UNITED STATES MARINE CORPS

FIELD MEDICAL TRAINING BATTALION-EAST
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MCECST

2401-NAV-1001/2 LAND NAVIGATION

TERMINAL LEARNING OBJECITVES:

1. Given a lensatic compass, a surveyed point with a level platform, an azimuth marker and a surveyed known direction, determine the error in a lensatic compass to within three (3) degrees.
(2401-NAV-1001)

2. Given a lensatic compass, a map, and designated objectives, while wearing a fighting load, navigate with a map and compass to arrive at the designated objective(s).
(2401-NAV-1002)

ENABLING LEARNING OBJECTIVES:

1. Given a list of choices, identify the separation distances for proper functioning of a lensatic compass in accordance with reference TC 3-25.26 Marine Map Reading and Land Navigation.
(2401-NAV-1001a)

2. Given a scenario, determine the separation distances for proper functioning of a lensatic compass in accordance with reference TC 3-25.26 Marine Map Reading and Land Navigation.
(2401-NAV-1001b)

3. Given a list of choices, identify the marginal information on a topographical map in accordance with reference TC 3-25.26 Marine Map Reading and Land Navigation.
(2401-NAV-1002a)

4. Given a list of choices, identify the purposes of contour lines in accordance with reference FM 3-25.26 Marine Map Reading and Land Navigation.
(2401-NAV-1002b)

5. Given a list of choices, identify the types of contour lines in accordance with reference FM-3-25.26 Marine Map Reading and Land Navigation.
(2401-NAV-1002c)

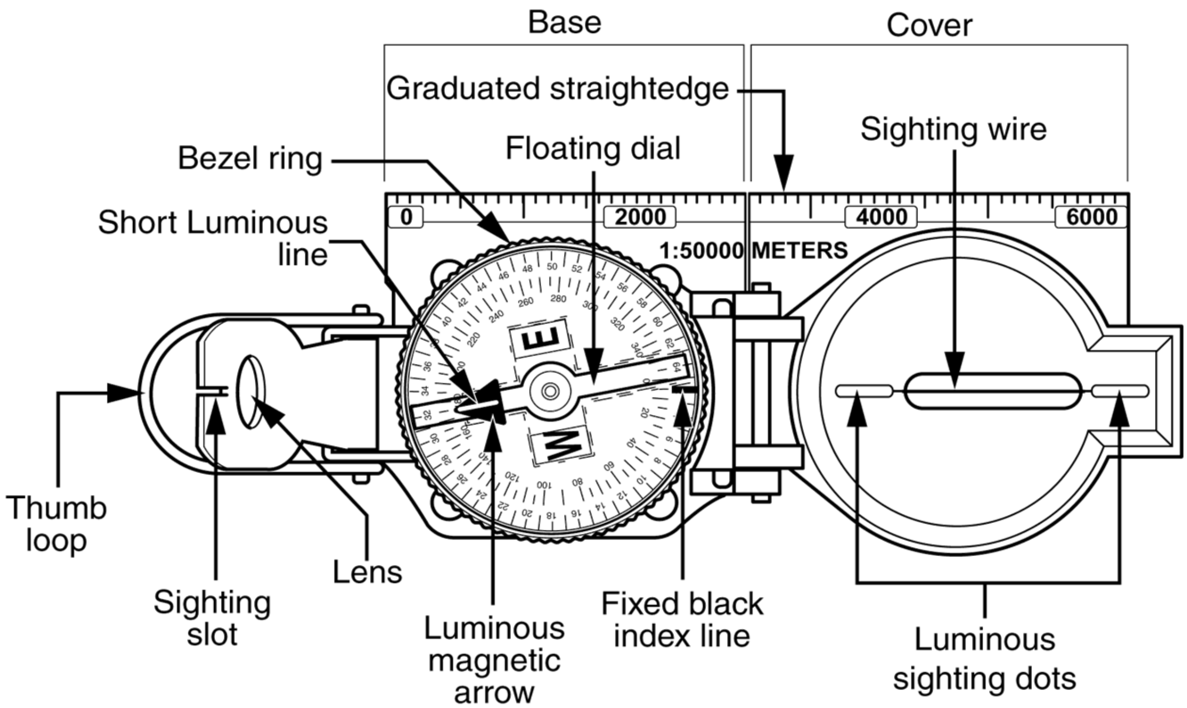
6. Given a list of choices, identify the features found on a topographic map in accordance with reference FM 3-25.26 Marine Map Reading and Land Navigation.
(2401-NAV-1002d)

7. Given a list of choices, identify the colors of a topographical map in accordance with reference FM 3-25.26 Marine Map Reading and Land Navigation.
(2401-NAV-1002e)

8. Given a list of choices, identify the process for determining an azimuth in accordance with reference FM 3-25.26 Marine Map Reading and Land Navigation.
(2401-NAV-1002f)

9. Given a scenario, a lensatic compass, a map, and designated objectives, while wearing a fighting load, navigate with a map and compass to locate designated objectives in accordance with reference FM 3-25.26 Marine Map Reading and Land Navigation.
(2401-NAV-1002g)

1. **NOMENCLATURE OF THE LENSATIC COMPASS**. The primary instrument you will use to determine and maintain direction during land navigation is the lensatic compass. It provides you with the most reliable means of maintaining direction while navigating from one point to another.



a. **Description**. The lensatic compass consists of three major parts.

(1) Cover. The compass cover protects the floating dial. It contains the sighting wire and two luminous sighting dots used for night navigation.

(2) Base. The base of the compass contains the following movable parts:

(a) The floating dial is mounted on a pivot so it can rotate freely when the compass is held level. Printed on the dial in luminous figures are an arrow and the letters "E" and "W". The North Seeking Arrow always points to magnetic north and the letters fall at east 90 degrees and west 270 degrees on the dial. There are two scales; the outer scale denotes mils and the inner scale (normally in red) denotes degrees.

(b) Encasing the floating dial is a glass face containing a fixed black index line.

(c) The bezel ring is a ratchet device that clicks when turned. It contains 120 clicks when rotated fully; each click is equal to 3 degrees. A short luminous line that is used in conjunction with the north-seeking arrow during navigation is contained in the glass face of the bezel ring.

(d) The thumb loop is attached to the base of the compass.

(e) When opened, the straightedge on the left side of the compass has a coordinate scale; in new compasses the scale is 1:50,000.

(3) Lens. The lens is used to read the dial, and it contains the rear-sighting slot used in conjunction with the sighting wire to aim in on objects. The rear sight also serves as a lock, and clamps the dial when closed for its protection. The rear sight must be opened more than 45 degrees to allow the dial to float freely.

2. **USING THE LENSATIC COMPASS**.

a. **Inspection**. Compasses are delicate instruments and should be cared for accordingly. Conduct a detailed inspection whenever you obtain and use a compass. One of the most important parts to check is the floating dial, which contains the magnetic needle. You must also make sure the sighting wire is straight, the glass and crystal parts are not broken, the numbers on the dial are readable, the bezel ring when turned has distinct clicks, and most important, that the floating dial does not stick.

b. **Accuracy**. A compass in good working condition is very accurate. However, you must periodically check (calibrate) your compass on a known line of direction, such as a surveyed azimuth at a declination station. If your compass varies more than 3 degrees from the azimuth at the calibration point, you should not use it.

c. **Protection**. If traveling with the compass unfolded, make sure the rear sight is fully folded down onto the bezel ring. This will lock the floating dial and prevent vibration, as well as protect the crystal and rear sight from damage.

d. **Using the Center Hold Technique**. The lensatic compass is used to determine or follow magnetic azimuths both during the day and at night. To use it with the maximum degrees of accuracy, it is important that certain techniques be understood and properly applied. Like developing the techniques for shooting a rifle, you must develop a proper holding position, zero (calibrate) your compass, and practice until you master the techniques for accurately "shooting" an azimuth.

(1) Open the compass to its fullest so that the cover forms a straightedge with the base.

(2) Move the lens to the rearmost position, allowing the dial to float freely.

(3) Place your thumb through the thumb loop, form a steady base with your third and forth fingers, and extend your index finger along the side of the compass.

(4) Place the thumb of the other hand between the lens and the bezel ring; extend the index finger along the remaining side of the compass, and the remaining fingers around the fingers of the other hand.

(5) Pull your elbows firmly into your sides; this will place the compass between your chin and belt.

(6) To measure an azimuth, simply turn your entire body toward the object, pointing the compass cover directly at the object.

(7) Once you are pointing at the object, look down and read the azimuth from beneath the fixed black index line.

(8) This method offers the following advantages over the compass to-check technique:

(a) It is faster and easier to use.

(b) It can be used under all conditions of visibility.

(c) It can be used when navigating over any type of terrain.

(d) It can be used without putting down the rifle; however, the rifle must be slung well back over either shoulder.

(e) It can be used without removing your eyeglasses.

b. **Using the Compass-To-Check Technique**.

(1) This method offers the following advantages over the center hold technique.

(2) It is more accurate.

(3) Used for performing intersection/resection.

(4) Open the compass so that the cover is vertical, forming a 90-degree angle with the base.

(5) Move the lens to the rearmost position, allowing the dial to float freely, then fold the rear sight slightly forward. Make sure not to fold the sight down too far, where it may lock the floating dial.

(6) Turn the thumb loop all the way down and put your right or left thumb through it. Form a loose fist under the compass, steady it with your other hand, and raise it up to eye level. If you are wearing wire rim glasses, you must remove them when using the compass-to-check technique.

(7) Look through the rear sighting slot and align the sights by centering the front sighting wire in the rear sighting slot.

(8) Keeping the compass level and the sights aligned; rotate your entire body until the sighting wire is lined up on the distant object.

(9) Glance down through the lens and read the azimuth directly under the index line. If glare on the top glass makes

it difficult to read, shade the glass with your hand. The azimuth you read is the magnetic azimuth from your position to the distant object.

2. **CHARACTERISTICS OF THE LENSATIC COMPASS**. Metal objects and electrical sources can affect the performance of a compass. However, non-magnetic metals and alloys do not affect compass readings. To ensure the proper functioning of your compass, keep yourself away from the following metal objects:

(a) **High Tension Power Lines**. 55 meters.

(b) **Field Gun, Truck, or Tank**. 18 meters.

(c) **Telephone Wires and Barbed Wire**. 10 meters.

(d) **Machinegun**. 2 meters.

(e) **Rifle**. 1/2 meter.

(f) **Steel Rimmed Glasses**. 1/3 meter.

3. **MARGINAL INFORMATION ON A MAP**. A map is a graphic representation of a portion of the earth's surface drawn to scale, as seen from above. It uses colors, symbols, and labels to represent features found on the ground. A map provides information on the existence, the location of, and the distance between ground features, such as populated places and routes of travel and communication. It also indicates variations in terrain, heights of natural features, and the extent of vegetation cover.

a. **Security of Maps**. All maps should be considered as documents that require special handling. If a map falls into unauthorized hands, it could easily endanger operations by providing information of friendly plans or areas of interest to the enemy. If a map is no longer needed, it must be turned in to the proper authority. If a map is in danger of being captured, it must be destroyed.

b. **Care of Maps**. Maps are documents printed on paper and require protection from water, mud, and tearing. Whenever possible, a map should be carried in a waterproof case, in a pocket, or in some other place where it is handy for use but still protected.

c. **Topographic Map**. A topographic map is a map that portrays terrain features in a measurable way usually through the use of contour lines, as well as the horizontal positions of the features represented.

d. **Marginal Information**. The instructions that are placed around the outer edges of a map are known as marginal information. This information will provide you with the information necessary to read your map. However, since all maps are not the same, it becomes necessary to examine all the marginal information carefully, every time a different map is used.

e. **Bar Scale**. Located in the center of the lower margin. It is used to convert map distance to ground distance. Maps have three or more bar scales, each in a different unit of measure.

f. **Contour Diagram**. Located in the lower margin. It states the vertical distance between adjacent contour lines on the map.

g. **Declination Diagram**. Located in the lower margin. It indicates the angular relationships of true, grid and magnetic north.

(1) True North. A line from any point on the earth's surface to the North Pole is a true north line. True north is usually represented by a line ending with a star. True north is used almost exclusively for navigating by natural means. When direction is determined by the sun, shadows, stars, or any other natural means, the base direction is true north.

(2) Magnetic North. The direction to the north magnetic pole is indicated by the north-seeking needle of your lensatic compass. Magnetic north is usually symbolized by a line ending with a half arrowhead. Any time you are using the compass to plan or follow an azimuth in the field, you must be working with azimuths measured from magnetic north.

(3) Grid North. This base line is established by using the vertical grid lines on the map. Grid north may be symbolized by the letters GN. It is seldom the same as the true north or magnetic north. Anytime you are using a protractor in

conjunction with a vertical grid line to determine or plot an azimuth on a map, you must be working with an azimuth measured from grid north.

(4) Using magnetic north or grid north as the base line we define grid azimuth and magnetic azimuth.

(a) A grid azimuth is an angle measured in a clockwise direction from grid north.

(b) A magnetic azimuth is an angle measured in a clockwise direction from magnetic north.

h. **Legend**. Located in the lower left margin. It illustrates and identifies the topographical symbols of some of the prominent features on the map. The symbols are not always the same on every map, so the legend must always be referred to when using a map.

i. **Sheet Name**. Found in two places; center of the upper margin, and the left side of the lower margin. Generally, a map is named after outstanding cultural or geographic feature.

j. **Series Name**. Found in the upper left margin; the name given a series is that of the most prominent area.

k. **Adjoining Sheets Diagram**. Located in the lower margin and usually contains nine rectangles, each one representing a map with its sheet number. The Diagram is used whenever you must link two or more maps together.

l. **Map Scale**. The scale note is a representative fraction, which gives the ratio of a map distance to the corresponding distance on the earth's surface. For example, a scale note of 1:50,000 would indicate that the distance covered by one inch on the map would equal 50,000 inches on the actual ground.

m. **Credit Note**. In the lower left margin and lists the procedure, dates, and general methods of preparation or revisions. This information is important to the map user in evaluating the reliability of the map as it indicates when and how the map information was obtained.

4. **COLORS USED ON A MILITARY MAP**. To facilitate the identification of features on a map, the topographical and cultural information is usually printed in different colors. These colors may vary from map to map. On a standard large-scale topographic map, the colors used on a map represent certain features.

a. **Black**. Indicates cultural (man-made) features, such as buildings and roads.

b. **Blue**. Identifies hydrography or water features such as lakes, swamps, rivers, and drainage.

c. **Green**. Identifies vegetation with military significance.

d. **Red**. Classifies cultural features, such as populated areas, main roads, and boundaries, on older maps.

e. **Brown**. Identifies all relief features, such as contours on older edition maps.

f. **Reddish-Brown**. The colors red and brown are combined to identify cultural features, all relief features, and elevation, such as contour lines on red-light readable maps.

g. **Other**. Occasionally other colors may be used to show special information. These are indicated in the marginal information as a rule.

5. **NATURAL AND MAN-MADE TERRAIN FEATURES**. The mapmaker uses symbols to represent the natural and man-made features of the earth's surface. These symbols resemble, as closely as possible, the actual features themselves as viewed from above. They are positioned in such a manner that the center of the symbol remains in its true location. An exception to this would be the position of a feature adjacent to a major road. If the width of the road has been exaggerated, then the feature is moved from its true position to preserve its relation to the road. Field Manual 21-26 gives a description of topographic feature and abbreviations authorized for use on our military maps. Use your legend to identify your symbols.

a. **Method of Depicting Relief**. Before we can discuss terrain features in depth we will discuss how a map shows relief and elevation.

(1) Contour Lines. Contour lines are the most common method of showing relief and elevation on a standard topographic map. A contour line represents an imaginary line on the ground, above or below sea level. All points on the contour line are at the same elevation. The elevation represented by contour lines is the vertical distance above or below sea level. The three types of contour lines used on a standard topographic map are as follows:

(a) Index. Starting at zero elevation or mean sea level, every fifth contour line is a heavier line. These are known as index contour lines. Normally, each index contour line is numbered at some point. This number is the elevation of that line.

(b) Intermediate. The contour lines falling between the index contour lines are called intermediate contour lines. These lines are finer and do not have their elevations given. There are normally four intermediate contour lines between index contour lines.

(c) Supplementary. These contour lines resemble dashes. They show sudden changes in elevation of at least one-half the contour interval.

(2) Contour Interval. Before the elevation of any point on the map can be determined, the user must know the contour interval for the map he is using. The contour interval measurement given in the marginal information is the vertical distance between adjacent contour lines.

(3) Terrain Features. All terrain features are derived from a complex land mass known as a mountain or ridgeline. The term ridgeline is not interchangeable with the term ridge. A ridgeline is a line of high ground, usually with changes in elevation along its top and low ground on all sides, from which a total of 10 natural or man-made terrain features are classified.

(4) Types of Slopes. Depending on the military mission, you may need to determine not only the height of a hill, but the degree of the hill's slope as well. The rate of rise or fall of a ground form is known as its slope. The speed at which equipment or personnel can move is affected by the slope of the ground or terrain feature. This slope can be determined from the map by studying the contour lines--the closer the contour lines, the steeper the slope; the farther apart the contour lines, the gentler the slope. Four types of slopes that concern the military are as follows.

(a) Gentle. Contour lines showing a uniform, gentle slope will be evenly spaced and wide apart.

(b) Steep. Contour lines showing a uniform, steep slope on a map will be evenly spaced, but close together. Remember, the closer the contour lines, the steeper the slope.

(c) Concave. Contour lines showing a concave slope on a map will be closely spaced at the top of the terrain feature and widely spaced at the bottom. Example: The inside of a bowl.

(d) Convex. Contour lines showing a convex slope on a map will be widely spaced at the top and closely spaced at the bottom. Example: The outside of an upside-down bowl.

(5) Major Terrain Features.

(a) Hill. A hill is an area of high ground. From a hilltop, the ground slopes down in all directions. A hill is shown on a map by contour lines forming concentric circles. The inside of the smallest circle is the hilltop.

(b) Ridge. This is a sloping line of high ground. If you are standing on the center of a ridge, you will normally have low ground in three directions and high ground in one direction with varying degrees of slopes. If you cross a ridge at right angles, you will climb steeply to the crest, and then descend steeply to the base. When you move along the path of the ridge, depending on the geographic location, there may be either an almost unnoticeable slope or a very obvious incline. Contour lines forming a ridge tend to be U-shaped or V-shaped. The closed end of the contour line points away from high ground.

(c) Saddle. This is a dip or low point between two areas of higher ground. A saddle is not necessarily the lower ground between the hilltops; it may be simply a dip or break along a level ridge crest. If you are in a saddle, there is high ground in two opposite directions and lower ground in the other two directions. A saddle is normally represented as an hourglass or by figure eight shaped contour lines.

(d) Valley. This is a stretched-out groove in the land, usually formed by streams or rivers. A valley begins with high ground on three sides, usually has a course of running water through it. If standing in a valley, there is high ground in two opposite directions and a gradual inclination in the other two directions. Depending on its size and where a person is standing, it may not be obvious that there is high ground in three directions, but water flows from higher to lower ground. Contour lines forming a valley are either U-shaped or V-shaped. To determine the direction water is flowing, look at the contour lines. The closed end of the contour line (U or V) always points upstream or toward high ground.

(e) Depression. This is a low point in the ground or a sinkhole. A depression could be described as an area of low ground surrounded by higher ground in all directions, or simply a hole in the ground. Usually only depressions that are equal to or greater than contour interval will be shown. On maps, depressions are represented by closed contour lines that have tick marks pointing toward low ground.

(6) Minor Terrain Features.

(a) Finger. (Spur) A finger is a short continuous sloping line of higher ground, normally jutting out from the side of a ridge. A finger is formed by two roughly parallel streams cutting draws down the side of a ridge. The ground will slope down in three directions and up in one. Contour lines on a map depict a finger with a U or V pointing away from high ground.

(b) Draw. A draw is a less developed stream course than a valley. In a draw, there is essentially no ground and, therefore, little or no maneuver room within its confines. If you are standing on a draw, the ground slopes upward in three directions and down in the other direction. A draw could be considered as the initial formation of a valley. The contour lines depicting a draw are U-shaped or V-shaped, pointing toward high ground.

(c) Cliff. A cliff is a vertical or near vertical feature; it is an abrupt change of the land. When a slope is so steep that the contour lines converge into one "carrying" contour of contours, this last contour line has ticks pointing toward low ground. Cliffs are also shown by contour lines very close together and, in some instances, touching each other.

(7) Supplementary Terrain Features.

(a) Cut. A cut is a man-made feature resulting from cutting through high ground, usually to form a level bed for a road or railroad track. Cuts are shown on a map when they are at least 10 feet high, and they are drawn with a contour line along the cut line. This contour line extends the length of the cut and has tick marks that extend from the cut line to the roadbed, if the map scale permits this level of detail.

(b) Fill. Fill is a man-made feature resulting from filling a low area, usually to form a level bed for a road or railroad track. Fills are shown on a map when they are at least 10 feet high, and they are drawn with a contour line along the fill line. This contour line extends the length of the filled area and has tick marks that point toward lower ground. If the map scale permits, the length of the fill tick marks are drawn to scale and extend from the base line of the fill symbol.

6. **PLOTTING A POINT ON A TOPOGRAPHICAL MAP**. Before you plot a point you need to be familiar with the protractor that will aid you in plotting points.

a. **Orient a Map**. The first step for a navigator in the field is orienting the map. A map is oriented when it is in a horizontal position with its north and south corresponding to the north and south on the ground.

(1) Using a Compass. When orienting a map with a compass, remember that the compass measures magnetic azimuths. Since the magnetic arrow points to magnetic north, pay special attention to the declination diagram.

(a) Determine the direction of the declination and its value from the declination diagram.

(b) With the map in a horizontal position, take the straightedge on the left side of the compass and place it alongside the north/south grid line with the cover of the compass pointing toward the top of the map. This will place the fixed black index line of the compass parallel to the north/south grid lines of the map.

(c) Keeping the compass aligned as directed above, rotate the map and compass together until the magnetic arrow is below the fixed black index line on the compass.

(d) Rotate the map and compass in the direction of the declination diagram. This will orient the map to grid north.

(2) Using Terrain Association. A map can be oriented by terrain association when a compass is not available or when the user has to make a quick reference as he moves across country. Using this method requires careful examination of the map and the ground, and the user must know his approximate location.

(a) Terrain During the Different Seasons of the Year. In those areas of the world where the seasons are distinctive, a detailed examination of the terrain should be made during each season. The same piece of land does not present the same characteristics during both spring and winter.

1. During winter, the snow packs the vegetation, delineating the land, making the terrain features appear as clear as they are shown by the contour lines on the map. Ridges, valleys, and saddles are very distinctive.

2. During spring, the vegetation begins to reappear and grow. New vegetation causes a gradual change of the land to the point that the foliage conceals the terrain features and makes the terrain hard to recognize.

3. During summer months, the effects are similar to those in the spring.

4. Fall makes the land appear different with its change of color and gradual loss of vegetation.

5. During the rainy season, the vegetation is green and thick, and the streams and ponds look like small.

b. **Protractor**. There are several types of protractors—full circle, half circle, square, and rectangular. All of them divide the circle into units of angular measure, and each has a scale around the outer edge and an index mark. The index mark is the center of the protractor circle from which all directions are measured.

(1) The military protractor contains two scales: one in degrees (inner scale) and one in mils (outer scale). This protractor represents the azimuth circle. The degree scale is graduated from 0 to 360 degrees with each tick mark representing one degree. A line from 0 to 180 degrees is called the base line of the protractor. The index or center of the protractor is where the base line intersects the horizontal line, between 90 and 270 degrees.

(2) When using the protractor, the base line is always oriented parallel to a north-south grid line. The 0- or 360-degree mark is always toward the top or north on the map and the 90-degree mark is to the right.

(a) <u>To Determine the Grid Azimuth</u>:

<u>1</u>. Draw a line connecting the two points (A and B).

<u>2</u>. Place the index of the protractor at the point where the drawn line crosses a vertical (north-south) grid line.

<u>3</u>. Keeping the index at this point, align the (0 to 180-degree) line of the protractor on the vertical grid line.

<u>4</u>. Read the value of the angle from the scale; this is the grid azimuth from point A to point B.

(b) <u>To Plot an Azimuth From a Known Point on a Map</u>:

<u>1</u>. Convert the azimuth from magnetic to grid, if necessary.

<u>2</u>. Place the protractor on the map with the index mark at the center of mass of the known point and the base line parallel to a north-south grid line.

<u>3</u>. Make a mark on the map at the desired azimuth.

4. Remove the protractor and draw a line connecting the known point and the mark on the map. This is the grid direction line (azimuth).

(3) To obtain an accurate reading with the protractor (to the nearest degree or 10 mils), there are two techniques to check that the base line of the protractor is parallel to a north-south grid line.

(a) Place the protractor index where the azimuth line cuts a north-south grid line, aligning the base line of the protractor directly over the intersection of the azimuth line with the north-south grid line. The user should be able to determine whether the initial azimuth reading was correct.

(b) The user should re-read the azimuth between the azimuth and north-south grid line to check the initial azimuth.

(c) Note that the protractor is cut at both the top and bottom by the same north-south grid line. Count the number of degrees from the 0-degree mark at the top of the protractor to this north-south grid line and then count the number of degrees from the 180-degree mark at the bottom of the protractor to this same grid line. If the two counts are equal, the protractor is properly aligned.

c. **Grid Squares**. To navigate, you have to know how to find your location on a map. The map has lines running up and down and side to side. These lines form small squares, 1,000 meters on each side, called grid squares. The lines that form grid square are numbered along the outside edge of your map. No two grid squares will have the same number. The precision of a point location is shown by the number of digits in the coordinates; the more digits, the more precise the location.

(1) 4-digit coordinates label a point to the nearest 1,000 meters.

(2) 6-digit coordinates label a point to the nearest 100 meters.

(3) 8-digit coordinates label a point to the nearest 10 meters.

(4) 10-digit coordinates label a point to the nearest 1 meter.

d. **4-Digit Grid Coordinates**. You desire to determine the grid coordinates of Hill 367 to the nearest 1,000 meters. First, identify the grid square in which it is located. Remember the cardinal rule of reading RIGHT then UP. Reading right, you identify the last north-south grid line before arriving at Hill 367 as "70". Reading up, you identify the last east-west grid line before arriving at Hill 367 as "40". The identity of the grid square is 7040. Note that the point where these two grid lines intersect in the lower left hand corner of the grid square identifies the grid square as 7040. You have, therefore, located a point to the nearest 1,000 meters by using a 4-digit grid coordinate.

e. **6-Digit Grid Coordinates**. Next, you will need to locate points within grid squares. Imagine dividing the grid square into 100 smaller squares. Each green line here represents a tic mark on your protractor, equaling 100 meters. We read a point in these smaller grid squares to determine a 6-digit grid just like we did to determine the 4-digit grid 7040. To determine the location of point A, we apply the rule "read right, then up". Reading right from the 70 line, we count over 2 lines (or 200 meters); then reading up from the 40 line, we count up 8 lines (or 800 meters). We have just determined that point A is located at grid 702408.

(1) To write the 6-digit coordinates that locate a point, you simply combine the two readings, in this case, "702408". The vertical reading is always placed before the horizontal reading.

(2) You do not actually draw the lines within the grid square, since such lines would obstruct other information. You determine a 6-digit grid coordinate by using your coordinate scale and protractor. Then round your value to the closest number on your coordinate scale.

f. Locating point C using the coordinate scale on the protractor.

(1) We can identify the 4-digit grid coordinates simply by reading the map. In this case, we see this is "0267". Place the proper coordinate scale of your protractor with the zero-zero point at the lower left hand corner of the grid square (0267).

(2) Keeping the horizontal line of the scale directly on top of east-west grid line (in this case, line 67), slide it

to the right until the vertical line of the scale touches the point (in this case, point C) for the coordinates desired. Here we see that point C is 5 tic marks (500 meters) from the 02 north-south line. So, our first three coordinates are 025.

(3) Examine the two sides of the coordinate scale to ensure that the horizontal line of the scale is aligned with the east-west grid line, and the vertical line of the scale is parallel with the north-south grid line. Determine your UP reading by first reading the value of the grid line to the left of point C (67). Add to this value the number, which tells how far into the grid square point D is. In this case, it is 7 tic marks (700 meters) from the 67 east-west line. Your second three coordinates are 677. You have now successfully plotted the 6-digit grid 025677.

f. **Without a Coordinate Scale**. In order to determine grids without a coordinate scale, the reader simply refers to the north-south grid lines numbered at the bottom margin of any map. Then he reads RIGHT to the north-south grid line that precedes the desired point (this first set of two digits is the RIGHT reading). Then by referring to the east-west grid lines numbered at either side of the map, the map reader moves UP to the east-west grid line that precedes the desired point (these two digits are the UP reading). Coordinates 1484 locate the 1,000-meter grid square in which point X is located; the next square to the right would be 1584; the next square up would be 1485, and so forth (Figure 4-15). To locate the point to the nearest 100 meters, use estimation. By mentally dividing the grid square in tenths, estimate the distance from the grid line to the point in the same order (RIGHT and UP). Give complete coordinate RIGHT, then complete coordinate UP. Point X is about two-tenths or 200 meters to the RIGHT into the grid square and about seven-tenths or 700 meters UP. The coordinates to the nearest 100 meters are 142847.

g. **Recording and Reporting Grid Coordinates**. Coordinates are written as one continuous number without spaces, parentheses, dashes, or decimal points; they must always contain an even number of digits. Therefore, whoever is to use the written coordinates must know where to make the split between the RIGHT and UP readings. Normally, grid coordinates are determined to the nearest 100 meters (six digits) for reporting locations. With practice, this can be done without using plotting scales. The location of targets and other point locations for fire support are determined to the nearest 10 meters (eight digits)

7. **DETERMINE STRAIGHT AND CURVED LINE DISTANCE**.

a. **Graphic Scales**. You may use the bar scale on your map to convert distances on the map to actual ground distance. The bar scale is divided into two parts. To the right of the zero, the scale is marked in full units of measure and is called the primary scale. To the left of the zero, the scale is divided into tenths and is called the extension scale. Most maps have three or more bar scales, each using a different unit of measure. Be sure to use the correct scale for the unit of measure desired.

(1) The graduated straightedge of the lensatic compass is engraved with a graphic scale. This graphic scale represents 6,000 meters of ground distance on a map with a scale of 1:50,000. This distance is divided, by lines, into 100-meter increments.

(2) The coordinate scale on the protractor you have been issued may also be used to determine distance. If a coordinate scale is used to determine ground distance, you must be sure it is at the same scale as the map you are using.

(3) Your choice of graphic scale to use when determining ground distances is unimportant. If properly used, they will all produce the same results. Use whichever form is available to you or is the most practical for the problem at hand.

b. **Determining Straight Line Distance**. To determine straight-line distance between two points on a map, lay a straight-edged piece of paper on the map so that the edge of paper touches both points and extends past them. Make a tick mark on the edge of the paper at each point. Remember that the center of the topographic symbol accurately designates the true location of the object on the ground.

(1) To convert the map distance to ground distance, move the paper down to the graphic bar scale, and align the right tick mark (b) with a printed number in the primary scale so that the left tick mark (a) is in the extension scale. In this case the right tick mark (b) is aligned with the 3,000 meter mark in the primary scale, thus the distance is at least 3,000 meters.

(2) To determine the distance between the two points to the nearest 10 meters, look at the extension scale. The

extension scale is numbered with zero at the right and increases to the left. When using the extension scale, always read it right to left. From the zero to the end of the first shaded square is 100 meters. From the beginning of the clear square to the left is 100 to 200 meters; at the beginning of the second shaded square is 200 to 300 meters. Remember, the distance in the extension scale increases from right to left.

(3) To determine the distance from the zero tick mark (a), estimate the distance inside the squares to the closest tenth. As you break down the distance between the squares in the extension scale, you will see that tick mark (a) is aligned with the 950-meter mark. Adding the distance of 3,000 meters determined in the primary scale, we find that the total distance between (a) and (b) is: 3,000 + 950 = 3,950 meters.

c. **Determining Curved Line Distance**. To measure distance along a winding road, stream, or other curved line, you still use the straight edge of a piece of paper. In order to avoid confusion concerning the start point and the ending point, a six-digit coordinate, combined with a description of the topographical feature, should be given for both the starting and ending points. Place a tick mark on the paper and map at the beginning point from which the curved line is to be measured. Place a paper strip or other material with a straightedge along the center of the irregular feature, and extend the tick mark onto the paper strip. Because the paper strip is straight and the irregular feature is curved, the straightedge will eventually leave the center of the irregular feature. At the exact point where this occurs, place a tick mark on both the map and paper strip. Keeping both tick marks together (on paper and map), place the point of the pencil close to the edge of the paper on the tick mark to hold it in place and pivot the paper until another straight portion of the curved line is aligned with the edge of the paper. Repeat this procedure, carefully aligning the straightedge with the center of each feature and placing tick marks on both the map and paper strip each time it leaves the center, until you have the desired distance.

(1) Place the paper strip on a graphic scale and determine the ground distance measured.

8. **DETERMINE AZIMUTHS**. In the simplest terms, an azimuth is a straight line from one point to another. A more complete definition however is that: An azimuth is an angle measured in a clockwise direction from a predetermined base line. Before

attempting to determine or follow an azimuth in the field, you must have a clear understanding of each part of this definition.

a. **An Azimuth is an Angle**. When we say that an azimuth is an angle, we mean that it is some part of a circle. But just how much of a circle does each azimuth represent? If a circle were divided into 360 equal "Slices of pie" each slice would be a degree.

b. **Angle Measured in a Clockwise Direction**. When we say that an azimuth is angle measured in a clockwise direction, we mean that each of the angles discussed above must have a starting point, and from there progress in numerical value in a clockwise direction around the circle until they return to the starting point. The starting point will have a value of 0 degrees, or (since it is also the final direction line) 360 degrees. It may be properly expressed as either 0 degrees or 360 degrees. Since the degrees value of azimuths always progresses in a clockwise direction, all azimuths between 0 degrees and 180 degrees will be on the right side of the circle, and all azimuths between 180 degrees and 360 degrees will be on the left side of the circle. Keep in mind that there are only 360 degrees in a circle. While working map problems if you should mathematically arrive at a figure exceeding 360 degrees, then you have gone completely around the circle and started over again. For example, if you add 15 degrees to 350 degrees, it would be expressed as 5 degrees, not 365 degrees.

c. **From a Predetermined Base Line**. When we say that an azimuth is an angle measured in a clockwise direction from a base predetermined base line, we mean that it is a certain number of degrees measured in a clockwise direction from a predetermined reference line. It is this portion of the definition that causes the most misunderstanding, confusion, and often loss of direction in the field. The base line we speak of is north. There are three lines- true north, magnetic north, and grid north. The most commonly used are magnetic and grid north.

d. **Determining Back Azimuths**. A back azimuth is the opposite direction of an azimuth. It is the same as doing an "about face." To obtain a back azimuth from an azimuth use the acronym LAMS, (**Less Add - More Subtract**).

(1) LESS THAN 180 DEGREES - ADD 180 DEGREES.

(2) MORE THAN 180 DEGREES - SUBTRACT 180 DEGREES.

(3) The back azimuth of 180 degrees may be stated as 0 degrees or 360 degrees.

e. **Determining Grid Azimuths**. To determine the direction from one point to another on the map (grid azimuth) you need to perform the following steps:

(1) Draw a line connecting the two points (A&B).

(2) Place the index of the protractor at the point where the drawn line crosses a vertical (north-south) grid line. The index of a protractor is the center of the protractor. There is a vertical and a horizontal line to enable you to align the protractor.

(3) Keeping the index at this point, align the 0 to 180 degree base line of the protractor on the vertical grid line. When using the protractor, the base line is always oriented parallel to a north-south grid line. The 0 degree or 360 degree mark is toward the top of the north on the map and then the 90-degree mark is to the right.

(4) Read the value of the angle from the inner scale (outer scale is MILS and is used for other purposes, i.e. range cards); this is the grid azimuth from point A to point B.

f. **Plotting Grid Azimuths**. To plot a grid azimuth from a certain point on the map complete the following steps.

(1) Place the protractor on the map with the index mark at the center of mass of the known point and the 0 to 180 degree base line parallel to a north-south grid line.

(2) Make a mark on the desired grid azimuth.

(3) Remove the protractor and draw a line connecting the known point and the mark on the map. You have now plotted the grid azimuth.

g. **Converting Azimuths**. Because there is an angular difference between grid north and magnetic north, a conversion from magnetic to grid (or vice versa) is needed.

(1) Declination Diagram. As previously discussed, azimuths measured with a protractor are grid azimuths (measured from grid north), and azimuths determined with the compass are magnetic azimuths (measured from magnetic north). You cannot

follow a grid azimuth with a compass, nor can you plot a magnetic azimuth with a protractor, because of the angular difference between grid north and magnetic north. This means that before you can plot a magnetic azimuth on a map you must convert it to a grid azimuth. Likewise, before you can use a grid azimuth to land navigate; you must convert it to a magnetic azimuth.

(a) The mapmaker provides you with a convenient tool for accomplishing this conversion by placing the declination diagram in the bottom margin of your map. Declination diagrams display the difference between grid and magnetic north.

(b) A complete set of instructions is included in the declination diagram for your use in converting azimuths. The G-M angle is always expressed to the nearest 1/2 degree. If the G-M angle expressed includes 30 degrees, round up to the nearest whole degree. For example the G-M angle below is 8 degrees.

(2) Conversion Notes. Refer to the conversion notes that appear with the declination diagram explaining the use of the G-M angle. One note provides instructions for converting magnetic azimuths to grid azimuths. The other provides instructions for converting a grid azimuth to a magnetic azimuth. The conversion (addition or subtraction) is governed by direction of magnetic north relative to grid north. Each map (declination diagram) is different because of its location relative to magnetic north. Remember the Acronym LARS.

(3) Converting Grid Azimuths to Magnetic Azimuths. Examine your declination diagram.

(a) Suppose that you plotted a 39-degree azimuth on your map, and you want to know what azimuth to follow on your compass. To convert that grid azimuth to a magnetic azimuth, you simply follow the instructions. By subtracting the G-M angle (8 degrees) from the grid azimuth (39 degrees), you have converted the grid azimuth to the correct magnetic azimuth (31 degrees).

(4) Converting Magnetic Azimuths to Grid Azimuths. Again, examine your declination diagram.

(a) Suppose that you shot a 238-degree azimuth with your compass, and you want to plot this on your map. To convert that magnetic azimuth to a grid azimuth, add the magnetic azimuth (8 degrees) to the grid azimuth (238 degrees), to get a grid azimuth of 246 degrees.

h. **90-Degree Offset**. The purpose of a 90-degree offset is to bypass enemy positions or obstacles and still stay oriented, detouring the obstacle by moving at right angles for specified distances. For example, if moving on an azimuth of 90 degrees, change your azimuth to 180 degrees and travel for 100 meters; then change your azimuth to 90 degrees and travel for 150 meters; then change your azimuth to 360 degrees and travel for 100 meters; then change your azimuth back to 90 degrees, and you will be on your original azimuth line.

(1) Remember the acronym **"RALS"** – Right **Add**, Left **Subtract** when determining your new azimuth during 90-degree offsets. You see on the slide that we were originally following an azimuth of 90 degrees when you encountered the obstacle. We decide to turn right to offset the obstacle, so we add 90 degrees to our original azimuth, giving us 180 degrees. We then walk to the edge of the obstacle (tracking the distance traveled) and then turn left, which means we subtract 90 degrees from our current azimuth, which gives us 90 degrees. We walk past the obstacle (adding this distance to our original pace count and then turn left to head back to our original course. Since we turned left, we will subtract 90 degrees from our current azimuth, which gives us a new azimuth of 0 degrees. We walk the same distance we walked in our initial leg around the obstacle and turn right to return to our original course. Since we are turning right, we add 90 degrees to the 0-degree azimuth we've been walking and we're now back on our original azimuth of 90 degrees.

9. **RANGE ESTIMATION**.

a. **Five-Degree Method**. If time and tactical conditions permit, a relatively accurate method of determining range is the five-degree method. All that is required is a lensatic compass and the knowledge of how to pace off distances.

(1) Select and mark a start point.

(2) From the start point, shoot an azimuth to the object (target point) to which you are trying to determine the range. Note the azimuth.

(3) Standing at the start point, turn right (or left) until the reading on the compass is 90 degrees greater (or less) than the azimuth to the target point.

(4) Walk at a right angle to the line between the start point and the target point; stop periodically to shoot an azimuth to the target point.

(5) When the compass shows a difference of five degrees from the original start point to target point azimuth, turn back toward the start point. It is critical that the reading of the compass be precise.

(6) Walk back toward the start point using a 36- to 40-inch pace (approximately one meter); count the number of paces to the start point.

(7) When you reach the start point, multiply the number of paces you counted by eleven. For example, if you counted 100 paces, multiply 100 by 11. The range to the object is approximately 1100 meters.

b. **Dead Reckoning**. Dead reckoning is moving a set distance along a set line. Generally, it involves moving so many meters along a set line, usually an azimuth in degrees. This is one of the simplest techniques to use while navigating in an unfamiliar area or in the absence of a map, but it has less tactical value.

(1) Preparation.

(a) The first step in dead reckoning is to determine your own location or starting point.

(b) The next step requires you to determine the distance from the starting point to the objective. The unit of measure normally used for this movement is meters. Once determined, convert this distance to your pace count.

(c) The final step is to determine the magnetic azimuth in degrees from the starting point to the objective.

(2) Technique.

(a) This basic technique can be used by one or more individuals. When used by a single person from the starting point, the user may apply either the compass centerhold technique or the compass to cheek technique and determines the desired azimuth of travel. A distant object or feature is selected in the direction of travel. Keeping that object or feature in sight, initiate movement toward it and use the pace count to keep track of distance.

(b) When used by two or more individuals, the technique is even simpler. The person holding the compass becomes the navigator. He utilizes the centerhold or compass to cheek technique from the starting point, and determines the direction of travel. A second person (point man) is then sent out in the direction of travel in front of the navigator.

(c) The navigator uses hand-and-arm signals to tell the point man to move right or left until he is lined up with the azimuth. Movement is initiated and the navigator or any other member starts a pace count. This process is repeated until the objective is reached or the total distance has been traveled. If the prescribed distance has been traveled and the objective is not found, look for it within a reasonable distance.

c. **Pace Count**. One method used to measure ground distance is the pace count. A pace is equal to one natural step, about 30 inches long. In order to accurately use the pace count method, you must know how many paces it takes you to walk 100 meters. To determine this, you must walk an accurately measured course, which can be as short as 100 meters or as long as 600 meters. The pace course, regardless of length, must be on similar terrain to that you will be walking over. It does no good to walk a course on flat terrain and then try to use that pace count on hilly terrain.

(1) Remember to always start on the left foot when beginning your pace count and to count every other step.

(2) There are many methods to keep track of the distance traveled when using the pace count. Some of these methods are.

(a) Put a pebble in your pocket every time you have walked 100 meters according to your pace count.

(b) Tie knots in a string.

(c) Put marks in a notebook.

(3) Your pace count must often be adjusted in the field because of the following conditions.

(4) To determine your average pace count over 600 meters, divide the total paces by 6. The answer will give you the average paces it takes you to walk 100 meters. It is important that each person who navigates while dismounted knows his pace count.

(a) Slopes. Your pace will lengthen on a down slope and shorten on an upgrade. Keeping this in mind, if it normally takes you 120 paces to walk 100 meters, your pace count may increase to 130 or more when walking up a slope.

(b) Winds. A head wind shortens the pace and a tail wind increases it.

(c) Surfaces. Sand, gravel, mud, snow and similar surface materials tend to shorten the pace.

(d) Elements. Snow, rain, or ice causes the pace to be reduced in length.

(e) Clothing. Excess clothing and boots with poor traction affect the pace length.

(f) Visibility. Poor visibility, such as in fog, rain or darkness will shorten your pace.

1. Considerations for getting a pace count at night.

2. Always start on the same foot.

3. Count every other step.

4. Pace count will be larger at night.

d. **Drift**. This is the tendency to stray from a straight line. Some of the reasons for this are as follows:

(1) Physical. For example, one of the navigator's legs is shorter than the other, causing him to deviate either left or right.

(2) Load. An unbalanced load may pull you slightly off balance.

(3) Terrain. On slopes, an individual has a tendency to deviate down the slope (path of least resistance).

(4) Elements. There is a normal tendency to edge away from rain, snow, or the sun to receive the impact over the shoulder or on the back.

(5) Inherent Tendency. Movement around obstacles; right-handed people tend to go around trees and obstacles to the right; left-handed people tend to go around trees and obstacles to the left.

e. **100 Meter Unit of Measure Method**. To use this method, the soldier must be able to visualize a distance of 100 meters on the ground. For ranges up to 500 meters, he determines the number of 100-meter increments between the two objects he wishes to measure. Beyond 500 meters, the soldier must select a point halfway to the object(s) and determine the number of 100-meter increments to the halfway point, then double it to find the range to the object.

10. **PRESETTING A LENSATIC COMPASS**.

a. To preset a compass during daylight hours, or with a light source, perform the following steps.

(1) Hold the compass level in the palm of your hand.

(2) Rotate it until the desired azimuth falls under the fixed black index line, maintaining the azimuth. Use 320 degrees for this example.

(3) Turn the bezel ring until the luminous line is aligned with the north-seeking arrow. Once the alignment is obtained, the compass is preset.

b. During limited visibility or darkness, an azimuth may be set on the compass by the click method. Remember that one click on the bezel ring equals 3-degrees.

(1) Rotate the bezel ring until the luminous line is over the fixed black index line.

(2) Divide the desired azimuth by three. The result is the number of clicks that you have to rotate the bezel ring.

(3) Count the desired number clicks. If the desired azimuth is smaller than 180 degrees, the number of clicks on the bezel ring should be counted in a counterclockwise direction. For example: If the desired azimuth is 90 degrees, divide this number by 3, and you will arrive at 30 clicks. FOR AN AZIMUTH LESS THAN 180 DEGREES, TURN COUNTERCLOCKWISE.

(4) If the desired azimuth is larger than 180 degrees, subtract the number of degrees from 360 degrees, then divide by 3 to obtain the number of clicks. Count them in a clockwise direction. For example: If the desired azimuth is 210 degrees, subtract this from 360 degrees to arrive at 150 degrees. 150 degrees divided by 3 = 50 clicks clockwise. FOR AN AZIMUTH GREATER THAN 180 DEGREES, TURN CLOCKWISE.

(5) Sometimes the desired azimuth is not exactly divisible by three. In this case, round up or down to the nearest whole degree.

(6) Assume centerhold technique, rotate body until arrow is aligned with the luminous line. Proceed forward in the direction of the front cover's luminous dots.

REFERENCES:

Map Reading and Land Navigation, FM 3-25.26