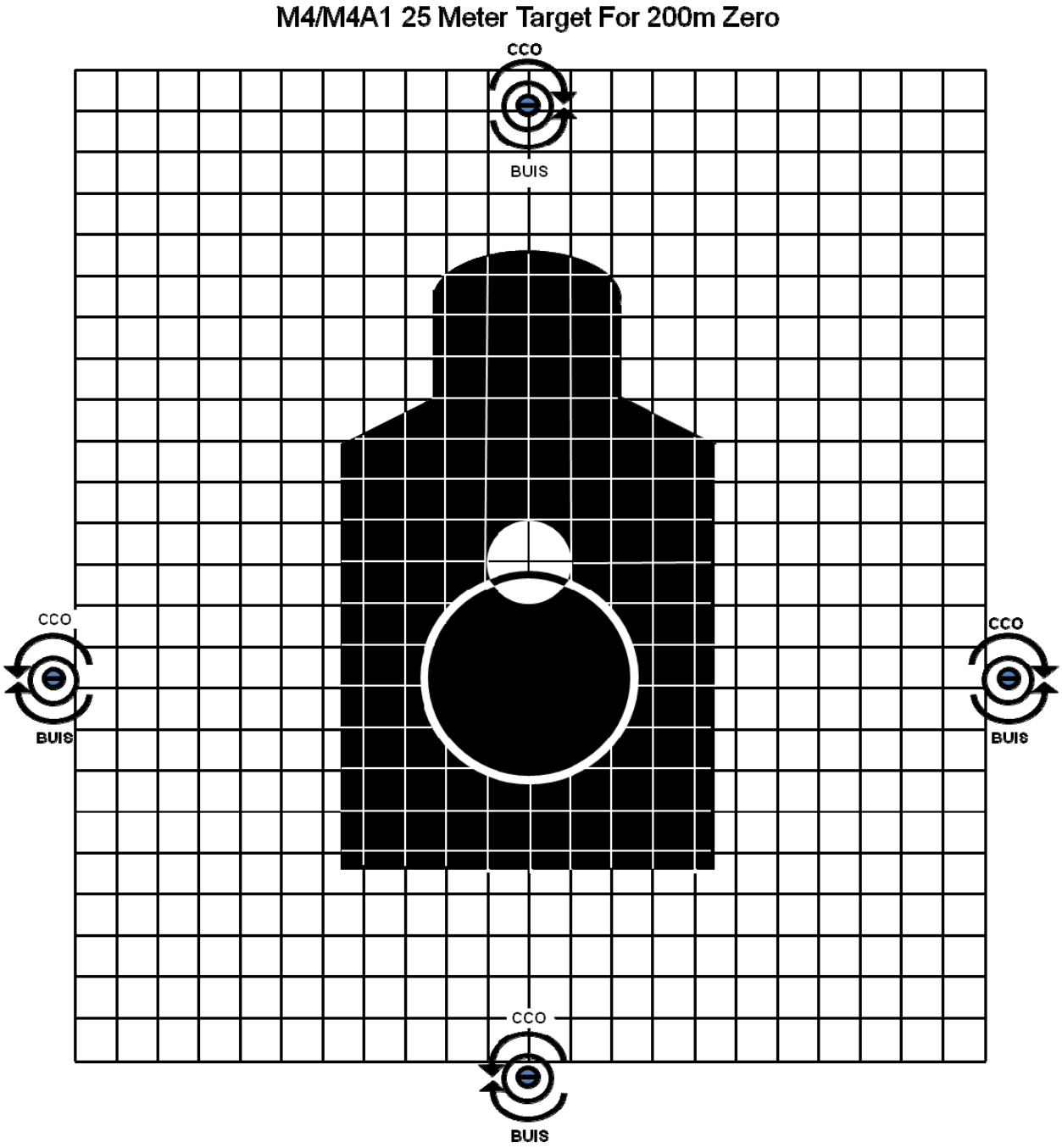
[2] 9-Ring and 10-Ring have same center position as POI circle (8-Ring)

APPENDIX B

200 M ZERO TARGETS[1]

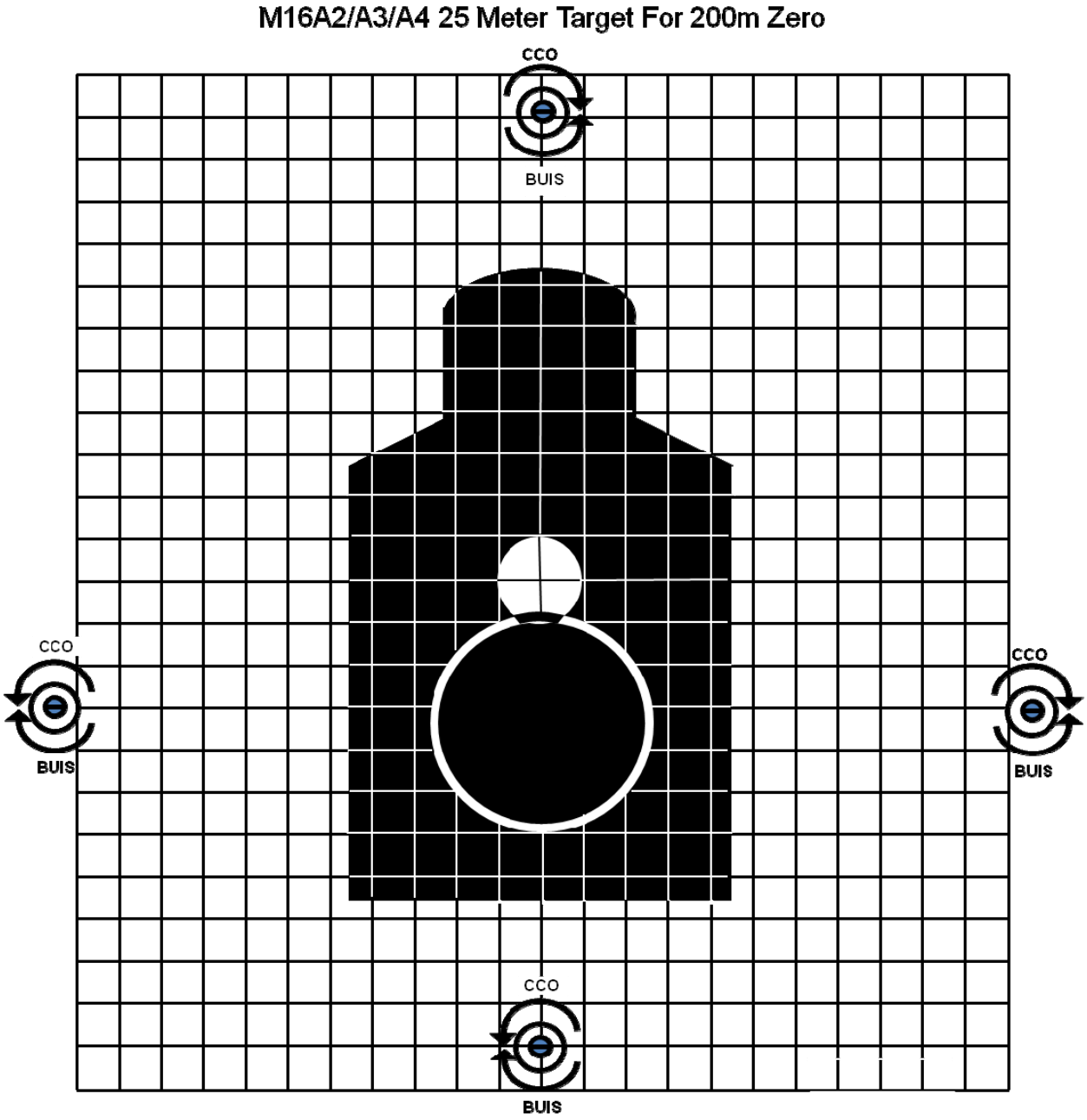
[1] Targets are not shown to correct size or scale.

25 m M4 Carbine.



Value of ONE click in MOA for M4/M4A1 sights			
WEAPON	ELEVATION KNOB	WINDAGE KNOB	FRONT SIGHT POST
BUIS	N/A	1MOA = 2 clicks	2 MOA = 1 click
CCO	1MOA = 2 clicks	1MOA = 2 clicks	N/A

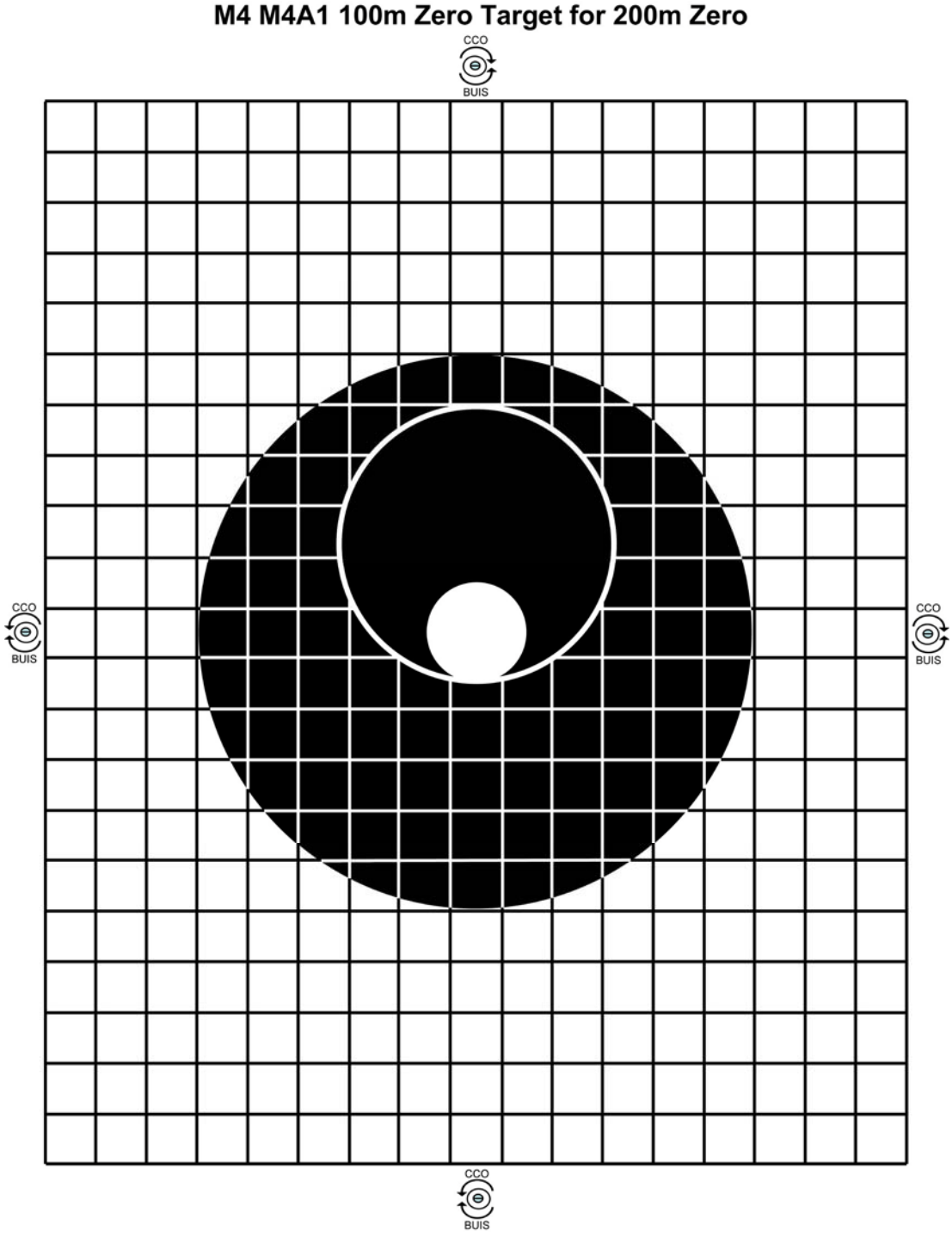
25 m M16 Rifle.



Each square equals One MOA

Value of ONE click in MOA for M16A2/A3/A4 sights			
WEAPON	**ELEVATION KNOB**	**WINDAGE KNOB**	**FRONT SIGHT POST**
M16A2/A3	N/A	1MOA = 0.5 click	1 MOA = 1 click
M16A4 (carrying handle)	N/A	1MOA = 1 click	1 MOA = 1click
BUIS	N/A	1MOA = 2 clicks	1 MOA = 1 click
CCO	1MOA = 2 clicks	1MOA = 2 clicks	N/A

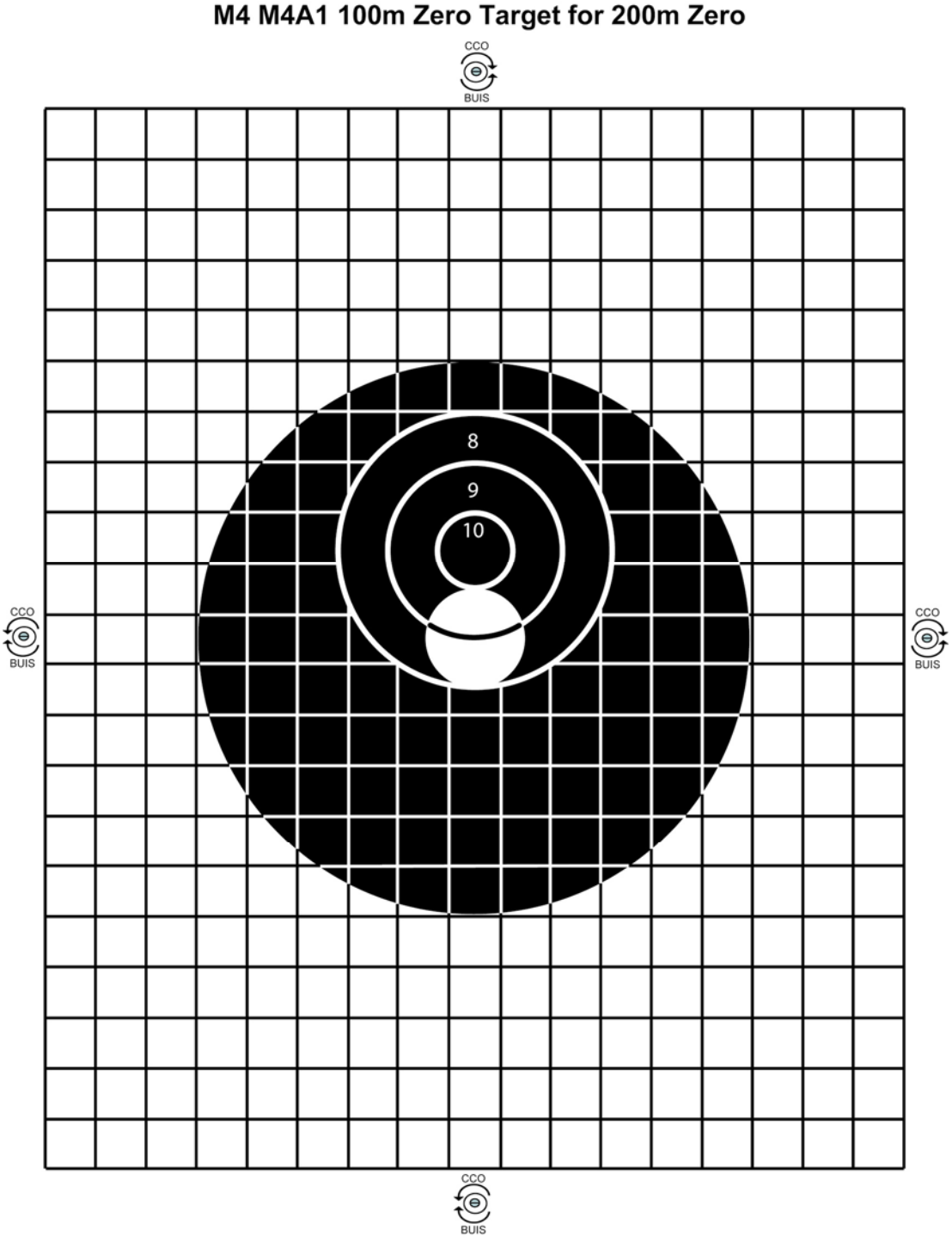
100 m M4 Carbine.



Each square equals One MOA

Value of ONE click in MOA for M4 M4A1 iron sights			
WEAPON	ELEVATION KNOB	WINDAGE KNOB	FRONT SIGHT POST
BUIS	N/A	1 MOA = 2 clicks	2 MOA = 1 click
CCO	1 MOA = 2 clicks	1 MOA = 2 clicks	N/A

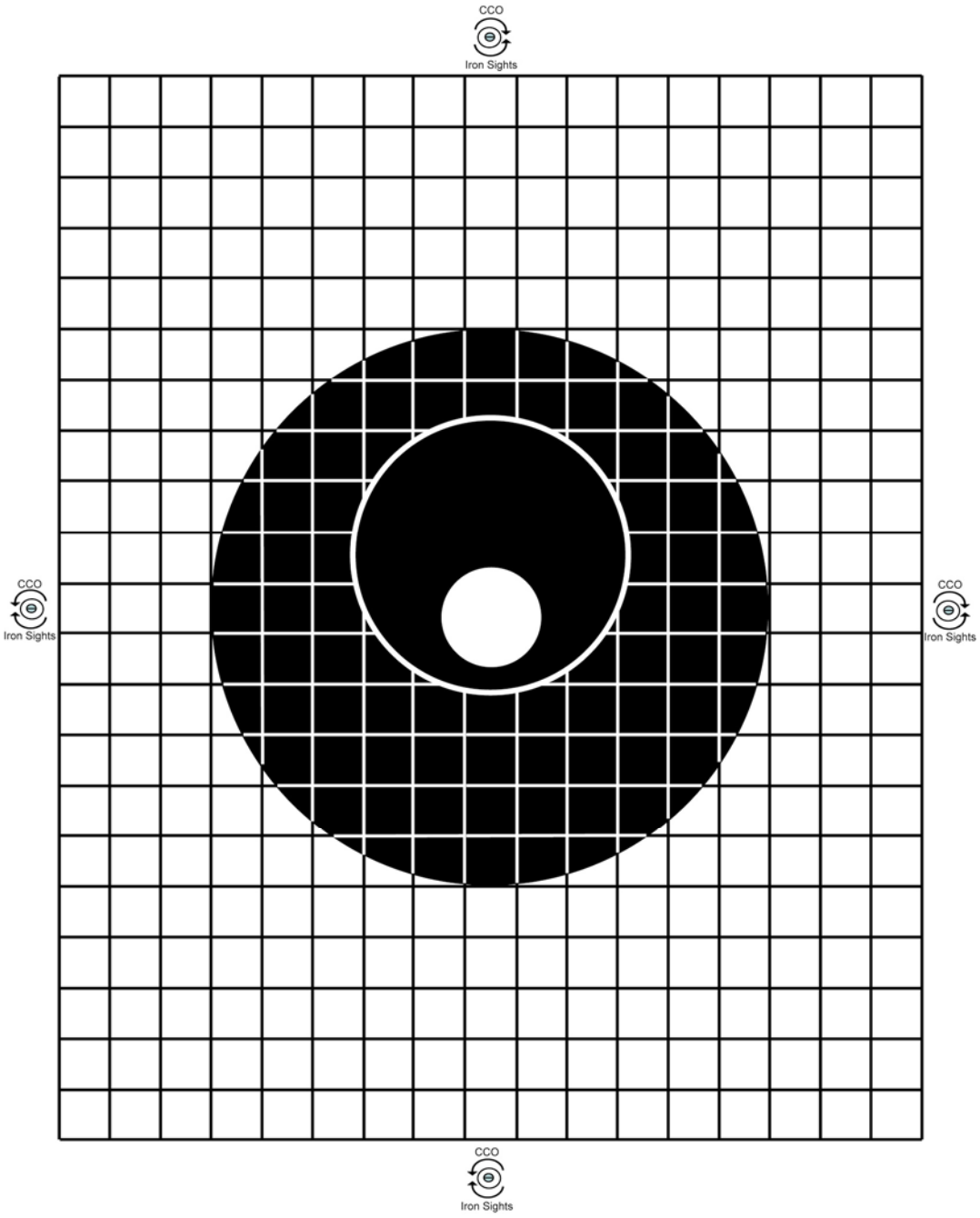
100 m M4 Carbine with Scoring Rings.



Value of ONE click in MOA for M4 M4A1 iron sights			
WEAPON	**ELEVATION KNOB**	**WINDAGE KNOB**	**FRONT SIGHT POST**
BUIS	N/A	1 MOA = 2 clicks	2 MOA = 1 click
CCO	1 MOA = 2 clicks	1 MOA = 2 clicks	N/A

100 m M16 Rifle.

M16A2 M16A3 M16A4 100m Zero Target for 200m Zero

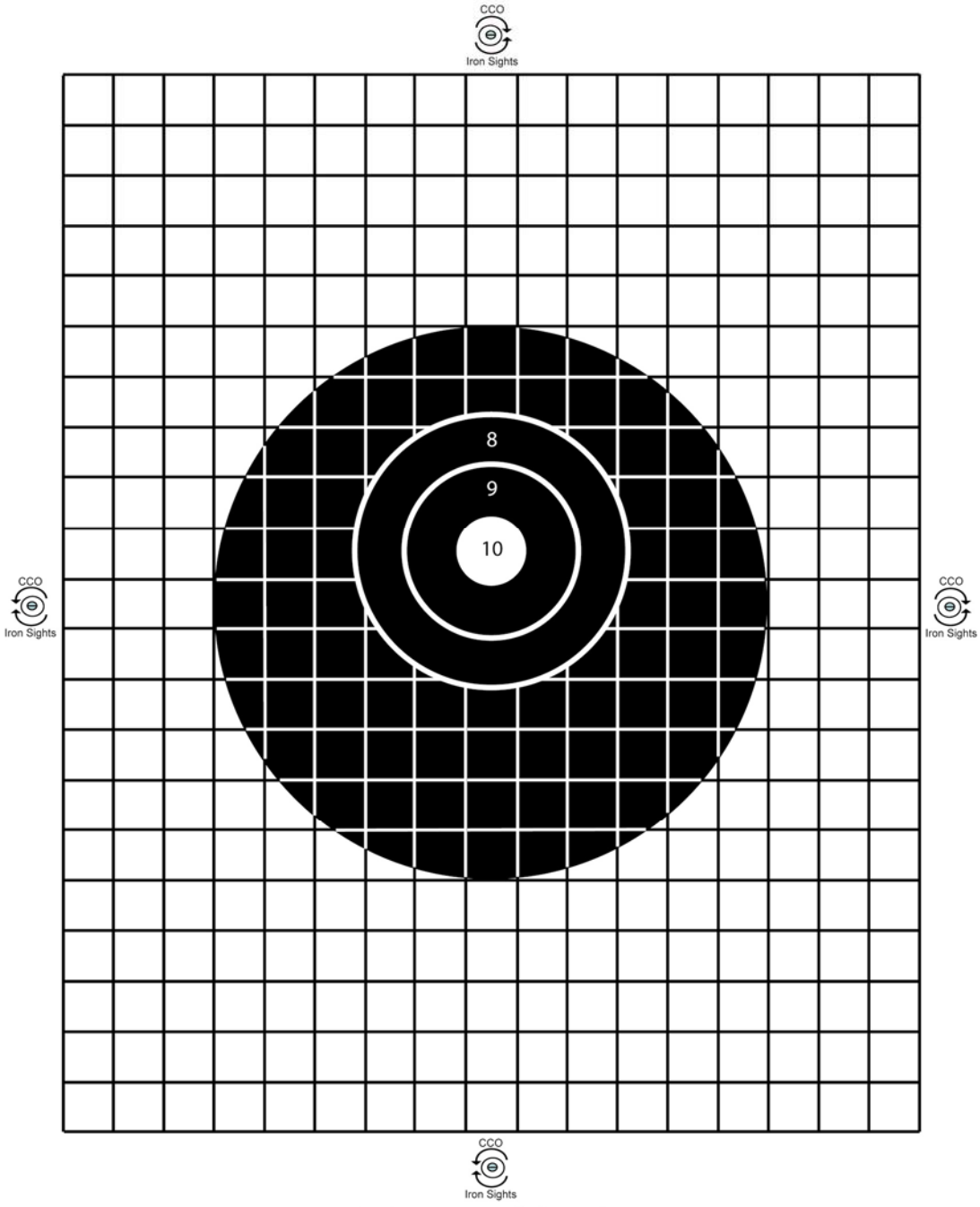


Each square equals One MOA

Value of ONE click in MOA for M16A2/A3/A4 Sights			
WEAPON	ELEVATION KNOB	WINDAGE KNOB	FRONT SIGHT POST
M16A2/A3	N/A	1 MOA = 0.5 clicks	1 MOA = 1 click
M16A4 w/carrying handle	N/A	1 MOA = 1 click	1 MOA = 1 click
BUIS	N/A	1 MOA = 2 clicks	1 MOA = 1 click
CCO	1 MOA = 2 clicks	1 MOA = 2 clicks	N/A

100 m M16 Rifle with Scoring Rings.

M16A2 M16A3 M16A4 100m Zero Target for 200m Zero

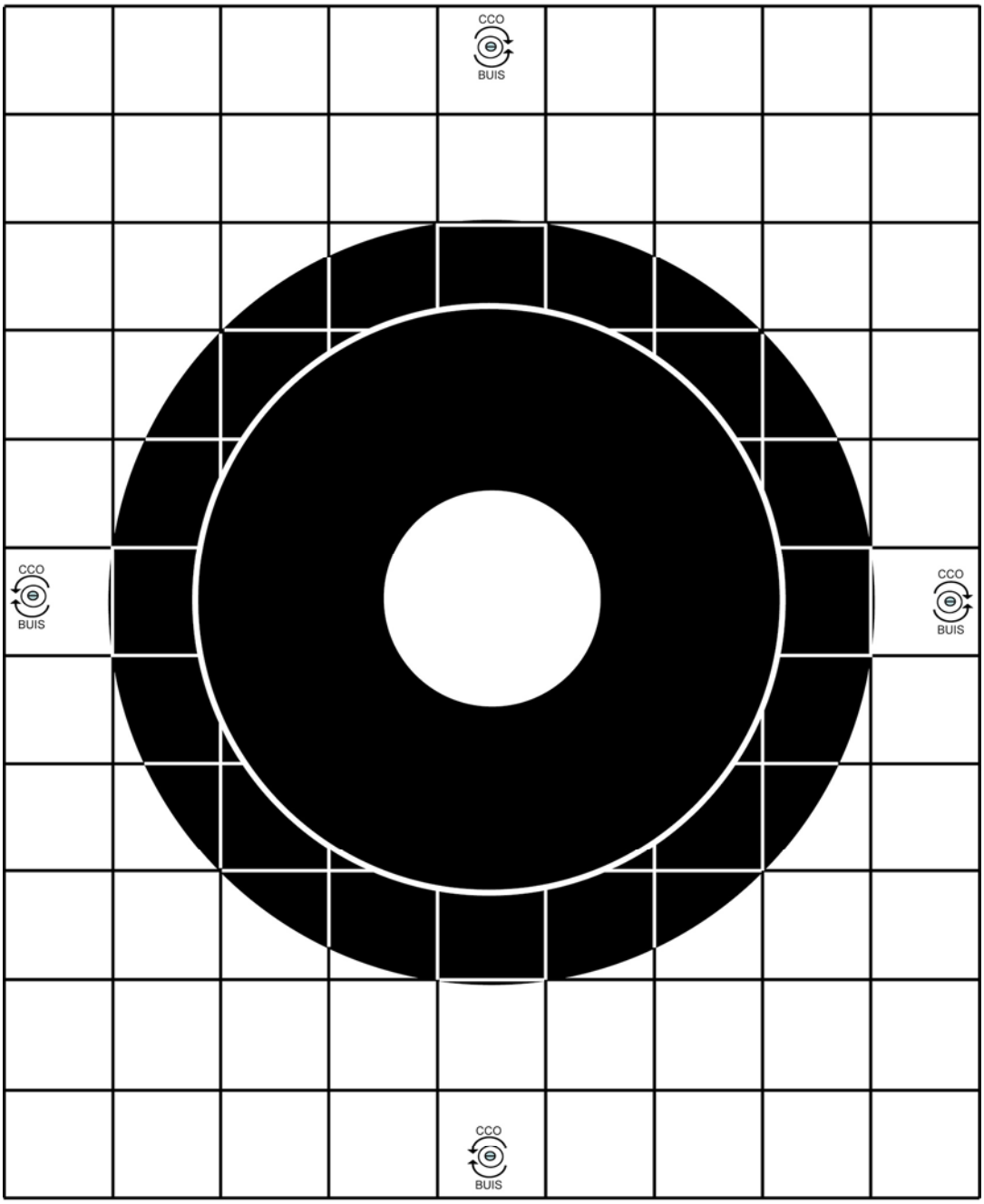


Each square equals One MOA

Value of ONE click in MOA for M16A2/A3/A4 Sights			
WEAPON	ELEVATION KNOB	WINDAGE KNOB	FRONT SIGHT POST
M16A2/A3	N/A	1 MOA = 0.5 clicks	1 MOA = 1 click
M16A4 w/carrying handle	N/A	1 MOA = 1 click	1 MOA = 1 click
BUIS	N/A	1 MOA = 2 clicks	1 MOA = 1 click
CCO	1 MOA = 2 clicks	1 MOA = 2 clicks	N/A

200 m M4 Carbine and M16 Rifle.

M16A2 M16A3 M16A4 M4 M4A1 200m Zero Target

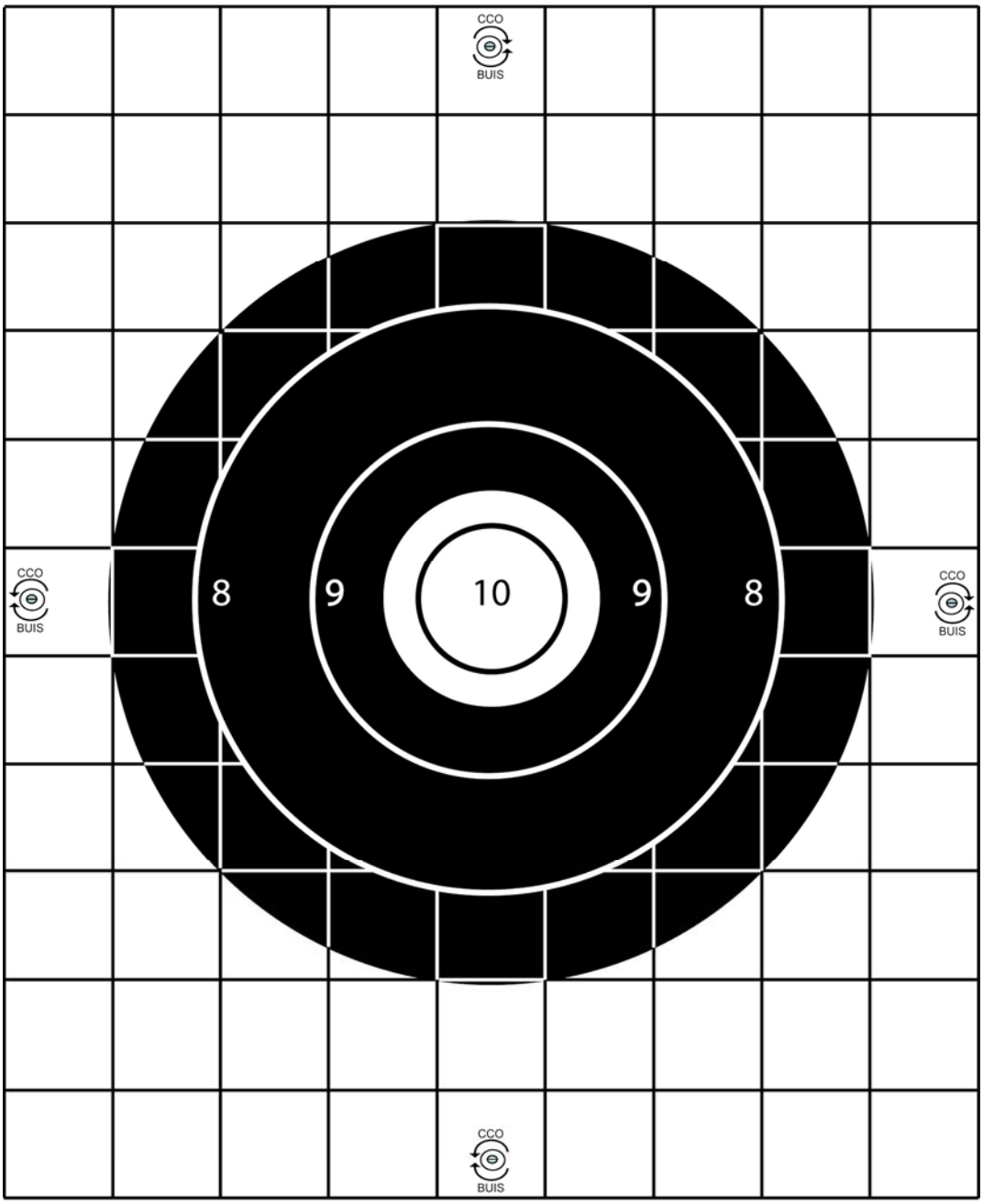


Each square equals One MOA

Value of ONE click in MOA for M16A2/A3/A4/M4/M4A1 Sights			
WEAPON	**ELEVATION KNOB**	**WINDAGE KNOB**	**FRONT SIGHT POST**
M16A2 / A3	N/A	1 MOA = 0.5 click	1 MOA = 1 click
M16A4 w/carrying handle	N/A	1 MOA = 1 click	1 MOA = 1 click
BUIS	N/A	1 MOA = 2 click	N/A
CCO	2 click = 1 MOA	1 MOA = 2 click	N/A
M4	N/A	N/A	2 MOA = 1 click

200 m M4 Carbine and M16 Rifle with Scoring Rings.

M16A2 M16A3 M16A4 M4 M4A1 200m Zero Target



Each square equals One MOA

Value of ONE click in MOA for M16A2/A3/A4/M4/M4A1 Sights			
WEAPON	ELEVATION KNOB	WINDAGE KNOB	FRONT SIGHT POST
M16A2 / A3	N/A	1 MOA = 0.5 click	1 MOA = 1 click
M16A4 w/carrying handle	N/A	1 MOA = 1 click	**1 MOA = 1 click**
BUIS	N/A	1 MOA = 2 click	N/A
CCO	2 click = 1 MOA	1 MOA = 2 click	N/A
M4	N/A	N/A	2 MOA = 1 click