PRECISION MARKSMAN

HECKLER & KOCH, INC.

PRECISION MARKSMAN I

DAY ONE
- Administration and Introduction
- Weapons Inspections
- Care & Cleaning
- Lunch
- Scope Theory & Adjustment
- Range Safety & Procedures
- Zero
- Data Book/Gun Book Recording
- Kims Games
- Debrief

DAY TWO
- Kims Game
- Sighting/Aiming & Trigger Control
- Shooting Positions
- Practical Applications/Positions
- Effects of Weather
- Lunch
- Confirm/Zeros
- Range Exercise 1
- Clean Weapons
- Range Exercise 2
- Debrief

DAY THREE
- Kims Game
- Ballistics
- Leads/Holds for Moving Targets
- Range Exercise 3
- Lunch
- Techniques of Camouflage
- Obs. Ex. Practical Applications
- Range Exercise 4
- Lunch
- Brief
- Night Shoot
- Debrief

DAY FOUR
- Kims Game
- Urban Operations
- Glass Shooting Techniques
- Glass Shoot
- Lunch
- Scenario Shoot
- Shoot Pre-Qualifications
- Debrief

DAY FIVE
- Final Kims Game
- Final Examination
- Shoot Qualifications
- Graduation/Course Critique

PRECISION MARKSMAN I

Description: Through lecture, demonstrations, class discussions and live fire range exercises, the student will be able to perform their knowledge and abilities to accurately fire, maintain, and prepare the precision rifle for active use and support of entry teams and department requirements.

OBJECTIVES: The student will be able to:

1. Demonstrate proper safety discipline, maintain proper weapon zero and weapons maintenance.
2. Accurately zero in different weather conditions. Accurately fire at targets from various distances during slow and cadence fire.
3. Demonstrate correct firing positions, fire from various position, and properly use sniper observer team.
4. Set and meet standards to perform duties required to support entry teams
5. Pass final testing standards of written and live fire exams.

REFERENCES: MC FMFM 0-11 FMFM-0-8 FMFM 1-3A
Competitive Marksmanship
U.S. MARINE CORPS SCOUT/SNIPER INSTRUCTORS SCHOOL

TRAINING AIDS: Accessories for Rifle
Optics
Personal Equipment

EACH STUDENT WILL HAVE:

1. Rifle 7.62 OR 5.56
2. Optics
3. Essential Equipment
4. 300 rounds of ammo

TOTAL TIME: **40 Hours**

PRECISION MARKSMAN I

CARE AND CLEANING

TERMINAL LEARNING OBJECTIVES

A. GIVEN A RIFLE AND CLEANING EQUIPMENT WITHOUT THE AID OF REFERENCES PREFORM PREVENTING MAINTENANCE

B. <u>ENABLING LEARNING OBJECTIVES</u>:

1. Given a rifle without the aid of references, disassemble the rifle.

2. Given a rifle and cleaning gear, without the aid of references, clean the rifle.

3. Given a rifle and approved lubricant Protectant, without the aid of references, lubricate the rifle.

4. Given a rifle, without the aid of references, reassemble the rifle.

5. Given a rifle, without the aid of references, inspect the rifle .

INSPECTING THE RIFLE AND SCOPE

A Weapon in use and in the elements should be inspected constantly for wear and tear. The fact that the weapon is in use is sufficient reason to indicate the need for continuous inspection and cleaning. This should occur at least daily. Prior to cleaning, the rifle must be cleared and checked.

A. MUZZLE

1. Check the crown for dents
2. Check the bore for pits
3. Check the barrel for buldges

B. SCOPE

1. Check the scope for serviceability
2. Ensure locking rings are secure
3. Inspect lenses for scratches
4. Ensure turrets rotate smoothly and do not wobble
5. Check O-rings
6. Inspect the inside of the scope for condensation
7. Ensure reticle is in tact
8. Check to see that the scope is snug and straight in the mounts
9. Check all mounting screws

C. RECEIVER

1.Remove the bolt and check for freedom of movement

2.Inspect to see that extractor is clean, not worn and has back tension

3.Ensure the ejector has spring back tension

4.Ensure the receiver and magazine are clean

5.Check to see that the floor plate functions properly

6.Inspect Allen torque screws to ensure they are not rounded off

7.Insert the bolt and ensure smooth operation with no binding

8.With the safety on, pull the trigger and check safety operability

9.With the safety off, pull the trigger and the hammer should fall

10.Inspect trigger pull

D. STOCK

1.Check stock and bedding for cracks

2.Look for possible solvent seeping from the receiver onto bedding

3.Ensure there is no material between the stock and the barrel

4.Check sling swivels

5.Inspect the butt pad for wear

CLEANING THE RIFLE

PRIOR TO CLEANING, ENSURE A SAFETY CHECK IS PREFORMED

A. CLEANING MATERIALS

1) Cleaning patches

2) Camel hair brush (for lenses)

3) Bore brush, .30 cal., 5.56

4) Bore brush, .45 cal

5) Bore cleaner

6) Lubricant, medium

7) Lubricant, light

8) Brush, all purpose

9) Lens paper, optical (great northern toilet tissue or comparable grade)

10) Anti-fog compound

11) Cleaning rod, brass

12) Bore guide

13) The following materials should not be used:
    a) Steel sectioned cleaning rod

b) Dry cleaning solvent
c) Hoppes #9 solvent
d) WD-40

14) Compressed Air is a good option for lenses

B. <u>CLEANING BEFORE FIRING</u>

INSURE THE RIFLE IS SECURE ON A STABLE CLEANING RACK, OR USE THE TWO MAN METHOD BY ONE HOLDING WHILE THE OTHER PUNCHES THE BORE.

1. BORE

A.Remove the bolt

B.Replace the bolt with a bore guide

C.Using a brass or protected cleaning rod, push a .30 caliber bore brush dipped in solvent through the bore from the receiver end. Push the brush all the way through. Repeat this approximately 20 times. Never push a rod through the bore from the muzzle in or you risk damaging the crown.

D.When cleaning always keep the muzzle end lower than the receiver to prevent solvent from running into the trigger housing. Take steps to ensure solvent doesn't seep into the bedding surface as this will cause erosion to occur and degrade accuracy.

E.Begin running cleaning patches through the bore from the receiver end with a bore guide. Push the patches all the way through and pull back out. Repeat this procedure with clean patches until they come out clean. (one patch at a time)

2. CHAMBER

A.Use a .45 bore brush to clean the chamber. Insert the bore brush with a twisting motion. Continue rotating the brush a minimum of ten times. As the brush is removed continue the rotation. Do not scrub the chamber with an in and out motion. (this will raise burrs)

B.Dry the chamber by wrapping a patch around the .45 cal brush and using the same rotating motion insert it into the chamber and rotate five times.Change the patch and continue this procedure until the patches come out clean. Take Q-Tips and get into the smaller areas.

3. BOLT

Using an all-purpose brush, scrub the entire bolt with breakfree. Pay particular attention to the bolt face and around the extractor.

4. RECEIVER

Using an all-purpose brush scrub the receiver, floor plate, sling swivels, magazine follower and spring, trigger, and trigger guard with breakfree.

5. STOCK

Clean the stock with a damp rag. Ensure water does not get into the action.

C. CLEANING DURING FIRING AND WHILE IN THE FIELD.

1. BORE

Run a patch through the bore approximately every 20 rounds when feasible.

2. STOCK

Keep foreign objects from getting between the stock and the barrel. A cloth can be run between the two regularly in a “shoe shine” fashion.

3. SIGHT

Keep the metal surface of the sight wiped clean. Depending on the finish or if painted a light lube may be required. Ensure that no lubricant or solvent ever touches the lenses. Use a lense brush to wipe off the outside of the sight. Compressed air will greatly assist in removing material from the lenses without scratching. High quality toilet tissue should be used to “dap” the lenses clean. (most types of lense paper are too coarse)

4. RIFLE

Common sense in maintaining the rifle is key. Keeping exposed metal lubricated without soaking, covering lenses at all times when not in use, and using rifle bags or cases when rifles are not in use will keep the weapons serviceable. Never lean a scoped weapon against anything. Storage of the weapon in a clean dry place and proper weapon placement in storage will keep long time protection in play.

D. CLEANING AFTER FIRING

Every rifle must be cleaned after it has been fired because of deposits of primer fouling, powder residue, carbon, and metal filings. Even modern primers leave residue that will collect moisture and promote rust if not removed. Cleaning should be done as soon as possible after firing is completed.

LUBRICATION PROCEDURES

A. NORMAL

For normal environments all metal parts should be lightly lubed with

breakfree. The bolt should be lightly greased around the locking lugs. Inspect these high friction areas regularly for wear.

B. COLD WEATHER

Only apply lightweight oils or Lubricant Arctic Weather (LAW). Graphite will also work in these conditions. Keep weapons stored in the same temperatures as those experienced outside. This will prevent condensation from building up and freezing the weapon.

C. HOT, HUMID CLIMATE

Regular cleaning is the key in this environment. Optics can experience actual fungus growth if not sealed. Everything deteriorates faster in this environment so all rubber or plastic parts require constant inspection.

D. SALT WATER EXPOSURE

Salt water exposure will quickly cause corrosive effects on metal. If a weapon gets submersed in salt water it must quickly be thoroughly rinsed with fresh water, dried, and cleaned. Drying the weapon out will take time but it can be done by field stripping the weapon and laying it in the sun or a more preferred method would be a dry and warm climate controlled room.

E SANDY AREAS

Sand must be prevented from getting in between any loving parts of the weapon. If it does occur cleaning will have to be thorough to prevent malfunctions and possible long term scarring. Lubricants and grease will pick up and hold sand. Only very light weight oils or graphite should be used. Compressed air is a good way to blow sand out of a weapon without risk. Never rub areas that have been exposed to sand.

REPAIRING THE RIFLE

A. RIFLE RECORD

The Rifle Gunbook is the heart and soul of any precision weapon. This subject will be covered again in another period of instruction but must be understood as an integral pert of documentation and maintenance. Each weapon should have a gunbook that documents all maintenance, rounds fired, and particular data specific to that weapon.

B. CLEANING THE OPTICS

One of the most important parts of the weapon system is the optics. They should always be covered and protected when not in use. Oils and lubricants should never come in contact with the glass of any optics. To get objects out of glass areas a combination of compressed air and high grade toilet tissue should be used. All moveable parts on optics should be inspected to ensure they move freely and are seated properly.

CLEANING THE OPTICS

WHEN CLEANING OPTICS USE CARE NOT TO GET SOLVENT ON THE LENSES.

1.Remove any dirt, lent, or other foreign objects from the lenses with a combination of compressed air and high grade toilet tissue.

2.Anti-fog compound or breath condensation can be used to get smudges off of the lenses. Do not wipe but use a dabbing motion with high grade toilet tissue or a lense cleaning device made by the manufacturer. **Avoid using most forms of lense paper.**

3.Ensure all Allen screws and other fittings are free of dirt or other material.

4.Lightly lube any exposed metal after cleaning. Ensure that this is not overdone.

5.Rubbing alcohol can be used as a last resort to remove heavy smudges or fingerprints. Again use a dabbing motion with the high grade toilet tissue.

SCOPE MAINTENANCE

A. SCOPE

1. When stored in the rifle case the rifle should be placed so that the scope will not be damaged.

2. When out of the armory, the scope cover should always be on.

3. Store the rifle with the scope cover on unless the cover is damp. Moisture can collect and result in massive rust.

4. Do not allow sunlight to shine directly through the scope. Light focused onto the cross hairs might melt them or the mil dots.

5. When zeroing the scope, do not over tighten the lock screws or force the knobs.

6. When adjusting the scope, adhere closely to the procedures given in the class on “Scope Theory and Scope Adjustment”.

7. Avoid breathing on the lenses in cold weather because they will frost up.

MAKING THE RIFLE FIELD READY

A.Place duct tape over the muzzle and floor plate.

B.Slide a piece of cloth between the fore stock and the barrel.

C.Place high grade toilet tissue into the lense areas and close them in the lens caps or tape it in with duct tape.

D.In the field during long movements the bolt should always be closed over the rounds in the magazine.

E.A gun/drag bag can be used if the situation will allow it. This provides the best protection for the weapon but presents it own set of problems in employing the weapon syatem.

CARE OF AMMUNITION

A.Never use cleaning solvents on ammunition.

B.Keep ammunition out of direct sunlight.

C.Keep ammunition as clean and grit free as possible at all times.

D.Only use match grade ammunition that you have fired and accumulated data for. Check ammunition for dents in the casing, nicks in the projectile, improperly seated bullets or primers, and corrosion.

RIFLE RECORD

IN ORDER TO KEEP A WELL MAINTAINED RIFLE, RECORDS NEED TO BE KEPT TO INSURE PROPER MAINTENANCE. YOUR ARMORER CAN AND WILL USE AS MUCH INFORMATION AS POSSIBLE TO PREFORM APPROPRIATE REPAIRS AND TIMELY MAINTENANCE CYCLES. You have a gunbook issued for your use. If you already are maintaining a gun book continue with the original. For those that are starting a new gunbook we will fill out the basic data at this time.

REVIEW

QUESTIONS

PRECISION MARKSMAN

SIGHTING, AIMING, & TRIGGER CONTROL

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A. TERMINAL LEARNING OBJECTIVE

Given a (scoped) rifle, a support, and ammunition, without the aid of references, perform sighting, aiming and trigger control.

B. ENABLING LEARNING OBJECTIVES

a. Without the aid of references, describe scope sighting techniques for the rifle

b. Without the aid of references, describe trigger control for the rifle

c. Without the aid of references, describe breathing control for the rifle

d. Given a rifle, a support, and ammunition, without the aid of references, apply sighting techniques

e. Given a rifle, a support and ammunition, without the aid of references, apply aiming techniques

f. Given a rifle, a support, and ammunition, without the aid of references, apply trigger control techniques

g. Given a rifle, a support, and ammunition, without the aid of references, apply breathing control techniques

1. SCOPE SIGHTING TECHNIQUES

a. Scope Shadow

During aiming, the shooter must ensure that there is no shadow present in the field of view. If the eye is too far, too close or off center, shadow will appear. This will directly impact on the impact of rounds fired. If the shadow appears on the left the round will strike to the right of the target. A completely clear picture should be seen and no shots fired until the shooter has adjusted the eye positon needed.

b. Eye Relief

Eye relief is defined as the distance from the shooters eye to the eye piece lens. This relief must be exact in order for the shooter to be able to achieve maximum shot placement. It is an integral part of the shooters position. Adjustments to where scopes are mounted and where the shooter places the cheek on the weapon need to be made before any firing takes place. Butt spacers, adjustable combs, and second man inspections will greatly enhance the shooters ability to adjust or “build” the weapon to the individual. Eye relief must be consistent for every shot. Most scopes have an eye relief of 2” or 3”.

c. Sight Picture

Sight picture is the correct placement of the aiming point (crosshairs) on the target for the desired impact. For correct sight picture the intersection of the crosshairs is placed in the center of the desired impact area resulting in a quartered target. The shooters primary focus is on the crosshairs and not the target. Concentration on the crosshairs should not be too intense as this will cause the reticle to blur. Approximately 3-12 seconds is a good rule of thumb before eye strain will become a factor. It is important that during the initial “gun building” that a solid focus is obtained. Parallax adjustments and focussing should be done prior to any attempt to zero takes place.

2. TRIGGER CONTROL

a. Definition

Trigger control is the ability to move the trigger to the rear to allow the hammer to fall without disturbing the crosshairs.

b. Surprise Shot

The shooter should fire the weapon exactly when the rifle settles into the desired aiming point, but it should be a subconscious effort not to disturb the crosshairs. Trigger control should become a subconscious movement made by the shooter every time with great consistency. Learning your desired trigger pull and how to adjust with target exposure time and moving targets will require a lot of practice. The key is consistency.

c. Two Types of Trigger Control

1. Uninterrupted Trigger Control

This is the preferred method. Once pressure is applied, firing of the shot is completed. The shooter is commited to an unchanging rate of pressure without speeding up, slowing down, or stopping. Any slack in the trigger is taken up initially with the remainder being the pressure to fire the shot.

2. Interrupted Trigger Control

This method of trigger control is used in extremely windy conditions, when engaging moving targets, or when target exposure time is limited because the rifle may not completely settle. This forces the shooter to fire the shot when the target comes into the desired aiming point. The shooter takes up the initial slack and begins normal trigger control. The pressure is halted until he has focus and proper sight picture for the type of target being engaged or conditions being experienced and then breaks the shot.

d. Finger Placement on the Trigger

Finger placement is correct when it allows the trigger to be moved straight to the rear without disturbing the crosshairs. Each shooter is different. The most desired is a natural placement as it will require less thought and provide the most consistency.

e. Errors in Trigger Control

The majority of shooting errors result from poor trigger control.

1. Flinching

This is simply anticipating the weapon going off and the recoil associated with it. It is indicated by the shooter moving the head, closing the eyes, tensing the shoulders, moving shoulders to the rear, or a combination of these.

2. Bucking

This is an attempt by the shooter to take up the recoil before the shot is fired by moving the shoulders into the weapon. Tense shoulder muscles and forward motion greatly impact on the accuracy of the shot.

3. Jerking

When a shooter attempts to make the rifle fire at a certain time by rapidly applying pressure to the trigger and disturbs the alignment of the rifle it is called jerking.

f. Follow-through

Follow-through is defined as the continued application of the fundamentals after each round has been fired. The shooter does not shift the position, move the head, or begin bolt manipulation until the rifle has been fired. Re-aquiring the target is the final step before calling the shot during the follow-through process. Not following through is one of the most common mistakes shooters make.

3. BREATHING CONTROL

a. Natural Respiratory Pause

When shooting individuals should take natural breaths, then exhale until the point where they experience a point celled “natural respiratory pause”. This natural pause is where the shooter is completely relaxed in there respiratory cycle. This pause will very in length with individuals but can be extended out to as much as 8 seconds. Many factors come into play when determining and maintaining the pause. Physical fitness, stress, and natural lung capacity.

4. TECHNIQUES FOR NATURAL RESPIRATORY PAUSE.

a. Normal Breathing

The shooter breathes normally, as the shot approaches the shooter pauses, gets his aiming point, applies trigger pressure, and takes the shot. Continued breathing will cause movement in the chest and abdomen that will interrupt the fundamentals of marksmanship. Shooting during the natural respiratory pause is the preferred method because it allows the shooter to perform all required functions while breathing is comfortably halted.

b. Decreased Breathing

This technique will be used by shooters that have trouble extending their natural respiratory pause. As the shot approaches the shooter takes up slack in the trigger and begins to decrease breathing. As the aiming point is aquired the shooter decreases his breathing to a pause. This type of shooter can achieve proper the aiming point during the shallow decreasing breaths, then pauses and breaks the shot.

c. Cardiopulmonary Pause

As the heart beats it transmits a vibration through the body. This vibration can interrupt the fundamentals of marksmanship by moving the sights and in extreme cases the rifle. This is particularly apparent when firing unsupported and when firing long range. The heart beat will be visibly noticeable by the vertical movement of the crosshairs on the target. Too fire effectively the shooter should learn to fire at a reduced beat of the heart or lull for each shot.

PRECISION MARKSMAN

SHOOTING POSITIONS/BOLT OPERATION

1. TERMINAL LEARNING OBJECTIVE

A. Given a rifle, a support, a sling, target, and ammunition, without the aid of references, assume shooting positions.

2. ENABLING LEARNING OBJECTIVES

A. Without the aid of references, identify the factors common to

all unsupported shooting positions

B. Without the aid of references, identify the factors common to all supported shooting positions

C. Without the aid of references, describe the methods for bolt operation

D. Given a rifle, a support, and ammunition, without the aid of references, assume the supported kneeling shooting position.

E. Given a rifle, a support, and ammunition, without the aid of references, assume the supported kneeling shooting position

F. Given an sniper rifle, a support, and ammunition, without the aid of references, assume the supported sitting shooting position

G. Given an sniper rifle, sling, and ammunition, without the aid of references, assume the unsupported shooting positions per

ELEMENTS OF A GOOD SHOOTING POSITION

a. Bone Support

The weight of the rifle should be supported by bone rather than muscle. Muscle will fatigue and cause movement. The shooter must learn positions that offer good bone support to avoid “muscling” the weapon. Relaxation without movement is the key to maintaining a good position.

b. Muscular Relaxation

Muscular relaxation helps the shooter hold steady and increase the ability to aim. Muscular relaxation is realized by maximizing bone support to achieve a minimum arc of movement and consistency in resistance to recoil. Tense muscles will cause excessive movement of the rifle and disturb aim. Without the combination of bone support and muscular relaxation the rifle will never settle into an aiming point, thereby making it impossible for the shooter to apply good trigger control and place a well-aimed shot. Only through practice and achieving a natural point of aim will the shooter be able to apply muscular relaxation.

c. Natural Point of Aim

The point at which the rifle naturally rests in relation to the target is called natural point of aim. Once the shooter is in position and aimed in on his target, the method of checking for natural point of aim is for the shooter to close the eyes, take a couple of breathes, and relax as much as possible. Upon opening the eyes the shooter should see the crosshairs resting on the desired aiming point. The rifle is an extension of the shooters body and the position needs to be adjusted until the rifle points naturally at the preferred aiming point on the target. Continual checking of the position and natural point of aim will keep the shooter on target.

FACTORS COMMON TO ALL SHOOTING POSITIONS

a. Placement of the Non-Shooting Hand and Elbow.

b. Rifle Butt in the Pocket of the Shoulder

c. Grip of the Shooting Hand

d. Rear Elbow

e. Spot Weld

SUPPORTED POSITION FUNDAMENTALS

A.A precision shooter should always attempt to shoot from a supported position. Using any support available that is steady and reliable is the key. Packs, tripods, bipods, filled bags etc… all will provide the shooter with a stable platform. Even a partners body may be used in some cases to get the job done.

B.Never allow the barrel to touch any part of the support. This will disturb the natural whip of the barrel and degrade accuracy.

C.Cushion the rifle on the support. This will keep the weapon from sliding around and make the position more sound. The location of the support is important. The best location is just behind the front sling swivel. Avoid getting the balance of the weapon to become an issue.

D.Use the prone whenever possible.

E.Ensure that the weapon is straight on the support without touching the sides of the rifle. Recoil must be straight back into the shooter and the support should allow this to happen freely.

SUPPORTED POSITIONS

a. Supported Prone

The supported prone is the steadiest of all positions and should be used whenever possible. Major points in the supported prone are to keep the position as low as possible, keep the body in line with the rifle, feet placement should allows for muscular relaxation, and the non-firing hand is placed under the rear sling swivel.

b. Supported Kneeling

There are many situations when a shooter will not be able to get into the preferred supported prone. When kneeling the shin is straight up and down, the leg forming a support. The non-shooting elbow is extended just over this knee. The non-shooting hand still grasps the rear sling swivel. This position can be adjusted to conform to available cover by moving to a high, medium, or low knelling position.

c. Supported Sitting

Sitting is one of the more stable shooting positions. If the available support is too low for the kneeling the sitting position will be used. There are three types of sitting. The open and crossed leg, and the crossed ankle. The size and flexibility of the individual shooter will play part in the ability to use a particular type of sitting position.

1. Open Leg

2. Crossed Leg

3. Crossed Ankle

d. Supported Standing

This is the least stable of the supported positions. Rest the rifle stock over or beside the support. Grasp the weapon as in the kneeling or sitting position. The non-shooting hand may be placed on the support to form a V notch for the weapon to be placed into. The shooting arm is inverted in to the body as close as possible to help support the weapon.

e. Using Your Partner as a Support

As you will see when we do this, shooting off of your partner is not a preferred method but it does provide you with another alternative in some situations. In all instances both team members have to maintain tactical awareness and communicate. The team must breathe as one and the positions stability will depend on how well both members work in unison.

1. Prone

2. Kneeling and Sitting

3. Standing

UNSUPPORTED SHOOTING POSITIONS

a. Hawkins Position

This position is as old as rifle marksmanship. It is simply using a balled up fist as a support while in the prone. It is better used on a downhill slope or rooftop. Care must be taken to avoid recoil to “jump” the rifle out of control when firing. The shoulder will not absorb the recoil as usual and it is possible to get the angle of jump to up into the face.

b. Prone Position

The big difference in this and the supported prone is the placement of the non-firing hand. It will go well forward of the floor plate up close to sling swivel. Use of the sling will greatly enhance this position. All other concerns are consistent with the supported prone.

c. Sitting Position

In all three sitting positions the non-shooting hand is placed well forward of the floor plate up close to the sling swivel. The shooting hand grips the small of the stock firmly while exerting slight rearward pressure to place the butt of the rifle into the pocket of the shoulder. Use of a sling is highly encouraged in order to accurately shoot from these positions.

1. Crossed Leg

2. Open Leg

3. Crossed Ankle

d. Kneeling Position

In all three kneeling positions the non-shooting hand is placed well forward of the floor plate up close to the sling swivel. And as in the sitting the firing hand grips the stock firmly while exerting rearward pressure to place the butt of the rifle in the pocket of the shoulder.

1. High Kneeling

2. Medium Kneeling

3. Low Kneeling

BOLT OPERATION

A.Once the shooter has fired keeping the same position is paramount to a follow-on shot. Shooters should learn to reload with as little movement as possible.

B.Immediate reloading by “rapid bolt manipulation” is the key. Smooth is fast and speed will come with practice. The shooter should not be in such a hurry to “rack” the bolt that the position is disturbed.

C.The shooter must learn to manipulate the bolt quickly and re-aquire the target or potential follow-on shots. The spot weld of the shooter should not move during bolt movement. Continual practice will allow the shooter to develop a quick and smooth style that will provide rapid accurate fire.

PRECISION MARKSMAN

SCOPE ADJUSTMENT PROCEDURES & SCOPE THEORY


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TERMINAL LEARNING OBJECTIVE

Given a rifle with scope, ammunition, scope tools, white card or cloth, observer, and target, without the aid of references, operate the scope

ENABLING LEARNING OBJECTIVES

A. Without the aid of references, identify the characteristics and nomenclature of the scope

B. Given a rifle with scope, white card or cloth, and scope tools, without the aid of references, focus the scope

C. Given a rifle with scope, and scope tools, without the aid of references, adjust the scope to remove parallax from the scope

D. Given a rifle with scope, scope tools, and cleaning gear, without the aid of references, maintain the scope

SCOPE NOMENCLATURE AND FEATURES

a. Description. The average unaided eye can distinguish a one inch object at 100 yards. With the combination of magnification and good optics the sniper can increase the amount of detail he sees.

b. Magnification and Light Gathering

SCOPE ADJUSTMENT PROCEDURES

a. Purpose

b. Focusing the Scope

1.

2.

3.

4.

c. Parallax

1) Definition. If the target (still 300 yards away) is not clearly focused, what is known as parallax is occurring. Parallax comes from the image of the target not being focused on the same plane as the reticle. It is defined as the apparent movement of the reticle across the target when the position of the head is slightly moved. If the target appears to be moving or is out of focus, the objective lens should be focused.

2) Steps to Adjust for Parallax

A.

B.

C.

ZEROING THE SCOPE

a. Zeroing Features

b. Zeroing Process

c. Zeroing Procedures

1.

2.

3.

4.

5

FIELD EXPEDIENT ZEROING

a. Reasons for Field Expedient Zeroing

There may be times when a shooter will have to re-zero in an unfavorable situation. There may not be a 100yd range at hand, or you know that you "bumped" the scope and your zero is off and there is no time to get to a range. In these extreme cases you can still get an accurate zero on a 25yd stretch of ground. There are two techniques.

b. 25-Yard/900-Inch Method

c. Observation of Impact Method

PRECISION MARKSMAN

BALLISTICS

TYPES OF BALLISTICS

The formulas used to obtain the information in this lesson are from the Sierra Bullet Company Loading Manual. This information is to be used as a guideline only. Variations in weapons and ammunition will dictate that the final ballistics data will eventually come from the sniper's data book and personal knowledge acquired through experience. There are three types of ballistics: internal, external, and terminal.

a. Internal Ballistics

Internal ballistics is the science of projectile motion within the rifle. It is most simply all that happens within the rifle from the instant the primer ignites until the bullet leaves the barrel.

1. Primer. The primer is the first step in the combustion of gunpowder which starts the process of internal ballistics. Primer designs are chiefly of two main designs. The American Boxer and the Berdan.

a.The boxer design is simple. A metal cup with a primer mixture or compound is covered with a paper disc over which is an anvil. When struck by the firing pin the anvil crushes the mixture and the mix is ignited. All American primers use mixtures that are non-mercuric and non-corrosive. Early primers used mixtures with mercury and chlorate which caused severe barrel corrosion.

b.The Berdan primers are a foreign design which are sometimes found in this country. The cartridge for this type of primer is characterized by two flash holes in the primer pocket. The primer itself is constructed without an anvil. The anvil actually being the case. This design is not popular here because it is difficult to re-cap.

2. Cartridge (Case)

The cartridge case has four functions. It acts as a container holding the powder, bullet, and primer. The cartridge, upon ignition of the powder charge, builds pressure equally in all directions forming a gas tight seal making the pressure push the projectile onto the rifling and down the barrel. The case also provides proper head space for the cartridge. The fourth and final function of the case is to provide uniformity of position within the chamber both at the base and the neck.

a. Rimmed Case

b. Belted Case

c. Rimless Case

d. Auto Pistol

3. Ammunition

Modern ammunition uses smokeless powder. There are two types:

a. Single Base which is composed of a mixture of nitric acid and

cellulose such as cotton called nitrocellulose.

b. Double based powder which is a mixture of nitrocellulose and nitroglycerine.

c. There are three forms of modern powders. They are flake, ball (spherical), and tubular.

4. Pressure

As the powder burns, the pressure generated increases. On a graph it appears as a rising curve over time to the maximum or “peak” pressure. Ideally the peak pressure will be attained just prior to the bullet exiting the muzzle. The generation of 50-55,000 PSI within the rifle is the driving force of internal ballistics. It has numerous effects upon the cartridge case, the rifle, and the bullet. All of which effect the inherent accuracy of the rifle/cartridge combination.

5. Bolt Locking Lug Dispersion

Locking lug dispersion will occur opposite to the plane of the lugs. In building a precision rifle, care must be taken to ensure that the locking lugs of the bolt are square and true with the receiver. Lug dispersion is also a source of lateral vibrations imposed upon barrel motion through the bending of the receiver.

6. Rifling

As the powder charge oxidizes and the pressure increases, the bullet begins to move. The initial resistance of the case neck friction holding the bullet is overcome and the bullet enters the rifling. The bullet moves through a smooth surface prior to impacting with the rifling allowing for a less distorted bullet at the start. If the bullet impacts at the start pressure will build up too quickly and randomly. More consistent bullet movement and pressure formation is obtained when the bullet has a small distance to travel before impacting the rifling. As a rule, the bearing surface of the bullet should be 0.010 inches from the rifling. This is done by limiting the overall length of the cartridge and headspacing the rifle to exact dimensions. The temperature of high pressure powder combustion and repeated impact of bullets into the start of the rifling causes barrel throat erosion. Barrel round counts or erosion guides help to determine barrel life expectancy.

5. Barrel Vibration

There are four different vibrations that are imposed simultaneously upon the

barrel.

a. Longitudinal vibrations are caused by the bullet impacting with the rifling. (chamber forward)

b. Verticle vibrations are caused by the recoil of the rifle. This is a buckle movement forced by the recoil into the shoulder and the round striking the rifling. Newton's Law.

c. Lateral vibrations or side to side movement can be caused by flawed bedding, the shooters grip or position, or case head or locking lug dispersion imposed on the barrel.

d. Torsional vibrations are caused by the spinning of the bullet moving down the barrel. Similar to an off-center loaded wash load.

5. Bullets

The last factor of internal ballistics concerns the bullet and its movement through the barrel.

BALLISTICS TERMINOLOGY

a. External Ballistics. Concerns the path of the bullet from the muzzle to the target.

b. Terminal Ballistics. Concerns what happens to the bullet after it hits the target and what the bullet actually does to the target upon impact.

c. Muzzle Velocity. Muzzle velocity refers to the speed of a bullet as it leaves the barrel. It is measured in feet per second (FPS), just centimeters past the crown of the muzzle. Muzzle velocity will vary from rifle to rifle, depending on a variety of factors such as barrel erosion. The M118 7.62 special ball ammunition at acceptance travels at 2550 fps +/- 30 fps.

DATA FOR M118 173 gr. MATCH BULLET MUZZLE VELOCITY
2585fps 60 deg. F, Sea Level

(A) Retained Velocity (fps)
(B) Mid-Range Trajectory (in)
(C) Drop Between Yard Lines (min)
(D) Time of Flight (sec)

Range	(A)	(B)	(C)	(D)
100	2407	.7	N/A	.1
200	2233	3.0	1.5	.2
300	2066	7.3	3.0	.4
400	1904	14.0	3.5	.5
500	1750	24.0	4.0	.7
600	1603	37.6	4.5	.9
700	1466	56.2	5.0	1.0
800	1339	80.6	5.0	1.3
900	1222	112.5	6.0	1.5
1000	1118	153.5	7.0	1.8

d. Line of Sight

e. Line of Departure

f. Trajectory

g. Mid Range Trajectory/Maximum Ordinate

h. Bullet Drop

i. Time of Flight

j. Retained Velocity

k. Angle of Jump (Vertical)

l. Zero Distance

FACTORS WHICH AFFECT TRAJECTORY

a. Gravity

b. Drag

1. Temperature

2. Altitude/Barometric Pressure

a. Altitude

b. Barometric Pressure

c. Elevation Change

POINT OF IMPACT RISE AT NEW ELEVATION (MINUTES)

RANGE	2500 ft	5000 ft	10,000 ft
100	.05	.08	.13
200	.1	.2	.34
300	.2	.4	.6
400	.4	.5	.9
500	.5	.9	1.4
600	.6	1.0	1.8
700	1.0	1.6	2.4
800	1.3	1.9	3.3
900	1.6	2.8	4.8
1000	1.8	3.7	6.0

1. With a rifle zeroed at sea level, shooting at 700 yards at 5000 feet will result in rounds hitting the target 1.6 minutes high. The sniper will need to come down on his fine tune 1 1/2 minutes to correct for this.

2. Although the information provided in this chart is computer generated, it has been tested and is a good basis for estimating fine tune adjustments, although temperature and angle of fire may alter this.

3. Humidity

4. Ballistic Coefficient (BC)

5. Wind

SHOOTING FROM AN ANGLE

a. Conditions For Shooting From an Angle

b. Techniques For Shooting From an Angle

ANGLE FIRING

Special Ball 173 gr.

ANGLE (up or down) (IN DEGREES)	COSINE	ANGLE (up or down) (IN DEGREES)	COSINE
0	1.00	50	.64
2.5	.995	52.5	.605
5	.99	55	.57
7.5	.985	57.5	.535
10	.98	60	.50
12.5	.97	62.5	.46
15	.96	65	.42
17.5	.95	67.5	.38
20	.94	70	.34
22.5	.925	72.5	.30
25	.91	75	.26
27.5	.89	77.5	.215
30	.87	80	.17
32.5	.845	82.5	.13
35	.82	85	.09
37.5	.795	87.5	.045
40	.77	90	0.00
42.5	.735		
45	.70		
47.5	.67		

DETERMINED
OR
ESTIMATED RANGE X COSINE (for appropriate angle) = Actual Range for Scope

TERMINAL BALLISTICS

When a projectile impacts with a substance such as body tissue or ballistic gelatin, there are various actions that occur almost simultaneously. We will first discuss the primary or permanent wound cavity.

a. Primary Wound Cavity

b. Secondary Wound Cavity

c. Damage Incurred by Secondary Projectile

PRECISION MARKSMAN

EFFECTS OF WEATHER

TERMINAL LEARNING OBJECTIVE

Given a rifle, ammunition, and target on a known distance Range, without the aid of references, correct for the effects of weather conditions

ENABLING LEARNING OBJECTIVES

A. Without the aid of references, describe the techniques for the classification of winds

B. Without the aid of references, identify the procedures for detecting wind velocity

C Without the aid of references, identify the effects of varying weather conditions on the trajectory of a bullet

D. Without the aid of references, identify the effects of varying weather conditions on shooting performance

EFFECTS OF WEATHER ON THE SNIPER

a. Mental Attitude

b. Physical Effects on the Sniper

EFFECTS OF WIND

a. The Sniper

b. The Bullet

1. The Velocity of the Wind

2. The Range to the Target

3. The Velocity of the Bullet

4. The Size and Weight of the Bullet

WIND CLASSIFICATION

a. Direction

b. The Clock System

1. Full Value Wind

2. Quarter Value Wind and Half Value Wind

3 No Value Wind

DETERMINING WIND VELOCITY

a. The Flag Method

1) $\frac{\text{Angle of the flag from the pole}}{4} =$ Speed in MPH

b. The Observation Method

1) Under 3 MPH

2) 3 to 5 MPH

3) 5 to 8 MPH

4) 8 to 12 MPH

5) 12 to 15 MPH

6) 20 to 25 MPH

c. Mirage

1.

2.

3.

4.

5.

6.

7.

DETERMINING CORRECT WINDAGE ADJUSTMENTS

a. Calculating Windage

1. Range X Wind Velocity in MPH = Minutes full
   Range Constant value wind

2. Range Constant
   A.

   B.

   C.

   D.

   E.

3) Range

4) Example

A 10 mph wind is blowing from 9 o'clock. The range to the target is 500 yards.

Therefore, Range (R)=5, Velocity (V)=10mph, 500 yard Range Constant=15.

$$\frac{R \times V}{15} = \frac{5 \times 10}{15} = \frac{50}{15} = 3.3 \text{ or } 4 \text{ minutes full value wind}$$

b. Windage Charts

EFFECTS OF DIFFERENT LIGHTING CONDITIONS

a. Bright Light

    1. Small or Large Bull's-eye

    2. Flattened Bull's-eye

b. Hazy Light

c. Light Overcast

d. Dark Heavy Overcast

e. Scattered Clouds

f. Moving Clouds

EFFECTS OF TEMPERATURE

a. Extreme Heat

1. The Sniper

2. The Rifle and Bullet

3. Countermeasures

b. Extreme Cold

1. The Sniper

2. The Rifle and Bullet

3) Countermeasures

EFFECTS OF PRECIPITATION

a. The Sniper

b. The Rifle and Bullet

c. Countermeasures

PRECISION MARKSMAN

DATA BOOK/GUN RECORD

INTERNATIONAL

TRAINING

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TERMINAL LEARNING OBJECTIVE

Given a data book, rifle, ammunition, a target, and gun book, record all appropriate information in the data book and gun book

ENABLING LEARNING OFBECTIVES

A. Without the aid of references, describe procedures to maintain the data book

B. Without the aid of references, describe the procedures to maintain the gun book

COMPLETING THE DATA BOOK BEFORE FIRING

a. Purpose of the Data book

b. Initial Issue of the Data Book

1. Sniper's Name
2. Organization
3. Rifle Serial Number
4. Date

c. Prior to Firing

1. Windage Zero and Elevation Zero
2. Rifle/Scope Number
3. Time

4. Wind

5. Location

6. Temperature

7. Light

8. Ammunition

9. Hold

USE OF THE DATA BOOK DURING FIRING

a. Stationary Targets

1. Recording the Call

2. Plot the Shot

3. Adjust Elevation and Windage

b. Moving Targets

1. Recording the Call

2. Plotting the Shot

DATA BOOK ANALYSIS

a. Record Remarks

b. Record Elevation and Windage Adjustments

c. Analyzing the Data Book

d. Shot Analysis

1. Group Tends to Be Low and Right
    a. Left hand not positioned properly
    b. Right elbow slipping
    c. Improper trigger control
2. Group Scattered About the Target
    a. Incorrect eye relief or sight picture
    b. Concentration is on the target, not on the cross hairs
    c. Changing stock weld from shot to shot
    d. Incorrect position
3. Good Group with Several Erratic Shots
    a. Flinching: Shots may be anywhere
    b. Bucking: Shots scattered from 7 to 10 o'clock
    c. Jerking: Shots may be anywhere

4. Group Strung Up and Down Through the Target
    a. Breathing while firing
    b. Improper vertical alignment of cross hairs
    c. Changing stock weld from shot to shot

5. Compact Group Out of the Target
    a. Incorrect zero
    b. Failure to compensate for wind
    c. Improper point of aim
    d. Scope shadow

6. Group From Center of the Target Out the Bottom
    a. Scope shadow
    b. Changing position of the rifle in the shoulder

7. Horizontal Group Across the Target
    a. Scope shadow
    b. Canted weapon
    c. Improper point of aim

MAINTENANCE OF THE GUN RECORD

a. Cover

1) Type of Weapon

2) Serial Number

3) Date

4) Type of Round

3) Number of Round

PRECISION MARKSMAN

LEADS FOR MOVING TARGETS

TERMINAL LEARNING OBJECTIVE

Given a rifle system, ammunition, and a known distance range, without the aid of references, engage moving targets.

ENABLING LEARNING OBJECTIVES

1. Without the aid of references, identify the types of moving targets

2. Without the aid of references, identify the techniques for engaging moving targets

TYPES OF MOVING TARGETS

a. Moving Target

b. Stop and Go Target

c. Bobbing Target

TECHNIQUES FOR ENGAGING MOVING TARGETS

a. Tracking

1. The tracking method should be used in the following situations:

2. Engaging Stop and Go Targets

3. Engaging a Bobbing Target

4. Common Errors Made when Engaging Moving Targets

HOLDS AND LEADS FOR MOVING TARGETS

A. Hold

B. Continual Hold

C. Engaging a Bobbing Target

D. Common Error Made When Engaging Moving Targets

HOLDS AND LEDS FOR MOVING TARGETS

A. Hold

B. Lead

1. Time of Flight

2. Speed of the Target

3. Angle of Target Movement

ANGLE OF MOVEMENT

100 yds. Leading Edge to Center of Target
200 yds. Leading Edge to 1.5 inches
300 yds. 2.5 inches to 5 inches
400 yds. 6 inches to 9 inches
500 yds. 9 inches to 12.5 inches
600 yds. 15 inches to 24 inches

TYPES OF LEADS

1. Full Lead

2. Half Lead

3. No Lead

Using the Mil Scale for Leads

PRECISION MARKSMAN

TECHNIQUES OF CAMOUFLAGE

TERMINAL LEARNING OBJECTIVE

Given a cammie stick and materials, rifle, optics, area of operation, without the aid of references, camouflage self and equipment to match the area of operation.

ENABLING LEARNING OBJECTICES

A. Without the aid of references, identify the types of camouflage in accordance

B. Without the aid of references, describe the techniques of camouflage for snow, desert, urban, jungle, and woods.

C. Without the aid of references, apply face camouflage

D. Without the aid of references, describe the purpose of the ghillie suit and veil

TARGET INDICATORS

a. Sound

b. Movement

c. Improper Camouflage

1. Shine

2. Outline

3. Contrast With the Background

PERSONAL CAMOUFLAGE

a. Types of Personal Camouflage

b. Advantages/Disadvantages

c. Uses for Personal Camouflage

CLOTHING AND GEAR CAMOUFLAGE

a. History of the Ghillie Suit

b. Ghillie Suit

c. Field Expedient Ghillie

d. Camouflaging Gear

1 . Rifle

2. Optical Gear

3. Packs and Web Gear

CAMOUFLAGING FOR SPECIFIC GEOGRAPHIC AREAS

a. Snow

b. Desert/Urban

c. Jungle/Woodland

CAMOUFLAGE DURING MOVEMENT

a. Hiding

b. Blending

c. Deceiving

PRECISION MARKSMAN

TECHNIQUES OF OBSERVATION

TERMINAL LEARNING OBJECTIVE

Given binoculars and a spotting telescope, without the aid of references, use proper techniques of observation to conduct hasty and detailed searches of a given area.

ENABLING LEARNING OBJECTIVES

A. Without the aid of references, describe techniques for searching an area

B. Without the aid of references, describe techniques for night observation

C. Given binoculars and a spotting telescope, without the aid of references, conduct continuous observation of an area

OBSERVATION AIDS

a. Binoculars

1. Description

2. Uses For Binoculars
   a.
   b.
   c.
   d.
   e.
   f.
   g.
   h.

3. Method of Holding the Binoculars
   a.
   b.
   c.
   d.

4. Interpupillary Adjustment

5. Focal Adjustment

b. Spotting Telescope

c. Other Binoculars

d. Night vision Devices

e. Illumination

TYPES OF SEARCHES

a. Hasty Search

1. Procedures

2. Advantage

b. Detailed Search

1.

2.

3.

4.

5.

6.

c. Maintaining Observation

NIGHT OBSERVATION

a. Darkness Adaptation

b. Off Center Vision

c. Factors Affecting Night Vision

d. Twilight

PRECISION MARKSMAN

URBAN OPERATIONS

INTERNATIONAL

TRAINING

DIVISION

TERMINAL LEARNING OBJECTIVES

Given an area of operation, without the aid of references, conduct defensive and offensive sniper operations in support

ENABLING LEARNING OBJECTIVES

A. Without the aid of references request information on suspect

B. Without the aid of references, request information on operation for sniper team support

C. Given a mission and an area of operation, without the aid of references, support relay and gather information for tactical operations

I. OUTLINE

I. SITUATION

A. SUSPECT

1. Information - Describe the situation using the enemy's capabilities Additionally, include the following if relevant:

   A. Details of the target(s) - including descriptions, sketches, and/or photos (target and/or known suspects)
   B. Personal details of the suspect(s) - such as OB/POB/other descriptions
   C. Personal details of the suspect(s) relatives with photos
   D. Personal details of suspect(s) associates/visitors/friends with photos
   E. Where and with whom does suspect(s) conduct business
   F. Personal details of suspect(s) boy/girlfriend or wife/husband with photos
   G. Prison records of suspect(s) and associates
   H. Work or trade of suspect(s), his friends, relatives; and hours of work
   I. Social habits and/or perversions
   J. Club memberships - pubs, clubs, bars visited
   K. Cars/vehicles used by suspect(s), visitors, and friends
   L. Terrorist/guerilla trace and history - note associates and specialties
   M. Terrorist/guerrillas weapons and equipment
   N. Legally held weapons
   O. Animals - type and where kept(especially dogs and geese)

B. FRIENDLY

Describe the friendly situation if it applies. The following will also be included:

1. Base operations location.
2. Reaction force locations.
3. Description and locations of friendly covert vehicles.
4. Locations of other OP's.
5. Location of back up OP (mutually supporting).
6. Reaction time of Emergency Reaction Force to Emergency Rendezvous (ERV) and/or OP.

II. EXECUTION

A. CONCEPT OF THE OPERATION. General overview of entire operation. Include alternates; back up OP plans, and back up plan.

B. OTHER TASKS/COORDINATING INSTRUCTIONS

1. Insertion (Base to Drop Off Point).

a. Method
b. Type of transport and seating plan
c. Covering force (security element)
d. Primary and alternate routes

2. Route in.

a. areas of responsibility and tasks
b. Primary and alternate routes - land marks, obstacles
c. Back up route
d. Security element

1.
2.
3.

5. OCCUPATION OF AREA OF OPERATION

a. Entry method/ploys
b. Entry party

1.
2.

6. OP construction/modification. Explain what has to be done, who is going to do it, and the priority of work

7. OP security/protection (including alarm/early warning system).

a. Layout: personnel and equipment

b. Watch system

c. All tasks/actions - explain how mission is to be accomplished. This will include logging and reporting photography, and/or taking out selected targets

d. Administrative type tasks - this will include such things as rest, head calls, chow, etc

8. OP departure

a. Time of exit
b. Exit method
c. Tasks - during and prior to exit, including sterilization of the OP site

9. ERV (Emergency Rendezvous Point).

a. Locations and descriptions
b. Escape route to ERV
c. Actions for use and actions at

10. Withdrawal

a. Time
b. Tasks - how
c. Route to and actions
d. distances, bearings, land marks, and obstacles
e. Back up OP route

11. Actions:

    a. Compromise - security elements

    b. Casualties

12. Orders for opening fire - if not previously covered

13. Debrief

III. ADMIN AND LOGISTICS.

A. Rations and water

B. Arms and ammo

C. Special/Individual equipment (also include entry equipment and construction tools, equipment, and materials)

D. Medical

IV. COMMAND AND SIGNAL

A. Signal Instructions

1. Hand and arm signals

2. Radio communications - to include procedures, type taken, and number taken (spares). Batteries also

3. Frequencies and call signs

4. Code words/Brevity codes/Nick names (for targets)

5. Radio check instructions, required reports/reporting times, message traffic

PRECISION MARKSMAN

GLASS SHOOTING


INTERNATIONAL
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DIVISION

GLASS SHOOTING

TERMINAL LEARNING OBJECTIVE

WITHOUT THE AID OF REFERENCES STATE THE EFFECTS OF VARIOUS TYPES OF GLASS

INTRODUCTION

Many tests have been performed on glass shooting. It is not a definite science, and although many trends have been found, the only thing guaranteed is that there are no guarantees.

A. Types of Glass

1. Window Pane

2. Safety Glass

3. Wire Reinforced

4. Tempered Glass

5. Structural Glass

6. Auto Glass

7. Airplane Glass

8. Bullet Proof Glass

9. Thermal Glass.

B. Bullet Weight and Velocity

C. Bullet Composition

1. Full Metal Jacket

2. Lead Tip Bullet

D. Secondary Fragmentation

1. Perpendicular

2. Angle

3. Bullet Fragmentation

E. Miscellaneous Information

1. Screens

2. Simultaneous Shots

a. Plate Glass

b. Laminated

c. Weakening Glass

3. Angles

4. Weight

5. Temperature

F. TESTS ON GLASS PENETRATION

1. Purpose of The Tests