Group 6 ES Training:

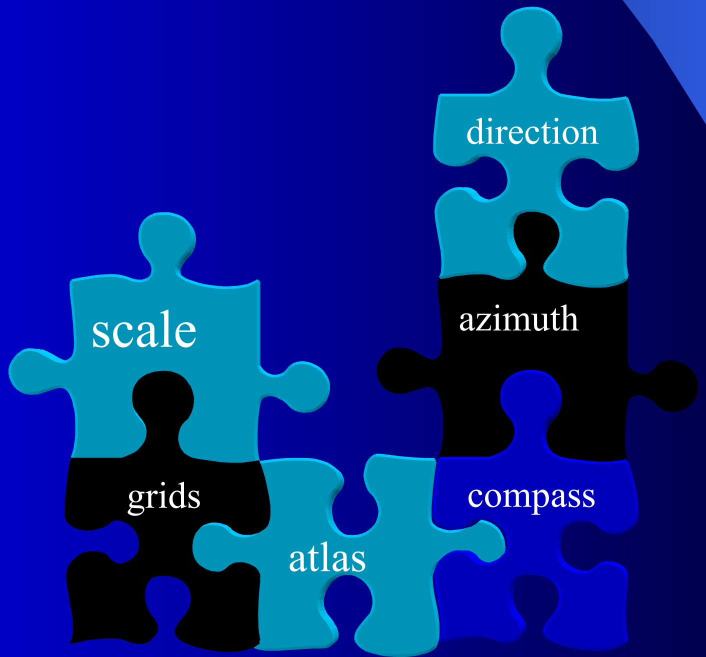
MAPS and Compass Use
Part 1 of 2

Agenda

- MAP READING
- LAND NAVIGATION
- COMPASS USE AND GPS

Overview

- Part 1: MAPS READING AND LAND NAV
- Part 2: COMPASS USE AND GPS



Getting Started

- Definition and Purpose
- Types of Maps
- Care of Maps
- Scales & Standards, Features
- Direction
- Distance

MAPS

Definition

A map is a graphic representation of a portion of the earth's surface (as seen from above), drawn to scale and uses colors, symbols and labels to represent features found on the ground.

Purpose:

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.

Types of Maps

Topographic Map. This is a map that portrays terrain features in a measurable way (usually through use of contour lines), as well as the horizontal positions of the features represented. The vertical positions, or relief, are normally represented by contour lines on military topographic maps. On maps showing relief, the elevations and contours are measured from a specific vertical datum plane, usually mean sea level.

Types of Maps

Planimetric Map. This is a map that presents only the horizontal positions for the features represented. It is distinguished from a topographic map by the omission of relief, normally represented by contour lines. Sometimes, it is called a line map.

Types of Maps

Photomap. This is a reproduction of an aerial photograph upon which grid lines, marginal data, place names, route numbers, important elevations, boundaries, and approximate scale and direction have been added.

Other types of maps

- **Atlases**. These are collections of maps of regions, countries, continents, or the world. Such maps are accurate only to a degree and can be used for general information only.
- **Geographic Maps**. These maps give an overall idea of the mapped area in relation to climate, population, relief, vegetation, and hydrography. They also show general location of major urban areas.
- **Tourist Road Maps**. These are maps of a region in which the main means of transportation and areas of interest are shown. Some of these maps show secondary networks of roads, historic sites, museums, and beaches in detail. They may contain road and time distance between points. Careful consideration should be exercised about the scale when using these maps.
- **City/Utility Maps**. These are maps of urban areas showing streets, water ducts, electricity and telephone lines, and sewers.
- **Field Sketches**. These are preliminary drawings of an area or piece of terrain.
- **Aerial Photographs**. These can be used as map supplements or substitutes to help you analyze the terrain, plan your route, or guide your movement.

Map Care

CARE

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.

a. Care must also be taken when using a map since it may have to last a long time. If it becomes necessary to mark a map, the use of a pencil is recommended. Use light lines so they may be erased easily without smearing and smudging, or leaving marks that may cause confusion later. If the map margins must be trimmed for any reason, it is essential to note any marginal information that may be needed later, such as grid data and magnetic declination.

b. Special care should be taken of a map that is being used in a tactical mission, especially in small units; the mission may depend on that map. All members of such units should be familiar with the map's location at all time.

Map Scale

- **Scale.** Because a map is a graphic representation of a portion of the earth's surface drawn to scale as seen from above, it is important to know what mathematical scale has been used. You must know this to determine ground distances between objects or locations on the map, the size of the area covered, and how the scale may affect the amount of detail being shown. The mathematical scale of a map is the ratio or fraction between the distance on a map and the corresponding distance on the surface of the earth. Scale is reported as a representative fraction with the map distance as the numerator and the ground distance as the denominator.
    - ***Representative fraction (scale)=map distance*———**
        - ***ground distance***
- As the denominator of the representative fraction gets larger and the ratio gets smaller, the scale of the map decreases. Defense Mapping Agency maps are classified by scale into three categories. They are small-, medium-, and large-scale maps. The terms "**small scale,**" "**medium scale,**" and "**large scale**" may be confusing when read in conjunction with the number. However, if the number is viewed as a fraction, it quickly becomes apparent that 1:600,000 of something is smaller than 1:75,000 of the same thing. Therefore, the larger the number after 1:, the smaller the scale of the map.

Map Scale

- 1) ***Small***. Those maps with scales of 1:1,000,000 and smaller are used for general planning and for strategic studies. The standard small-scale map is 1:1,000,000. This map covers a very large land area at the expense of detail.
- (2) ***Medium***. Those maps with scales larger than 1:1,000,000 but smaller than 1:75,000 are used for operational planning. They contain a moderate amount of detail, but terrain analysis is best done with the large-scale maps described below. The standard medium-scale map is 1:250,000. Medium scale maps of 1:100,000 are also frequently encountered.
- (3) ***Large***. Those maps with scales of 1:75,000 and larger are used for tactical, administrative, and logistical planning. The standard large-scale map is 1:50,000; however, many areas have been mapped at a scale of 1:25,000.

GRIDS

GEOGRAPHIC COORDINATES

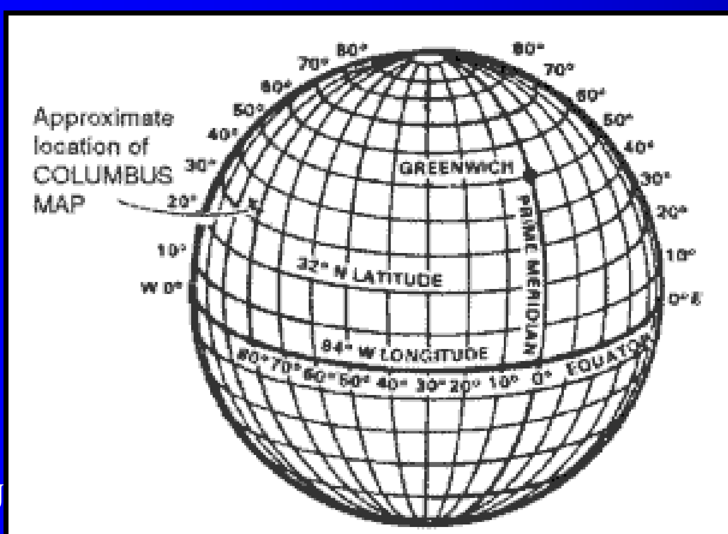
One of the oldest systematic methods of location is based upon the geographic coordinate system. By drawing a set of east-west rings around the globe (parallel to the equator), and a set of north-south rings crossing the equator at right angles and converging at the poles, a network of reference lines is formed from which any point on the earth's surface can be located.

a. The distance of a point north or south of the equator is known as its latitude. The rings around the earth parallel to the equator are called parallels of latitude or simply parallels. Lines of latitude run east-west but north-south distances are measured between them.

b. A second set of rings around the globe at right angles to lines of latitude and passing through the poles is known as meridians of longitude or simply meridians. One meridian is designated as the prime meridian. The prime meridian of the system we use runs through Greenwich, England and is known as the Greenwich meridian. The distance east or west of a prime meridian to a point is known as its longitude. Lines of longitude (meridians) run north-south but east-west distances are measured between them.

Reference lines.

c. Geographic coordinates are expressed in angular measurement. Each circle is divided into 360 degrees, each degree into 60 minutes, and each minute into 60 seconds. The degree is symbolized by ° , the minute by ′, and the second by ″. Starting with 0° at the equator, the parallels of latitude are numbered to 90° both north and south. The extremities are the north pole at 90° north latitude and the south pole at 90° south latitude. Latitude can have the same numerical value north or south of the equator, so the direction N or S must always be given. Starting with 0° at the prime meridian, longitude is measured both east and west around the world. Lines east of the prime meridian are numbered to 180° and identified as east longitude; lines west of the prime meridian are numbered to 180° and identified as west longitude. The direction E or W must always be given. The line directly opposite the prime meridian, 180° , may be referred to as either east or west longitude. The values of geographic coordinates, being in units of angular measure, will mean more if they are compared with units of measure with which we are more familiar. At any point on the earth, the ground distance covered by one degree of latitude is about 111 kilometers (69 miles); one second is equal to about 30 meters (100 feet). The ground distance covered by one degree of longitude at the equator is also about 111 kilometers, but decreases as one moves north or south, until it becomes zero at the poles.



Latitude and longitude.

d. Geographic coordinates appear on most maps or charts; on some they may be the only method of locating and referencing a specific point. The four lines that enclose the body of the map (neatlines) are latitude and longitude lines. Their values are given in degrees and minutes at each of the four corners. The line running up the right side is longitude. In addition to the latitude and longitude given for the four corners, there are, at regularly spaced intervals along the sides of the map, small tick marks extending into the body of the map. Each of these tick marks is identified by its latitude or longitude value. Near the top of the right side of the map is a tick mark and the number 20'. The full value for this tick marks is 32° 20'00" of latitude. At one-third and two-thirds of the distance across the map from the 20' tick mark will be found a cross tick mark (grid squares 0379 and 9679) and at the far side another 20' tick mark. By connecting the tick marks and crosses with straight lines, a 32° 20'00" line of latitude can be added to the map. This procedure is also used to locate the 32° 25'00" line of latitude. For lines of longitude, the same procedure is followed using the tick marks along the top and bottom edges of the map.

Map features

- Terrain features.
- Drainage characteristics.
- Vegetation.
- Climate.
- Coasts and landing beaches.
- Roads and bridges.
- Railroads.
- Airfields.
- Urban areas.
- Electric power.
- Fuels.
- Surface water resources.
- Ground water resources.
- Natural construction materials.
- Cross-country movements.
- Suitability for airfield construction.
- Airborne operations

DIRECTION

- *Being in the right place at the prescribed time is necessary to successfully accomplish any mission or directive. Direction plays an important role in a emergency services provider's everyday life. It can be expressed as right, left, straight ahead, and so forth; but then the question arises, "To the right of what?" This section defines the word azimuth and the three different norths. It explains the use of some field-expedient methods to find directions. It also includes some advanced aspects of map reading, such as intersection and resection.*

6-1. METHODS OF EXPRESSING DIRECTION

Standards provide a way of expressing direction that is accurate, is adaptable to any part of the world, and has a common unit of measure. Directions are expressed as units of angular measure.

a. **Degree**. The most common unit of measure is the degree (°) with its subdivisions of minutes (') and seconds (").

1 degree = 60 minutes.

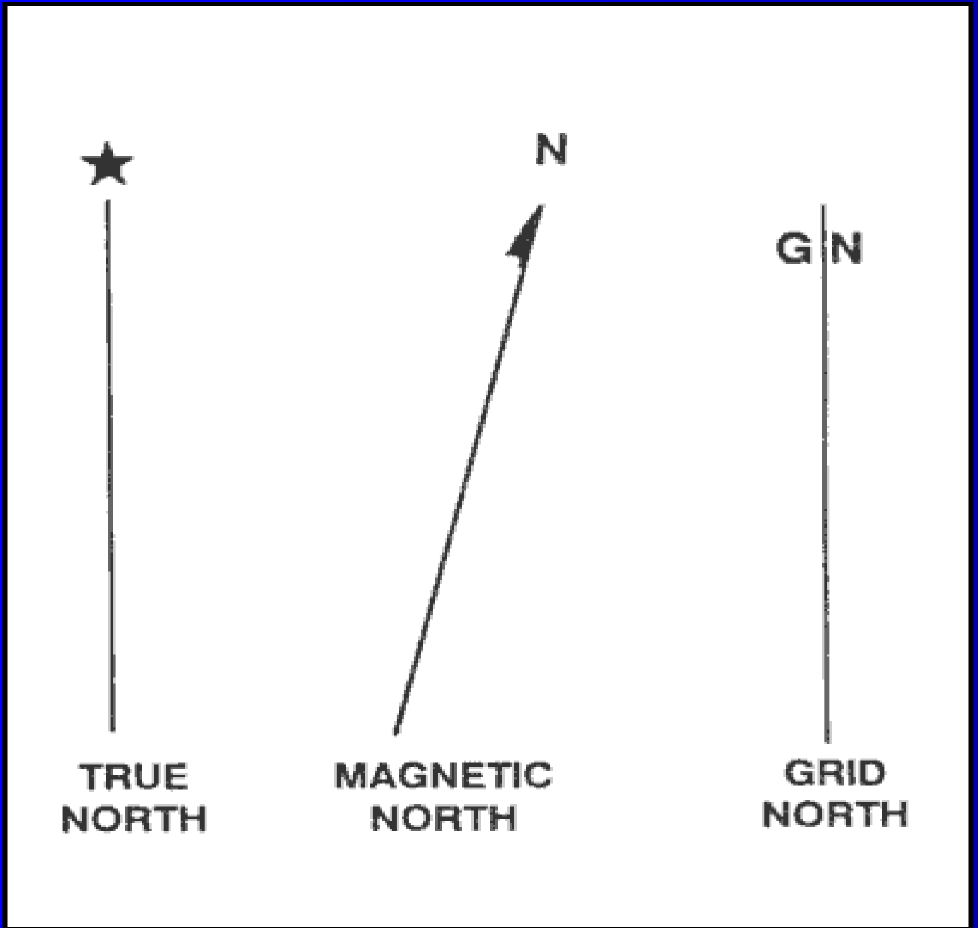
1 minute = 60 seconds.

b. **Mil.** Another unit of measure, the mil (abbreviated), is used mainly in artillery, tank, and mortar gunnery. The mil expresses the size of an angle formed when a circle is divided into 6,400 angles, with the vertex of the angles at the center of the circle. A relationship can be established between degrees and mils. A circle equals 6400 mils divided by 360 degrees, or 17.78 mils per degree. To convert degrees to mils, multiply degrees by 17.78.

c. **Grad.** The grad is a metric unit of measure found on some foreign maps. There are 400 grads in a circle (a 90-degree right angle equals 100 grads). The grad is divided into 100 centesimal minutes (centigrads) and the minute into 100 centesimal seconds (milligrads).

BASE LINES

In order to measure something, there must always be a starting point or zero measurement. To express direction as a unit of angular measure, there must be a starting point or zero measure and a point of reference These two points designate the base or reference line. There are three base lines— true north, magnetic north, and grid north. The most commonly used are magnetic and grid.



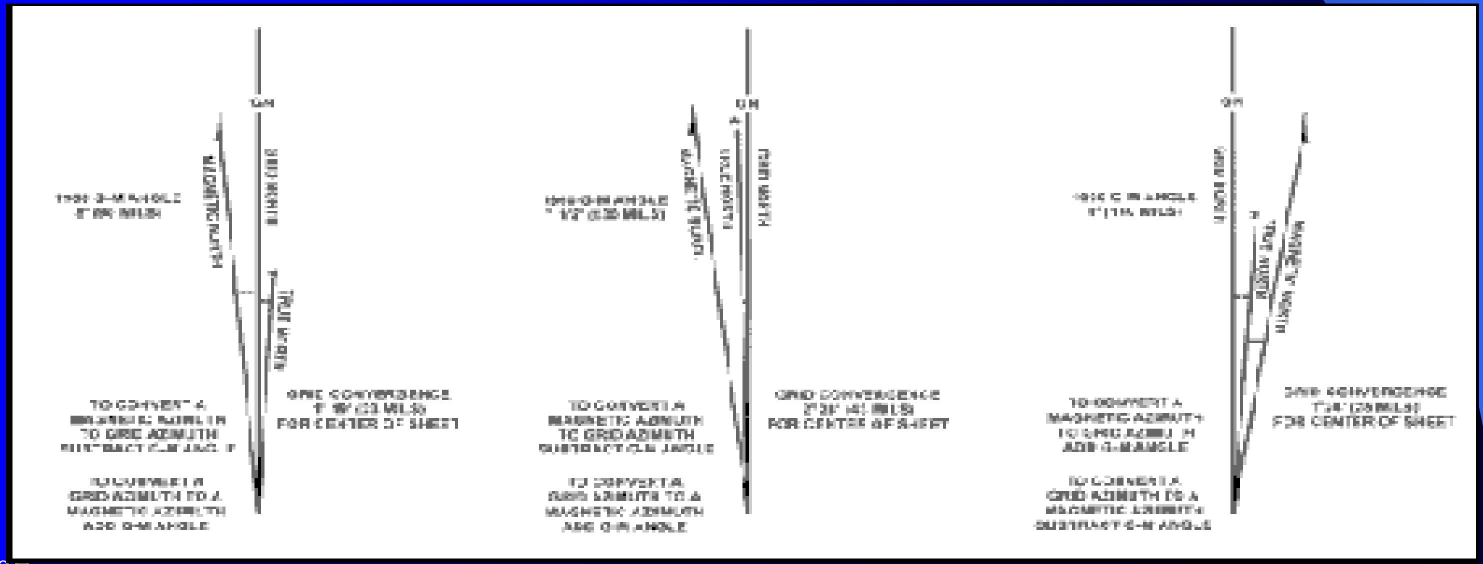
True North. A line from any point on the earth's surface to the north pole. All lines of longitude are true north lines. True north is usually represented by a star

Magnetic North. The direction to the north magnetic pole, as indicated by the north-seeking needle of a magnetic instrument. The magnetic north is usually symbolized by a line ending with half of an arrowhead Magnetic readings are obtained with magnetic instruments, such as lensatic and M2 compasses.

Grid North. The north that is established by using the vertical grid lines on the map. Grid north may be symbolized by the letters GN or the letter "y"

DECLINATION DIAGRAM

Declination is the angular difference between any two norths. If you have a map and a compass, the one of most interest to you will be between magnetic and grid north. The declination diagram below shows the angular relationship, represented by prongs, among grid, magnetic, and true norths. While the relative positions of the prongs are correct, they are seldom plotted to scale. Do not use the diagram to measure a numerical value. This value will be written in the map margin (in both degrees and mils) beside the diagram.



Location. A declination diagram is a part of the information in the lower margin on most larger maps. On medium-scale maps, the declination information is shown by a note in the map margin.

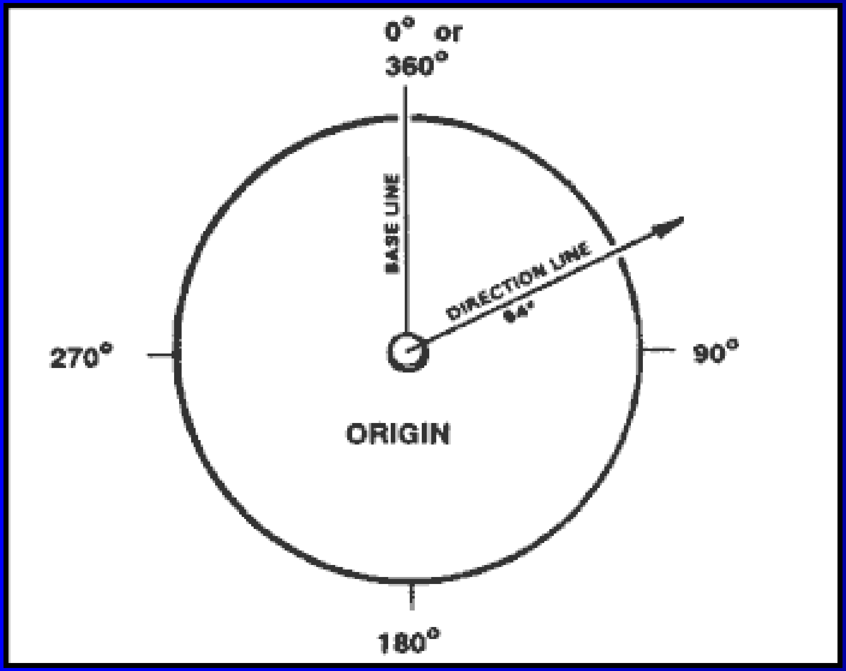
b. **Grid-Magnetic Angle.** The G-M angle value is the angular size that exists between grid north and magnetic north. It is an arc, indicated by a dashed line, that connects the grid-north and magnetic-north prongs. This value is expressed to the nearest 1/2 degree, with mil equivalents shown to the nearest 10 mils. The G-M angle is important to the map reader/land navigator because azimuths translated between map and ground will be in error by the size of the declination angle if not adjusted for it.

c. **Grid Convergence**. An arc indicated by a dashed line connects the prongs for true north and grid north. The value of the angle for the center of the sheet is given to the nearest full minute with its equivalent to the nearest mil. These data are shown in the form of a grid-convergence note.

d. **Conversion.** There is an angular difference between the grid north and the magnetic north. Since the location of magnetic north does not correspond exactly with the grid-north lines on the maps, a conversion from magnetic to grid or vice versa is needed.

AZIMUTHS

An azimuth is defined as a horizontal angle measured clockwise from a north base line. This north base line could be true north, magnetic north, or grid north. The azimuth is the most common military method to express direction. When using an azimuth, the point from which the azimuth originates is the center of an imaginary circle This circle is divided into 360 degrees or 6400 mils.



INTERSECTION

Intersection is the location of an unknown point by successively occupying at least two (preferably three) known positions on the ground and then map sighting on the unknown location. It is used to locate distant or inaccessible points or objects and areas. There are two methods of intersection: the map and compass method and the straightedge method.

Intersection, using a straightedge.

a. When using the map and compass method—

(1) Orient the map using the compass.

(2) Locate and mark your position on the map,

(3) Determine the magnetic azimuth to the unknown position using the compass.

(4) Convert the magnetic azimuth to grid azimuth.

(5) Draw a line on the map from your position on this grid azimuth.

(6) Move to a second known point and repeat steps 1, 2, 3, 4, and 5.

(7) The location of the unknown position is where the lines cross on the map. Determine the grid coordinates to the desired accuracy.

b. The straight edge method is used when a compass is not available. When using it—

(1) Orient the map on a flat surface by the terrain association method.

(2) Locate and mark your position on the map.

(3) Lay a straight edge on the map with one end at the user's position (A) as a pivot point; then, rotate the straightedge until the unkown point is sighted along the edge.

(4) Draw a line along the straight edge

(5) Repeat the above steps at position (B) and check for accuracy.

(6) The intersection of the lines on the map is the location of the unknown point (C). Determine the grid coordinates to the desired accuracy.

RESECTION

Resection is the method of locating one's position on a map by determining the grid azimuth to at least two well-defined locations that can be pinpointed on the map. For greater accuracy, the desired method of resection would be to use three or more well-defined locations.

a. When using the map and compass method

b. (1) Orient the map using the compass.

(2) Identify two or three known distant locations on the ground and mark them on the map.

(3) Measure the magnetic azimuth to one of the known positions from your location using a compass.

(4) Convert the magnetic azimuth to a grid azimuth.

(5) Convert the grid azimuth to a back azimuth. Using a protractor, draw a line for the back azimuth on the map from the known position back toward your unknown position.

(6) Repeat 3, 4, and 5 for a second position and a third position, if desired.

(7) The intersection of the lines is your location. Determine the grid coordinates to the desired accuracy.

When using the straightedge method

(1) Orient the map on a flat surface by the terrain association method.

(2) Locate at least two known distant locations or prominent features on the ground and mark them on the map.

(3) Lay a straightedge on the map using a known position as a pivot point. Rotate the straightedge until the known position on the map is aligned with the known position on the ground.

(4) Draw a line along the straightedge away from the known position on the ground toward your position.

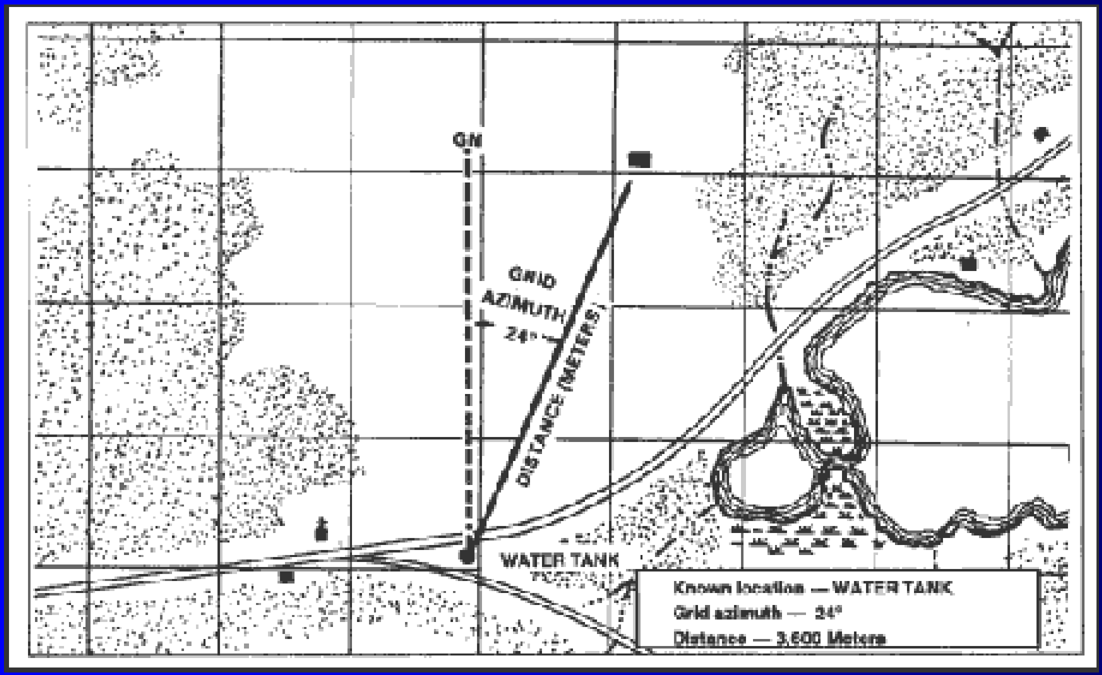
(5) Repeat 3 and 4 using a second known position.

(6) The intersection of the lines on the map is your location. Determine the grid coordinates to the desired accuracy.

POLAR COORDINATES

A method of locating or plotting an unknown position from a known point by giving a direction and a distance along that direction line is called polar coordinates. The following elements must be present when using polar coordinates Present known location on the map.

- Azimuth (grid or magnetic).
- Distance (in meters).



Distance

A map is a scaled graphic representation of a portion of the earth's surface. The scale of the map permits the user to convert distance on the map to distance on the ground or vice versa. The ability to determine distance on a map, as well as on the earth's surface, is an important factor in planning and executing missions.

The numerical scale of a map indicates the relationship of distance measured on a map and the corresponding distance on the ground. This scale is usually written as a fraction and is called the representative fraction. The RF is always written with the map distance as 1 and is independent of any unit of measure. (It could be yards, meters, inches, and so forth.) An RF of 1/50,000 or 1:50,000 means that one unit of measure on the map is equal to 50,000 units of the same measure on the ground.

a. The ground distance between two points is determined by measuring between the same two points on the map and then multiplying the map measurement by the denominator of the RF or scale

EXAMPLE:

The map scale is 1:50,000

RF = 1/50,000

The map distance from point A to point B is 5 units

5 x 50,000 = 250,000 units of ground distance

b. Since the distance on most maps is marked in meters and the RF is expressed in this unit of measurement in most cases, a brief description of the metric system is needed. In the metric system, the standard unit of measurement is the meter..

1 meter contains 100 centimeters (cm).

100 meters is a regular football field plus 10 meters.

1,000 meters is 1 kilometer (km).

10 kilometers is 10,000 meters.

GRAPHIC (BAR) SCALES

A graphic scale is a ruler printed on the map and is used to convert distances on the map to actual ground distances. The graphic 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 graphic scales, each using a different unit of measure

when using the graphic scale, be sure to use the correct scale for the unit of measure desired.

OTHER METHODS

Determining distance is the most common source of error encountered while moving either mounted or dismounted. There may be circumstances where you are unable to determine distance using your map or where you are without a map. It is therefore essential to learn methods by which you can accurately pace, measure, use subtense, or estimate distances on the ground.

a. **Pace Count**. Another way to measure ground distance is the pace count. A pace is equal to one natural step, about 30 inches long. 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 and count the number of paces you take. A pace course 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. To determine your pace count on a 600-meter course, count the paces it takes you to walk the 600 meters, then 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.

(1) There are many methods to keep track of the distance traveled when using the pace count. Some of these methods are: put a pebble in your pocket every time you have walked 100 meters according to your pace count; tie knots in a string; or put marks in a notebook. Do not try to remember the count; always use one of these methods or design your own method.

(2) Certain conditions affect your pace count in the field, and you must allow for them by making adjustments.

(a) *Slopes*. Your pace lengthens on a downslope and shortens 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*. Falling snow, rain, or ice cause 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.

b. **Odometer**. Distances can be measured by an odometer, which is standard equipment on most vehicles. Readings are recorded at the start and end of a course and the difference is the length of the course.

(1) To convert kilometers to miles, multiply the number of kilometers by 0. 62.

EXAMPLE:

16 *kilometers* = 16 x 0. 62 = 9. 92 *miles*

(2) To convert miles to kilometers, divided the number of miles by 0. 62.

EXAMPLE:

10 *miles* = 10 *divided by* 0. 62 = 16. 12 *kilometers*

NEXT MONTH

- Compass Use