NAVIGATIONAL TERMS AND BRANCHES OF NAVIGATION

A. Definition of Terms:

1. Navigation – the art or science of determining the ship’s position or aircraft and of conducting a ship or aircraft from one position to another. The problem of Navigation are those of Position, Direction and Distance.

2. Branches of Navigation:

   a. Dead Reckoning – 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.
   b. Piloting – a near shore navigation method by which the movements of a ship are directed by reference to landmarks, navigational aids or soundings.
   c. Electronic Nav – a method of navigation which employs the use of various electronic devices. Differs from piloting primarily in the manner of collecting information.
   d. Celestial Nav – the position of a ship is determined by the observation of celestial bodies such as Sun, Moon, Planets and Stars.

3. Earth – the planet with whichwe are most familiar. Although it is approximately an oblate spheroid for the navigational purposes, we assumed it to be a true sphere.

   DIAMETER OF THE EARTH:
   1. Polar Diameter – 6,864.57 Nautical Miles
   2. Equatorial Diameter – 6,887.91 Nautical Miles Difference of – 23.34 Nautical Miles

4. Axis – the diameter about which the Earth rotates. The North end is the north pole while the South end is the south pole.

5. Great Circles – a circle on the surface of the Earth, the plane of which passes through the center of the Earth.

6. Small Circle – a circle on the surface of the Earth, the plane of which does not passes through the center of the Earth.

7. Equator – the great circle which is equidistance to the pole. The planes is perpendicular to the surface of the Earth’s axis.

8. Meridians – great circles on the surface of the Earth that passes through the poles.


10. Latitude – the angular distance between the position and the equator measured northward or southward from the equator along a meridian and labelled as appropriate N or S.

11. Longitude – the angular distance between the position of the prime meridian measured either Eastward or Westward from the prime meridian along the arc of the equator to the meridian of the position in degrees from 0° to 180° and labelled E or W.

12. Directions – angular inclination of that line to the meridian measure right or counterclockwise from the north point of the meridian and expressed in three digits.
13. Course – as applied to marine navigation is the intended direction of travel of a ship through the water.

14. Heading – the direction of the ship points or head at a given time.

15. Bearing – the direction of a terrestrial object from the observer, azimuth as applied to celestial bodies.

16. Distance – the length of a line joining two places on the surface of earth and expressed in nautical miles. The shortest distance between two points on the surface of the earth is along the great circle joining them.

17. Speed – the velocity of travel and it is expressed in knots. One (1) knot is equals to one (1) nautical mile per hour.

Note: One nautical mile is equals to 6,080.2 feet one minute of one minute of arc of a great circle and also for navigation purposes equals to 2,000 yards.

**NAVIGATIONAL AIDS, INSTRUMENTS**

A. DEFINITION OF TERMS:

1. Direction Measuring Instruments
   a. Compass – instrument that indicates directions
   b. Magnetic Compass – depends on earth’s magnetic field for its directive force
   c. GyroCompass – depends on the tendency of the pedolus gyroscope to seek to align its axis with that of the earth.
   d. GyroCompass Repeaters – located at various parts throughout the ship to indicate the master gyro heading.
   e. Bearing circles – a non magnetic ring formed to fit sungly over the compass bowl about which it can be turned to any desired direction. Used to determine bearings of terrestrial objects.
   f. Azimuth circles – similar to the bearing circle with a special attachment for observing the sun. Used to determine bearing of celestial objects.
   g. Pelorous (dumb compass) – consist of a compass stand, compass bowl and compass card. Used in determining bearings.
   h. Alidade – an azimuth circle having a telescopic sight mounted over it.

2. Speed Measuring Instruments
   a. Taffrail log
   b. Pito-static log
   c. Impeller type
   d. Engine revolution counter

3. Short Range Measuring Device
   a. Stadimeter used to find range of objects of known height or height of objects on known distance.

4. Depth Measuring Device
   a. Hand lead – lead weight attached to a marked line from 7 to 14 lbs
   b. Deep sea lead – from 30 to 100 lbs
   c. Sounding machine – works under pressure
   d. Echoe sounder (FATHOMETER) – works under speed of sound.
5. **Electronic Instruments**
   a. Radio receiver – receives signals and weather informations
   b. Radio direction finder (RDF) – receiver and a loop antenna which has directional properties.
   c. Radio detection and ranging (RADAR) – used for obtaining bearings and ranges of objects in all conditions of visibility.
   d. Long range Navigation (LORAN) – measures the difference in the time of reception of two radio signals which is used to determine a hyperbolic line of position.
   e. Sonic ranging (SONAR) – it uses speed of sound under water. It gives bearing and distance of objects underwater.

6. **Celestial navigation instruments**
   b. Star finder (HO-2102-D) – provides the navigator with the position of the celestial bodies relative to the position of the observer.
   c. Chronometer – accurate clock of superior construction for maintaining accurate time aboardship.
   d. Ship’s clock – ordinary clock set to keep standard or zone time
   e. Comparing watch – used for timing celestial observation
   f. Stop watch – useful in piloting for identification of lights and in celestial observation.

7. **Plotting instruments**
   a. Pencils – soft lead with eraser
   b. Parallel ruler – for drawing straight lines and plotting directions
   c. Drafting machine – measuring directions
   d. Protractors – for measuring angles
   e. Triangles – for transferring lines from compass rose to any place on the chart or vice versa
   f. Navigator case – contains drawing compass dividers and screwdrivers.

8. **Weather instruments**
   a. Barometer – measure atmospheric pressure (Mercurial and Aneroid)
   b. Thermometer – determine temperature
   c. Psycrometer – measures relative humidity (wet or dry)
   d. Anemometer – measures wind direction and wind speed.

9. **Miscellaneous instruments**
   a. Binoculars – provides for early sighting of object and identification of navigational aids
   b. Flashlight – useful during twilight observation for reading the watch and sextant.

B. **Definition of terms:**
   1. **Chart** – pictorial representation of the earth’s surface or part of it with provision for determining position, distance and direction and information of interest to the navigator. This shows usually coastal area of water and give a great deal of hydrographic information which is useful to the navigator.
   2. **Map** – for most part shows land areas, their political subdivision and topography
   3. **Chart projection** – methods of representing the curved surface of the earth on flat surface.
Kinds of chart projections:

Chart classification and their corresponding scales:

a. Mercator Projections  
b. Sailing charts ---- 1:600,000 – and smaller

2. Gnomonic projectors
   b. general charts --- 1:100,000 – to 1:600,00

3. Lambert conformal projectors
   c. Coast charts ------ 1:50,000 – to 1:100,00

4. polinaic projectors
   d. harbor charts ---- scales larger than 1:50,000

4. Chart Numbering –
   Charts are stowed aboardship by portfolio and are arranged in each portfolio in accordance with consecutive numbers. Numbers consist of a letter and a portfolio number followed by 2 digits number which indicates charts within the portfolio.

   Letter A – for General Charts  
   Letter B – for supplementary charts  
   Letter W – general charts, gives information for the entire world.

Examples: A1310 – the consecutive number of the 10th chart in the portfolio 13th in the general in nature.  
B1212 – the consecutive number of the 12 chart in the portfolio 12th in supplementary in nature.

5. Guides for probable accuracy of charts
   a. Reoncy of the surveying agency  
   b. Completeness of soundings  
   c. Printing and  
   d. Scale

6. Chart Symbols:
   a. Fathom lines – system of lines that indicates extent of fairway and restricted waters  
   b. Soundings – (Depth of Water) numbers scattered on water areas of the charts. Soundings can be either in feet or fathoms and can be determined from under the title of the charts.  
   c. Light – (light house, lighted beacons, lighted bouys) indicated on the charts by a red color star. Characteristics and features near the symbols.

   Examples: Group flashing (GP fl) 30 seconds 156 ft at 19 miles  
   d. bouys – opel or red colors other than black, slid shape for black vertical stripes and horizontal stripes. (lighted with red color rays)  
   e. compass rose – use to measure directions. The outer indicated true directions while the inner part indicates Magnetic directions. It also gives variation to locality.  
   f. shorelines –  
      • Sandy beach – rows of fine dots  
      • Gravel – small circles  
      • Boulders – irregular shapes  
   g. heights – numbers in feet above high water  
   h. Abbreviations used in charts maybe found from under the title of the charts
I. **PRESENTATION:**
   a. Types of compass
      1. Magnetic Compass – a compass depending on its directive force upon the attraction of any magnetism of the earth for a magnet to turned in any horizontal direction.
         a. Standard compass – one which is used by ship navigated or piloted usually located on the bridge and where least affected by unfavorable magnetic influences. The indication of this compass is termed as per standard compass (PSC)
         b. Steering compass – one just forward of the wheel used by the helmsman. Its indications is termed as (PSTGC)
         c. Boat compass – a small mounted in a box for convenient used in small craft.

   Principles of Operations:
   1. Depends on its directive force on the earth magnetic field
      a. The earth acts as if it had a magnet in its interior powerful enough the field of influence extends to the surface.
      b. The whole earth acts as a magnet
         1. Magnetic Poles – the two poles on the surface of the earth when the magnetic dip lies 90°.

   Magnetic Earth Boundaries – North Magnetic Pole = 74° North and 101° West
   South magnetic Pole = 68° South and 144° East

   2. Magnetic meridian – aline horizontal magnetic force of the earth
   3. Magnetic equator – that line on the surface of the earth connecting all points at which magnetic dip is zero
   4. Magnetic declination – variation
   5. Magnetic dip – the angle between the horizontal and line of force by the earth is magnetic fiels

   2. Basic Principles (Law of Polarity)
      1. Unlike poles attract
      2. Like poles repel
         a. Lines of Force – the direction of magnetic field enters south poles leaves north poles or south pole to north pole within the magnetic in the external field.

   3. Variation – (Magnetic Declination) = the angle between the magnetic and geographical meridians. Easterly labelled “E”, if magnetic north is east or the right of the true north and westerly, if west labelled “W” or to the left of the true north. The amount and yearly change are shown in the compass rose of the chart for the locality, it remain the same for anyheading of the ship at any given time.

   4. Deviation – Error of magnetic compass due to disturbing magnetic influence in the vicinity of the compass. The angle between the magnetic meridian and the axis of the compass card. Easterly and labelled “E” if the compass north is east or to the right of the magnetic north and westerly if west or to the side of it. The amount is different for heading and this can be found from the deviation table usually attached to the compass.

   **APPLICATION OF THE COMPASS ERROR:**
   1. Direction Involved:
      a. True – referred to the true north, differs from magnetic north by variation.
      b. Magnetic – referred to magnetic north, differs from compass by deviation.
      c. Compass – referred to compass north or zone of the compass card, differs from true by compass error.

   2. Uncorrecting – converting from true to magnetic and to compass card or from true to compass, subtract easterly error and add westerly errors

   3. Correcting – converting from compass to magnetic and to true or from compass to true, add easterly error and subtract westerly error.
4. **Key to remember the Rule in Correcting:**

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Compass  | Deviation  | Magnetic  | Variation  | True  |
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**Problem/ Exercises: (Correcting)**

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5. **Key to remember the Rule in Uncorrecting:**

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OUTLINE OF INSTRUCTION

b. Advantage:
   1. Simple and Reliable – almost everything can happen to the ship, but still the magnetic compass will be operative and only heavy damage to the compass itself will put out of operations.

c. Limitations:
   1. Subject to magnetic disturbance of a magnetic materials in the vicinity
   2. Deviation changes if the ships magnetic property change
   3. Useless in the polar region – the directive force of a magnetic compass non magneticship is the horizontal component of the earth magnetism
   4. It does not point to true north.
   5. Deviation changes with heading.

   2. **Gyro Compass** – compass that measures the direction by means of the principles of gyroscopic inertia and precision.

   **Gyro Compass Advantages Over the Magnetic Compass:**
   1. True North/ Magnetic North
   2. Not affected by proximity of a magnetic pole/ Useless in the pole
   3. Not affected by proximity of a magnetic material/ Affected by magnetic material
   4. Can be transmitted to the gyro repeaters/ Can not be repeated by magnetic compass.
   5. Subject to mechanical failure/ Immune to mechanical failure
   6. Both not affected by roll or fitch/ Shock by heavy seas
   7. Affected by electrical failure/ Unaffected by electrical failure
   8. Requires a services of a skilled technicias/ Little skill only
   9. Accuracy decreases at higher latitudes
   10. Adjust/ Compensate errors as latitude change
   11. Not advisable to be used at aircrafts/ Widely used by aircrafts

3. **Repeaters** - can also be treated as compass due to its parts. The compass cards is driven through syncho system which receives an electrical input from the master gyro.

4. **Compass Errors:**
   1. The angular difference between compass direction and the corresponding true direction. This is also the algebraic sum of the variation and the deviation.
   2. Used in converting compass direction to the true direction or vice versa.

5. **Lighted Beacons**
   a. Similar to lighthouses
   b. Less powerful than lighthouse
   c. Generally unwatched

6. **Lighted Buoys** – lighted floating markers
7. This lighted aids to navigation have individual characteristics, to get full benefit from the light, the navigator must understand their use and be able to interpret data concerning them in light list and on charts.

CHARACTERISTICS OF LIGHT
1. Standard colors – White, Red and Green
2. Brillancy – Range of visibility
3. System of Operation
   a. General System –
      1. Fixed (F) – Continuous steady lights
      2. Flashing light (FL) – shows single flash at regular interval, the duration of light always shorter than the duration of darkness. Not more than 30 flashes per minute.
      3. Group Flashing (GP-FL) – Shows group of 2 or more flashes at regular intervals.
      4. Quick Flashing (QK-FL) – Shows not less than 60 flashes per minute.
      5. Interrupted Quick Flashing (I-QK-FL) – Shows quick flashes for about 4 seconds, followed by a dark period of about 4 seconds.
      6. Short-Long Flashing (S-L-FL) – Shows short flashes of about 0.4 seconds followed by a long flashes of about 4 times in durations.
      7. Group Occulting (Gp-OCC) – a light with a group of 2 or more eclipses.

4. The period of flashing or occulting is at interval required for it to go through a full of change.

LIGHT LIST IN PHILIPPINE ARCHIPELAGO
1. Information Contained:
   a. Number – start from North to South in their approximate order (geographical)
   b. Name of Location
   c. Position – by latitude and longitude
   d. Characteristic and Power
   e. Height of light in feet above water

I. PRESENTATION:

A. Definitions:
   1. Bearing – direction of a terrestrial object from an observer, azimuth as applied to a celestial body
   2. Fixes – position obtained from lines of position take at the same time, or the intersection of two or more lines of position take simultaneously.
   3. LOP – a line on some point of which the ship is located. This is established by following means.
      a. By Ranges – if two objects appear to be in line as seen from the ship, the ship must be along this line.
      b. By Bearing – if the direction of the known object is sighted from the ship, the ship must be along this line.