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

DETAILED INSTRUCTOR GUIDE

LESSON TITLE

EFFECTS OF WEATHER

COURSE TITLE

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

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

INSTRUCTOR PREPARATION CHECKLIST

ESSENTIAL DATA

LESSON DESIGNATOR	SLR.9
LESSON TITLE	Effects of Weather
DATE PREPARED	1 October 1999
TIME	45 min
METHOD	Lecture
LOCATION	Indoor/outdoor classroom
INSTRUCTORS REQUIRED	One Primary Marksmanship Instructor (PMI)
REFERENCE	MCRP 3-01A
TRAINING AIDS/EQUIPMENT	Slides (sSLR.9-1 - sSLR.9-7)

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DETAILED OUTLINE

EFFECTS OF WEATHER

INTRODUCTION (3 MIN)

1. GAIN ATTENTION. The well-trained Marine who understands how to obtain a steady position, carefully align his sights, and execute perfect trigger control may still fail to hit the center of the target. Failure to hit the target can occur because the Marine failed to compensate for the effects of weather. Some conditions, such as wind, can cause significant changes in bullet impact. Other conditions, such as light, temperature, and precipitation have less of an effect, but can easily cause the Marine to miss the center of the target. Once the Marine recognizes how weather conditions affect him, his rifle, and ammunition, he can take appropriate measures to correct for these effects and keep his shots centered on the target.

2. OVERVIEW. This lesson will cover the effects of weather on shooting to include the effects on the Marine; the effects of wind; wind classification; wind velocity; and determination of correct windage adjustment. It will also cover the effects of different lighting conditions, temperature, and precipitation on the Marine, the rifle, and the trajectory of the bullet.

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

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

b. ENABLING LEARNING OBJECTIVES

1) Without the aid of references, determine wind velocity IAW MCRP 3-01A. (PVTX.11.4d)

2) Without the aid of references, identify the method for classifying winds IAW MCRP 3-01A. (PVTX.11.4e)

3) Without the aid of references, identify the effects of weather on the Marine and marksmanship IAW MCRP 3-01A. (PVTX.11.4f)

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

5. EVALUATION. The Marine will be evaluated in a comprehensive written exam for Phase I of this course following the completion of lessons SLR.1 - SLR.12.

TRANSITION: There are two ways the weather can affect the Marine before he delivers a shot. The weather can cause physical discomfort as well as affect mental attitude, distracting the Marine from successful target engagement. Proper preparation and practice can eliminate these problems and allow the Marine to shoot accurately in adverse weather conditions.

BODY (40 MIN)

1. (1 MIN) EFFECTS OF WEATHER ON THE MARINE

a. Mental Attitude. The accomplishments made on the firing line and in the field stem partly from the ability to mentally adjust to unusual or adverse weather conditions. To engage the target accurately, concentration must be maintained on the fundamentals of marksmanship, and the mental discipline must be developed to overcome the effects of adverse weather conditions.

b. Physical Effects. Adverse weather conditions have definite physical effects on every Marine. The Marine must be prepared for the weather so he is comfortable when shooting. Attention must not be diverted from shooting.

Confirm by questions.

TRANSITION: The weather condition that has the greatest effect on shooting performance is wind. Wind can have a great effect on the Marine as he prepares for his shot and on the bullet once it leaves his rifle. Dry fire practice and knowledge of the measures to compensate for the wind will minimize the effects of wind on shooting performance.

2. (3 MIN) EFFECTS OF WIND

a. The Marine. The effect the wind has on the Marine will depend on the velocity of the wind and the firing position. The stronger the wind, the more difficult it will be to hold the weapon steady. The wind is the one weather condition that affects all Marines in the same way. However, measures can be taken to counter the effects the wind has on your ability to fire accurately:

1) If the situation permits, choose a shooting position that is the least susceptible to the effect of the wind. The prone shooting position offers the most stable firing position in windy conditions, while windy conditions make the standing position the least stable.

2) If the situation permits, counteract the effects of wind by timing your shots. By waiting for a steady wind or a lull in the wind, the Marine can balance himself properly and deliver a well-aimed shot on the target.

3) The effects of wind can be partially offset if the Marine trains carefully and has a positive mental attitude.

Refer to slide sSLR.9-1.

b. The Bullet. The effect the wind has on the round as it travels down range is referred to as deflection. The wind deflects the bullet laterally in its flight path to the target. It is an effect that increases with the distance to the target. The deflection of the bullet can be compared to that of a boat crossing a river with a strong current. The skipper of the boat may aim for a point directly across the river but may end up farther downstream because of the current. There are two factors that affect the amount of deflection of the bullet:

1) The Velocity of the Wind. The greater the velocity of the wind, the more it will deflect the bullet.

2) The Range to the Target. Because the initial velocity of the bullet as it leaves the muzzle of the rifle is high, the wind will have little effect on bullets traveling short distances. The velocity of the round decreases as it travels down range, causing the wind to produce a greater deflection. Therefore, the wind deflection increases the farther a round must travel before it strikes the target.

Confirm by questions.

TRANSITION: As we have learned, wind has a significant impact on not only the Marine but also the bullet once it leaves the rifle. Winds blowing from different angles have different effects on the bullet. The velocity and direction of the wind in relation to the bullet must be determined to offset the wind's effects.

3. (5 MIN) WIND CLASSIFICATION

Classifying the wind is a two step process; first the direction of the wind must be determined and then the value of the wind must be determined.

a. Wind Direction. Winds are classified according to the direction from which they are blowing in relation to the direction of fire. For example, if the flag is blowing left, the wind is known as a right wind because it is coming from the right. The direction of the wind can be determined in several different ways. When shooting takes place on the range, the direction of the range flags indicates the direction of the wind. The Marine on the range should use the range flags as a training aid to assist him in reading the wind by associating their direction with an observation of the movement of vegetation near the target. When shooting takes place in the field, any means available should be used to determine the direction of the wind such as observing the direction vegetation is moving or feeling the wind against the body.

Refer to slide sSLR.9-2.

b. Wind Value - The Clock System. The clock system is used to determine the value of the wind as full, half, or no value. The clock system refers to a sectored circle in which winds blowing from different directions are assigned different values. These values, along with the speed of the wind, are used to calculate the sight adjustments to compensate for the wind. The direction of fire to the target is always considered to be 12 o'clock. The direction from which the wind is blowing determines the relative value of the wind. The relative value of a wind indicates its ability to deflect the bullet in its flight to the target.

1) Full Value Wind. Wind blowing from either right or left directly across the Marine's front (3 o'clock or 9 o'clock) is assigned a full value since it will have the greatest effect on bullet deflection.

2) No Value Wind. Winds blowing directly in the Marine's face (12 o'clock) or at his back (6 o'clock)

are of no value since they will not deflect the bullet.

3) Half Value Wind. Winds blowing from other directions are assigned intermediate values. For example, wind blowing from 1:30 is referred to as a half value wind. A half value wind deflects a bullet half the distance laterally as a full value wind. For example, if a 10 mph wind from 3 o'clock (full value) deflects a bullet 9 inches to the left at 300 yards/meters, the same 10 mph wind from 1:30 (half value) would deflect the bullet only 4.5 inches to the left at 300 yards/meters.

Confirm by questions.

TRANSITION: Once the direction of the wind is determined and the corresponding value assigned to it, velocity must be determined to make adjustments to your rifle sights to compensate for deflection. Velocity is the speed the wind is blowing. There are two primary field expedient methods for determining wind velocities in miles per hour (mph): the Observation Method and the Flag Method.

4. (10 MIN) DETERMINING WIND VELOCITY

a. The Observation Method. The observation method is the primary method used to determine wind velocity in a tactical situation and should be practiced on the range.

1) During KD firing, the flag method is an ideal learning tool to get you familiar with observing your surroundings and to determine wind velocity on the range. For example, the range flags may be moving in different directions making it difficult to gauge the wind. This includes the flags at either end of the firing points in the pits as well as the flags at each yard line. In these cases, wind will have to be determined by observing the terrain closest to the target. This can be done by associating the movement of the flags with an observation of the movement of trees or grass near the impact area or dust kicked up by a round impacting the berm near the target from another shooter.

2) Using the observation method, the Marine observes his surroundings and gauges the wind velocity by the movements of the objects around him and the feel of the wind on his body.

a) Under 3 mph. The wind can hardly be felt on the face, but the presence of a slight wind can be detected by drifting smoke.

b) 3 to 5 mph. Wind can be felt lightly on the face.

c) 5 to 8 mph. Wind keeps tree leaves in constant motion.

d) 8 to 12 mph. Wind will raise dust and loose paper.

e) 12 to 15 mph. Wind will cause small trees to sway.

f) 20 to 25 mph. Wind will cause large trees to sway.

Refer to slide sSLR.9-3.

b. The Flag Method. The flag method of determining wind velocity is the primary method used on the KD range. The flag method is based on the observation of a flag or some other cloth object which is blowing in the wind. It requires the Marine to estimate the angle (in degrees) that the flag is blowing away from its vertical pole. Dividing this angle by 4 will give the wind velocity in mph.

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

2) This information is based on a dry flag. A wet flag is heavier and may give a false reading by indicating a lower velocity than the wind is really blowing.

Confirm by questions.

TRANSITION: As we have discussed, it is important to understand the effects of wind on marksmanship and accurately estimate the wind's direction, value, and velocity. With this knowledge, the Marine need only apply this information to a relatively simple mathematical formula or to a windage chart to determine the correct windage adjustment to ensure an accurate shot on the target.

5. (10 MIN) DETERMINING CORRECT WINDAGE ADJUSTMENTS

There are several methods that can be used to calculate windage adjustments needed on the rifle’s windage knob to

compensate for the wind prior to firing.

Refer to slide sSLR.9-4.

a. Windage Chart – Observation Method. To calculate the number of clicks to make the proper windage adjustment on the rifle sight, refer to the observation method windage chart. Once wind velocity and value, along with range to the target are determined, review the chart to determine the proper windage adjustment.

1) Match wind velocity, value, and range to the target with the chart.

2) The number in the block which intersects the value and the range is the correct number of clicks to apply to the rear sight windage knob.

Refer to slide sSLR.9-5.

b. Windage Chart – Flag Method. Another method is to refer to the windage chart for the flag method that is in the data book. Match the figures in the chart with the wind conditions and range. The number in the block which intersects the value and the range is the correct number of clicks to apply to the rear sight windage knob.

c. Calculating Windage Clicks. A third method uses a fairly simple mathematical formula to determine how many clicks of windage are applied to the rifle to compensate for the effects of wind. This formula is good only for the M16A2 service rifle based on full value wind. If the wind is not full value, adjust accordingly. The rifle has a windage scale which is gauged in 1/2 inch per 100 yards/meters of range per click on the rear sight windage knob.

Refer to slide sSLR.9-6.

1) $\frac{\text{Range X Wind Velocity in mph}}{\text{Range Constant}} = \text{Clicks for full value wind}$

2) The range constant will depend on the type of ammunition. The range constant for M855 ammunition is as follows:

a) If the range to the target is 200-400 yards/meters, the range constant is 5.

b) If the range to the target is 500-700 yards/meters, the range constant is 4.

3) The range that the formula uses is measured in 100-yard/meter increments. At a range of 300 yards/meters to the target, a 3 would be entered for the range in the formula.

4) In adjusting the windage on the rifle, the rear sight aperture must always be moved into the direction from which the wind is blowing. For example, if the wind is blowing from the right, the rear sight aperture must be moved right.

5) A working example of this formula is:

A 10 mph wind is blowing from 9 o'clock. The range to the target is 500 yards/meters. Therefore, Range (R)=5, Velocity (V)=10 mph, 500-yard/meter Range Constant=4.

$$\frac{R \times V}{4} = \frac{5 \times 10}{4} = \frac{50}{4} = 12.5 \text{ or } 13 \text{ clicks left on the windage knob}$$

d. Recording Types of Wind Conditions in the Data Book. The types of wind conditions which existed during firing should be recorded in the data book. This information will help determine how different wind conditions affect your battlesight zero (BZO). (The data book will be discussed in detail in lesson SLR.11.)

Confirm by questions.

TRANSITION: While windy conditions can affect the path of the bullet as well as your mental state, light conditions affect marksmanship in a different way. The effects of different light conditions do not affect the trajectory of the bullet, but the way the target is perceived. The effects of light and how they can affect your shooting must be understood before you can learn how to overcome them.

6. (5 MIN) EFFECTS OF DIFFERENT LIGHT CONDITIONS

Many inexperienced Marines do not recognize that light conditions can affect shooting accuracy. A change in light condition, which may not be noticed, can cause the Marine to aim at what he thinks is the correct aiming point, but really is not. What appears to be center mass on the target may in fact be several inches higher or lower, left or right. The sights on your rifle may need to be adjusted to compensate for

the effects of changing light conditions. Maintaining a center mass hold, regardless of how indistinct the target appears, ensures the best chances for an effective shot. Common light conditions include:

a. Bright Light. Bright light conditions exist under a clear blue sky with no fog or haze present to filter the sunlight.

1) Bright light can make a target appear smaller and farther away. As a result, it is easy to overestimate range.

Refer to slide sSLR.9-7.

2) Bright light shining from above will make the front sight post appear shorter and bright light from the side will make the front sight post appear narrower. This affects aiming because the Marine will aim at center mass using the perceived tip of the front sight post which will be altered due to the effects of light.

b. Haze. Haze exists when smog, fog, dust, smoke, or humidity is present. Haze is not bright, but it can be uncomfortable to the eyes. Haze can make a target appear indistinct, making it difficult to establish sight picture.

c. Overcast. Overcast conditions exist when a solid layer of clouds blocks the sun. The amount of light changes as the cloud cover thickens. Overcast conditions make a target appear larger and closer. As a result, it is easy to underestimate range.

1) Light Overcast. Light overcast conditions exist when no blue sky is visible and a thin layer of clouds is present. In light overcast, both the target and the rifle sights appear very distinct. Light overcast is comfortable on the eyes with no glare present, making probably the best light condition for shooting.

2) Dark Heavy Overcast. Dark heavy overcast conditions exist when the sky is completely overcast with most of the light blotted out by the clouds. As the overcast thickens, it becomes difficult to identify the target from the surroundings.

d. Scattered Clouds. Scattered cloud conditions exist when the clouds are broken up into small patches with the sun appearing at times between the clouds. Your eyes may have problems adjusting between a target which is brightly lit and one that is shadowed.

e. Moving Clouds. Moving clouds exist when scattered clouds move across the sky rapidly, making the sun appear periodically. Rapidly moving clouds can fatigue the eyes due to the rapid changes from bright light to shadows. This condition is probably the most difficult to contend with because the light changes rapidly. If the situation permits, this condition can be compensated for by selecting one of the two light conditions (bright light or shadow) in which to fire. Best results will be obtained if each shot is fired under the same light condition.

f. Record Light Condition in the Data Book. A significant change in light condition should be recorded in the REMARKS block of the data book. This information will help determine how the type of light condition or change in condition affects your BZO.

Confirm by questions.

TRANSITION: In addition to the effects that wind and light conditions have on a Marine, the trajectory of the bullet, and the appearance of the target, excessive heat and cold can also affect a Marine, the trajectory of the bullet, and the weapon. It is essential to learn how to compensate for extremes in temperature to engage a target effectively.

7. (5 MIN) EFFECTS OF TEMPERATURE

a. Extreme Heat

1) Effects of Extreme Heat on the Marine. Hot temperatures can lead to rapid fatigue and cause distractions that can result in inaccurate shooting. This can cause blurred vision and reduce concentration levels. Excessive heat can cause muscle cramps, heat exhaustion, or heat stroke. Increased fluid intake, good physical condition, and periodic rest breaks (if possible) will help offset these effects.

2) Target/Front Sight Post. At high temperatures, ground mirage can cause a target to appear indistinct and drift from side to side. Heat waves or mirage may distort the target shape or the appearance of the front sight post. Mirage created by the heat of the rifle barrel can cause difficulty in seeing the sights clearly. Maintaining a center mass hold will ensure the best chance for accurate target engagement.

3) The Rifle and Bullet. In hot weather, rifle chamber pressure increases, causing the bullet to exit the muzzle at a higher velocity and impact the target above the point of aim. Hot air is less dense than cooler air and provides the bullet with less resistance. This allows the bullet to travel faster, causing it to experience less deflection when there is wind. To avoid changes in propellant temperature, ammunition should be protected from direct exposure to the sun.

b. Extreme Cold

1) The Marine. Extreme cold can cause the Marine to shiver, feel uncomfortable, have lapses in memory, and have difficulty holding a frigid rifle with numb hands. Shivering can make aiming very difficult, if not impossible. Trigger control is difficult to execute properly if the fingers are numb. Additionally, the potential for frostbite is a concern. Proper dress in cold climates is paramount.

2) The Rifle and the Bullet. Extreme cold will affect the rifle and the bullet. In cold weather, rifle chamber pressure decreases, causing the bullet to exit the muzzle at a lower velocity and impact the target below the point of aim. The air is denser at lower temperatures and tends to slow the speed of the bullet, causing the bullet to experience a greater deflection when there is wind.

c. Record Temperature in the Data Book. A substantial temperature change (20 degrees or more) should be recorded in the REMARKS block of the data book. A substantial change will require the rifle to be rezeroed.

Confirm by questions.

TRANSITION: Precipitation in the form of rain, snow, hail, and sleet, like temperature, can affect shooting performance. The temperature and wind that accompany precipitation affect the bullet. However, if a Marine is distracted by precipitation, he may shoot poorly regardless of any corrections he may have made to compensate for the effects of temperature and wind.

8. (1 MIN) EFFECTS OF PRECIPITATION

a. The Marine. Precipitation can affect concentration and comfort. Depending on the amount of precipitation, the target may be obscured or not visible at all making it difficult to establish sight picture. A positive mental attitude will provide the best performance.

b. The Rifle and Bullet. Freezing rain and other types of precipitation can make the weapon difficult to handle or may foul the weapon and cause stoppages. Water buildup in the barrel or compensator can cause erratic shots. Therefore, the rifle should be carried Weak Side Sling Arms (Muzzle Down) to keep moisture out of the bore.

Confirm by questions.

TRANSITION: To become a combat-effective rifleman, it is vital to develop the ability to compensate for the effects of weather through weapon sight adjustment and mental and physical preparation. Through an understanding of how wind, temperature, light, and precipitation affect him and the trajectory of the bullet, the Marine can develop the skill and confidence to engage targets accurately under a variety of adverse weather conditions.

OPPORTUNITY FOR QUESTIONS: (1 MIN)

1. Respond to questions from the class.

2. Prompt Marines with questions to the class.

a. QUESTION: What is the Marine's greatest weapon against adverse weather conditions?

ANSWER: A good mental attitude.

b. QUESTION: Which of the four shooting positions does the wind have the greatest effect on?

ANSWER: The standing position.

c. QUESTION: What are the two methods for determining wind velocity?

ANSWER: The Observation Method and the Flag Method.

INSTRUCTOR'S NOTE: *Ask Marines as many questions*

as necessary to ensure they fully understand the material presented in this class.

SUMMARY: (1 MIN)

On the range and in combat, the Marine will be subjected to a wide variety of adverse weather conditions including wind, excessive temperatures, precipitation, and light conditions. An understanding of how these weather conditions can affect your performance, the rifle, and the trajectory of the bullet can aid learning to compensate for these conditions. Through physical and mental preparation and sight adjustment, combined with practice and adherence to the fundamentals of marksmanship, the effects of adverse weather on your performance can be overcome.

SLIDES

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