

## NAVIGATIONAL TERMS, BRANCHES OF NAVIGATION

- A. Navigation: - The art or science of determining the ship's or aircraft's position and of conducting a ship or aircraft from one position to another. The problems of navigation are those of position, direction and distance.

### FOUR (4) BRANCHES OF NAVIGATION:

1. Dead Reckoning (DR) – a method of navigation by which the position of the ship is calculated from the direction and rate of progress through the water from the latest well-determined position.
2. Piloting – near-shore navigation method by which the movement of a ship is directed by reference to landmarks, navigational aids or soundings.
3. Electronic Navigation – a method of navigation which employs the use of various electronic devices. It differs from piloting primarily in the manner of collecting information.
4. Celestial Navigation – the position of the ship is determined by the observation of celestial bodies such as the sun, moon, planets and stars.

### B. Nautical Terms:

1. Earth - the planet with which we are most familiar, although it is approximately an ablate spheroid, for navigational purposes, it is assumed to be a true sphere.

#### DIAMETER OF THE EARTH:

- a. Polar Diameter – 6,864.57 nautical miles;
  - b. Equatorial Diameter – 6,887.91 nautical miles or a
  - c. Difference of 23.34 nautical miles
2. Axis – the diameter about which the earth rotates. The north end is the north pole while the south end is the south pole.
  3. Great Circles – a circle on the surface of the earth, the plane of which passes through the center of the earth.
  4. Small Circle – a circle on the surface of the earth, the pale of which does not pass through the center of the earth.
  5. Equator – the great circle which is equidistant to the poles. The plane is perpendicular to the surface of the earth's axis.
  6. Parallel – small circle on the surface of the earth having planes parallel to the plane of the equator and perpendicular to the earth's axis.
  7. Meridians – great circle on the surface of the earth that passes through the poles.
  8. Prime Meridians – meridians used as the origin of measurement of longitude, the meridian of Greenwich England.
  9. Latitude – the angular distance between the position and the equator measured northward or southward from the equator along a meridian and labeled as appropriate N or S.
  10. Longitude – the angular distance between the position and the prime meridian measured either eastward or westward from the prime meridian along the area of the equator to the meridian of the position in degrees from 0 – 180 deg and labeled E or W.

11. Direction – angular inclination of that line to the meridian measured right or counter clockwise from the north point of the meridian and expressed in three digits.
12. Course – as applied to marine navigation, is the intended direction of travel of a ship through the water
13. Heading – the direction in which the ship point or heads at a given time.
14. Bearing – the direction of a terrestrial object from the observer; azimuth as applied to the celestial bodies.
15. Distance – the length of a line joining two places on the surface of earth and is expressed in nautical miles. The shortest distance between two point on the surface of the earth is along the great circle joining them.
16. Speed – the velocity of travel and is expressed in knots. One (1) knot is equal to 6,080.2 feet per hour. One (1) minute of angular measurement in great circle for navigation purpose, is also equals to 2,000 yards.

## II. NAVIGATIONAL AIDS:

- A. Aids to navigation: - any device external to a vessel or aircraft intended to assist a navigator to determine his position or safe course or to warn him from danger or obstruction to navigation.

Buoys – the primary functions is to warn of some danger or to delineate channels.

### VARIOUS TYPE OF BUOYS:

1. Can Buoy – built up of steel plates having the shape of a tin cylinder used to mark left side of the channel from seaward.
2. Nun Buoy – built up of steel plates, the above water portion having the shape of truncated cone, cone in shape used to mark right side of the channel from seaward.
3. Bell Buoy – steel floats with a flat top on which a framework containing a bell is mounted. Most bell buoys are sounded by the motion of the sea and struck by compressed gases or electrically operated hammer.
4. Spar Buoy – slightly tapering pole or spar frequently used to mark side of channel. May replace the nun or can buoys.
5. Gong Buoy – similar in construction to bell buoy but has four (4) gongs each of different tones.
6. Whistle Buoy – provides a sound signal which is useful at night and also during fog and low visibility; cone in shape with a whistle, sounded by the motion of the sea.
7. Lighted Buoy – having batteries or gas tanks. Framework supports the light. A metal float on which is mounted a short skeleton tower.
8. Combination Buoy – lights and sound signals are combined, such as lighted bell buoys, lighted gong buoys and a lighted whistle buoy.
9. Radar Reflected Buoy – radar reflectors which return a strong echo to the radar screen are fitted on many buoys of all types.
10. Lighthouses – it is a man made permanent fixture having a light of certain characteristics and is usually watched.
11. Lightships – such as
  - a. Floating lighthouses that mark approaches or entrances to harbors.
  - b. Used when building a permanent structure is impractical.

12. Lighted Beacons – similar to lighthouses and generally unwatched.
13. Lighted Buoy – lighted floating marker.

NOTE: These lighted aids to navigation have individual characteristics. To obtain the full benefits from the light, the navigator must understand their uses and be able to interpret data concerning them in light list and charts.

## B. Characteristics of Lights:

### 1. General System:

- a. Fixed light (F) – continuous steady light.
- b. Flashing Light – shows single flash at regular interval, the duration of light always shorter than the duration of darkness not more than 30 flashes per minute.
- c. Group Flashing (GP FL) – shows groups of two or more flashes at regular intervals.
- d. Quick flashing (QK FL) – shows not less than 60 flashes per minute.
- e. Interrupted Quick Flashing (I QK FL) – shows quick flashes for about 4 seconds followed by a dark period of about 4 seconds.
- f. Short Long Flashing (S L FL) – shows short flashes of about 0.4 second followed by a long flash of about 4 seconds in duration.
- g. Group Occulting (GP OCC) – a light with a group of 2 or more eclipse.

### 2. Standard Colors of Lights:

- a. White, Red, and Green.
- b. Brilliancy – range of visibility.

### 3. Light List Philippine Island: (Information Contained)

- a. In the Philippines, the number starts from North to south in their approximate order (Geographical)
- b. Name and Location
- c. Position by Latitude and Longitude
- d. Characteristics and Power
- e. Height of light in feet above the water
- f. Visibility in miles
- g. Structure description

## III. NAVIGATIONAL INSTRUMENTS:

### A. Direction Measuring Instruments:

1. Compass – instrument that indicates directions.
2. Magnetic Compass – depends on earth's magnetic field for its directive force.
3. Gyro Compass – depends on the tendency of the pendulous gyroscope to seek and align its axis with that of the earth.
4. Gyro Compass Repeaters – located at various parts throughout the ship to indicate the master gyro heading.

5. Bearing Circle – a non magnetic ring formed to fit snugly over the compass bowl which can be turned to any desired direction. Used to determine bearings of terrestrial objects.
6. Azimuth Circle – similar to the bearing circle with a special attachment for observing the sun. Used to determine bearing of celestial objects.
7. Pelorus (Dumb Compass) – consists of a compass stand, compass bowl and compass card. Used in determining bearings.
8. Alidade – an azimuth circle having a telescopic sight mounted over it.

B. Short Range Measuring Device:

Stadimeter – used to find range of objects of known height or height of objects.

C. Depth Measuring Device:

1. Hand Lead – lead weight attached to a marked line from 7 to 14 lbs.
2. Deep Sea Lead – from 30 to 100 lbs
3. Sounding machine – works under pressure.
4. Echo Sounder (Fathometer) – works by sound waves.

E. Electronic Instruments:

1. Radio Receiver – receives signals and weather information.
2. Radio direction Finder (RDF) – receiver and a loop antenna which has directional properties.
3. Radar (Radio Direction and Ranging) – used for obtaining bearings and ranges of objects in all conditions of visibility.
4. Loran (long Range navigation) – measures the difference in the time reception of two synchronized radio signals which is used to determine a hyperbolic line of position.
5. Sonar (Sonic Ranging) – uses speed of sound under water. It gives bearing and distance of objects underwater.

F. Celestial navigation Instruments:

1. Sextant – measuring angular heights of celestial bodies and measuring angles between two visible objects.
2. Chronometer – accurate clock of superior construction for maintaining accurate time aboardship.
3. Ship's Clock – ordinary clock set to keep standard or zone time.
4. Comparing Watch – used for timing celestial observation.
5. Stop Watch – useful in piloting for identification of lights and in celestial observation.
6. Star Finder (H02102-D) – provides the navigator with positions of the celestial bodies relative to the position of the observer.

G. Plotting Instruments:

1. Pencils – soft lead pencil with eraser.
2. Navigator Case – contains drawing compass dividers, screwdrivers etc.

3. Parallel Ruler – for drawing a straight line in plotting direction.
4. Drafting Machine – measuring directions.
5. Protractor – for measuring angles.
6. Triangles – for transferring lines from compass rose to any place on the chart or vice versa.

H. Weather Instruments:

1. Barometer – measures atmospheric pressure (Mercurial and Aneroid)
2. Thermometer – determines temperature.
3. Psychrometer – measures relative humidity (wet and dry).
4. Anemometer – measures wind direction and wind speed.

IV. CHART READING:

- A. Chart – a pictorial representation of the earth surface or part of it with provision for determining position, distance and direction and information of interest to the navigator. This shows usually coastal areas of water and gives a great deal of hydrographic information which is useful to the navigator.
- B. Map – for most part shows land areas including their political subdivision and topography.
- C. Chart Projection: - methods of representing the curved surface of the earth on a flat surface.

KINDS OF PROJECTIONS:

1. Mercator projection
2. Gnomonic projection
3. Lambert non formal projection
4. Polyconic projection

D. Charts Symbols:

1. Fathom Lines – system of lines that indicates extent of fairways and restricted waters.
2. Soundings – (depth of water) numbers scattered on water areas of the charts. Sounding can be either in feet or fathoms and can be determined from the title of the charts.
3. Light (Lighthouse, Lighted Beacons, Lighted Buoys ) – indicated on the charts by a red color or star. Characteristics and features near the symbols.

Examples: GP FL – 30 seconds 156 ft and 19 miles.

4. Buoys – opal or red colors other than black solid shape for black vertical stripes and horizontal stripes, lighted red/gray.
5. Compass Rose – used to measure directions. Outer indicates true direction, the inner indicates magnetic directions and it also gives variation to locality.

E. Shorelines:

1. Sandy Beach – rows of fine dots.
2. Gravel – small circles
3. Boulders – irregular shapes

F. Heights – numbers in feet above high water.

V. TYPES OF COMPASS AND OPERATION:

- A. Gyro compass – a compass that measures the direction by means of the principles of gyroscopic inertia and precision.
- B. Magnetic Compass – a compass on its directive force upon the attraction of the magnetic poles of the earth.

TYPES OF COMPASS

1. Standard Compass – one which is used for ship's navigation or piloting usually located on the bridge and where least affected by unfavorable magnetic influence. The indication of this compass is termed Per Standard Compass (PSC).
2. Steering Compass – one just forward of the wheel used by the helmsman. Its indication is termed as Per Steering compass (PSTGC).
3. Boat Compass – a small compass mounted in a box for convenient use in small craft.

PRINCIPLES OF OPERATIONS:

Depends on its directive force on the earth's magnetic field

1. The earth acts as if it has a magnet in its interior. Powerful enough such that the field of influence extends to the surface.
2. While the earth acts as a magnet.
  - a. Magnetic Pole – the poles on the surface of the earth, where the magnetic dip is 90 degrees.
  - b. Magnetic Boundaries –
    1. North Magnetic Pole – 74 deg North 101 deg West.
    2. South Magnetic Pole – 68 deg South 144 deg East.
  - c. Magnetic Meridian – a line horizontal to the magnetic force of the earth.
  - d. Magnetic Equator – the line on the surface of the earth connecting all points at which magnetic dip is zero.
  - e. Magnetic Declination – Variations
  - f. Magnetic Dip – the angle between the horizontal and line of force by the earth's magnetic field.

C. Advantage of the Magnetic Compass:

Simple and Reliable – almost everything can happen to the ship; still the magnetic compass will be operative and only heavy damage to the compass itself will put it out of operation.

D. Limitations:

1. Subject to magnetic disturbance of magnetic materials in the vicinity.
2. Deviation changes of the ships magnetic property changes.
3. Useless in the polar regions.
4. It does not point to true north.
5. Deviation changes with headings.

E. Gyro Compass Advantages Over magnetic Compass:

GYRO COMPASS	MAGNETIC COMPASS
1. Points to true North	1. Points to Magnetic North
2. Not affected by proximity of a magnetic material	2. Affected by magnetic material
3. Can be used in polar regions	3. Useless in the poles
4. Can be transmitted to gyro repeaters	4. Cannot be transmitted by repeaters
5. Subject to mechanical failure	5. Immune to mechanical failure
6. Not affected by roll and pitch	6. Affected by heavy seas
7. Affected by electrical failure	7. Unaffected by electrical failure
8. Required services of a skilled technician and not advisable to be used on air	8. Little skill only and widely used by aircrafts

F. Gyro Repeaters – may also be treated as a compass due to its parts. The compass card is driven through synchro system which receives an electrical input from the Master Gyro.

VI. BEARING AND FIXES:

- A. Bearing – direction of terrestrial object from observer, azimuth as applied to a celestial body.
- B. Fixes – position obtained from lines of position taken at the same time or the intersection of two (2) or more lines of position taken simultaneously.
- C. LOP (Line of Position) – a line on some point of which the ship is located. This is established by the following means:

1. By Ranges – if two objects appear to be in line as seen from the ship, the ship must be along this line.
2. By Bearing – if the direction of the known object is sighted from the ship, it must be along this line.
3. By Distance – if the distance to known object is determined, the ship must be somewhere on a circle of which the object is the center.

D. Method of Establishing a Fix:

1. Two Cross Bearings
2. Two Ranges – by distance in miles or in yards.
3. Three Cross Bearings
4. Two Distance Lines
5. Range and Bearings.
6. Bearing and Distance of different objects.
7. Bearing and Distance of same objects.

E. Selecting object for Obtaining a Fix:

1. Primary consideration is the angle between bearings. Best result is from 90 degrees angles. As the angle become smaller, accuracy decreases. Three bearings intersecting at approximately 60 degrees also provides a good fix.
2. If LOP (Line of Position) creates a triangle, the position is at the center of the triangle. This indicates that there is an error somewhere.

F. Fix by Angles:

1. Select three fixed charted visible objects. Some must be taken in selection that the ship and all three objects should not lie on a circumference of a circle.
2. Measure the angle between the right and center objects and the left and the center objects usually with a sextant.
3. Set the movable arms of the three (3) arm protractor to these angles.
4. Passing through object and adjusted so that all the arms are aligned to the three objects, the center is the ship's position.