COMMAND AND STAFF TRAINING INSTITUTE
BANGLADESH AIR FORCE

Individual Staff Studies Programme (ISSP)

PROFESSIONAL SUBJECT-1 : FLYING AND AIRMANSHIP FOR NAVIGATORS
PHASE-8 : PART-I

PROFESSIONAL SUBJECT-1 : FLYING AND AIRMANSHIP FOR NAVIGATORS
PHASE-8 : PART-I

First Edition : Jun 2011

Revised by : **Wg Cdr Md Shafiqul Alam, (GD(N)**
Sqn Ldr SM Hasan Ali Masud, GD(N)

Approved vide Air HQ/10066/Air Trg/Vol-46/64A dt 18 Jan 2011.

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SUBJ : PROFESSIONAL SUBJECT-1 (FLYING AND AIRMANSHIP FOR NAVIGATORS)

Weeks: 05 **Period: 50**

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RESTRICTED

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Total Pd in Survival					**04**

Notes :

1. **Total Pd in Phase - I : 51**
2. **40 mts comprises one pd.**

INTRODUCTION TO THE PHASE

Scope of the Phase

1. Phase-4 consists of Part-I and Part-II. It is divided into 4 different tasks. This phase aims at preparing staff papers. It includes how to prepare warning orders, operational order & Administrative Order. Each task has self Assessed Exercise with solution. It will greatly help the junior offr to be acquainted with different types of orders & instruction.

Objectives

2. At the end of this phase, you are expected to fulfill the fol training objectives :

a. To know how & when orders & instructions are to be initiated.

b. To acquaint with the procedure of writing warning & operational orders.

c. To recognize the basic principles which apply to the writing operational and administrative order.

GROUP-'A' : NAVIGATION

TOPIC-1 : THE EARTH, DISTANCE AND DIRECTION

THE EARTH

The Form of the Earth

1. For most navigational purposes the Earth is assumed to be a perfect sphere, although in reality it is not. For many centuries man has been concerned about the shape of the Earth; the early Greeks in their speculation and theorizing ranged from the flat disc to the sphere, and even cylindrical and rectangular earth have been propounded.

2. Even now the precise shape of the Earth is not known, though it is generally accepted that it is almost spherical, being slightly flattened at the poles. This shape is more properly termed an oblate spheroid, which is the figure generated by the revolution of an ellipse about its minor axis. Because of this flattening, the Earth's polar diameter is approximately 27 statute miles shorter than its average equatorial diameter.

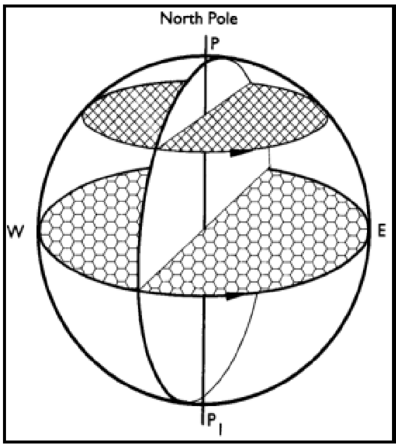
3. The ratio between this difference and the equatorial diameter is termed the compression of the Earth, and indicates the amount of flattening. This ratio is approximately 1/300, but differ3ent geodesists have calculated different values. Some of the more common values referred to in navigation tables are :

Clarke (1866)	1/295
Clarke (1880)	1/293
Hayford (1909)	1/297
Hough (1956)	1/297

4. The differences between these spheroids and a true sphere are so small that they have little application in practical navigation. It is of interest to note that the latest geodetic information obtained from satellite measurements indicates that the Earth is pear-shaped, the greater mass being in the southern hemisphere.

The Poles

5. The extremities of the diameter about which the Earth rotates are called poles. In Fig 1a these are represented by P and P_1.



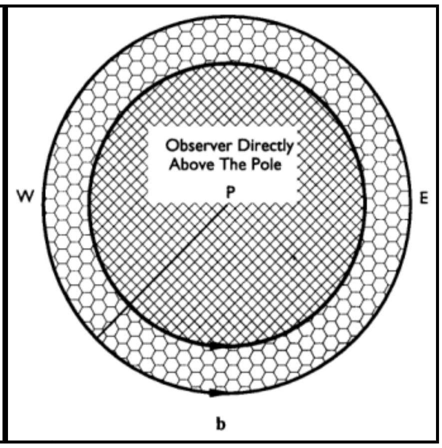


Fig 1a Earth Reference **Fig 1b Earth References**

East and West

6. East is defined as the direction in which the Earth is rotating. This direction, anti-clockwise to an observer looking down on the pole P, is shown by the arrows in Figs 1a and 1b. West is the direction opposite to east.

North and South

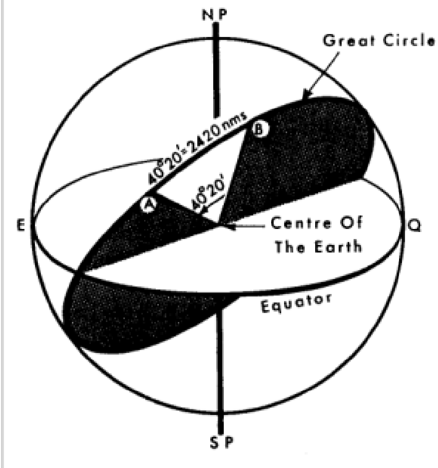
7. The two poles are distinguished arbitrarily; the north pole (P in Fig 1a) is said to be the pole which lies to the left of an observer facing east. North in therefore that direction in which an observer would have to move in order to reach north pole; it is at right angles to the east west direction. The other pole (P_1 in Fig 1a) is known as the south pole. The directions east, west, north and south are known as the cardinal directions.

Lines Drawn on the Earth

8. The shortest distance between two points is the length of the straight line joining them. It is, however, impossible to draw a straight line on a spherical surface. In other words, all lines drawn on the Earth are curved, some regularly and others irregularly. The regularly curved imaginary lines on the Earth which are of interest to the navigator are described below.

9. **Great Circle**. A great circle is a circle on the surface of a sphere whose center and radius are those of the sphere itself. Because its plane passes through the center of the sphere, the resulting section is the largest that can be obtained, hence the name great circle. Only one great circle may be drawn through two places on the surface of a sphere which are not diametrically opposed. The shortest distance between any two points on the surface of a sphere is the smaller are of the great circle joining them (see Fig 2).

10. **Small Circle**. A small circle is a circle on the surface of a sphere whose center and radius are not those of the sphere. All circles other than great circles on the surface of a sphere are small circles (see Fig 3).



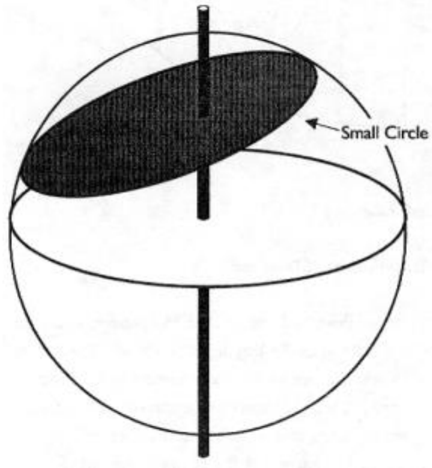


Fig – 2 Great Circle **Fig-3 Small Circle**

11. **<u>The Equator</u>**. The quarter is the great circle whose plane is perpendicular to the axis of rotation of the Earth. Every point on the equator is therefore equi-distant from both poles. The equator lies in an east-west direction and divides the Earth into northern and southern hemispheres.

12. **<u>Meridians</u>**. Meridians are semi-great circles joining the poles; every great circle joining the poles forms a meridian and its anti-meridian. All meridians indicate north-south directions.

13. **<u>Parallels of Latitude</u>**. Parallels of latitude are small circles on the surface of the Earth whose planes are parallel to the plane of the equator. They therefore lie in an east-west direction (See Fig 4).

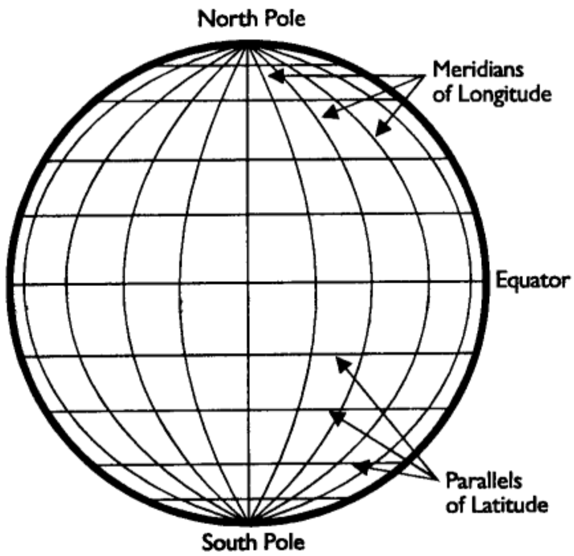


Fig – 4 Equator, Meridians and Parallels

14. **Rhomb Line**. A rhomb line (or Loxodrome) is a regularly curved line on the surface of the Earth cutting all meridians at the same angle. Only one such line may be drawn through any two points. Parallels of latitude are rhumb lines as are the meridians and the equator, though the latter two are special cases as they are the only examples of rhumb lines which are also great circles. Thus, when two places are situated elsewhere than on the equator or on same meridian, the distance measured along the rhumb line joining them is not the shortest distance between them. Houwever, the advantage of the rhumb line is that its direction is constant, therefore the rhumb line between two points may be followed more conveniently than the great circle joining them since the direction of the latter changes continuously with reference to the meridians. The saving in distance effected by flying a great circle rather than a rhumb line increases with latitude but it is appreciable only over great distances, consequently flights of less than 1,000 miles are usually made along the rhumb line. Rhumb lines are convex towards the equator (excepting parallels of latitude, the equator and meridians) and lie nearer the equator than the corresponding great circles (see Fig 5).

Earth Convergence

15. From Fig 5 it can be seen that the meridians are only parallel to one another where they cross the equator, elsewhere the angle of inclination between selected meridians increases towards the poles. This angle of inclination between selected meridians at a particular latitude is know variously as Earth convergence, true convergence, meridian convergence and convergency.

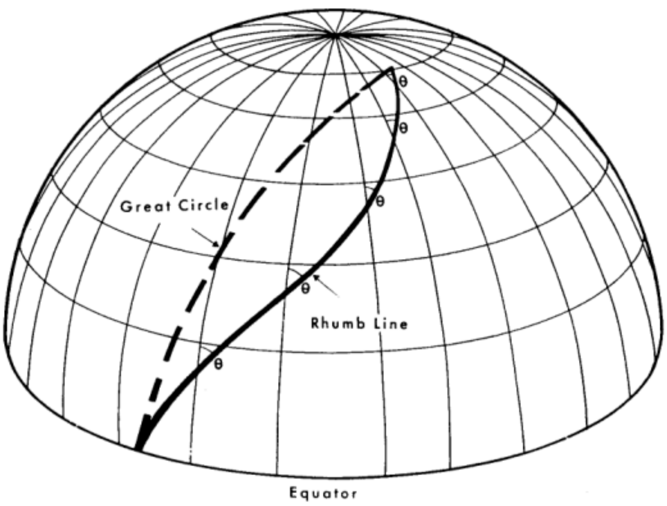


Fig 5 Rhumb Line

UNITS OF MEASUREMENT

Angular Measurement

16. The sexagesimal system of measuring angles and distances is universally employed in navigation. In this system the angle subtended at the center of a circle by an are equal to the 360th part of the circumference is called a degree. A right angle is divided into 90 degrees (°), each degree is sub-divided into 60 minutes(!) and each minute into 60 seconds (“). The size of any angle may be expressed in terms of degrees, minutes and seconds.

17. In spherical calculations it is frequently convenient to express spherical distances (ie, great circle distances) in terms of angular measurement rather than in linear units. This is possible because of a simple relationship between the radius, are, and the angle at the center of a circle. Thus the length of the are of a great circle on the Earth might be expressed as 10° 38’, this would convey little unless there were some ready means of converting angular units to linear units. This difficulty of converting from angular to linear units has been overcome by the definition of the standard unit of linear measurement on the Earth, the nautical mile.

Measurement of Distance

18. Assuming the Earth to be a true sphere, a nautical mile is defined as the length of the are of a great circle which subtends an angle of one minute at the center of the Earth. Thus the number of nautical miles in the are of any great circle equals the number of minutes subtended by that are at the center of the Earth. The conversion of an angular measurement of spherical distance to linear units requires only the requction of the angle to minutes of are; the number of minutes is equal to the spherical distance in nautical miles (see Fig 6).

19. In Fig 6, if AB, the are of a great circle, subtends an angle at the Earth’s center of 40° 20’, AB is said to be 40° 20’ in length, 40°20’ is equivalent to 2,420 minutes of are which is equal to a length of 2,420 nautical miles.

20. Because of the Earth’s uneven shape the actual length of the nautical mile is not constant, but varies with latitude. On the Clarke spheroid of 1866 the length of one minute of latitude varies from 6046 feet at the equator to approximately 6108 feet at the poles. However, for the purpose of navigation a fixed unit of measurement is helpful, and the length of the nautical mile is taken to be 6080 feet; this is known as the Standard Nautical Mile. Some nations, including the USA use the International Nautical Mile of 6076.1 feet.

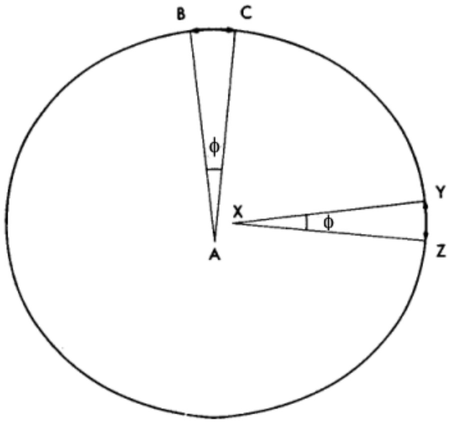


Fig 6 Angular Distance

21. The geographic mile is defined as being the length of one minute of are of the Earth's equator, and is approximately equal to 6087 feet.

22. The other mile unit in common use is the statute mile (so called because its length is determined by law), this is 5,280 feet in length. It is a purely arbitrary unit of measurement and, unlike the nautical mile, is not readily converted into angular measurement terms. At one time the statute mile was used in navigation but for many reasons was found inconvenient. The nautical mile has now been adopted as the unit of measurement in navigation.

23. **Metric Units**. The kilometer is used in some European countries. This unit is the length of 1/10,00th part of the average distance between the equator and either pole; it is equivalent to 3,280 feet.

24. **Conversion of Units**. The following values should be known by the navigator :

a. 66 nm = 76 st m

b. 41 nm = 76 km

c. 41 st m = 66 km

Speed and its Measurement

25. Speed is a rate of change of position. It is usually expressed in linear units per hour. As there are three main linear units, there are three expressions of speed:

a. Knots, or nautical miles per hour (k).

b. Miles per hour ie statute miles per hour (mph).

c. Kilometres per hour (km/hr).

Direction on the Earth

26. In order to fly in a given direction, the navigator must be able to refer to a datum line or fixed direction whose orientation he knows or can determine. The most convenient datum is the meridian through his own position, since it is the north-south line. By convention direction is measured clock-wise from north, to the nearest degree, ie from 000° to 360°. It is always expressed as a three-figure group; thus, east, which is 90° from north, is written 090°, and west 270°.

27. **True Direction**. Direction measured with reference to true north, the direction of the north geographic pole, is said to be true direction. True direction possesses a number of advantages which commend its use to the navigator; it is a constant directional reference (ie true direction about a point does not change), it forms the basis of nearly all maps and charts, and it facilitates plotting. AT present (1967) the BAF is introducing heading reference systems which directly and continuously indicate true direction, eg HRS Mk 2. However, magnetic direction will continue to be the basis of the majority of aircraft heading reference systems for some years yet, for magnetic systems are cheaper and simpler, and true direction can be derived quite easily from their outputs.

28. **Magnetic Direction**. The Earth acts as though it is a huge magnet whose field is strong enough to influence the alignment of a freely suspended magnetic needle anywhere in the world. The poles of this hypothetical magnet are known as the north and south magnetic poles and, like those of any magnet, they can be considered to be connected by lines of magnetic force. Although the magnetic and geographic poles are by no means coincident (the respective north poles are separated by approximately 1200 mls), the lines of force throughout the equatorial and temperate regions are roughly parallel to the Earth's meridians. A feely suspended magnetic needle will take up the direction indicated by the Earth's lines of force and thus assume a general north-south direction; the actual direction in which it points, assuming no other influences are acting upon it, is said to be magnetic north. With such a datum available it is possible to measure magnetic direction. Thus knowing the angle by which the direction of magnetic north differs from true north at any given point (an angle which is accurately measured on the ground and displayed on plotting charts) the navigator is able to convert magnetic direction, which he can measure, to true direction which he requires.

Variation

29. The angular difference between the direction of true north and magnetic north at any given point, and therefore between all true directions and their corresponding magnetic directions at that point, is called variation. Variation is measured in degrees and is named east (+) or west (-) according to whether the north-seeking end of a freely-suspended magnetic needle, influenced only by the Earth's field, lies to the east or west of true north at any given point. The algebraic sign given to variation indicates how it is to be applied to magnetic direction to convert it to true direction. At any point, therefore, a navigator can determine true direction by measuring magnetic direction with a magnetic needle and converting it to true direction by application of local variation. A useful mnemonic is :

"Variation east, magnetic least.		Variation east, magnetic best."	
Direction magnetic 100° (M)		Direction magnetic	100° (M)
Variation	10° E (+)	Variation	10° W (-)
Direction true	110° (T)	Direction true	090° (T)
	(see Fig 7a)		(see Fig 7b)

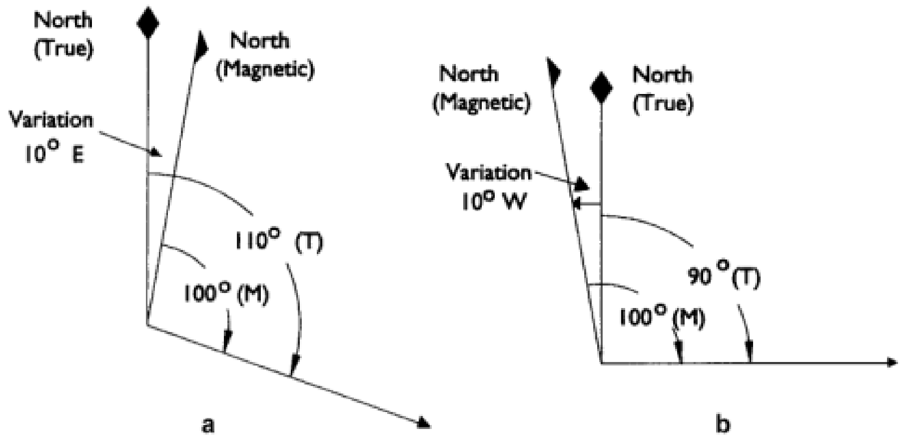


Fig 7 variation

Isogonals

30. Variation is not constant over the Earth's surface but varies from place to place. This change is gradual and follows a more or less regular pattern. In England variation changes one degree over approximately 60 miles in the direction of greatest change. By means of a magnetic survey the variation at numerous points is accurately measured and tabulated. From such a survey it is possible to discover a number of points where variation has the same value. Lines joining these points of equal variation are known as isogonals. Isogonals are printed on the charts used by the navigator to enable him to obtain true direction from magnetic direction at any given point.

31. The variation at any given point is not a fixed quantity but is subject to gradual change with the passage of time because the magnetic axis of the Earth is constantly changing. This change, which is indicated in the margin of the chart, is not large but in certain places may amount to as much as one degree in five years. It is important, therefore, that charts indicate the date to which variation values apply, and also the annual changes, so that the navigator may bring the values of the isogonals up to date.

Deviation

32. When a freely-suspended magnetic needle is influenced only by the Earth's magnetic field, the direction it assumes is known as magnetic north. If such a needle is placed in an aircraft, it is subject to a number of additional magnetic fields created by various electrical circuits and magnetized pieces of metal within the aircraft; consequently its north-seeking end deviates from the direction of magnetic north and indicates a direction known as compass north.

33. The angular difference between the direction of magnetic north and that of compass north, and therefore all magnetic directions and their corresponding compass directions, is called deviation. Deviation is measured in degrees and is named east (+) or west (-) according to whether the north-seeking end of a compass needle, under various disturbing influences, lies to the east or west of magnetic north. The algebraic sign given to deviation indicates how it is to be applied to compass direction to convert it to magnetic direction.

34. Deviation is not, as might be imagined, a constant value for a given compass; instead it varies with the heading of the aircraft. Nor is the deviation experienced by two different compasses likely to be the same under identical conditions. Thus in order to convert the directions registered by a particular compass to magnetic directions, the navigator requires a tabulation of the deviations of that compass found on various compass headings. Such a tabulation of the deviations, usually in the form of a card, must be provided and placed near the compass to which it applies.

35. The deviation of a compass will change as its position in the aircraft is changed. Deviation will also change, over a period of time, due to changing magnetic fields within the aircraft. Moreover, as the aircraft flies great distances over the Earth, changes occur in deviation because of the Earth's changing magnetic field. It is not sufficient, therefore, to prepare a deviation card and expect it to last indefinitely, the card must be renewed at frequent intervals in 9order that it may always record the deviation as accurately as possible. A useful mnemonic for the application of deviation is :

"Deviation east, compass least,

Deviation west, compass best."

Direction compass 100° (C)

Deviation 4° E (+)
Direction magnetic 104° (M) (Fig 8a)

Direction compass 100° (C)

Deviation 4° E (+)
Direction magnetic 104° (M) (Fig 8b)

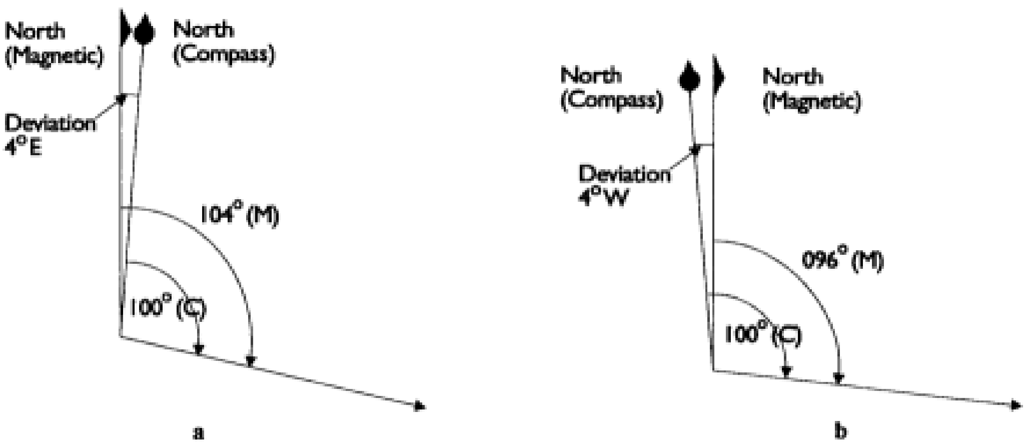


Fig 8 Deviation

Derivation of True Direction

36. It is possible therefore to express a direction given with regard to a particular compass needle as true direction, provided deviation and variation are known. The practical value of such a process is evident when it is realized that the navigator has continual recourse to a magnetic compass for indications of heading. To avoid the complications arising from the changing values of variation and deviation during flight, plotting is invariably carried out in true directions. In Fig 9 :

Compass direction	225° (C)
Deviation	2° W (-)
Magnetic direction	223° (M)
Variation	12° W (-)
True direction	211° (T)

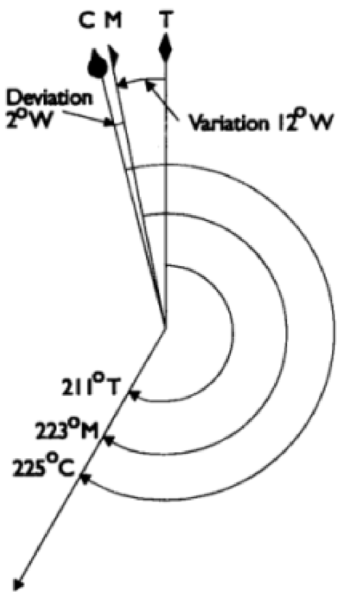


Fig 9 Three Expressions for Direction

TOPIC-2

POSITION ON EARTH, LAT-LONG, GEOREF

Introduction

1. Since air navigation is the process of directing an aircraft from one point to another, it is essential that the navigator should be able to define positions on the Earth's surface.

2. Mathematically, a point can be defined by reference to two mutually perpendicular axes. Thus the point 'P' (Fig 1a) is defined, in general terms, by the Cartesian co-ordinates +x and +y, which have linear values. Similarly point 'R' is positioned by the co-ordinates 'x', 'y'.

3. When the point 'P' lies on a sphere (Fig 1b), a similar system may be employed but the co-ordinates may have either linear or angular units of measure (see Fig 1b).

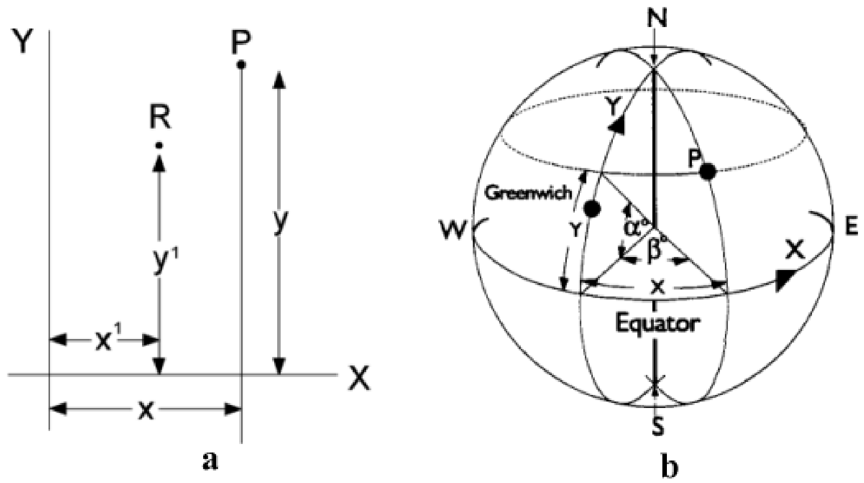


Fig 1

LATITUDE AND LONGITUDE

General

4. On the Earth position is normally defined by a reference system known as latitude and longitude. The chosen axes are the equator (X) and the meridian of Greenwich (Y) – the prime meridian.

Latitude

5. Latitude is defined as the angular distance from the equator to a point, measured northward or southward along the meridian through that point. This quantity is expressed in degrees, minutes and seconds and is annotated N or S according to whether the point lies north or south of the equator (see Fig 2).

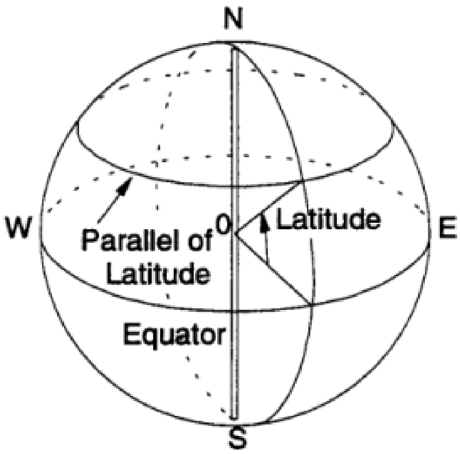


Fig 2 Latitude.

Longitude

6. The longitude of any point is the shorter angular distance along the equator between the prime meridian and the meridian through the point (Fig 3). It is expressed in degrees, minutes and seconds, and is annotated E or W according to whether the point lies to the east or west of the prime meridian. As the plane of the Greenwich Meridian bisects the Earth, longitude cannot be greater than 180°east or west.

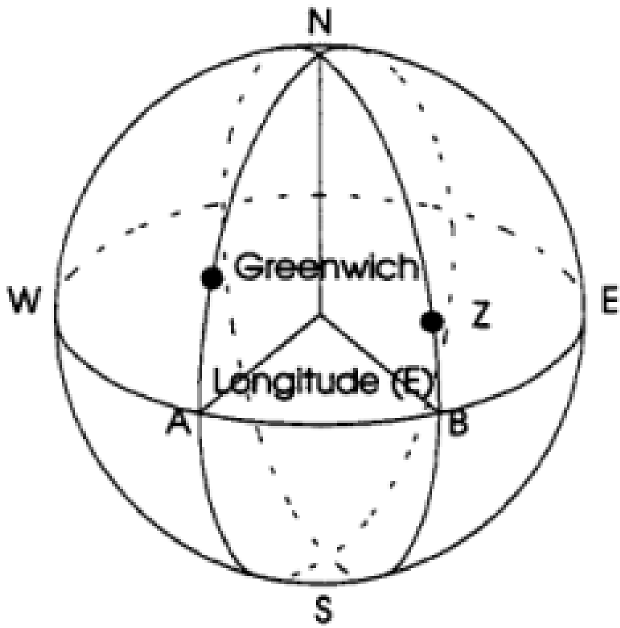


Fig 3. Longitude

Recording Position

7. In air navigation it is usually sufficient to express latitude and longitude in degrees and minutes only. By convention, the group of figures representing latitude is always written first and is followed by the figures expressing longitude. To avoid ambiguity figures below ten are preceded by the digit O. The letters N, S and E, W are used to indicate the sense of the latitude and longitude co-ordinates. Thus the position of a point situated in latitude 53 degrees 21 minutes north and in longitude zero degrees 5 minutes east, is written : 53 21 N 00 05 E.

Change of Latitude

8. The change of latitude (ch lat) between two points is the are of a meridian intercepted between their parallels of latitude. It is annotated N or S according to the direction of the change from the first point to the second.

9. If the two points are on the same side of the equator, as in Fig 4a, the ch lat is found by sub tracking the lesser latitude, that of A, form the greater, that of B. If A and B are on opposite sides of the equator, as in Fig 4b, the ch lat is equal to the sum of the latitude of A and B. In Fig 4a the ch lat of point B from an observer at point A is named N, in Fig 4b the ch lat of point B from point A is named S.

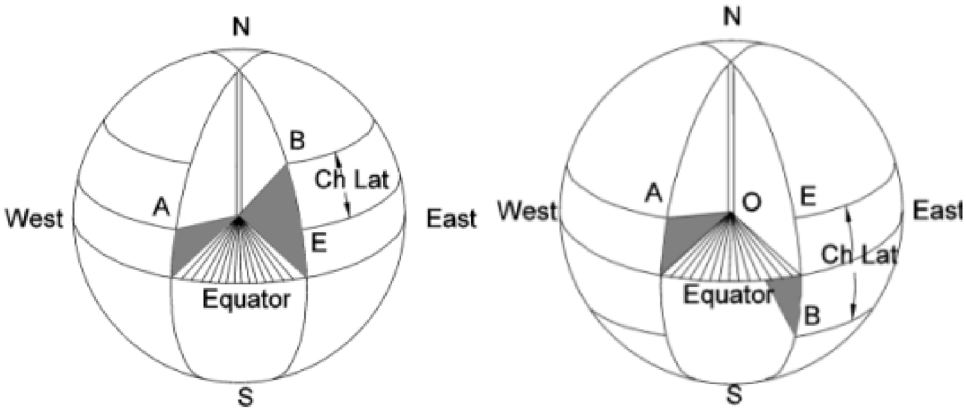


Fig 4. Change of Latitude

Change of Longitude

10. The change of longitude (ch long) between two points is the smaller are of the equator intercepted by the meridians trough the two points. It is annotated E or W according to the direction of the change from the first point to the second.

11. In Fig 5a since the longitudes of B and A are of the same sign the change of longitude is the difference between them, and the change of longitude of A from B is easterly. In Fig 5b the change of longitude of A from B is again easterly and, as the longitude are of opposite sign, the change of longitude is the sum of the longitudes of B and A. In Fig 5c the change of longitude of A from B is westerly and its amount is 360°minus the sum of the longitudes of B and A. This is the smaller are of the equator intercepted by the meridians of B and A.

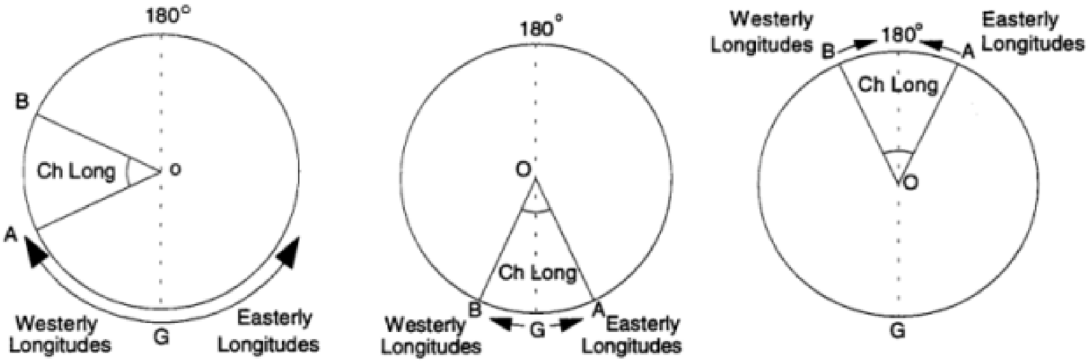


Fig 5. Change of Longitude

Departure

12. The distance between two given meridians, measured along a stated parallel and expressed in nautical miles, is called departure. In general terms it is defined as the east-west component of the rhumb line distance between two points. The value of departure between two meridians varies with latitude decreasing with increasing latitude (Fig 6); the change of longitude between these meridians of course remains the name, irrespective of the latitude.

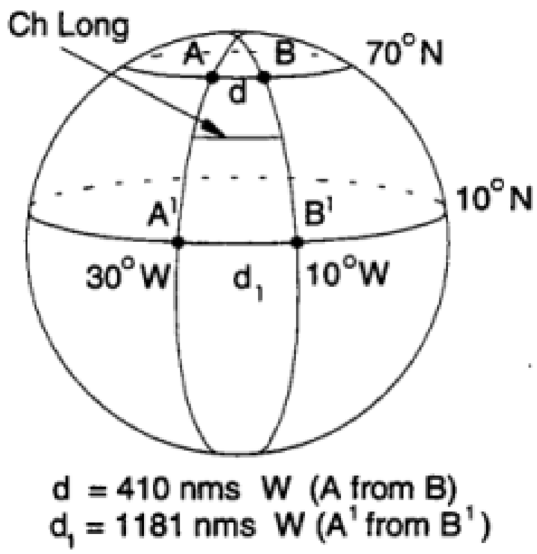


Fig 6. Departure and Change of Longitude.

13. The departure between any two points is thus a function of their latitude and the change of longitude, and the relationship is given by:

Departure (nms) = ch long (mins)

X cos mean lat :

Where mean lat = $\frac{\text{lat A + lat B}}{2}$

Disadvantages of the Latitude and Longitude Reference System

14. The latitude and longitude method of reporting position suffers from certain disadvantages:

a. The possibility of confusion in areas close to the equator and the prime meridian.

b. The necessity of giving a 10 or 11 figure group to obtain positional accuracy of 1 min eg 5136N 0125W or 5136N 10125W.

c. One minute of latitude and one minute of longitude represent different distances on the earth, except at the equator, and the distance represented by one minute of longitude decreases with increasing latitude.

15. To overcome these disadvantages military forces have, since the first World War, used reporting systems based on networks of lines (grids) which are a fixed distance apart and cut each other at right angles. Examples of these systems discussed in this chapter are :

a. The National Grid System.

b. The Universal Transverse Marketer Grid.

c. Geographical Reference System (GEOREF).

GEOGRAPHICAL REFERENCE SYSTEM (GEOREF)

Introduction

16. The use of latitude and longitude as a method for reporting position suffers from the disadvantage stated in para 14. These disadvantages can be overcome by the use of a reporting system based on a lettered rectangular grid. However, rectangular grids which ignore the curvature of the earth, while satisfactory over a limited area, become excessively distorted with any great extension of the area of use. To avoid this distortion, any reference system which is to have universal coverage, must be based on the graticule of meridians and parallels.

17. The world Geographic Reference System, or GEOREF, has been introduced with the object of providing a simple, speedy, unambiguous method of defining position which is capable of universal application. It incorporates the best of both systems by utilizing the orthodox graticule of meridians and parallels by expressing the position of any point, in relation to it, by a system of lettered co-ordinates. In this way the disadvantages of latitude and longitude stated in para 14 sub paras a and b are overcome.

18. It is emphasized that the GEOREF system replace neither the latitude and longitude nor the rectangular grid methods of reporting positions, but provides a convenient means of reporting position within the framework of the former system.

Description of the System

19. The GEOREF system divides the surface of the earth into quadrangles, the sides of which are specific are lengths of longitude and latitude. Each quadrangle is then identified by a simple, systematic, lettered code.

20. The first division of the earth's surface is into 24 longitudinal zones, each 15° wide, which are lettered A to Z inclusive (Omitting I and O), commencing eastwards from the 180° meridian. A corresponding division is made of the earth's surface into 12 latitudinal bands, each 15° wide, which are lettered A to M inclusive (omitting I). In this case, the lettering commences northwards from the South Pole. The earth is therefore divided into 288 quadrangles, of 15° sides, each of which is identified by a unique combination of two letters. The first letter is always that of the longitude zone or easting and the second that of the latitude band or nor thing. In this respect the system differs from that of latitude and longitude in which the latitude is always given first.

21. Thus Wiltshire is in the 15° quadrangle MK (see Fig 7).

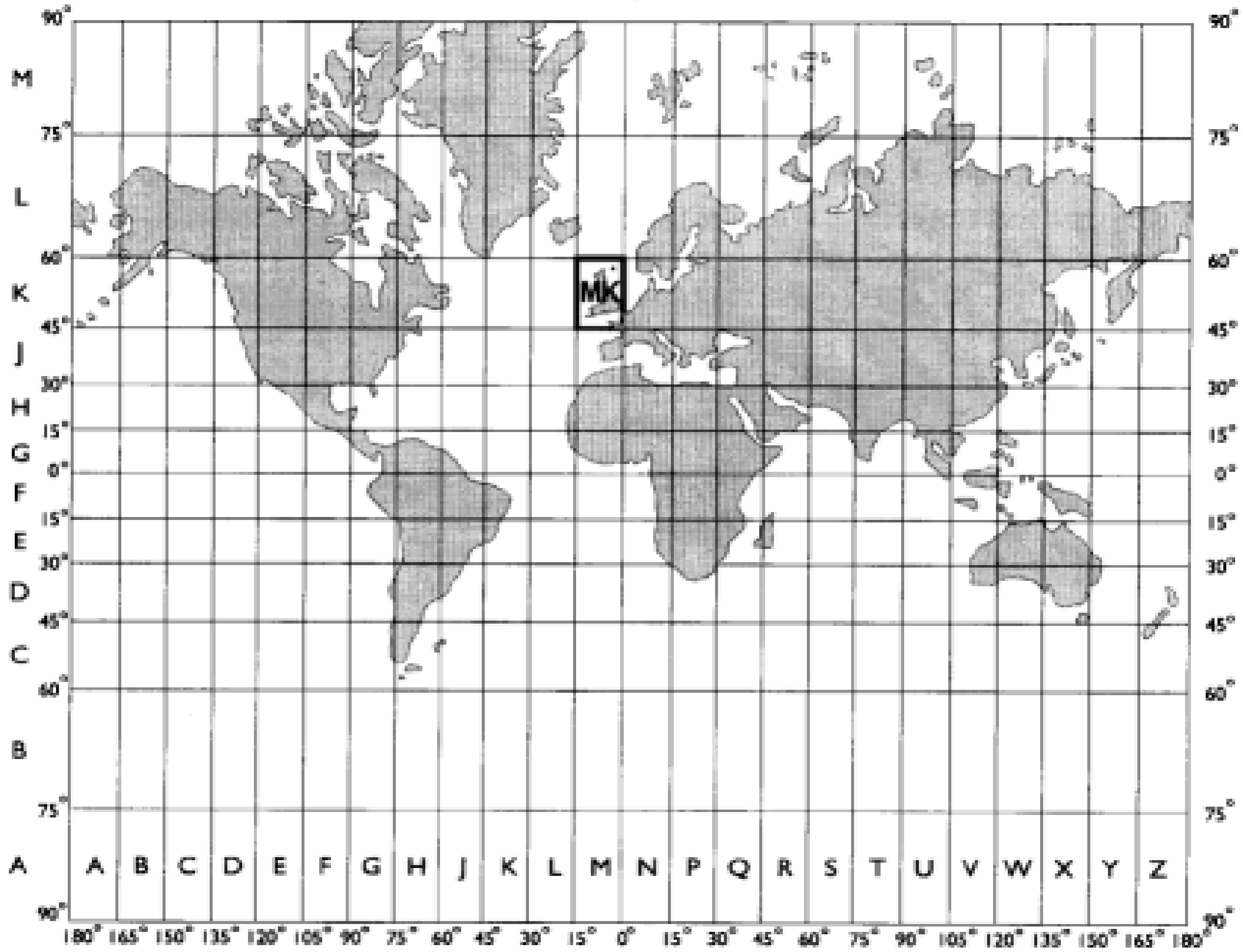


Fig 7

22. Each 15° quadrangle is now sub-divided into 15 one-degree longitudinal zones and latitudinal bands, lettered A to Q inclusive (omitting I and O), commencing eastwards and northwards respectively from the south-west corner of the 15° quadrangle. Thus the 15° quadrangles are subdivided into 225 one-degree quadrangles each being identified by means of four letters. The first two letters identify the 15° quadrangle, the third letter the one-degree zone of longitude, and the fourth letter the one degree band of latitude.

23. Salisbury in the County of Wiltshire therefore lies in the one-degree quadrangle MK PG (See Fig 8).

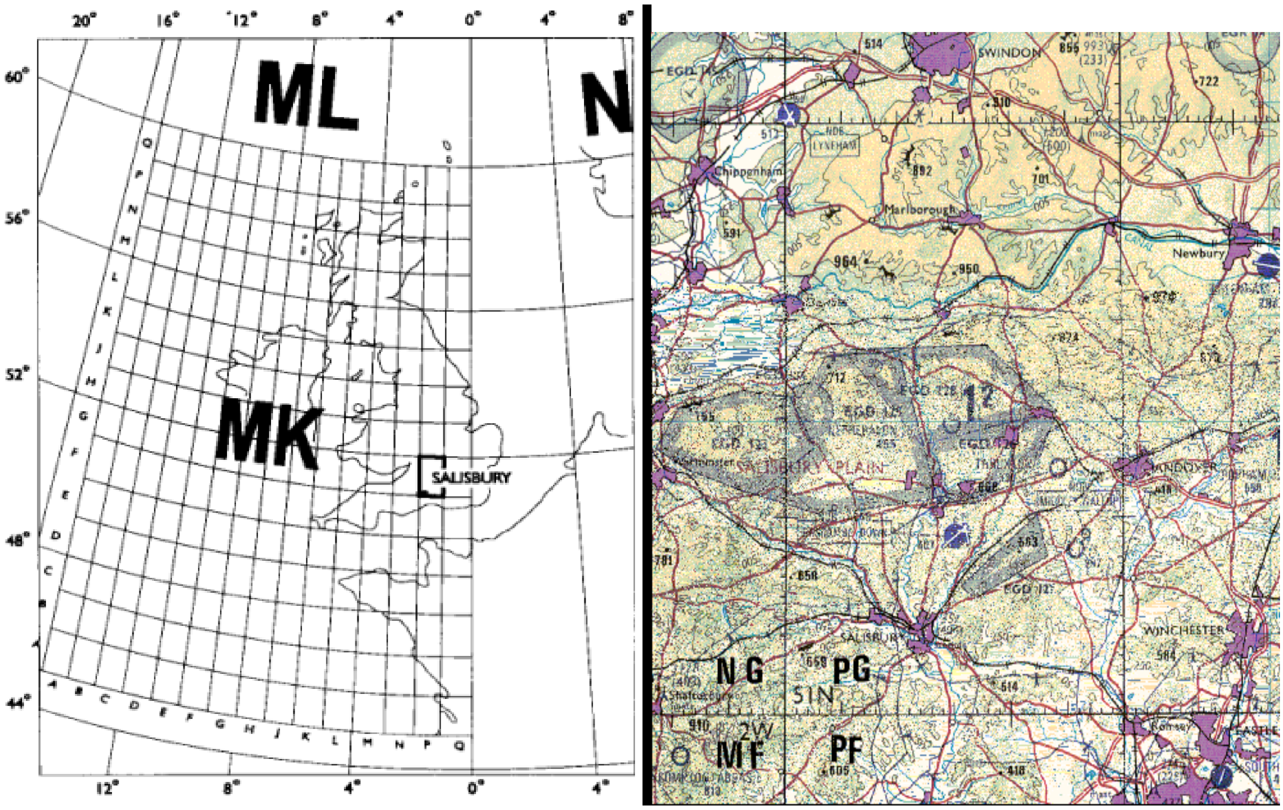


Fig 8

24. The one-degree quadrangles are now further sub-divided into 60 longitudinal zones (each 1’ of are) and 60 bands of latitude (each 1’ of are). The one-minute zones of longitude are numbered (from 00 to 60 inclusive) eastwards from the south-west corner of the one-degree quadrangle whilst the one minute bands of latitude are numbered similarly northwards.

25. The reference number of any point can now be given, to an accuracy of one minute of are, by quoting four letters and four numerals. The four letters denote the one-degree quadrangle. If the number of minutes of easting or northing is less than ten, the first numeral is always). Thus the reference of Salisbury Cathedral (51° 04’ N 01° 48 W) is MKPG 1204 (see Fig 8).

26. Occasions may arise (very infrequently) when it is necessary to define a position to an accuracy greater than one minute. The GEOREF system can be expanded to allow for this. A reference to one tenth of a minute of longitude and latitude is obtained by a further subdivision of the one-minute quadrangle into tenths of a minute of latitude northwards form the bottom left-hand corner of the minute quadrangle. The accuracy is now approximately 608 ft, and the reference is given by quoting six numerals instead of four. A further refinement to an accuracy of approximately 61 ft is obtained when the eastings and nothings are given additional figures. In this case, the first four numerals represent the eastings in minutes and hundredths of a minute of longitude and the remaining four numerals represent the northings to a similar accuracy. Thus the GEOREF of Salisbury Cathedral, to an accuracy of one-tenth of a minute, is KMPG 122039 and to a hundredth of a minute, KMPG 12250386. (See note to para 26 continued on page following Fig 8).

Note : Messages giving land positions to an accuracy greater than one nautical mile will use the local rectangular grid. This includes the reporting of crashed aircraft, and positions referred to in air operations in support of land or amphibious forces. Positions at sea, for which an accuracy of greater than one nautical-mile is required, will be designated by GEOREF using six or eight figures as detailed in this paragraph.

27. On local operations where the risk of ambiguity with a neighbouring 15^0 quadrangle is unlikely, the first two letters of the reference may be dropped. The reference given in para 25 would then become PG 1204.

28. When a position lies on a dividing meridian of two longitudinal zones or a dividing parallel of two bands of latitude, the reference letters quoted are for the most easterly zone or the most northerly band; eg the GEOREF of 50^0N 00^0W is NKAT 0000 (See Fig 8).

<u>Use of GEOREF</u>

29. The GEOREF system is used specifically in:

a. The control and direction of forces engaged in the air defence of the United Kingdom and the countries of the North Atlantic Treaty Organization.

b. The coastal defence of the United Kingdom.

30. Although the system has now a restricted use it is available for universal application should the occasion arise. Whenever security demands, it is a simple operation to change the code letters from time to time.

<u>Conversion of Latitude and Longitude to GEOREF Co-ordinates</u>

31. As we have seen, the basis of the GEOREF system is the division and sub-division of the Earth’s surface into 15° and 1° quadrangles. Remembering this (and that the origin for GEOFEF is 90°S, 180° E/W we can derive a simple method for converting a latitude and longitude position into GEOREF co-ordinates.

32. Using the conventional signs for N (+), S (-), E (+) and W (-), add 90 to the latitude and 180 to the longitude. For a position 5505N 1025W we thus get :

$$\begin{array}{l} \ \ 90^\circ \\ \underline{+55^\circ} \\ 145^\circ 05' \end{array} \qquad\qquad \begin{array}{r} 180^\circ \\ \underline{-\ \ 10^\circ\ 25'} \\ 169^\circ 25' \end{array} \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ (1)$$

Now divide the degrees portion by 15 :

$$\begin{array}{l} \underline{\quad 9 \quad} \\ 15/145 \\ \\ \underline{\quad 135 \quad} \\ \quad\ 10 \end{array} \qquad\qquad \begin{array}{l} \underline{\quad 11 \quad .} \\ 15/169 \\ \\ \underline{\quad 169 \quad .} \\ \quad\ \ 4 \end{array}$$

and add 1 to the quotients; making them 10 and 12 in the above example. Write down the letters corresponding to these numbers, omitting I and O in the count. Writing longitude first, we get MK; this is the identity of the 15° quadrangle. To obtain the identity of the 1° quadrangle add 1 to each remainder, and write down the corresponding otters (again discarding I and O); in the above example this gives EL. The final (minutes) portion of the GEOREF is given directly from (1), ie 3505. Thus 5505N 1025W corresponds to MKEL 3505 in GEOREF.

33. If, having added 90 or 180, the degree portion is not divisible by 15; ie the quotient is o, then the position is in the first or A sector. To establish a direct alphabetical-numerical relationship we simply add 1 to the quotient, as was done in the above example.

Advantages and Disadvantages

34. Advantages :

a. GEOREF provides an easy and quick method of position reference.

b. There is no risk of ambiguity.

c. It is eminently suitable for use over R/T or telephone.

d. It is capable of universal application.

e. For purposes of security, it is comparatively simple to change the code letters from time to time.

f. To quote a reference to an accuracy of 1' of longitude and latitude the group is smaller than the corresponding reference by latitude and longitude.

35. **Disadvantages** :

a. Like the latitude and longitude system it compares infavourably with a rectangular grid since a different scale has to be used for the measurement of eastings and northings.

b. The system can be confusing to the navigator because, contrary to latitude and longitude procedures, the eastings are given before the northings. Similarly in the southern and western hemispheres, the co-ordinates are still given as eastings and northings and not as southings and westings.

TOPIC-3

THE TRAINGLE OF VELOCITIES

Ref : AP3456

Vol – 7

Part – 2

Section – 1

Chapter – 1

(INTENTIONALLY BLANK)

TOPIC-4
POSITION LINES

Introduction

1. Earlier we discussed several co-ordinate systems which are used to define position on the Earth; we shall now examine the methods of determining the aircraft's position.

Terminology

2. A position determined without reference to any former position is called a fix. This is a generic term and it is often qualified to indicate the fixing method, eg radar fix.

3. Instantaneous fixes can be obtained from radio and radar systems, and the symbol O is used when plotting these position on the chart. A pin point, the visual identification of the position vertically beneath the aircraft, is also an instantaneous fix but is represented by the chart symbol O. These rapid-fixing facilities are not always available, and in these circumstances the navigator must make use of position lines in order to determine his position.

4. It is possible to fly over an identifiable feature, eg a motorway, without knowing the precise point of crossing; all that can be said is that at that particular time the aircraft was somewhere on the line of the motorway. This is known as a position line (P/L) and, as will be seen later, two or more such lines will provide a fix. Position lines may be classified according to the observation method employed, the general classifications are visual, astronomical and radio.

5. Sometimes one may only be able to obtain a single position line, even so this information can be used to refine the DR position at that time. The method of weighing the accuracy of the position line against that of the DR position is described later in this chapter. The resultant position is known as the most probable position (MPP) and is represented by the symbol MPP.

POSITION LINES

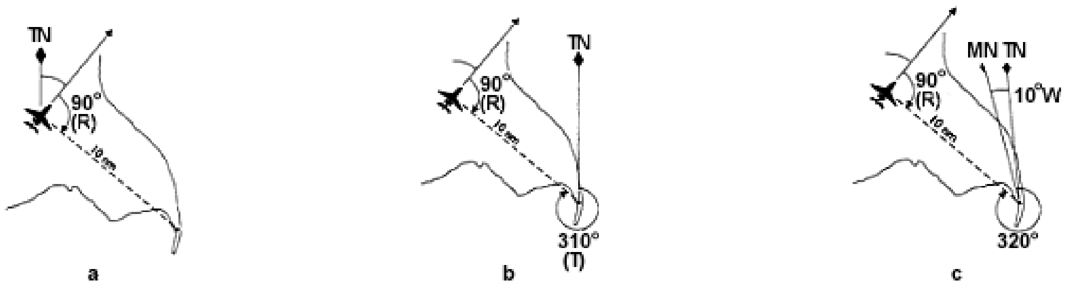
General

6. Position lines can be straight or curved, depending on the information they convey. Bearing are straight position lines representing the angular relationship between the aircraft and a known position, or the orientation of a line feature. Circular position lines represent the aircraft's range from a position, the radius of the curve being equal to the range. Both forms of position line and their sub-classifications are discussed below.

Bearings

7. **Relative Bearings**. A bearing may be taken relative to the fore and aft axis of the aircraft either by using a radio compass tuned to a radio beacon (see AP 1234C Section 21), or by making a visual observation with, say, an astro-compass or a periscope sextant. To obtain the true bearing of the beacon or object, the true heading of the aircraft must be added to the relative bearing (either directly or by offsetting the azimuth scale of the measuring instrument). The reciprocal of this true bearing plotted from the beacon or object gives the position line for the time of the observation. It is essential that the true heading applied to the relative bearing is that obtaining at the time of the observation, Example. At 1015 hours, while on a heading of 310° (T) a prominent headland is observed on a bearing of 080° relative.

True bearing	=	080° + 310° = 030° (T)
Plot reciprocal	:	030° (T) + 180°= 210° (T)



a — **Spurnhead is 090° Relative at 10 nm**

b — **Range and Bearing from Spurnhead is 10 nm on 310°(T)**

c — **Position 10 nm on the 320° Radial from Spurnhead**

Visual relative bearings also can be obtained reasonable accurately by utilizing the known bearing (from the observation position in the aircraft) of a wing tip or tail plane relative to the aircraft's fore and aft axis. The wing tip or other point is sighted when in line with the terrestrial object, and the known bearing then becomes the relative bearing and is dealt with as above.

8. **Transit Bearings**. A line drawn on a chart through two features observed to be in line, ie in transit, must pass through the aircraft's position at the time of sighting. This line, a true bearing, is therefore a position line :

ESTABLISHMENT OF POSITION AND THE USE OF POSITION LINES

9. **Line Features**. Stretches of coast line, road, railway or river, though lacking prominent features suitable for pinpoints, may be used as position lines provided that they are marked on the charts in use.

10. **Position Lines from Ground D/F Stations**. A position line may be obtained by a direction finding ground station taking a bearing on an aircraft's radio transmission. The bearing is passed to the aircraft by R/T usually in the form of either the true bearing of the aircraft from the station, or the magnetic track that the aircraft must make good to reach the station. The form is decided by the navigator's initial call : 'request true bearing' or 'request

QDM'. To use the latter information the navigator must apply the magnetic variation measured at the station, so obtaining the true track to the station, and then plot the reciprocal. The other information provided by the ground D/F station from the aircraft's transmissions is the magnetic heading to fly to reach that station, this is termed a steer. Using a local wing velocity the ground operator assesses the drift and applies this to the QDM measure to calculate the steer for the aircraft. Ground D/F facilities are provided on the following radio frequency bands :

a. MF (not in the UK)
b. HF ((not in the UK)
c. VHR.
d. UHF.

11. **TACAN and VOR Bearings**. TACAN and VOR beacons both transmit a rotating signal the phase of which, measured at the aircraft, gives the magnetic bearing of the beacon from the aircraft. To plot these bearings take the reading under the tail of the double-ended pointer (this is the magnetic bearing of the aircraft from the beacon) and apply the value of magnetic variation at the beacon. This gives the true bearing to plot.

Circular Position Lines

12. **Visual**. A plain range position line form a ground feature may be obtained using either the MK 9 series bubble sextant or the MK 2 series periscope sextant to measure the angular depression of the feature. The range can be calculated on the circular slide rule from the following formula, where relative height is the difference between the aircraft's altitude and the elevation of the feature in thousands of feet:

$$\frac{\text{Relative Height}}{\text{Depression Angle}} = \frac{\text{Range (mm)}}{9.4}$$

9.4 is a constant which takes account of the conversion of feet to nautical miles, and the similarity of the tangents of small angles to their values in radians.

13. **Radar Range Position Lines**. The range of a ground radar beacon can be obtained in an aircraft by equipments employing the transmitter/responder technique; Rebecca/Eureka and TACAN are the best known equipments of this type.

14. **Astronomical Position Lines**. The theory and practice of obtaining and plotting position lines from astronomical observations is dealt with in AP 3456, vol-7. At this juncture it is sufficient to say that the resultant position line is a range from the point immediately beneath the body (the substellar point). However the range (and hence the radius) is usually so great that the portion of the position line of interest to the navigator can be considered as a straight line.

Hyperbolic Position Lines

15. Navigation aids such as Decca and Oran provide hyperbolic position lines, which are normally combined with another of the same type to provide a fix. This is done by plotting on special charts, and the problem of transferring these lines to the standard plotting chart/ rarely arises. However in some circumstances (eg at the limits of effective cover), only a single position line may be available.

16. At these ranges the position line can be considered a straight line, and may be transferred from the special chart by :

a. Transferring the co-ordinates at which the line cuts two convenient lines of latitude or longitude or.

b. By measuring its bearing from some convenient point.

USE OF SINGLE POSITION LINES

17. A single position line can be used to provide navigation data in one or more of the following ways:

a. As a check on groundspeed.

b. As a check on ETA.

c. As a check on track made good.

d. As a check on true heading flown.

e. As a means of homing to an objective.

f. To refine a DR position by constructing the most probable position.

USE OF TWO OR MORE POSITION LINES

Introduction

18. 17. A single position line can be used to provide navigation data in one or more of the following ways:

a. Two-position Line Fix.

b. Three-position Line Fix.

c. Sandwich Fix.

d. Transfer of Position Lines.

e. Running Fixes

f. Sandwich Fix

g. Cocked Hat

Angle of Cut of Position Lines

19. If two position lines each in error by, say, $\pm$ 2nm are to be used to form a fix then the area of uncertainty caused by these errors is at a minimum when the lines are at right angles. Two position line fixes should not be constructed from lines with an angle of cut of less than 45° for this reason.

TOPIC-5
PRINCIPAL, PROPERTIES AND USES OF PROJECTIONS

Introduction

1. A map or a chart means plan sheet representing the earth's surface. The process of transferring the details of earth's surface on to a plan is termed projection. 'Projection' also refers to the resulting map or a chart. The subject "Maps and Charts" deals with the technique of projecting earth's surface on a plane surface. The distinction between a map or a chart is one of details. A map has minimum details and is used for comparing the features on earth with those on the map. A chart has minimum details and is used for plotting.

2. A Navigator is required to take an aircraft from one place to take on surface to another place on the earth's surface. Hence Maps and Charts are his fundamental means of navigation. A clear understanding of the techniques of making Maps and charts is essential for a navigator in order to be able to appreciate the accuracy and limitations of these fundamental means.

An Ideal Map

3. From the point of view of navigator an ideal map or a chart should have the following properties:

a. The distance of every place from every other place should bear a constant ratio to the true distances on the earth (Scale should be constant and correct).

b. Parallels of latitude must cut meridians at right angles.

c. Angles and bearings should be represented as on the earth.

d. Shapes and Areas should be correctly represented.

e. Rhumb line should be represented as a straight line.

f. Great circle should be represented as a straight line.

g. Adjacent sheets should fit.

h. Coverage should be worldwide.

4. On a plane surface two of these properties can never be achieved. Scale can never be both constant and correct and shapes of large areas can never be accurately represented. But for these two, all others can be achieved on a plane surface. Unfortunately not all together on one type of map.

Map Projections

5. The process of transferring the earth's surface on to a plane surface is known as projection. The resulting net work of parallels and meridians known as Gratitude is also referred to as "A Projection".

6. The process of map making involves three major steps :

a. Reduced Earth : The first step is theoretically reducing the earth to the required scale, in which form it is known as a Reduced Earth.

b. Graticule : The second step is transferring the graticule of the reduced earth on to a plane surface.

c. Topography : The last step is drawing the details of features of the earth's surface on the graticule.

Classification of Projections

7. The projections can be classified in various ways such as :

a. By their properties.

b. By their uses.

c. By the methods of projection used.

8. Proudly projections can be classified as perspective projections and non-perspective projections. Perspective or Geometric projections are those that are directly obtained by projecting the graticule of the reduced earth from a point on to a plane surface or a surface which can be easily turned into a plans surface. Non-perspective projections are those that are obtained by modifying a perspective projection or by drawing the graticuel using a mathematical formula.

MERCATOR

9. While the Mercator projection is actually derived mathematically, the analogy of a direct projection from a sphere to a particular developable surface, the cylinder, is shown as an aid to visualizing the appearance of the graticule in Figure.

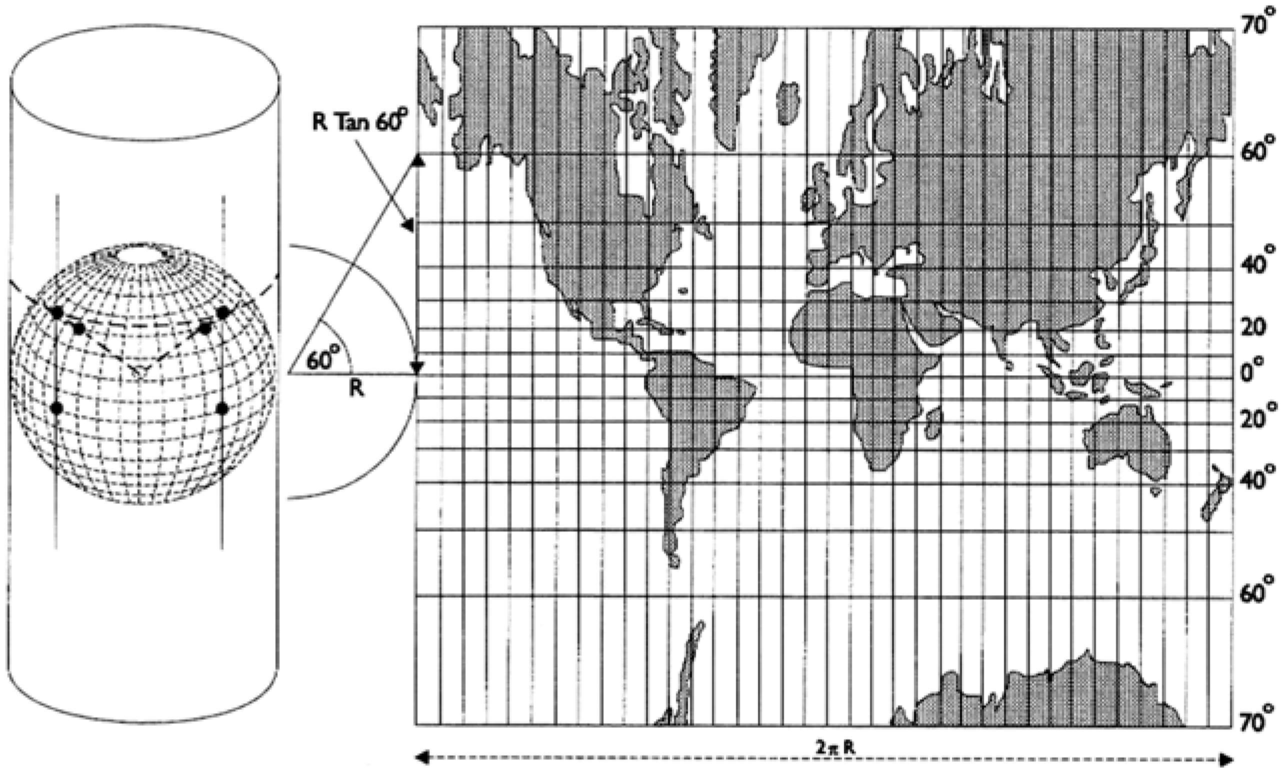


Fig No 1

10. The general appearance of the Mercator is beast described as being rectangular. Meridians of longitude are represented as equally spaced straight lines parallel to one another. They are cut at right angles by parallels of latitude represented by straight lines parallel to one another. The parallels of latitude are not equally spaced, but follow a define pattern from the equator. North and South of the equator the spacing between parallels increases.

Properties

11. a. **Type**. Cylindrical.

 b. **Light Source**. Center of reduced earth.

 c. **Meridians**. Parallel straight lines equally spaced.

 d. **Parallels**. Parallel straight lines unequally spaced.

 e. **Appearance of Graticule** : See in Fig No 1

 f. **Scale**. Correct at equator : else where expands as see lat near the pole.

 g. **Conformality**. Map is conformal.

 h. **Shapes and Areas**. Shapes are preserved; Areas are distorted away from equator.

j. **Rhumb Lines**. Rhumb lines are straight lines.

k. **Great Circles**. Curbed line convex to nearer pole.

l. **Fittings**. Sheet Fits East-West, North-South correctly.

m. **Coverage**. World wide except polar region.

Uses

12. It is used upto 12° S-N as plotting and topographical map. Over 12°, this map can not be used for plotting in the chart.

Plotting Position on the Mercator

13. On the standard Mercator, all parallels appearing on the chart are drawn as straight lines parallel to one another. Similarly, all meridians are drawn as straight lines parallel to one another and intersecting the parallels at right angles. The spacing between meridians is the same everywhere on the chart, but the spacing between parallels increases with departure from the equator. The result is a graticule that is rectangular in appearance.

14. The plotting of positions on a Mercator is made comparatively easy because of its rectangular graticule (See Fig 6-8). Every unprinted parallel is known to lie parallel to the printed parallels every unprinted meridian is known to lie parallel to the printed meridians. The location of any unprinted parallel can be determined from the division marks alon any one of the graduated meridians; the location of any unprinted meridian can be determined from the division marks along one of the graduated parallels. Consequently, if a position is to be plotted whose latitude fails to coincide with that of one of the printed parallels, the unprinted parallel, the unprinted parallel through the position to be plotted can be drawn (usually as a short line segment) by placing a protractor on the chart in such a way that one of its edges lies parallel to the printed parallels and cuts one of the graduated meridians at the appropriate division mark. Similarly, if a position is to be plotted whose longitude fails to coincide with that of one of the printed meridians, the unprinted meridian through the position can be drawn (again as a short line segment) by placing the protractor on the chart with its edge parallel to the meridians and cutting one of the graduated parallels at the appropriate division mark.

15. The procedure for determining the co-ordinates of a position already plotted on a Mercator is similar to the procedure for plotting a position. The latitude of the position, it does not fall on a printed parallel, is determined by placing a protractor on the chart in such a way that one of its edges falls on the plotted position, lies parallel to the printed parallels, and cuts any one of the graduated meridians; the latitude of the position is then read off the graduated meridian at the division mark cut by the protractor edge. Similarly, longitude of a position that does not fall on a printed meridian is determined by placing the protractor on the chart in such a way that one edge falls on the plotted position, lies parallel to the printed meridians, and cuts any one of the graduated parallels; the longitude of the position is then read off the graduated parallel at the division mark cut by the protractor edge.

Measuring Distances on the Mercator

16. Every straight lien drawn on a Mercator represents an exact rhumb line on the earth. It follows, therefore, that the distance between any two points on the Mercator, if measured along a straight line on the chart, will be the rhumb line distance between any point A and any point B on the chart, if measured along the straight line between them, will be equal to the earth distance between point A and point B along the rhumb line path between the two points.

17. The distance in NMs represented by any line on a Mercator is found by comparing its length with the chart's latitudinal scale, ie, the scale provided by any one of the fully-graduated meridians on the chart. Because the spacing between parallels on a Mercator increases on departure from the equator, the spacing between division marks along the latitudinal scale increases. As a result, the latitude scale expands with departure form the equator. Since the latitudinal scale on a Mercator is a changing scale, the measured length of a line will vary as the segment of the latitudinal scale used to measure the line is changed. To ensure the correct measurement of distances on a Mercator, it is imperative that the proper segment of the changing latitudinal scale be used during the measurement.

Measuring Directions on the Mercator

18. The Mercator chart is conformal. This means that directions are correctly represented on the chart. Hence, when the navigator uses his protractor to measure the direction of a point B from a point A on his chart, the measured direction will be equal to the direction of point B from point A on the earth. It is significant to realize, however, that straight lines on a Mercator represent rhumb lines on the earth, and as a result, the directions measured on the Mercator are rhumnb line directions.

19. Measuring the true direction of any straight line on the Mercator is particularly simple because the true constant throughout its entire length. Hence, any meridian may be used as the reference datum in measuring the true direction of the lien.

LAMBERT CONFORMAL

20. The Lambert conformal was developed conformal was developed to provide a single projection for use as a world topographical map and a universal plotting map. The analogy of a projection on to a developable surface, this time a cone, is used to explain the appearance of the Lambert conformal. A direct conical type of projection would have all meridians as straight lines that meet at a point and the parallels as arcs of concentric circles whose center is at the point of intersection of the meridians as shown in Fig. 3. Therefore, meridians and parallels intersect at right angles.

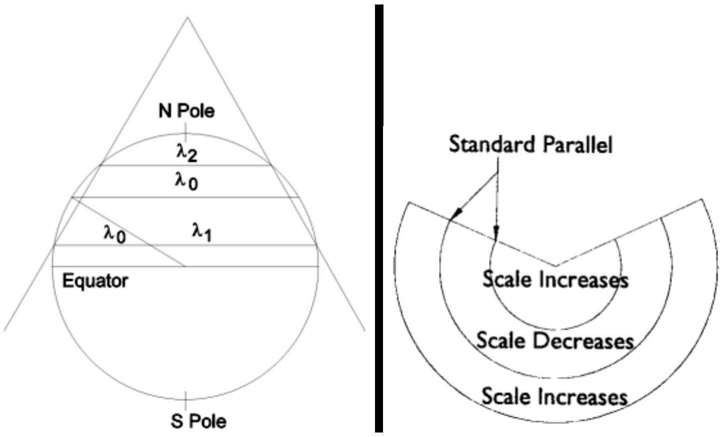


Fig No. 3.

21. To minimize scale errors, two standard parallels are employed in the construction of the Lambert conformal (See Fig 3). On these two standard parallels, scale is true; between them scale is too small and beyond them, too large. The projection is, therefore, specially suited for maps with an east-west dimension with a latitude extent not exceeding approximately 30°.

Properties

22. a. **Type**. Conical.

b. **Light Source**. Centre of RE.

c. **Meridians**. Straight Lines converging to the pole.

d. **Parallels**. Arcs of concentric circles unequally spaced.

e. **Appearance of Graticule**.

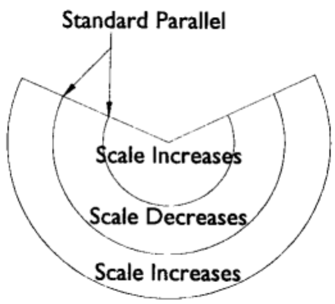


Fig No. 4.

f. **Scale**. Along Sps-correct Between SPs-contacted Outside SPs-expanded.

g. **Conformal**. Yes.

h. **Shapes and Areas**. Preserved approx everywhere depending on choice of SPs.

j. **Rhumb Lines**. Curves concave to nearer pole.

k. **Great Circles**. Approx a straight line.

l. **Fittings**. Sheets fit N.S.E-W, if the same standard parallel is closed.

m. **Coverage**. One hemisphere.

Uses

23. Since the projection is conformal, and can be considered as constant scale projection.

Plotting Position on the Lambert Conformal

24. A comparison of the graticule of a Lambert conformal chart will reveal several distinct differences. On a Lambert conformal meridians are drawn as straight lines which converge, ie, which are inclined to each other and are not parallel as they are on a Mercator chart. Again, on a Lambert conformal chart, the parallels are drawn as arcs of concentric circles and not as parallel straight lines as they are on a Mercator chart. Because of the differences between the graticules of the two charts, it is necessary to the two charts, it is necessary to adopt procedures for plotting and reading off positions on a Lambert conformal chart that differ somewhat from those used on a Mercator chart.

25. On every Lambert conformal plotting chart, the locations of unprinted parallels are indicated by division marks along selected, fully graduated meridians. Similarly, the locations of unprinted meridians are indicated by the division marks along selected, fully-graduated parallels. When a position which does not fall on some printed meridian is to be plotted, a segment of the local meridian through the position can be drawn as a short line by placing the protractor on the chart in such a way that the ruling edge passes through the appropriate division marks on two graduated parallels, one above and one below the position to be plotted. When a position which does not fall on some printed parallel is to be plotted, its location along the local meridian through the position can be determined by measuring the required distance up or down, as the case may be, form the nearest printed parallel; the required distance is established by setting the dividers to span, along any graduated meridian, the chart distance between the nearest printed parallel and the division mark representing the unprinted parallel through the position.

26. The procedures for reading off the co-ordinates of positions already plotted on a lamber conformal are essentially the reverse of those used for plotting positions. If the plotted position does not fail on a printed meridian, its longitude is determined by placing protractor on the chart in such a way that on edge passes through the position and, at the same time, intersects two graduated parallels at corresponding division marks on them; longitude is then read of either of the graduated parallels at the division mark cut by the protractor's edge. If the plotted position does not fall on a printed parallel, its latitude is determined by measuring its vertical displacement in minutes of latitude from the printed parallel nearest the plotted position, and adding (or subtracting) the displacement in

minutes (or from) the latitude of the nearest printed parallel. The vertical displacement is measured by spanning it with dividers, and transferring the spanned distance to any graduated meridian where it is read off in minutes of latitude (See Fig. 4).

Measuring Distance on the Lambert Conformal

27. On a Lambert conformal chart, any north-south straight line portrays a segment of an exact great circle on the earth, any other straight line (on the chart) Portrays a near great circle on the earth. As result any distance measured along a straight line on a Lambert conformal will be the great circle distance or very nearly so.

28. The spacing between parallels on a Lambert conformal chart though not uniform, are very nearly so, with the result that the latitudinal scale provided by the graduated meridians, though not constant, is nearly so. Consequently, the distance along any straight line on the chart can be measured in NMs, using any convenient segment of the latitudinal scale. When greater accuracy is required, however, it is advisable to use the latitudinal scale at the mid-latitude of the line whose length is being measured.

Measuring Directions on the Lambert Conformal

29. As the name implies, the Lambert conformal chart is based on a conformal projection, and hence angles measured or plotted on the chart are correct. Furthermore, because straight lines on the chart are either exact great circles or are very nearly so, any direction measured on the chart is the great circle direction or is very nearly so.

30. Because meridians converge on a Lambert conformal chart, any straight line drawn on the chart, if not a meridian, crosses successive meridians at angles that differ with each crossing. In other words, on a Lambert conformal chart, the true direction of any straight line that is not a meridian changes continuously and differs at every point along it. Any expression of the true direction of any such line is valid only at one point on the line.

POLAR STEREOGRAPHIC

31. The purpose of the polar Stereographic is to provide a graticule of the polar areas suitable for sue as plotting chart. A Stereographic projection is one in which the graticule of the reduced earth is projected directly on to a plane surface, tangential to the R E. from a source of light diametrically opposite the point of tangency. With the point of tangency at one of the poles, the projection is known as the Polar Stereographic.

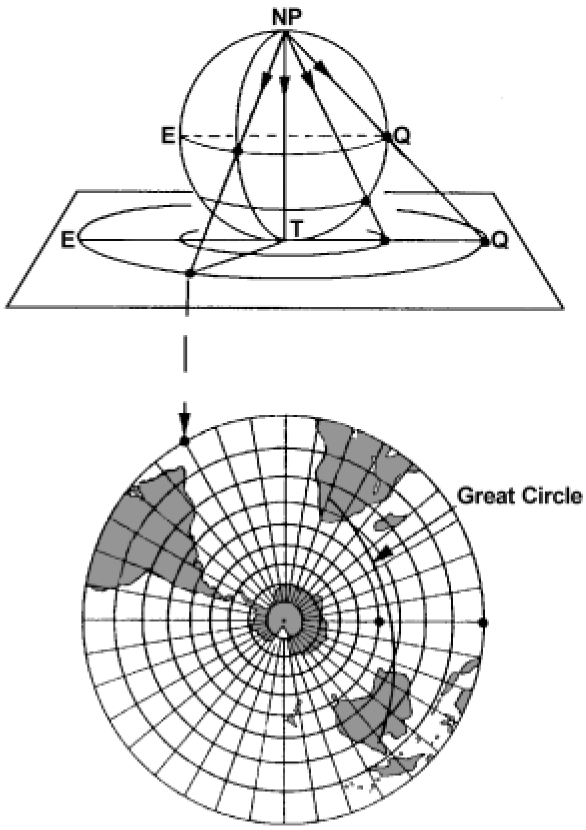


Fig No. 7.

32. The meridians appear as straight lines radiating form the pole, spaced their correct change of longitude apart, ie, there is no gap in the cone and therefore the constant of the cone is equal to one. The parallels appear as circles concentric about the pole (Fig 7).

Properties

33. a. **Type**. Azimuthally.

b. **Light Source**. Opposite Pole.

c. **Meridians**. Straight Line radiating from the pole.

d. **Parallels**. Concentric Circles unequally spaced.

e. **Appearance of Graticule**.

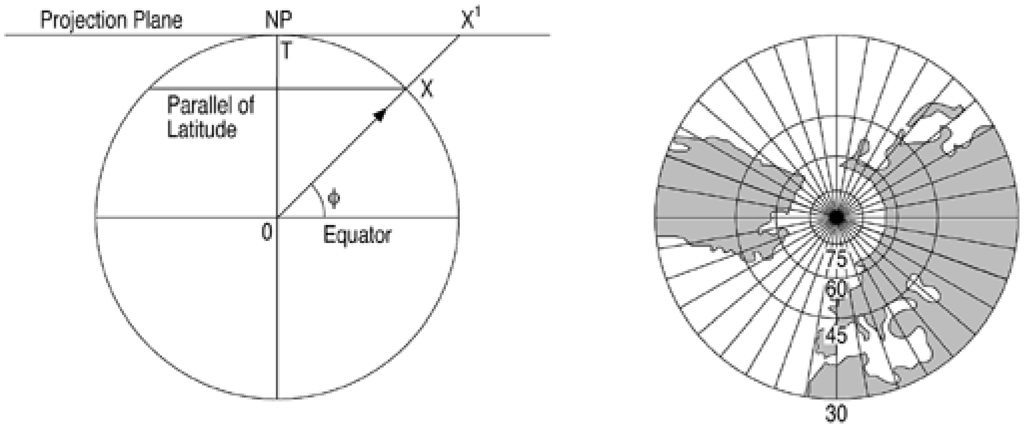


Fig No. 8.

f. **Scale**. Expands equally in all directions away from pole.

g. **Conformal**. Yes.

h. **Shapes and Areas**. Shapes of small areas near point of tangency correct, Shapes and areas distorted elsewhere.

j. **Rhumb Lines**. Curves concave to nearer pole.

k. **Great Circles**. Approx a straight line in polar region.

l. **Fittings**. Sheets do not fit N-S. E-W.

m. **Coverage**. One hemisphere only.

Uses

34. As plotting and topographical map above 74° latitude.

GROUP-'B' : AIRMANSHIP

TOPIC-1 : ATS AND ICAO RULES OF THE AIR (ANNEX 2)

Definitions

1. **Acrobatic Flight.** Maneuvers intentionally performed by an aircraft involving an abrupt change in its attitude, or variation in speed.

2. **Advisory Airspace.** A generic term meaning variously, advisory area(s) or advisory route (s).

3. **Advisory Area.** A designated area within a flight information region where air traffic advisory service is available.

4. **Advisory Route.** A route within a flight information region along which air traffic advisory service is available.

5. **Aerodrome.** A defined area on land or water (including any buildings, installations and equipment) intended to be used either wholly or in part for the arrival, departure and movement of aircraft.

6. **Aerodrome Control Service.** Air traffic service for aerodrome traffic.

7. **Aerodrome Control Service.** A unit established to provide air traffic control service to aerodrome traffic.

8. **Aerodrome Traffic.** All traffic on the manoeuvring area of an aerodrome and all aircraft flying in the vicinity of an aerodrome.

> ***Note :*** *An aircraft is in the vicinity of an aerodrome when it is, entering or leaving an aerodrome traffic circuit.*

9. **Aerodrome Traffic Zone**. An airspace of defined dimension established around an aerodrome for the protection of aerodrome traffic.

10. **Aeronautical Information Publication.** A publication issued by or with the authority of a state and containing aeronautical information of a lasting character essential to air navigation.

11. **Aeronautical Station.** A land station in the aeronautical mobile service carrying on a service with aircraft stations. In certain instances, an aeronautical station may be placed on board a ship.

12. **Aeroplane.** A power-driven heavier-than-aircraft, deriving its lift in flight chiefly from aerodynamic reactions on surfaces which remain fixed under given conditions of flight.

13. **Aircraft.** Any machine that can derive support in the atmosphere from the reactions of the air.

14. **Air Defence Identification Zone (ADIZ).** The area of air space over land or water, extending upward from the surface, within which the ready identification, the location, and the control of aircraft are required in the interest of national security.

15. **Air Traffic.** All aircraft in flight or operating on the manoeuvring area of an aerodrome.

16. **Air Traffic Advisory Service.** A service provided within advisory airspace to ensure separation, in so far as possible, between aircraft, which are operating on IFR Flight plans.

17. **Air Traffic Control Clearance.** Authorization for an aircraft to proceed under conditions specified by an air traffic control unit.

18. **Air Traffic Control Service.** A service provided for the purpose of:

a. Preventing collisions:

(1) Between aircraft, and

(2) On the manoeuvring area between aircraft and obstructions, and

b. Expediting and maintaining an orderly flow of air traffic.

19. **Air Traffic Control Unit.** A generic term meaning variously area control center, approach control office or aerodrome control tower.

20. **Air Traffic Service.** A generic meaning variously flight information service, alerting service, air traffic advisory service, air traffic control service, area control service, approach control service or aerodrome control service.

21. **Air Traffic Service Unit.** A generic term meaning variously, flight information center or air traffic control unit.

22. **Airway.** A control area or portion there of established in the form of a corridor equipped with navigational aids.

23. **Alerting Service.** A service provided to notify appropriate organizations regarding aircraft need of search and rescue aid and assist such organizations as required.

24. **Alternate Aerodrome.** An aerodrome specified in the flight plan to which a flight may proceed when it becomes inadvisable to land at the aerodrome of intended landing.

Note : An alternate aerodrome may be the aerodrome of departure.

25. **Altitude.** The vertical distance of a level, a point or an object considered as a point measured from measured from mean sea level.

26. **Approach Control Office.** A unit established to provide air traffic control service to controlled flights arriving at, or departing from, one or more aerodromes.

27. **Approach Control Service.** Air Traffic Control service for arriving or departing controlled flights.

28. **Area Control Center**. A unit established to provide air traffic control service to controlled flights in control areas under its jurisdiction.

29. **Area Control Service.** Air traffic control service for controlled flights in control area.

30. **ATS Route.** A specified route designed for channeling the flow of traffic as necessary for the provision of air traffic services.

Note *: The term ATS route is used to mean variously, airway, advisory route, controlled or uncontrolled route, arrival or departure route,, etc.*

31. **Ceiling.** The height above the ground or water of the base of the lowest layer of cloud below 6,000 metres (20000 feet) covering more than half the sky.

32. **Clearance Limit.** The point to which an aircraft is granted an air traffic control clearance.

33. **Control Area.** A controlled airspace extending upwards from a specified height above the surface of the earth without an upper limit unless one is specified.

34. **Controlled Aerodrome.** An aerodrome at which air traffic control service is provided to aerodrome traffic.

Note : *The term controlled aerodrome indicates that air traffic control service is provided to aerodrome traffic but does not necessary imply that a control zone exists, since a control zone is required at aerodromes where air traffic control service will be provided to IFR flights, but not at aerodromes where it will be provided only to VFR flights.*

35. **Controlled Airspace.** An airspace of defined dimensions within which air traffic control service is provided to controlled flights.

36. **Controlled Flight.** Any flight which is provided with air traffic control service.

37. **Control zone.** A controlled airspace extending upwards from the surface of the earth to specified upper limit.

38. **Cruising level**. A level maintained during a significant portion of a flight

Note : The word level, except in the expression flight level designates the vertical position, regardless of the reference data or the units of vertical distance used. In air-ground communications a level will be expressed in terms of altitude, height or a flight level depending upon the reference datum and the altimeter setting in use in a particular area.

39. **Current flight**. The flight plan, including changes, if any brought about subsequent clearances.

40. **Danger Area.** An airspace of defined dimensions within which activities dangerous to the flight of aircraft may exist at specified times.

41. **Expected Approach Time.** The time at which it is expected that an arriving aircraft will be cleared to commence approach for a landing.

42. **Final Approach.** That part of an instrument approach procedure from the time the aircraft has :

a. Completed the last procedure turn, where one is specified or

b. crossed a specified fix or

c. intercepted the last track specified for the procedure, until it has crossed a point in the vicinity of an aerodrome from which :

(1) a landing can be made or

(2) a missed approach procedure is initiated.

43. **Flight Crew Member.** A crew member charged with duties essential to the operation of an aircraft during flight time.

44. **Flight Information C4entre.** A unit established to provide flight information service and alerting service.

45. **Flight Information Region.** An airspace of defined dimensions within which flight information service and alerting services are provided.

46. **Flight Information Service.** A service provided for the purpose of giving advice and information useful for the safe and efficient conduct of flights.

47. **Flight Levels.** Surfaces of constant atmospheric pressure which are related to a specific pressure datum, 1013.2 mb (29.92 inches), and are separated by specific pressure intervals.

Note 1 - *A pressure type altimeter setting, will indicate altitude :*

a. when set to a QNH altimeter setting, will indicate altitude.

b. when set FE altimeter setting, will indicate height above the AFE reference datum;

c. when set to a pressure of 1013.2 mb (29.92 inches), may be used to indicate flight levels.

Note 2 - *The terms height and altitude used in Note 1 above, indicate altimetric rather than geometric heights and altitudes.*

48. **Flight Plan.** Specified information provided to air traffic services, units, relative to an intended flight or portion of a flight of an aircraft.

49. **Flight Visibility.** The visibility forward from the cockpit of an aircraft in flight.

50. **Ground Visibility.** The visibility at an aerodrome, as reported by an accredited observer.

51. **Heading.** The direction in which the longitudinal axis of an aircraft is pointed, usually expressed in degrees from North (true, magnetic, compass or grid).

52. **Height.**

a. The vertical distance of a level a point, or an object considered as a point, measured from specified datum.

Note : *The datum may be specified either in the text or in an explanatory note in the publication concerned.*

b. The vertical dimension of an object.

Note : *The term height may be used in a figurative sense for a dimension other than vertical, eg the height of a letter or a figure painted on runway.*

53. **IFR.** The symbol used to designate the instrument flight rules.

54. **IFR Flight.** A flight conducted in accordance with the instrument flight rules.

55. **IMC.** The symbol used to designate instrument meteorological conditions.

56. **Instrument Approach Procedure.** A series of predetermined manoeuvres for the orderly transfer of an aircraft under instrument flight condition from the beginning of the initial approach to a landing, or to a point from which a landing may be made visually.

Note : *The term instrument flight conditions is used in this definition in preference to other terms such as instrument meteorological conditions, because the latter term refers to meteorological conditions necessitating under instrument flight rules, but does not necessarily imply flight by reference to instruments, which is the intent of the present wording.*

57. **Instrument Meteorological Conditions.** Meteorological conditions expressed in terms of visibility, distance from cloud, and ceiling, less than the minima specified for visual meteorological conditions.

58. **Landing Area.** The part of the movement area intended for the landing or take-off run of aircraft.

59. **Manoeuvring Area.** That part of an aerodrome to be used for the take-off and for the movement of aircraft associated with take-off and landing.

60. **No Light Area.** Area in which aircraft may engage in night flying without displaying navigation lights or conforming to the semicircular rules. Details are to be notified to the ATCC at least two hours before the exercise begins, giving:

a. The area concerned.

b. Estimated times of entry and departure.

c. Track and altitude to be maintained.

61. **Pilot-in-command.** The pilot responsible for the operation and safety of the aircraft during flight time.

62. **Prohibited Area.** An airspace of defined dimensions, above the land areas or territorial waters of a State, within which the flight of aircraft is prohibited.

63. **Reporting Point.** A specified geographical location in relation to which the ;position of an aircraft can be reported.

64. **Restricted Area.** An airspace of defined dimensions, above the land areaas or territorial waters of aa State, within which the flight of aircraft is restricted in accordance with certain specified conditions.

65. **Runway.** A defined rectangular area, on a land aerodrome, prepared for the landing and take-off run of aircraft along its length.

66. **Signal Area.** An area on an aerodrome used for the display of ground signals.

67. **Taxiway.** A defined path, on a land aerodrome, selected or prepared for the use of taxing aircraft.

68. **Terminal Control Area.** A control area normally established at the confluence of ATS routes in the vicinity of one or more major aerodromes.

69. **Track.** The projection on the earth's surface of the path of an aircraft, the direction of which path at any point is usually expressed in degrees from North (true, magnetic or grid).

70. **Transition Altitude.** The altitude in the vicinity of an aerodrome at or below which the vertical position of an aircraft is controlled by reference to altitude.

71. **VFR.** The symbol used to designate the visual flight rules.

72. **Visibility.** The ability, as determined by atmospheric conditions and expressed in units of distance, to see and identify prominent unlighted objects by day and prominent lighted objects by night.

74. **Visual Meteorological Conditions.** Meteorological conditions expressed in terms of visibility, distance from cloud, and ceiling, equal to or better than specified minima.

75. **VMC.** The symbol used to designate visual meteorological conditions.

Designations

76. Flight Information Region.

77. Controlled Airspace

    a. Control Area.
    b. Control Zone.
    c. Air Way.

78. Advisory Airspace

a. Advisory Area.

b. Advisory Route.

79. Air Defence Identification Zone (ADIZ).

80. Prohibited Area.

81. Danger Area.

82. Restricted Area.

83. No Liter Area.

Safety Altitude Instructions (BAF)

84. Three factors affect the safety altitude:

a. The navigational error assumed in deciding the highest ground over which there is any possibility of the aircraft being flown.

(1) Due to the wide range of speeds and the varying accuracy of fixing aids in operation it is not possible to lay down an arbitrary figure for this error.

b. The airflow effect over high ground.

(1) An allowance of 10 per cent of the height of the highest ground is to be made.

c. The altimeter setting system in force.

(1) An allowance of 1,500 feet is to be made.

d. An example of the calculation of safety altitude for an aircraft expected to fly over ground 3,000 ft high is as follows:

(1) 3,000 ft plus (b) 300 ft plus (c) 1,500 ft equals 4,800 feet (Safety altitude).

e. Application of the semicircular system of cruising level where applicable will then give the minimum altitude to fly.

Altimeter Setting Procedure (BAF)

85. In general the following altimeter settings are used:

a. At all Aerodromes ………………QNH.

b. En-route ……………………….. ..1013.2 mbs, or 29.29 inches.

c. Control Areas and Zones …..... A value of QNH as specified by the ATCC concerned.

d. Transition level is the level at which the pilot of a descending aircraft changes to QNH from the standard setting (1013.2 mbs). This may be regarded as the lowest flight level at which an aircraft can safely proceed on the 'en-route' altimeter setting.

e. Transition Altitude is the level at and below which QNH setting is mandatory.

f. Transition Later is the airspace between Transition Level and Transition Altitude.

g. Aircraft climbing change from QNH to 'en-route' setting after leaving transition altitude and before reaching transition level.

h. A descending aircraft when above Transition level is to report his altitude as flight level (eg 6,500 ft as flight level 65; 12,000 ft as FL 120).

j. In ascent altitude is to be given in feet up to the Transition altitude and as flight level above it.

86. **Flights within Controlled Airspace.**

a. **Under VFR.** Aircraft are to be flow in VMC and in accordance with the Rules of the Air.

b. **Under IFR.**

(1) **Flight Plan**. File a flight plan as required.

(2) **ATC Clearance**. Before entering a controlled airspace obtain AC clearance to do so and adhere strictly to the terms of that clearance thereafter.

(3) **Communications.** Establish two-way communication with the appropriate ATC unit and maintain a continuous listening watch.

(4) **Position Reporting.** Pass position report over each specified reporting point.

(5) **Emergency.** Inform the controlling unit immediately if any emergency compels deviation from the terms of present clearance.

(6) **<u>Communication Failure.</u>**

(a) In VMC, continue flying in VMC and land at the nearest suitable aerodrome.

(b) **<u>In IMC.</u>**

i. Continue according to current flight plan, maintaining last acknowledged or assigned cruising level (s) for which clearance has been received.

ii. Arrive as closely as possible to ETA.

iii. Commence descent as nearly as possible to the last acknowledged Expected Approach Time or, if not. Expected Approach Time has been acknowledged, as nearly as possible to the flight ETA, and

iv. Land within 30 minutes of ETA or the last acknowledged Expected Approach Time whichever is the later or leave the controlled airspace before this time.

Note *:* ***<u>Expected Approach Time.</u>*** *Calculated by ATC, this is the time at which it is expected that an arriving aircraft will be cleared to begin an approach for landing.*

87. **<u>Flight Within Advisory Space.</u>**

a. Aircraft requiring air Traffic Advisory Service under IFR within the Advisory Routes and Areas are to :

(1) File a Flight plan.

(2) Comply with reporting procedures.

(3) Maintain communication with the unit providing the service, notifying changes in cruising level, track and ground speed.

88. **<u>Joining Airways.</u>**

a. A request for permission to join an airway is to be made on the appropriate frequency at least 10 minutes by R/T (20 minutes by W/T) before ETA at the point of entry. The selected entry point must be the Designated or on Request Reporting Point must convenient to the route. The entry request is to include the following:

(1) Call sign.

(2) Aircraft type.

(3) Position, cruising level and flight conditions.

(4) ETA at point of entry.

(5) Desired cruising level on airway.

(6) Route and point of first intended.

(7) True airspeed.

89. **Crossing Airways.**

a. Aircraft requiring to cross an airway under IFR are to:

(1) File a flight plan.

(2) Request crossing clearance 10 minutes by R/T (20 minutes by W/T) before ETA at entry point, giving:

(a) Identification.

(b) Aircraft type.

(c) Track (True)

(d) Place and estimated time of crossing.

(e) Desired crossing level.

(f) Ground speed.

(3) Maintain two-way communication with the controlling authority.

(4) Report on entering and leaving the airway.

(5) Selected crossing points should be associated with a radio facility to assist accurate navigation and airways are to be crossed at an angle of 90 degrees to the direction of the airway, or as close to this angle as is practicable.

b. **Entering Control Areas.** Procedure to enter control areas is similar to the procedure for joining airways.

90. **Position Reporting.**

a. Position reports are to be passed to the appropriate ATC Unit as follows:

(1) Within control area/ zone as instructed.

(2) On reaching control area/zone boundary.

(3) In ADR’s and airways at each designated reporting point.

(4) Outside controlled and advisory airspaces half hourly irrespective of the weather conditions.

(5) When passing from one FIR to another.

(6) On request reporting points.

b. Position reports should be made as soon as possible after the aircraft has passed the reporting point.

c. When passing from one FIR to another the position reports is to be passed to the ATC Units controlling both regions.

d. **<u>Contents of Position Reports.</u>** Position reports are to contain the following in the order stated:

(1) Aircraft identification.

(2) Position.

(3) Time of Position.

(4) Flight level or altitude.

(5) Flight conditions.

(6) ETA at next reporting point.

91. **<u>Pre-Flight Action.</u>**

a. The captain and crew of the aircraft will:

(1) have the flight authorized.

(2) Obtain a weather forecast from the Meteorological office.

(3) Report to flight planning section where he/they will carry out full flight planning in accordance with Air Headquarters instructions.

(4) Compile a flight plan when required.

(5) Ensure that the air traffic control officer is notified of the flight, and if a flight plan is necessary that a copy is passed to him.

(6) Obtain from the air traffic control officer final air traffic instructions and clearance necessary or applicable to the intended flight, at the same time notifying the control officer of any corrections to the flight plan that may be necessary.

92. **<u>Diplomatic Clearance and Flight by BAF Aircraft Abroad.</u>**

a. Regulations concerning flights by Bangladesh Air Force aircraft to or over commonwealth or foreign countries and details regarding diplomatic clearance are to be obtained from the Deputy Director of Air Transport, Air headquarters, Dhaka.

b. BAF aircraft, so far as possible and consistent with operational necessity, are to be flown in accordance with air traffic regulations issued by the countries over which they are flown.

93. When flying VMC it is the direct responsibility of the person in command of an aircraft to avoid collision with other aircraft, notwithstanding that the flight is being conducted on an air traffic clearance.

94. **Diversions.**

a. There are two grades of diversions, which are :

(1) Grade 1- This diversion is issued by the operating authority either direct or through air traffic control

(2) Grade 2 - This diversion may be issued either by the operating authority or by air traffic control, and is advisory.

Note 1 : Either grade may be issued for administrative reasons.

Note 2 : The final decision on whether or not to divert remains with the captain of the aircraft.

Flight Plans

95. a. A Flight Plan is a specified information provided to air traffic services units, relative to the intended flight of an aircraft.

b. It is the responsibility of the captain of an aircraft to ensure the flight plan is correctly complied and contains all the data relative to the intended flight.

c. No deviation shall be made from a flight plan without informing the appropriate air traffic services unit as soon as practicable.

d. Flight plans are to be submitted to the nearest area control center, aerodrome control tower or air ground communications station either in person, or by telephone or radio as applicable.

e. A flight plan may be filed through intermediate stops.

f. Flight plans are require in the following cases :

(1) For all IFR flights prior to operating in controlled airspaces, advisory airspaces and other areas as may be exempted by Air Traffic Services.

(2) For all international operations.

(3) For all flights prior to departure from all aerodromes in Bangladesh, with the exception of such local flights as may be exempted by Air Traffic Control.

g. **Filing of Flight Plans.** Flight plans are to be filed in advance. The minimum period of advance notification is as follows:

(1) **In-Flight IFR Plan.** A flight plan filed from an aircraft in the air shall be transmitted at least ten minutes' flying time before the intended point of entry into a controlled airspace if transmitted by radio-telephony and twenty minutes if transmitted by radio-telegraphy.

(2) **On0Ground (Bangladesh).** Flight Plans will be accepted only within 45 minutes prior to departure. A flight plan for an IFR flight should be submitted at least 30 minutes prior to departure.

h. **Contents.** A flight plan shall comprise information as required to be filled in on BAF form 2919.

j. **Delay.** In case of a delay of one hour or more in the expected scheduled ground time, a new flight plan should be submitted and the old flight plan to be cancelled.

k. **Changes in Flight Plan.** The appropriate ATC authority is to be notified immediately, in case of any of the changes in the flight plans.

(1) **VFR Flight Plan.**

(a) Cancellation.

(b) More than 30 minutes in ETD (BAF) otherwise aas in sub para j. above.

(c) Route or destination.

(2) **IFR Flight Plan.**

(a) Outside controlled airspace.

i. As in sub-para IK (1) I above.

ii. Height.

(b) In controlled airspace.

i. More than 10 minutes in ETD.

ii. Height route or destinations.

iii. More than 5 minutes in ETA (Bangladesh, more than 3 minutes ETA at destination or over a next reporting pointy.

l. **Cancellation of IFR Flight Plans in-Flight.** Pilots may cancel IFR flight plans at any time by notifying traffic control provided they are operating in VFR weather conditions when they take such action and where conditions indicate that the remainder of flight can be conducted in accordance with visual flight rules.

m. The cancellation of an IFR flight plan is only acceptable when the pilot-in-command uses the expression “Cancel my IFR Flight Plan.”

n. The fact that an aircraft reports flying VMC does not of itself constitute cancellation of an IFR flight plan and unless definite cancellation is made in the manner indicated in sub-para k. (2), the flight will continue to be regarded in accordance with the instrument flight rules.

p. If a flight plan has been cancelled and subsequent IFR operation becomes necessary, a new IFR flight plan must be filed and air traffic clearance obtained before encountering instrument meteorological conditions.

Note : *Acceptance of a Flight Plan shall not constitute an ATC clearance or an authorization to depart. No aircraft shall from a controlled aerodrome without prior authorization obtained either by radio or visual signals from the Aerodrome Control Tower. ATC clearance shall be obtained on radiotelephony by IFR flights prior to take-off from aerodromes located in controlled airspaces.*

96. **Filing of Flight Plan (BAF).**

a. Following procedure of filing a flight will apply to BAF aircraft operating within Bangladesh. A flight plan is to be filed with the ATC of departure for all flight as specified below:

(1) **Flights in IMC/IFR.** For all transit flights planned in IMC/IFR, the Flight plan is to be invariably filed in writing irrespective of distance/ flying time involved.

(2) **Local Flight.** For flights in local flying area and over approved firing ranges, the Flight Plan can be filed on R/T. This may be done independently or in supplement to the Flying Programme supplied to ATC earlier.

(3) **Training Cross Country Flights**. When proceeding on a cross country flight, is a part of an approved flying syllabus of a training unit, it is sufficient to give ATC the serial number of the training cross country on telephone or R/T, provided the cross country syllabus is held by the ATC. For other cross country flights, not involving landing out station, details of each leg are to be given; this could be done by telephone, but not by R/T.

b. When giving approval of a flight on telephone, the ATCO is to pass information about the current NOTAMS. Latest weather report en-route and destination, and any other information considered necessary for the safe operating of the aircraft. Weather briefing is the personal responsibility of the captain of the aircraft, and para b. above does not absolve him of it; if the latest weather is not available with the ATC he is to get it from the Meteorological Section.

ATCO on duty has the right to demand a written Flight Plan whenever in his judgement the nature of flight or traffic requires it; or he considers it necessary to keep a record of the flight clearance. In all such cases he is to make the reason known to the pilot.

Note : *These instructions do not apply to civil and foreign aircraft using BAF airfields; the civil aircraft will file the flight plan according to DGCA/ ICAO requirements, and the foreign aircraft according to ICAO and any special instructions, if issued about their operations, by Air Headquarters.*

97. a. If on an IFR flight, when operating from within a controlled airspace, or when the point of entry into controlled is within 10 minutes' flying time (20 minutes when using W/D from the point of departure, ATC clearance must be obtained prior to departure.

b. **In-Flight Clearance.** If on an IFR flights, ATC clearance must be obtained prior to entering to controlled airspace, or if on a VFR flights, prior to entering into IFR weather conditions within controlled airspace.

c. If at the time of requesting clearance to enter a control area the aircraft is flying outside the flight information region in which the entry point is situated, then sufficient time be allowed for clearance to be obtained from the ATCC conc3erned by the ATCC with which the aircraft is in communication.

d. **Adherence to Air Traffic Control Clearance.** When an Air Traffic Control clearance has been obtained the pilot in command shall not deviate from the previsions there of unless an amended clearance is received. In case emergency authority is used to deviate from provision of an ATC clearance, the pilot-in-command shall notify air traffic control as soon as possible and, if practicable, obtained an amended clearance.

e. Further clearance must be obtained from the controlling authority if the original flight plan is modified in any of the items as stated in para K(2).

f. Pilots must keep in mind the fact that once an IFR flight has entered a control area or control zone, no deviation from the provision of a traffic clearance received shall be made, unless an emergency exists, without first obtaining approval from air traffic control for such change.

g. **Air Traffic Control Instructions.** Air traffic control instructions are the directions issued by an air traffic control unit for an aircraft to proceed or to delay its flight in a specified manner.

h. **IFR Approach Clearances.** An approach clearance issued to an aircraft is approval for one approach only. If landing is not completed after one instrument approach, a pilot shall follow the specified missed approach procedure, unless otherwise instructed by air traffic control, and request further clearance from air traffic control. Air Traffic Control will then determine whether the pilot will be cleared for another immediate attempt or be directed to stand by on a designated holding pattern at an assigned level until other aircraft in line have landed or taken off. This decision will be based upon existing traffic conditions unless an emergency situation exists. A decision to route the aircraft to an alternate aerodrome will be made by the pilot or aircraft operator involved after co-ordination, when practicable, with the air traffic control personnel concefrned.

j. A new approach clearance will be required prior to commencing an additional approach. If pilot elects to proceed to the alternate aerodrome as specified in the flight plan, he must so advise air traffic control and obtain a traffic clearance.

Note : *If the pilot decides that he can proceed under VFR weather condition to the aerodrome of destination he may do so by canceling his IFR flight plan and obtaining a clearance from aerodrome control when required.*

TOPIC- 2

ICAO ATS AIRSPACE CLASSIFICATIONS (ANNEX 11)

Reference: Jeppesen Airway Manual (MES – 1)

Section - Air Traffic Control

Classifications of Airspaces

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TOPIC-3

FLIGHT PROCEDURES (DOC 8168)

Reference: Japanese Airway Manual (MES – 1)

Section - Air Traffic Control

Flight Procedures

General Principles	General Information
	Accuracy of Fixes
	Turn Area Construction
Departure Procedures	General Criteria
	Standard Instrument departure
	Omni directional Departure
	Published Information for Departure
Arrival and Approach Procedures	General Criteria
	Arrival Segment
	Initial Approach Segment
	Intermediate Segment
	Final Approach Segment
	Missed Approach Segment
	Visual Manoeuvring (Circling) Area
En-route Criteria	En-route Criteria
Holding Procedures	Holding Criteria
	Obstacle Clearance

RNAV and Satellite Based Procedure	General Information for RNAV System
	Departure Procedures (RNAV)
	Arrival and Non-Precision Approach Procedures (RNAV)
	Arrival and Approach Procedures with Vertical Guidance (RNAV)
	Precision Approach Procedures (RNAV)
	RNAV Holding
	Enroute (RNAV)

TOPIC- 4

AIRCRAFT OPERATING PROCEDURES

Reference: Jeppesen Airway Manual (MES – 1)

Section - Air Traffic Control

Aircraft Operating Procedures

Altimeter Setting Procedures	Introduction to Aircraft Operating Procedures
	Basic Altimeter Setting Requirements
	Procedures for Operators and Pilots
	Altimeter Corrections
SSR Transponder Operating Procedures	Operations of Transponders
Simultaneous Operations on Parallel or Near-parallel Instrument Runways	Modes of Operations

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TOPIC- 5

AIR TRAFFIC MANAGEMENT (DOC 4444)

Reference: Jeppesen Airway Manual (MES – 1)

Section - Air Traffic Control

Air Traffic Management

Air Traffic Management	General Provision for Air Traffic Services
	Separation Methods and Minima
	Separation in the Vicinity of Aerodromes
	Miscellaneous Procedures

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TOPIC- 6

FLIGHT SAFETY GENERAL

Fire Precaution

1. Every aircraft is to carry where applicable, as part of its equipment fire extinguishers of approved pattern according to the scale in the schedule of equipment. The captain of the aircraft is to ensure that the correct number of extinguishers are carried in the aircraft.

2. Matches other than the “Safety” type are not to be taken into aircraft.

Chocks

3. Chocks are normally to be placed in front of the wheels of an aircraft before the engines are started and when crews are being changed eg in training sorties.

Maps

4. The captain of the aircraft is to ensure that maps covering the whole of the route or area over which the flight is to take place are carried in the aircraft. Maps covering the diversion are also to be carried.

5. There is sometime a possibility of maps being inaccurate. Map users are to report any error on published maps which is likely to endanger the safety of aircraft, as soon as possible to Air Headquarters.

Safety Equipment

6. **Responsibility of the Captain**. The captain of the aircraft is to ensure that his crew is proficient in the use of the safety equipment carried in the aircraft. He is also to ensure that passengers are suitably briefed before flight on the handling of the safety equipment which they may be called upon to use.

7. **Carriage and Wearing of Safety Equipment**. Detailed instructions regarding the carriage aid wearing of safety equipment is to be found in the appropriate manuals, T.O. Dash one for the aircraft type and in Chapter 14. Station Commander may authorise deviation from these principles if the flight conditions likely to be encountered, or the type of aircraft to be used, necessitate such deviation.

8. **Modification of Safety Equipment**. Safety equipment is not to be modified without the prior approval of the Air Headquarters.

9. **Parachutes**. On the following occasions :

   a. In training and operational aircraft, parachutes are to be worn by all occupants except as mentioned in sub-para (b) below. However, crew members whose duties prevent them from wearing a parachute are exempted from doing so.

b. In transport and communication aircraft, parachutes are to be carried for the occupants on the following occasion:

(1) President's flight.

(2) For VIPs VVIPs.

(3) Trial of dropping equipment.

(4) Air-tests after a minor or major accident.

(5) Training aircraft when the caption of the aircraft is uncategorized.

(6) Formation flying.

(7) When Station Commander consider the carriage of parachutes desirable.

c. **Exemption to Carry Parachutes**. For a specific flight, when it is considered impracticable to comply with the above orders, the Station Commander may modify the orders in sub-paras (a) and (b) above.

10. **Life-Saving Jackets**. Life-saving jackets are to be worn by or carried for all occupants of aircraft flying within five miles of the sea.

11. **Survival Packs**. A survival pack which contains a dinghy of an appropriate type is to be carried for all occupants of aircraft, when both a parachute and a life saving jacket are required to be worn.

12. **Multi-Seat Dinghies**. Multi-seat dinghies of sufficient capacity to accommodated all the occupants are to be carried in transport or communication aircraft when flying is intended or likely to be carried out over the sea.

<u>Safety Harness</u>

13. In fighters, bombers and training aircraft, safety harnesses are to be worn at all times. In transport aircraft, safety harness or belts where provided, are to be worn during flight at the discretion of the captain but are always to be worn during take-off and landing. Passengers and crew members not provided with a safety harness or belt are to station themselves at their crash position during :

a. Take-off and landing.

b. At the captain's discretion.

Oxygen Equipment

14. The captain of an aircraft in which oxygen equipment is fitted is responsible for the efficient use of that equipment by his passengers and crew. Before take-off he is to ensure that the equipment is serviceable and that the passengers and crew fully briefed on the use of the equipment.

15. Jet aircraft should operate only when enough oxygen is carried for the entire duration of the flight. In exceptional circumstances flights without oxygen may be authorised by the Station Commander.

Armament Exercises

16. To avoid aircraft being damaged by ricochets, Station Commanders are to ensure that air to ground ranges in use are cleared of stones, tocks, bullet heads and other hard objects prior to commencement of each day's exercise. This order does not apply to the tactical ranges.

17. All air to air exercises are to be carried out in pre-determined range areas. RSO (Two aircraft) is to ensure that there is no vessel/ship in the vicinity and that he is flying in the correct area. Air to air exercises may be conducted above weather provided radar aids can determine position of firing aircraft and a low-looking radar aid can declare range area clear of vessels.

18. **Armament Switches**. While carrying live armament stores armament switches are to be set at "fire" only when the aircraft is actually in the attack. At all other times, safety switches are to be at "safe".

Security of Aircraft

19. (Before leaving an aircraft at an out-station base or airfield) the captain of an aircraft is to ensure that :

a. The aircraft is properly secured and as far as possible protected from weather.

b. The appropriate lights are switched on if necessary.

c. If at a non- BAF airfield, the aircraft is secured and guarded as far as possible.

Restrictions on Aircrew

20. Aircrew are not permitted to fly or continue flying while fasting when the last meal was taken 5 hours or more before the flight. In addition, flying is not to be undertaken sooner than one hour after taking the fast.

21. No aircrew is to consume any type of alcohol less than 10 hours prior to flying.

Flying Fatigue

22. All aircrew are to be afforded periods of rest sufficient to ensure that their efficiency is not undermined by fatigue. Accordingly the following principles relating to crew duty time, maximum flying hours and crew rest periods have been laid down.

23. Where aircrew are likely to be employed or engaged in flying activity to the maximum, officers responsible for authorizing flights, and captains of aircraft are to ensure that all pilots/aircrew are fit for the assigned missions and what they have had at least 8 hours of rest prior to the commencement of the day's flying.

24. OC Wing/Squadrons and transport aircraft captains are authorised to reduce drew duty time and increase the rest time at any stage they consider that flying safety is being endangered as a result of fatigue. They are also to reduce or restrict the number of hours/sorties required to be done by an aircrew, when it is suspected that inefficiency in flying is attributable to flying fatigue.

Maximum Flying Hours

25. Aircrew are not to exceed the flying hour limitations laid down below, in their specific roles :

a. Transport.

(1) 1000 hours in a year.

(2) 300 hours in 3 consecutive months.

(3) 125 hours in 28 consecutive days.

b. Fighter and fighter Bomber. – 04 hours in a month.

c. Bomber. - 60 hours in a month.

d. Training. - 60 hours in a month.

TOPIC-7

EMERGENCY PROCEDURES

Reference: Jeppesen Airway Manual (MES – 1)

Section - Emergency

Emergency Procedures

Emergency Procedures	Definitions
	Emergency procedures
	Unlawful Interference
	Communication Failure

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GROUP-'C' : METEOROLOGY
TOPIC-1 : INTRODUCTION & ATMOSPHERE

Introduction

Definition

1. Meteorology is the branch of Science which deals with the earth's atmosphere and the physical processes occurring in it. It includes the study of all changing atmospheric conditions such as fog, snow, rain, thunder storms, wind- which go to make up our weather.

2. Study of weather is done in three stages :

a. **Stage-1.** Observation of different weather elements and phenomena such as atmospheric pressure, temperature, humidity, wind, clouds, visibility, rain thunderstorm, turbulence, ice-accretion etc.

b. **Stage-2.** To establish co-relation between changes in these elements.

c. **Stage-3.** To forecast the future occurrences of these phenomena.

3. Need for the study of Meteorology is to understand the behaviour of the ocean of air so that an aircrew can operate efficiently through it.

Aim of Study of Meteorology

4. Some weather manifestation can be awe-inspiring. We feel uncertain when we encounter phenomena we can not explain, but understanding breeds confidence. Moreover, the many and varied facts we need to know about the behaviour of the atmosphere can be grasped more easily by understanding the physical reasons underlying them. The aim is to help you to operate with maximum efficiency, safety and confidence in all types of weather.

Value of Weather Knowledge

5. At one time, pilots though it would be possible to get above the weather by flying at about 20,000 ft. Now a days it is realized that even above 40,000 ft, certain weather features are still important. These include; wind, temperature, pressure, density, condensation trails and sometimes even thunderstorm and icing. Winds at about 30,000 ft to 40,000 ft often exceed 100 kts in a narrow belt, and aircraft caught unprepared may be swept off their intended track or insufficient fuel to return to base.

6. Aircraft with modern aids operate regularly in weather, which would once have been considered too bad for flying. However, there are still minimum weather limits for safe flying. In adverse weather conditions, a knowledge of the weather and its forecast development is of the utmost value in helping inexperienced aircrew to avoid hazards and experienced aircrew to negotiate them confidently.

7. Accurate weather reports during flight are likely to be of value to other aircrew flying in the locality, particularly in adverse weather conditions. Apart from helping the meteorological officer to check his forecast, your reports may provide the first indication of unforeseen developments.

8. One of the best ways of acquiring useful weather information is to pay frequent visit to local Meteorological office. By discussion with the forecaster one can clear up many problems and also gain an insight into his difficulties.

9. The various components which make up the weather may have widely different meanings and importance for different people. A pilot may be chiefly interested in the weather at base and destination; the navigator may be more interested in winds and temperatures at various heights; whereas the signaler is probably concerned with these areas where bad weather may interfere with Communications. The forecaster caters all these varied requirements on request, but to use the service efficiently you must know what facilities are available, as well as the limitations of the service and be able to understand weather charts and technical terms.

ATMOSPHERE

Constitution of the Atmosphere

10. The atmosphere is the gaseous envelope surrounding the earth composed mainly of a mixture of about four-fifths by volume of nitrogen and about one fifth by volume of Oxygen is an inert gas, but Oxygen is essential for human life and for combustion processes.

11. The atmosphere also contains a small but very variable amount of invisible water vapour. From the standpoint of weather this is the most important constituent for clouds, fog, rain and snow. They can form only as a result of the invisible water vapour in the atmosphere changing into water droplets and ice crystals.

12. Suspended mainly in the lower layer of the atmosphere there are usually microscopic crystals of salt left from the evaporation of ocean spray, and particles of smoke. These latter are of significant importance to aircrew for they may seriously reduce visibility, specially near large towns and industrial areas.

13. Percentage composition of dry air is given in table below:

Nitrogen	78.03%	75.48
Oxygen	20.99%	23.18%
Argon	0.94%	1.29
Carbon dioxide	0.03%	0.045%
Hydrogen Helium Krypton Xenon	Traces only	Less than

14. The amount of oxygen available is of prime importance in connection with the performance of aircraft engines and is vital for the pilot operating at high altitudes as it determines whether a special oxygen surplus necessary. For all meteorological questions with which we shall be concerned dry air may be regarded as an uniform gas, obeying substantially the same laws as a pure elementary gas, but mixed in widely varying proportions with another gas, water vapour, the presence of which profoundly affects the behaviour of the atmosphere as a whole.

<u>Structure of the Atmosphere</u>

15. There is no upper limit of the atmosphere, it simply becomes extremely this at great heights. Nevertheless, even 200 miles up there is still enough air to render fast moving meteors while hot by friction and so make them visible by night as shooting stars.
Considering the characteristics and behaviour, the atmosphere has divided into following layers.

16. **<u>Troposphere.</u>** It extends from surface to 8 Killometers. Practically all weather phenomena occur within this layer. There is considerable motion air and convectional currents, which often carry heat and water vapour to considerable altitudes. Temperature decreases with height, wind increases with height within this layer.

17. **<u>Stratosphere.</u>** Above the troposphere lies the stratosphere. The base of stratosphere does not remain fixed. It varies in altitude with latitude, the season and the local weather below it. It is lower over poles than over the equator, lower in winter than in summer, and lower over depression than over anti-cyclones. It is extended from 12c to 80c. Stability is the particular characteristic of the lower stratosphere. Its steady winds and cloudless state offer the nearest approach to ideal flying conditions. Temperatures remain relatively constant throughout the year. Wind velocities generally decreases while temperatures actually increase above the tropopause. Stratosphere has been sub-divided into three layers :

a. **<u>Isothermal Layer.</u>** It is the base of stratosphere and extends from 12km. This is the layer of maximum concentration of ozone. Prevailing wind is easterly during summer and westerly in winter. No vertical motion in this layer and the average temperature is – 50^0c.

b. **<u>Warm Layer.</u>** This extends from 35-50km. This layer contains less ozone but absorbs maximum portion of the ultra-violet radiation. Top of the warm layer is called ozone-pause.

c. **<u>Upper Mixing Layer.</u>** It extends from 50-80km. There is strong turbulent mixing in this layer, that is temperature decreases with height and reaches the minimum at the top of the mixing layer.

18. **Ionosphere**. It extends form 80 km to 800 km and molecules and atoms are found in ionized state. It consists of three layer :

a. **E-Layer**. Layer of maximum ionization.

b. **F-Layer**. Oxygen is present in atomic stage.

c. **A-Layer**. This layer is called atomic layer. Almost all elements present in this layer stay as atom.

19. **Exosphere**. It extends from 800km and above. The temperature increases with height. The temperature at the top of the exosphere is about + 2000°c. Particles are almost outside gravity.

TOPIC– 2
ATMOSPHERIC PRESSURE & TEMPERETURE

ATMOSPHERIC PRESSURE

Definition

1. The atmospheric pressure at any level is equal to the weight of the column of air of unit cross-sectional area extending from that level to the top of the atmosphere. This weight per unit area, at sea-level, average about 14½ lb. Per square inch, but varies a little from day to day and from place to place.

Measurement of atmospheric pressure and its Unit

2. Atmospheric pressure is measured by means of a mercury or an aneroid barometer. In the former the pressure of the air is balanced against the weight of a column of mercury inside a glass tube; in the latter it is balanced against the springiness of the flexible metal lid of a box. The box is sealed after most of the air has been pumped out of it, and the movements inwards and outwards of the center of the lid rotate a needle over a dial. An increase of pressure compresses the flexible lid, while a decrease of pressure causes it to bulge outwards.

3. The aneroid barograph works on the same principle, and enables atmospheric pressure to be recorded as a continuous Trace on a chart wrapped round a revolving drum.

4. The mercury barometer is a more sensitive instrument. The standard new pattern barometer is used in the Meteorological office and in some air traffic control offices for determing atmospheric pressure and altimeter settings.

5. Atmospheric pressure is measured in millimeters or inches of mercury-the length of mercury column necessary to balance the pressure of the atmosphere. The unit of pressure now in general use in meteorology is the millibar (mb). A pressure of 1mb. Is equivalent to a force of 1000 dynes acting on 1 square centimeter. The normal air pressure at sea level in British islands is about 760 mm (1013-2mb).

Variation of Pressure

6. As one climbs into the atmosphere, air pressure decreases, air pressure decreases, because there is lesser weight of air above. The rate of decrease of pressure with height is not constant. Near the ground the air pressure decreases by 1mb for a climb of about 30 ft height up the depth of air equivalent to 1mb increases, and at 20,000ft it is necessary to climb about 50 ft for the pressure to drop by 1mb. Since cold air is denser than warm air, a climb of 1000 ft in cold air will obviously cause a larger reduction of pressure than would a similar climb in warm air. The rate of decrease of pressure with height is therefore greater in cold air than in warm, and greater near the surface than at high levels. These facts are

important in the design and calibration of an aircraft instrument which measures height – the altimeter.

7. The difference in height corresponding with a pressure change of one millibar for any value of temperature and pressure may be calculated very easily from the formula:

Height difference in ft for on mb pressure change $\frac{96T}{P}$, where T is the absolute temperature and P is the pressure. A few selected values are give below:

Temperature				**Pressure in millibars**						
Temperature		**Pressure in millibars**								
^{O}F	^{O}A	1050	100	950	900	800	700	600	500	300
100	311	28	30	31	33	37	43	50	60	99
50	283	26	27	29	30	34	39	45	54	90
0	255	23	24	26	27	31	35	41	49	82
-50	227	21	23	24	24	27	31	36	44	73

8. Pressure varies from place to place at the same level is known as horizontal variation of pressure or pressure gradient. Pressure gradient is the change of pressure per unit distance perpendicular to the isobar and is expressed as mb/degree latitude or kilometer or mile. For example the horizontal gradient is 2mbs per 100 miles or 0.02 mb/mile.

The Pressure Altimeter and its Calibration

9. The dial of an aneroid barometer can be graduated in feet instead of in units of pressure, and then the instrument becomes an altimeter. But in making the graduations an assumption has to be made about the temperature of the atmosphere. The particular assumption made in calibrating the Mark 19 altimeter is that the air temperature changes with height in accordance with the International standard Atmosphere (usually called the ICAO atmosphere because the specification was laid down by the International Civil Aviation Organization), in which :

a. At the level where the pressure is 1013. 2mb, the temperature is 15°C (59°F).

b. Up to 11 km. (about 36000 ft.) temperature decreases by 6.5°C per kilometer (about 1°C per 500 ft. and 1 °F per 300 ft.).

c. Above 11km the temperature is constant at – 56.5°C. (-69.7°F).

This altimeter gives a reading of true height only when the actual mean temperature of the air below the aircraft is the same as that in the IGAO atmosphere; if the air is colder than the standard atmosphere the altimeter over-reads, and vice-versa. For example, in an aircraft over however on a particular occasion when the atmosphere was considerably colder than standard, at 3000 ft. the altimeter was reading 3240 ft. (+8 percent error), whilst at 28,760 ft the reading was 30,060 ft. (+4|% percent error). Such errors due to non-standard air temperature can usually be reduced by making corrections to the indicated height using the height and airspeed computer.

Altimeter Sub-scale Settings

10. When this sub-scale is adjusted until it reads the current value of the atmospheric pressure at aerodrome level (QFE), the Altimeter needle will indicate zero height. If the aircraft then takes off and flies above the aerodrome, its altimeter will read the height of the aircraft above the aerodrome.

11. If the current value of the atmospheric pressure, corrected to mean sea level in accordance with actual prevailing conditions, were set on the sub-scale of an altimeter in an aircraft on the runway, the altimeter would read approximately an elevation of the airfield. The reading will not be exact because altimeters are calibrated in accordance with a standard atmosphere which seldom the same as the actual atmosphere. The error involved will be negligible at low level air fields but as elevation increases the error becomes appreciable.

12. The setting known as Airfield QNH overcomes this error. Air field QNH is the observed pressure at airfield elevation corrected for temperature and reduced to mean sea-level using ICAO formula, when this value is set on the sub-scale the altimeter will indicate altitude and when on the airfield, the airfield elevation (plus the height of the altimeter above the airfield).

13. To minimize the danger of collision between aircraft which may be flying in the same area at the same time, the ICAO Standard altimeter setting procedure is used. This procedure requires all altimeter sub-scales to be set to 1013.2 mbs, so that a safe standard of flight separation is ensured for all aircraft.

14. Values of QFE and QNH are always available as required both on the ground and the air.

15. Apart from the pressure altimeter, another instrument, the readings of which depend on air density, is the air speed indicator. The instrument is calibrated to read correctly under conditions of standard sea-level air density, and so under-reads at flying heights.

16. The performance of an aircraft depends on air density, for the lesser the density, the lower the lift and drag. This is specially significant at aerodromes where air density may be low owing to high air temperatures or to elevation of the site. In these circumstances

increased speed will be needed to acquire the minimum lift necessary for take-off, and so either longer runways must be provided or the aircraft load must be reduced.

17. There is, of course, a direct effect on aircrew, for the human mechanism works under conditions of normal atmospheric pressure and density. At 10,000 ft. air density is only about three-quarters of the normal sea-level value; above this altitude lack of oxygen can produce adverse physiological effects which are overcome by the use of oxygen masks or by pressurization.

ATMOSPHERIC TEMPERATURE

Significance of Atmospheric Temperature

18 A Navigator needs to know the air temperature in order to apply suitable corrections to the reading of instruments, such as the air speed indicator and the pressure altimeter. Pilots are concerned with the effect of air temperature on the performance of their aircraft and in connection with icing problems. Thermal winds and the broad zones of bad weather characteristic of temperate latitudes are dependent on horizontal variations of upper air temperature, while the development of showers and thunderstorms is largely governed by the rate of change of air temperature with height. Thus directly or indirectly or indirectly air temperature and its variations are of significance of aircrew.

Scales of Temperature

19. a. **Centigrade or Celsius (°c)**. This scale is used in all meteorological reports. On this scale melting point of ice is O°c and the boiling point of water under standard atmospheric pressure is 100°c.

b. **Fahrenheit (°F)**. On this the melting point of ice is 32°F, and the boiling point of water under standard pressure is 212°F, the two fixed points thus being separated by 180°F.

c. **Absolute (°A) or Kelvin (°K)**. This scale is scientific scale in which the degree is the same as the centigrade degree, but the absolute Zero is taken as –273°c. Which is (approximately) the lowest temperature theoretically obtainable. Thus the melting point of ICE is 273°A and the boiling point of water is 373°A.

20. The relationship between the centigrade, Fahrenheit, and Absolute Scales:

a. To convert °C to °A : add 273.

b. To convert °C to °F : multiply by $\frac{9}{5}$ and then add 32 (e.g. 10°C = 50°F).

c. To convert of °F to °C : Subtract 32 and then multiply by $\frac{5}{9}$ (e.g. 59°F=15°C).

Measurement of Temperature

21. To measure the temperature of the air at the standard height of about 4 feet above ground a mercury-in-glass thermometer, supported in a ventilated wooden Stevenson Screen to shield it from the sun and weather, is used.

22. The temperature of the air up to 50,000 ft or more is accurately measured at least every 12 hours at upper air reporting stations and ocean weather ships by the instrument known as the Radio sound. This automatically transmits a series of signals of a frequency dependent on pressure, temperature and humidity of the air. The signals are received at the observing stations and converted to readings of these elements by means of calibration curves.

Heating of the Atmosphere

23. Air temperature and the way it changes horizontally, vertically, and with time, largely govern the development of weather and upper winds. To understand them one must know something about the manner in which the earths atmosphere is heated. In this the physical processes of radiation, conduction and convection, all play their part.

24. **Solar Radiation**. The source of the earth's heat is the sun which emits heat and light energy. The sun's radiant energy travels across the 93 million miles of empty space and thorough the almost transparent terrestrial atmosphere to reached the earth surface, where it partially reflected back into space but partially absorbed and converted into heat. The important fact is that the sun's radiant energy warms the earth surface without appreciably heating the bulk of the earth's atmosphere through which it passes.

25. **Conduction and Convection.** Ground warmed by absorbed solar radiation transfers some of its heat to the layer of air in contact with it by the process of conduction. The process of heat by physical movement is known as convection. The rising convection currents are known to glider pilots as "thermal" they are often topped by a formation of cum7ulus clouds, and account for the bumpiness usually experienced on low-level flights on a sunny day.

26. **Terrestrial Radiation.** The sun, being at a very high temperature, emits energy in the form of short-wave radiation, much of it visible as light. Although much collar than the sun, the earth also constantly radiates energy, but in the form of long wave (infrared) invisible radiation. During the day the earth absorbs more energy than it emits, so that its temperature rises at it receives no solar radiation to make good the less by emission and its temperature falls.

27. The atmosphere readily transmits most of the incoming short ways solar radiation, but water vapour in the air absorbs a part of the outgoing long-wave terrestrial radiation and coverts into heat. Thus the invisible water vapour in the atmosphere acts raher like glass of green-house in permitting incoming solar radiation to pass through almost unimpeded but trapping, absorbing, and converting into heat, most of the outgoing long-wave radiation.

28. To summarize, the atmosphere is heated by process of conduction and convection and by absorption of much of the earth's long wave radiation by water vapor; it is warmed from below, rather than by direct solar radiation from above.

Lapse Rates and Inversion

29. The rate of decrease of temperature with height is known as lapse rate. The average lapse rate in the troposphere is about 2^0C per 1000 ft but on a particular occasion the lapse rate may differ considerably from this average value.

30. Quite often radio-sound measurements show that on particular occasions one or more atmospheric layers exist in which the air temperature increases with height. The condition is known as an inversion of temperature. The trpopoa use is generally associated with a temperature inversion.

31. Inversion based at ground level and extending through a shallow surface layer of air are frequently found at inland stations after a clear calm night.

Diurnal Variation of Temperature

32. A rhythmic variation normally observed during a 24 hours period, but the maximum surface air temperature over land usually occurs two or three hours after midday, with the minimum about sunrise. The diurnal variation of temperature is greater when the sky is clear than when it is overcast.

TOPIC-3
ATMOSPHERIC HUMIDITY & STABILITY

ATMOSPHERIC HUMIDITY

1. **Water Vapour.** Although as invisible gas, water vapour is a very important constituent of the atmosphere because under certain conditions it can condense into the millions of tiny droplets of water or crystals of ice which constitute clouds and fog. If there were no clouds, no precipitation, and no icing problems. It is necessary to know something about the water vapour content of the atmosphere and the physical processes of condensation and evaporation if we are to understand the formation of clouds and fog, and the development of precipitation.

2. **Evaporation**. If liquid water is in contact with unsaturated air, the water will slowly evaporate. The process will continue until the air becomes saturated with water vapour; there after no more water will evaporate unless the temperature of the air is raised. During the process of evaporation, heat is absorbed. About 600 calories of heat are needed to convert 1 gram of water into vapour.

3. **Saturation**. Air at a given temperature in contact with a flat surface of pure water (or ice) can take up only a limited amount of water vapour. The higher the temperature, the more water vapour it can contain. Air is said to be saturated at a particular temperature when it contains the maximum possible quantity of water vapour.

4. **Condensation.** If air containing water vapour is cooled, a temperature will be reached at which it becomes saturated; any further cooling below this temperature will result in the condensation of some of the invisible water vapour into water droplets, or if the temperature is low enough, into ice crystals. An important feature of condensation is that during the process latent heat is released : for every gram of water vapour which consensus to liquid about 600 calories of heat are released.

Note : *A calorie is the amount of heat required to warm one gram of water through one degree centigrade.*

5. **Dew Point.** The dew point is the temperature at which a given sample of moist air would become saturated if cooled at constant pressure. For example, if air at a temperature of 60^0F has a dew point of 40^oF, then it would be necessary to cool that air by 20^0F in order to cause saturation. Any further cooling would of course result in condensation taking place. Thus the dew-point is very significant in determining whether or not fog or clouds will form. The dew-point of a given sample of air increases or decreases only if water vapour is respectively added to or removed from the sample.

6. **Relative Humidity.** Relative humidity is a term used to express the degree of saturation of air. It is the percentage ratio of the amount of water vapour actually present in the particulars sample of air to the amount which would be needed to saturate it at that temperature.

7. **Diurnal Variation of Relative Humidity.** When moist air is warmed its relative humidity decreases, The temperature of air near the ground inland reaches a maximum in the dearly afternoon and falls to a minimum around dawn. The relative humidity at the surface tends to a diurnal variation in the opposite sense, usually reaching its grated value around sunrise. At this time, therefore, condensation in the air near the ground is most likely to take place.

8. **Condensation on Aircraft.** Condensation takes place on any surface whose temperature is below the dew-point of the air in contact with it. When it occurs rapidly on the windscreen of an aircraft the sudden reduction in visibility from the cockpit can be disconcerting if not expected. Such condensation is most likely when an aircraft descends rapidly from high levels where the temperature is low into the warmer and moister air nearer the ground. It can also occur when there is a temperature inversion and an aircraft climbs quickly into the warmer air at the top of the inversion. The condensed water vapour will gradually disappear by evaporation if the aircraft is flown at a level where the air temperature is high enough for the surface of the windscreen to be warmed above the dew-point of the surrounding air.

Most modern aircraft are fitted with heating devices, or other equipment such as alcohol sprays or clear vision panels, which either prevent condensation on windscreens or alleviate its effects.

9. **Measurement of Humidity.** Regular measurements of the humidity of air near the surface are made using wet-bulb and dry bulb thermo-meters. For routine measurement of humidity of the air a left, use is made of the fact that gold beaters' skin contracts in dry and expands when the air is moist. The Radio sounds are designed to emit additional radio signals of a frequency governed by the length of a piece of the skin, hence providing a measure of the humidity of the upper air at the level of the sound.

ATMOSPHERIC STABILITY(AIR IN VERTICAL MOTION)

Significance

10. The intensity of vertical air currents depends mainly on a property known as the stability of the atmosphere. In a stable atmospheric layer a sample of air tends to resist being displaced vertically, and if so displace, it returns to its original position. On the other hand, in an unstable layer vertically displaced air continues to rise or fall until more stable conditions are met. Whether or not a sample of air after being lifted will tend to return to its original position is determined by whether or not it finds itself colder and therefore more dense than the surrounding air in its new position; clearly this is governed in part by the temperature lapse rate in the surrounding air. The existing or environment lapse rate (ELR) is thus one factor of great importance in determining atmospheric stability; another is the change of temperature of the air sample itself after ascent or descent.

Adiabatic Temperature Changes

11. When a gas is compressed its temperature rises. If the pressure on a gas is reduced, the gas expands and cools. If no heat is allowed to enter or leave a gas the temperature changes produced in it solely through compression or expansion are known as adiabatic temperature changes. In the atmosphere, adiabatic temperature changes occur when air descends and is heated by compression, or when air on rising to higher levels where the pressure is lower expands and consequently cools.

Dry Adiabatic lapse Rate (DALR)

12. The rate of 3^0C per 1,000 ft is known as the dry adiabatic lapse rate. It applies to dry air, ie to air which remains unsaturated during all stages of its vertical motion.

Saturated Adiabatic Lapse Rate (SALR)

13. The rate of cooling in ascending saturated air is called the saturated adiabatic lapse rate (SALR). His is not a fixed value like the DALR, but depends on the amount of water vapour available for condensation, which itself depends on the temperature and pressure. Near the surface in temperate regions the SALR is about half the DALR, ie about 1.5^0 per 1000 but at the low temperatures prevailing at high levels in the atmosphere the saturated adiabatic lapse rate approaches the value for dry air.

Stability of Air

14. a. Dry air is always stable if the observed (ELR) lapse rate is less than the dry adiabatic lapse rate of 3^0C per 1000 ft.

b. Dry air is unstable if the observed environment lapse rate is greater than the dry adiabatic lapse rate of 3^0C per 1000 ft.

c. In the same way saturated air is stable if the observed environment lapse rate is less than the saturated adiabatic lapse rate.

Flying Conditions

15. a. In unstable air, the steeper the environments lapse rate. The less stable the air, and the more readily can vertical currents develop. A pilot flying in unstable air is likely to encounter clouds of the heap or cumuliform type, possible containing quite violent updrafts; the flight will usually be bumpy, and there may be showers or thunderstorms. Since vertical currents result in the dispersal of any impurities through a deep layer of the atmosphere, visibility in unstable air is usually good.

b. In stable air vertical motion reduced by the stability of an atmosphere characterized by a gentle lapse rate or an inversion: a flight in such conditions will generally be smooth, and any clouds encountered will be of the layer or stratus type. The weather will usually be fine, although drizzle or steady precipitation may occur. Surface visibility will tend to be moderate or poor owing to the concentration of atmospheric impurities beneath the stable layer; often fog, mist, or haze will be experienced in there conditions.

Ascent of Air in Depression

16. At a place where a depression is developing, the surface air pressure falls. This means the total weight of air in a vertical column above that place is being reduced : air is leaving the column. In this surface layer the air blows partially inwards, converging at an angle across the isobars towards the low pressure center, and hence it follows that in the higher levels air must flow outwards or diverge, so that more air must flow outwards or diverge, so that more air leaves the column aloft than enters it near the surface and this is ascending motion above the region of falling surface pressure. This ascending motion is very gradual altogether too slow to affect an aircraft in flight but never the less adiabatic cooling of the slowly rising air leads to condensation and formation of the cloud and precipitation normally associated with depressions frequently and ascending motion, instead of being spread uniformly over the whole area of the developing depression, is concentrated along the low-pressure troughs occupied by fronts or lines of convergence.

Descent Over Anticyclones

17. Slow descent of air aloft adiabatic heating causes the formation of and inversion which limits the development of cloud, and tends to bring about the evaporation and dissolution of clouds above the inversion. Hence, the weather in an anticyclone is normally dry, though not necessarily cloudless.

TOPIC-4
PRESSURE PATTERN AND ASSOCIATED WEATHER

Isobars

1. An Isobar is a line joining points having the same barometric pressure at the same level. (The level generally used on surface weather maps is mean sea level.)

2. **Straight Isobars.** It has been accepted that all isobars form closed curves when they are drawn over a sufficiently extensive area. However, they appear as straight lines over hundreds of miles and sometimes even over thousands of miles.

3. It has been found by experience that although the configuration of isobars may be variable and complex, they often make up certain well defined patterns to which special names have been given.

Low or Depression

4. depression is a part of the atmosphere where pressure is lower than the surroundings. It is bound by a series of closed isobars. The wind speed in any part of this area does not exceed 38 mph (33 kts). The deficiency of pressure at the center is of order of3-4 mbs.

5. Some depressions are deeper than others. The terms ‘Shallow Depressions and ‘Deep Depression are therefore used. A shallow depression is one in which the pressure at the center is not very much lower than the surroundings. It is sometimes also called a low or an area of low pressure. A deep depression is one in which the pressure is very much lower near the center than on the outside (as compared with a depression) and/ or winds reported from different parts of the depression may reach as high value as 38 mph.

6. The depressions of temperate latitudes generally move from west to east and have well-marked sectors with air masses of different origins and properties.

7. In depression of tropical areas the air masses in different sectors are not easily distinguishable from each other. They move, at least in their initial stages, from east to west. Isolated squally weather is occasionally met with in the disturbed weather area of such depressions.

8. The winds in all types of depression which affect the country blow in counter clockwish direction round their centers.

Tropical Storms

9. The natures of a tropical depression and a tropical storm are essentially alike, but the wind force associated with tropical storm exceeds 38 mph and may go upto 73 mph (63 kts).

10. On the basis of wind speed associated with the tropical storms there are two terms used.

11. **Tropical Storm**. When wind speed in any part of its closed circulation (Observed or in its absence inferred from isobaric gradient) is 39 mph (34 kts) to 54 mph (43 kts).

12. **Severe Tropical Storm**. When the wind speed in some part of its field reaches 55 mph (48 kts) to 73 mph (63 kts).

Cyclone

13. The cyclone is a tropical storm of great intensity. The diameter is sometimes less than 25 miles and sometimes as great as 600 miles. The minimum pressure at center is sometimes lower than 900 mbs, but usually of the order of 950 mbs. The winds in the center are nearly calm but round the calm center there is a ring of high winds reaching 73 mph or more. When the cyclone reaches phenomenal intensity and the wind speed cannot ordinarily be measured it is called a Severe Cyclone.

Western Disturbance (Extra Tropical Depression)

14. Disturbed weather conditions moving towards the country from the west are termed "Western Disturbances". They usually approach as waves of low pressure of shallow depressions in the temperate latitude, weather systems originating from Mediterranean Sea or the Middle East. At times they are 3 4 mbs. Deep, when they may be called "Western Depression". Such Western Disturbances are most frequent in the winter and spring seasons and are sometimes associated with well-marked warm and cold fronts.

Trough of Low Pressure

15. It is an outward extension from a cyclone in which the isobars are either U-shaped or V-shaped. It becomes V-shaped only when it is traversed by a front and is then known as V-shaped depression. The pressure is low within the trough and increases outward.

16. In frontal type, ie a V-shaped through marked change of wind and deterioration of weather generally occurs which are same as in fronts. Increased clouds with showers or other precipitation may be expected, Behind the trough weather usually improves rapidly.

Secondary Depression

17. It is a small depression within the circulation of a larger one. It circulates around the primary depression with the general air stream. Sometimes the secondary becomes well developed, when the primary gets filled up.

18. In winter intense secondary depressions cause much rain or snow, and also severe gales on the side away from the parent depressions. In summer most secondary the land often give thunderstorms.

Anti-Cyclone

19. When the isobars close around a central high-pressure region, the pattern is called an anti-cyclone. In an anti-cyclone pressure decreases outward from the center.

20. In an intensifying anti-cyclone air tends to subside and clouds disappear. This explains the common association between high-pressure systems and good weather. Although appreciable rain is unlikely near the center of an anti-cyclone, good flying conditions do not invariably occur; for example, poor visibility is frequently experienced because light winds and stable air retard the dispersal of smoke and dust.

Ridge of High Pressure

21. It is an outward extension from an anticyclone towards the low pressure. Pressure is highest in the region and decreases outward.

22. The weather in it is nearly always fair or fine, and there are rarely extensive cloud sheets such as appear in many anti-cyclones. However, the good weather is usually for short duration, owing to rapid movement of the system. Radiation fog may occur near the center of the ridge rarely persists.

Col

23. The ‘Col’ is saddle shaped region between two cyclones and two anti-cyclones arranged in such a way that the two cyclones (or anticyclones) are diametrically opposite to each other. Near the ground level the wind blows towards ‘Col’ region from the two anti-cyclones and outward from the ‘Col’ towards the two cyclones.

24. Sometimes fronts traverses the ‘Col’. Such fronts are usually very slow-moving, very slow moving, and clouds or precipitations may therefore persist for long periods. Very light winds or calm occur in a Col, but otherwise the water depends largely on circumstances. Over the land a Col is often associated with thunderstorms in summer, and with fog or low cloud in autumn and winter.

The Significance of Pressure System

25. When weather maps comprising a sequence at, say, 6 hourly intervals, are compared, the; patterns made by isobars, although tending to retain their identity, are usually found to change in shape and also to move progressively across the maps from one map to the next. Depressions are said to depend or intensify or to decay or fill up.

26. The change of shape and particularly the movements of pressure systems are more marked in high than in low latitudes. This is because the atmospheric pressure does not change much from day to day near the equator.

27. The various types of isobaric configurations are in general associated with particular types of weather. Hence the highs and lows, troughs and ridges etc., are particularly important features of the weather maps of middle and high latitudes, because these pressure systems tend to retain their identity and to carry their associated weather with them wherever they go. Their identification is therefore a considerable aid to forecasting.

TOPIC-5
WIND & VISIBILITY

WIND

Significance to Aircrew

1. Winds are of major importance to aircrew. At every take-off and landing a pilot must take into consideration the direction, speed and gustiness of the surface wind. Pilots and Navigators are concerned with winds at flying heights for by changing altitude and heading to take advantage of tail winds or minimize the effect of head winds they may greatly increase the effective range of an aircraft and allow either a greater margin of fuel for diversions or the carrying of a greater load. In fact, the intelligent use of knowledge of the upper winds may convert an abortive sortie into an effective one.

Description of Wind

2. In order to describe the wind precisely, we have to specify both the speed and the direction of the air motion. Wind speed is usually expressed in knots and wind direction either in direction either in points of compass or in degrees from true north. The direction given is always that from which the wind is blowing. For example, north wind or a wind direction of 360^0 means that wind is blowing from north to south.

3. Wind direction is shown on the weather charts by an arrow flying with the wind, and ending at the circle marking the position of the observing station. The wind speed is indicated by the number of feathers.

Veering and Backing of Wind

4. Veering and backing are terms used to describe changes of wind direction. The wind veers when the direction changes clockwise, eg from sough-east to south-east to west. It backs when the direction changes anti-clockwise.

Gusts

5. The wind seldom blows-steadily from one particular direction with constant speed. There are usually continuous variations both in speed and direction about the average value owing to turbulence or eddies. Such variations are called gusts and lulls, and are often pronounced near the grounds, where the eddies causing them are set up by friction between the moving air and obstacles such as cliffs, buildings etc, or by unequal heating of the earth's surface. These eddies also contain up-and-down currents which make the air feel "bumpy" to the crew of an aircraft.

6. Gusts are comparatively sudden but brief increase in wind speed, often associated with rapid fluctuation in wind direction. They are of significance particularly to light aircraft on landing and take-off. Increase in wind speed by at least 10 kts and lasting for less than one minute.

Squalls

7. Squalls are to be distinguished from gusts by their longer duration; a squall is a blast of wind which sets in suddenly lasts for some minutes and then dies away. It is usually associated with a rapidly moving cold front or a thunderstorm.

Gales

8. A gale is said to occur when the surface wind has a mean speed of 34 knots or more, or is gusting to 43 kts or over Gales are of particular significance when aircrafts are parked or moved in the open or are landing or taking off; warnings of their likely on set are issued by the meteorological office.

Surface Wind

9. Surface winds are measured by instruments called anemometers which are exposed at a standard height of about 33 ft above the ground in an open situation. The type of anemometer in use at most aerodromes consists of a wind vane for measuring direction, and hemispherical cups mounted on arms which the wind can rotate in a horizontal plane, their speed of rotation being a measure of wind speed. Both the vane and the cups are connected electrically to separate dials, the one reading wind direction in degrees, the other wind speed in knots. A duplicate set of dials is usually provided, one pair in the meteorological office and the other in air traffic control.

Upper Winds

10. The winds are determined upto altitude of 50,000 ft and are measured by locating and following by radar a target attached to an ascending hydrogen filled balloon.

11. Upper winds are also determined by a method similar in principle to that using radar, but relying on visual location of the balloon by means of a theodolite.

12. The air at rest will not begin to move unless the forces acting on it are unbalanced. For those operating in a vertical direction such as gravity downwards and buoyancy (upwards), can play no part in causing the air to move horizontally. Therefore we can ignore vertically acting forces when considering wind, which is defined as air in more or less horizontal motion.

13. The only other force acting on air at rest due to the pressure exerted equally in all directions by the surrounding atmosphere. A parcel of air remains at rest, if it is under the influence of equal but opposing forces. If there is horizontal pressure gradient, the horizontal forces acting on the parcel of air are unbalanced, and air begins to move. When there is a pressure gradient, there will be an initial tendency for the air to flow across the isobars in the direction from high to low pressure. But the result of flow will be almost parallel to the isobars.

Buy's Ballots Law

14. In the northern hemisphere winds tend to blow clockwise round a high-pressure area and anti-clockwise round low-pressure area. This rule is known as Buys Ballot's law, which may be remembered in the following form. "If you stand with your back to the wind lower pressure lies to your left in the northern hemisphere, but to your right in southern hemisphere'.

This law has an important application to flying, for if your aircraft is drifting to starboard (ie the wind is from port) it follows from the law that in northern hemisphere you are flying towards an area of low pressure. In this case your aircraft will be lower than the altimeter indicates possibly so much lower as to be dangerously near high ground on route.

Effect of the Earth's Rotation on Wind

15. When air begins to move horizontally it blows from high to low pressure, but that the motion has continued for some time the flow tends to be along the isobars, with low pressure on the left in the northern hemisphere. This apparent deviation to the right of the direction, we should expect the air to follows, is due to the fact that we measure the motion relative to the rotating earth.

16. Calm air is in fact moving in space from west to east with a speed equal to that of the earth's rotating surface. At the poles this speed is zero, but increases with decreasing latitude to about 1000 mph at the equator. Air will tend to retain the speed in space it had in its source region when it moves elsewhere. Thus air moving towards the equator will find itself traveling eastwards in space less rapidly than the earths surface beneath and so relative to the earth will appear to have been deflected to the right in northern hemisphere, to the left in the southern hemisphere. Similarly air moving from lower to higher latitudes will tend to retain the higher eastward speed in space of the earth surface at its place of origin, and will suffer similar apparent deflection.

17. The deviating effect will be proportional to the change of speed of the earth surface below the moving air. The actual speed of the earths surface at any point is proportional to the cosine of the latitude and this cosine value changes only slowly at small angles (low latitudes) and move rapidly at larger angles (high latitudes) up to 90^0. Hence the deviating effect is greatest at the poles and less (zero) at the equator.

Geostropic Force

18. The air in motion behaves as if it were acted upon by a force which is at right angles to its direction of motion and acts from left to right in the northern hemisphere. This force is known as the Geostropic force, and it can be shown mathematically that its value is proportional to the wind speed (V) and to the sine of the latitude.

That is the geosptrophic force varies as Vsino.

Geopstropic Wind

19. In the northern hemisphere air begins to move across the isobar from high to low pressure under the influence of the pressure gradient force. As its speed increases the air becomes progressively deflected to the right by the correspondingly increased geostrophic force, until eventually at appoint the speed reaches a value V such that the geostrophic force (proportional to V) balances the pressure gradient force and a steady state is reached. The resulting wind velocity is known as the geostrophic wind.

20. Air round a depression moves along curved path and it is then subject to a centrifugal force away from the point about which it is revolving, like any other body moving in curved path. Under this situation the pressure gradient force must balance this centrifugal force as well as the tendency to turn to the right. The resulting wind in these circumstances is called the gradient wind. Practically the cyclostrophic component due to centrifugal action) can be disregarded and that the geotropic wind gives a close approximation to the wind which actually blows at a height of about 2000 feet.

VISIBILITY

Definition and Its Explanation

21. Visibility in a definite direction is the maximum distance to which prominent suitable objects like trees, houses etc located in that direction and viewed against the horizon sky are visible to an observer of normal eyesight under existing conditions of atmosphere. For an object to be regarded as visible it must be recognized by the observer who has previous knowledge of its character from having seen it on occasions when the atmosphere was clear.

22. When the visibility is the same in all directions the prevailing visibility will be represented by a single value. But when the visual range is not uniform in all directions the prevailing visibility will be the greatest value of visual range which satisfies the condition that visual ranges equal to or greater than that value exist over at least half of the horizon not necessarily continuous.

Descriptive Terms

23. Descriptions such as good, moderate, or poor visibility, are usually applied to definite ranges of visibility. The descriptions generally used are given below:

VISIBILITY	DESCRIPTIVE TERMS
1-2 nm	Poor Visibility
2-5 “	Moderate Visibility
5-11”	Good Visibility
11-22”	Very Good Visibility
Over 22”	Excellent Visibility

Measurement

24. Visibility is measured with the help of visibility land marks. These are fixed objects at standard distances, the size of the object increasing with the distance. For measurement of visibility during night lights of certain illumination are selected at standard distances. Visibility during night is also measured with the help of the visibility meter. Instead of selecting lights at standard distances light is viewed through the visibility meter. Ground glasses carrying the value of visibility are inserted in the field of vision till the light is just clearly visible.

Visibility from the Air

25. The observer on the ground sometimes sees objects at a distance of few hundred feet and reports low visibility. But the pilot may feeloon looking from air that visibility is not really low. It may be remembered that visibility during the final glide will be the same as reported by the ground observer.

26. Even in perfectly clear weather, there is a limit to the distance that one can see from an aircraft. This limit is set by the curvature of the earth.

Effect of Position of Sun and Moon

27. The distance at which objects can be recognized may also vary with the direction of viewing in relation to the position of the sun or moor. For example, in haze, an observer with his back to the sun (looking down sun) can usually distinguish objects at a greater distance than when looking towards the sun (up sun), because the glare is less in the down sun direction.

28. On the other hand, in bright moonlight and slight mist objects can be seen more readily by an observer looking towards the moon (up moon) than away from it (down moon). In this case the reflection of moonlight from objects shows them up, and there is comparatively little glare.

Factors Which Reduce Visibility

29. The deterioration in visibility is due to the presence of minute solid particles suspended in the air such as dust and smoke. Very fine water droplets as in fog and mist and precipitation in the form of rain shower, snow, select etc. When the deterioration in visibility is due to suspended water droplets, and the visibility is less than 100 yds, it is called fog. When it is less than 2½ miles but equal to or more than 1100 yds. It is called mist. In both the case temperature is 70°F or less and relative humidity more than 75%. The presence of dust and smoke also reduce the visibility as in fog and mist. In industrial areas sometimes smoke and fog together reduce the visibility to extremely low values.

Visibility in precipitation and cloud varies within wide limits. The following will give and idea as to the extent upto which visibility may be reduced in precipitation.

a. Snow – Less than 100 yds.

b. Sleet – Less than 1000 yds.

c. Drizzle – Less than 300 yds.

d. Moderate rain – 24 miles.

e. Heavy rain – 1 mile and less.

f. Tropical rain – 100 yds or less.

g. Dense Clouds (Cumulonimbus and nimbostratus) – 10 yrds.

h. Status Clouds – about 15 to 30 yds.

j. Alto – Status – about 50 to 200 yds.

<u>Practical Aspect of Horizontal and Vertical visibility</u>

30. Visibility from the air to the ground is often different from the horizontal visibility on the ground. This may be due to an upper layer haze, when the ground visibility is good. It may also be due to a shallow fog or mist on the ground, when the vertical visibility is fairly good. An upper haze layer may obscure the view of the ground from the aircraft while flying above the haze layer. But the observer on the ground may be able to see quite far off distant objects. Such a situation generally occurs when there is an upper level inversion. Dust and smoke from the ground are lifted up and they spread horizontally below the inversion layer. Haze forms due to the presence of dust and smoke particles suspended in the air. Maximum visibility in haze is 4.9 NM. Relative humidity is less than 75%. A shallow layer of fog or mist may reduce the ground visibility to a very low value but there may be no difficulty from the aircraft to see quite far off distant objects. In such a situation visibility generally improves by climbing.

<u>Runway visual range – Definition</u>

31. The maximum distance in the direction of take – off or landing at which the runway or the specified lights or markers delineating it can be seen from a position above a specified point on its center line at a height corresponding to the average eye-level of pilots at touch down.

<u>Poor Visibility and the Pilot</u>

32. With no other hazard to flight operation caused by weather is there the possibility of a greater difference between what is reported and what the pilot experiences than with restriction to visibility. Slant range is not a very good indication of the slant range visibility which a pilot will have in a landing situation. Knowing this, a pilot must ralize that his good judgement is required to cope with the restriction to visibility hazards, probably more than with other weather hazards.

TOPIC-6
CLOUDS & FOG

CLOUDS

Factors Governing Cloud Formation

1. Cloud is formed as a result of condensation of water vapour present in the air. When air is cooled below its dew point the excess water vapour condenses out as visible water droplets. If the condensation occurs near the ground level it takes the form of dew, mist or fog. When condensation occurs above the ground level it takes the form of cloud. Clouds may, therefore, form as a result of cooling of air by one or more of the following processes :

   a. Mixing of two masses of nearly saturated air of different temperatures.

   b. Cooling by radiation.

   c. Adiabatic cooling due to vertical ascent which may be due to :

      1. Orographic uplift.

      2. Convection.

      3. Turbulence.

      4. Frontal uplift.

Orographic Clouds

2. a. When the wind is forced upward due to a mountain or hill, it expands and cools. Condensation takes place and clouds thus formed are called Orographic clouds.

   b. **Fohn Effect.** If precipitation occurs on the windward side of the barriers, the cloud base on the leeward side becomes higher than on the windward side. The descending air below the cloud base now warms up at the dry adiabatic lapse rate and comes down as a warm dry air. This is known as the Fohn effect.

   c. **Types of Cloud.** The type of clouds formed by orographic uplift depends upon the stability or instability of the air mass. If the air is stable St, Cu, Sc clouds will form; if it is unstable Cu or even Cb can form. In this case orography supplies the initial lift only and the amount of vertical development is proportionate to the amount of instability present.

Turbulence & Convection

3. a. In the stable air, turbulence causes cooling of the upper level and warming up of the lower level. Water vapour content, which normally decreases with height, becomes uniform throughout the turbulent layer. Thus the air which is carried upward becomes cooler and at the same time damper and sooner or later cloud forms. Since this upward movement covers a large area the cloud takes the form of an extensive sheet. Turbulence is most frequent near the ground level and St or Sc cloud forms. When turbulence occurs in higher levels due to wind shear Ac or Cc clouds form.

b. Convection occurs in an unstable air. When lapse rate exceeds dry adiabatic lapse rate convection takes place. In a saturated mass of air convection takes place. In a saturated mass of air convection takes place when the lapse rate exceeds the saturated adiabatic lapse rate. The requisite lapse rate is most easily established in the lower layers owing to solar heating of the surface. When air of polar origin moves towards lower latitudes it is progressively heated in the lower levels by contact with the warmer surface and thus the lapse rate is increased. The hot parcel of air rises up and cools at the saturated adiabatic lapse rate. Thus convection becomes more vigorous above the condensation level and clouds form up to great heights. Above the condensation level convection will persist if the lapse rate is greater than saturated adiabatic lapse rate. The height upto which cloud tops will reach depends upon the depth of the layer in which lapse rate exceeding saturated adiabatic lapse rate exists. Where the rising air meets an environment of its own temperature vertical ascent will cease. The clouds of the convection type are Cu or Cb depending upon the depth of the air layer in which lapse rate exceeds saturated adiabatic lapse rate.

Frontal Uplift

4. When two air masses of different temperature and humidity meet, the warm air rises above the colder air along the surface of separation known as the frontal surface. The rising air cools adiabatically, and clouds from when it is cooled below dew point. If the warmer air is stable, stratiform clouds form; and in unstable air convective clouds form. Clouds of the warm front are generally Ci, Cs, As and Ns; clouds of the cold front are Ac, Cu and Cb. As front extends over a wide area these clouds are very extensive.

CLOUDS IN RELATION TO FLYING

	CUMULIFORM	STRATFORD
Size of water Droplet.	Large	Small
Stability of air	Unstable.	Stable.
Flying Conditions.	Rough (Turbulent)	Smooth.
Precipitation	Showery.	Continuous.
Surface visibility	Good, except in Precipitation and blowing snow or dust	Usually poor
Visibility in the air	10 yards in CB and NS	15 to 200 yards.

Simple Classification

5. As first step clouds may be divided into two fundamental classes.

a. **Heap Clouds**. These clouds consist of isolated heaps or towers with marked vertical development. Large isolated clouds are sometimes 30,000 ft. or more in vertical thickness and about the same in horizontal diameter but heap clouds also occur in long narrow belts of almost continuous cloud. Well developed heap clouds are associated with changeable weather, and showers may occur locally, sometimes accompanied by thunderstorms, severe turbulence, and strong vertical currents.

b. **Layer Clouds**. Layer clouds form a fairly level sheet, often covering a wide area. The vertical thickness of layers may vary from a few tens of feet to several thousand feet. Such clouds usually give smoother flying conditions & less changeable weather than heap clouds. Since layer clouds are frequently split into filaments or round masses a more detailed classification is necessary for general use.

International Classification

6. In this classification clouds are first divided into 3 main families each of which is then subdivided into two or three classes (genera) as shown in the accompanying table. The 3 main families consist of high, medium, low clouds. Low clouds also include the clouds of vertical development.

Family	Classes (Genera)	Abbreviation	Limits of Height within Which Cloud Normally Lies
			Tropical Regions
High Cloud	Circus … Cirrostratus … Cirrocumulus ….	Ci Cs Cc	20,000 ft to 60,000 ft.
Medium Cloud	Altocumulus … Altostratus ….	Ac As	8,000 ft. to 25,000 ft
Low	Nimbostratus …. Status … … Stratocumulus … …	Ns St Sc	Near Surface to 8,000 ft
Cloud	Cumulus … … Cumulonimbus .. (Clouds of Vertical development)	Cu Cu	Near Surface to 60,000 ft.

Note : Nimbostratus often extends into medium cloud levels merging with altostratus. The ranges of cloud heights very considerably with latitudes.

Additional Types of Clouds

7. There are several sub-types and varieties of clouds such as :

a. **Lenticular**. Lenticular clouds have a shape rather like the cross-section of a lens. Their position is sometimes related to surface topography and individual clouds often remain nearly stationary. Strong vertical currents have occasionally been observed in the vicinity of these clouds.

b. **Castellatus**. As their name implies, castellatus clouds have castellated or turreted appearance. Altocumulus castellatus is usually associated with thundry weather.

c. **Mamma**. The under surface of mamma clouds appears to hang down in festoons or pouches. Such clouds occasionally appear in very unstable thundery conditions.

d. **Fractious**. Clouds in the form of irregular shreds which have a clearly rugged appearance. This term applies only to status and cumulus, e.g. stratus fractus.

High Clouds

8. High clouds can be classified into 3 main types :

a. Cirrus.

b. Cirrostratus.

c. Cirrocumulus.

Identification of High clouds

9. a. **Cirrus (Ci)**. Detached clouds of delicate and fibrous appearance, without shading, generally white in colour, often of a silky appearance. Cirrus is composed of ice crystals; and it appears in various forms such as isolated tufts, lines drawn across a blue sky, branching feather – li plumes, curved lines ending in tufts etc. Cirrus is sometimes arranged in bands.

b. **Cirrostratus (Cs)**. A thi whitish veil, which does not blue the outlines of the sun or moon, but gives rise to halos. It is also composed of ice crystals.

c. **Cirrocumulus (Cc)**. A cirri form layer or patch composed of small white flakes or of very small globular masses without shadows, which are arranged in groups or lines or more often in ripples resembling those of the sand on the sea shore. Cirrocumulus is generally composed of ice crystals.

Medium Clouds

10. Medium clouds can be classified into 2 main types :

  a. Alto-cumulus.

  b. Alto-stratus.

Identification of Medium Clouds

11. a. **Alto-cumulus (Ac)**. A layer or patches composed of laminae or rather flattened globular masses, the smallest elements pf the regularly arranged layer being thin and small.

  b. **Alto-stratus (As)**. Straited or fibrous veil, more or less gray or bluish in colour. The sun or moon may be dimly visible through it but there is no halo phenomena.

Low Clouds

12. Following types of clouds are called low clouds :

  a. **Low Clouds**

    (1) Stratus.

    (2) Strato-cumulus.

    (3) Nimbostratus.

  b. **Clouds of Vertical Development**

    (1) Cumulus.

    (2) Cumulous-Nimbus.

Identification of Low Clouds

13. a. A uniform layer of cloud resembling fog, but not resting on the ground.

  b. **Stratocumulus (Sc)**. A layer or patches composed of laminae or globular masses; the smallest of the regular arranged elements are fairly large; they are soft and gray, with darker parts.

  c. **Nimbostratus (Ns)**. A dense layer of dark gray colour and nearly uniform appearances and of great vertical thickness; it usually gives precipitation – rain, sleet or snow.

14. **<u>Identification of Clouds of vertical Development</u>**

a. **<u>Cumulus (Cu)</u>**. Thick clouds with vertical development; the upper surface is dome shaped, and exhibits protuberances, while the base is nearly horizontal.

b. **<u>Cumulo-nimbus (Cb)</u>**. Heavy masses of cloud, with great vertical development, whose cumuliform summits rise in the form of mountains or towers, the upper part having a fibrous texture and often spreading out in the shape of an anvil.

<u>FOG</u>

<u>Formation and Dissipation of Fog</u>

15. The physical processes which cause unsaturated air to become saturated are responsible for fog formation. Unsaturated air may become saturated in three different ways i.e. evaporation, cooling and mixing.

a. When air comes in contact with the water surface evaporation takes place. Evaporation continues until the vapour pressure in the air becomes equal to the saturation vapour pressure at the water surface. If the temperature of the water surface is higher than the temperature of the water surface is higher than the temperature of the air evaporation will make the air supersaturated and fog will form.

b. When air is cooled below dew point super saturation occurs and fog forms. This cooling may be due to :

(1) Radiation.

(2) Advection.

(3) Upslope motion.

c. When two samples of nearly saturated air are mixed horizontally the mixture may become supersaturated and fog, may form. For super saturation to occur in this way there should be a large difference of temperature between the air masses both of which are nearly saturated.

d. It should however, be remembered that for fog, formation the air should be saturated or superated or supersaturated in a sufficiently deep layer. A slight turbulence is therefore, necessary to cause mixing in a sufficiently deep layer but the layer of mixing should not be too deep. For in that case saturation cannot occur. A light wind and stable equilibrium are essential for fog formation.

Radiation Fog

16. Radiation fog occurs over land. During night land is cooled by radiation and the air layer in contact with the earth's surface is also cooled. If the air is cooled below dew point condensation occurs. If there is slight turbulent mixing the cooling is carried out in a sufficiently deep layer to cause radiation fog. In the absence of turbulent mixing dew only forms. This fog forms during night or early morning. It generally thickens at first after sunrise and then dissipates quickly due to heating. Radiation fogs occur most frequently over marshy lands and during winter. The conditions for the radiation fog are the following:

a. High humidity.

b. Clear skies.

c. Light wind.

17. Some empirical values of temperature and humidity have been found favourable for radiation fog. It has been observed that if the minimum temperature falls to 70°F or less and the humidity increases to 75% or more, fog may form.

18. Also fog does not form if it really remains calm. There should be slight wind. Stratus clouds form instead of fog if surface wind increases to more than 5-6 kts.

19. In terms of pressure distribution the existence of Col. Is favourable for fog formation.

Advection Fog

20. The word "advection" implies horizontal movement. Advection fog is formed when air flows over a cool surface so that its temperature is reduced below the dew point. The conditions favouring its formation are therefore :

a. Moist Air, so that little further cooling is required to produce condensation.

b. Movement of air over a surface having a temperature below the dew-point of the air.

Sea Fog

21. It is convenient to consider separately advection fogs formed over the land and over the sea. The latter fare usually known as "sea" and occur when a moist air mass, usually of tropical origin, moves slowly over cooler seas. Such fogs may occur at any time of day, and are not likely to clear as the result of solar heating, since this produces no appreciable change in the sea surface temperature.

22. Sea fog generally occurs with light winds, since a strong wind generally creates sufficient turbulence to lift the fog and form stratus. Lighter winds reduce the height to which turbulence extends so that the fog is concentrated in a shallow but dense layer, and with very light winds it is not unusual to sea the smoke or even the masts and upper works of ships rising above it.

23. With an on shore wind sea fog may be carried inland, the greatest penetration occurring at night and on winter days. Actual fog rarely reaches more than a few miles inland, however, usually being lifted to form low stratus.

Hill Fog

24. Hill fogs are simply low clouds, often formed orographically or formed elsewhere and drifting on to the hills. High ground near the coast is very liable to this type of fog.

Frontal Fog

25. When rain falls from the warmer air above the frontal surface through the cold air below, evaporation from the falling rain makes it super-saturated. Fog will form when the frontal surface is close to the ground. Frontal fog occurs with the well developed warm front and is arranged as a narrow hand along the front.

Smoke For

26. Smoke fogs generally mingle with water fogs, and the smoke provides additional nuclei on which water vapour may condense, so that, the fog becomes thicker. Smoke alone if it is prevented from dispersing, can sometimes produce a fog, though not a very dense one. The wind must be light, so that it does not carry the smoke away too quickly, and there must be an inversion of temperature not for above the ground.

Ice Crystal Fog

27. In Arctic regions fogs may occur which consist entirely of ice crystals. A very low temperature is necessary, 30°F. or lower and the fogs occur only near inhabited regions, being formed form the moisture produced by the burnings of fuels in precisely the same way as contrails.

28. Ice fogs are quite distinct from the summer fogs which are widespread and frequent in the Arctic; these are water fogs of the ordinary advection type, formed by the flow of air from temperate regions over ice, or over water cooled by melting ice.

Sea Smoke or Steam Fog

29. Sea smoke or steam fog may occur when very cold air blows over a relatively warm sea surface. Evaporation takes place from the water surface into the air mass which is so cold that it cannot contain all the water vapour, some of which, therefore, condenses to form a thick fog. It is often transitory of patchy because of the steep lapse rate of temperature between the water surface and the cold air which causes sufficient convection to disperse the fog. vertically. It then appears to resemble rising smoke.

TOPIC-7
FORECASTS, AIRCRAFT OBSERVATIONS AND REPORTS

Reference: Jeppesen Airway Manual (MES – 1)

Section - Meteorology

Forecasts, Aircraft Observations and Reports

Forecasts	Interpretation and Use of Forecasts
	Aerodrome Forecasts
	Landing Forecasts
	Take off Forecasts
Aircraft Observations and Reports	Routine Aircraft Observations
	Special Aircraft Observations
	Reporting of Aircraft Observations in Flight

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TOPIC-8

METEOROLOGICAL OBSERVATIONS AND REPORTS

Reference: Jeppesen Airway Manual (MES – 1)

Section - Meteorology

Meteorological Observations and Reports

Meteorological Observations and Reports	Routine and Special Observations
	Contents of Reports
	Observations and Reporting Met Elements

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TOPIC- 9 : SERVICES FOR OPERATING FLIGHT CREWS

Reference: Jeppesen Airway Manual (MES – 1)

Section - Meteorology

Services for Operating Flight Crews

Services for Operating Flight Crews	General Provisions
	Briefing, Consultation and Display
	Flight Documentation
	Information for Aircraft in Flight

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GROUP-'D' : SURVIVAL

TOPIC-1 JUNGLE SURVIVAL

Action After Landing

1. After landing carry out the following immediate action :

    a. First aid to injured personnel.

    b. Fix position.

    c. Rendezvous with crew members if scattered.

    d. Establish 2-way radio contact if possible.

    e. Prepare all signaling gear for immediate use.

    f. Check emergency equipment including rations.

    g. Institute immediate rationing.

    h. Elect a leader and apportion duties.

    j. Relax and formulate a plan of action.

2. Decision whether or not to leave the aircraft depend entirely on the factors prevailing at the time. If the aircraft is easily visible from the air, emergency ration adequate, water available, no sign of human habitation, surrounded by dense jungle, and air search is expected, stay with the aircraft, but if the factors available suggest that a trek may be the best plan, organize accordingly once a plan has been formulated, based on main factors and carefully considered, put it into effect at once and stick to it.

Staying with the Aircraft

3. If a decision is made to stay with the aircraft ensure that every possible means of attracting attention is made ready for instant use. Make use of the following :

    a. Parachute canopies spread out over the aircraft, over trees or pegged out in clearings.

    b. Yellow dinghies inflated and prominently displayed.

    c. Bright cowlings or panels spread out near the aircraft.

    d. Clothing spread out on the ground or hung on a line.

e. If possible keep a fire always alight. At night make flame, during the day make smoke.

f. Use pyrotechnics sparingly. Use only when aircraft are heard or seen.

g. Indicate special needs by use of the ground air emergency signaling code.

Leaving the Aircraft

4. If a decision is made to leave the aircraft the following points should be borne in mind.

a. Don’t take along unnecessary equipment.

b. Take such items as parachute canopies, shroud lines, survival kits, first aid kits, axes, knives, food and water.

c. Do not discard clothing. It is cold at night in the jungle.

d. When finally leaving the aircraft, lay out the appropriate ground emergency signal.

5. **Signaling**

a. **Use of Signal Mirror**. Hold mirror a few inches from face and sight at airplane through hole. Spot of light through hole will fall on face, hand or shirt. Adjust angle or mirror until reflection of light spot in rear of mirror disappears through hole while you are sighting airplane through hole. Do not continue to flash mirror in direction of plane after receipt of signal has acknowledged.

b. Aircraft Radio/Emergency Radio.

c. Smoke by Day. Add engine oil, rags soaked in oil or pieces of rubber to make black smoke, Burn green leaves, or moss to make white smoke.

d. Flame by night. Set up four fires if possible.

e. Signals with flash light, emergency radio light or landing light.

f. Spread out parachute Mae West and engine cowlings.

g. Fluorescent dye.

h. Disrupt the natural look of the ground.

Water

6. Survival is more dependent on a supply of drinking water than any other commodity. Normally in the jungle the supply of water can be purified by any of the following means.

a. Use the halazone tablets in the survival kit.

b. Two or three drops of iodine to one quart of water. All to stand for 30 minutes.

c. A few grains of permanganate of potash to a quart of water. Allow to stand for 3 minutes.

d. Boil for at least three minutes.

7. Sources of water which should be purified before drinking.

a. **Water Holes**. Water-found here will probably be muddy, and with pieces of rotten vegetation in it, so filter it first, then allow to stand for a few hours, filter again, then purify by one of the methods suggested.

b. **Digging**. Treat water as for a above. If on the seashore, dig a small hole a few yards above high tide, and as soon as you find water collecting, stop digging. Water collected in this way should be fairly free from salt, the fresh water floating on the top of salt water, hence don't go too deep. The water obtained in this way may taste slightly brackish, but will be safe to drink. If very strong, filter it a few times, or try again further up the foreshore.

c. **Stagnant Water**. This is not necessarily infected, but in order to make sure, filter it, then purify. Stagnant water may be found in small pools, amongst rocks, dead tree stems, etc.

d. **Large Rivers**. This water will be muddy and probably infected, so treat as for water holes.

8. **Sources of Water in Tropical Forests**. Fresh water, not need of purification :

a. **Rain**. Build a rain trap from large leaves, with framework made up from bamboo or branches.

b. **Jungle Wides (and Rattans)**. Select the lower loop of any vine, and cut out a length of four or five feet, from which drinkable water may be drained.

c. **Streams**. All fast flowing streams, having a mixed sandy and stone bed, provided this water will also be pure, and ready for drinking.

d. **Plants**. During the monsoons, or rainy season, water can be collected from natural receptacles found on various plants. This will be fresh rain water, and fit for human consumption.

e. **Bamboo**. In the base of large female bamboo stems will be found drinking water. It is not possible to guarantee finding water from this source on every occasions.

f. **Coconuts**. In the green unripe coconut will be found a very good substitute for water, i.e., "coconut milk". One nut way contain as much as two pints of this delicious cold fluid. Do not drink the milk form the ripe or fallen coconuts.

9. If only a small quantity of water is required to boil some fruits or vegetables, etc., take one section of bamboo, cut a hole in the top, and suspend over the fire by means of two horizontal sticks or two pieces of jungle vine or rattan.

10. If bamboo is not available make a vessel from fibrous barks or leaves. A container thus made will not burn below the waterline, moisten the area above the waterline to reduce the risk of the container catching fire.

Food

11. Many species of fruit and vegetables can be utilized to augment the dry rations contained in the food packs. Most of these are described in detail in the relevant. Survival publication Main points to bear in mind are :

a. Avoid any fruit or vegetable which gives a milky sap. Common edible food/plants are tern, sweet, potatoes yours bread fruit, cassia maniox, peanuts and pineapple Berries, Bananas, Mango, sugar Cane etc.

b. Eat sparingly at first to note effects.

c. It is normally safe to eat anything that a monkey will eat.

d. All birds and reptiles are good to eat.

e. Fish can be obtained from streams, rivers and lakes. Rest time to fish are just dawn and just before dusk.

Animal Hazards

12. The jungle abounds in all forms of animal life most of which, however, will avoid the scent and sound of man. The main protections are given below:

a. **Mosquitoes**. Avoid swampy area-keep body covered-Camp to Lea ward of a smoky fire-Use anti-malaria tables in survival kit.

b. Wasps, Bees, Hornets and Ants Nest usually in tress-Avoid disturbing.

c. **Leeches**. Avoid swampy ground – de – leech periodically. Do not pull off burn with cigarette end or hot ember.

d. **Snakes**. Most snakes will glide away on being disturbed Exercise caution following animal tracks – Do not corner or antagonize a snake – If bitten, cut with a knife or razor blade to the depth of the bite in the direction of the blood vessels and tendons and squeeze or suck the poison out.

Camping

13. Choose camping sights in conformity with the following requirements :

a. Proximity to food and water.

b. On solid ground free from mud.

c. With natural protection from weather and animal life.

d. Any from decaying vegetation.

d. Not directly under coconut palms or dead trees.

Natives

14. Treat natives as friendly. Deal with the chief of headman. Request – do not demand – Give small trinkets as gifts – Lave native women alone.

Travel

15. Before you start to travel, make careful plans bearing in mind the following considerations :

a. Travel only during the day.

b. Pick the easiest path possible.

c. Travel along animal tracks or elephant trails if possible.

d. If a stream is found, follow it. It will most probably lead to human habitation.

Bamboo

16. Bamboo is the jungles most important single aid to the survivor. It can be used in the following ways:

a. To obtain water.

b. To transport water.

c. As a cooking utensil.

d. As a framework for tent.

e. As a fighting rod.

f. As a raft.

g. As fuel for the fire.

h. Young bamboo bots are excellent food after the small black hair attached to the edges of the leaves have been removed.

TOPIC-2

SEA SURVIVAL

IMMEDIATE ACTIONS AFTER DITCHING

Release and Board the Dinghy

1. Inflate the dinghies and get aboard. Don't jump in or you may damage the dinghy. Don't board an inverted dinghy, for if the air beneath is expelled a suction is created and dinghy may be difficult to set right. Make sure that all the survival equipment goes aboard especially parachute pack. With a little ingenuity it can be made to serve a multitude of purposes, especially as extra clothing.

Roll Call

2. The captain of each dinghy calls the roll, endeavours to find any missing crew passengers and then cuts the painter.

Paddle Clear and Salvage Equipment

3. Padlle clear off the aircraft. Beware of any jagged metal. Beware of the aircraft as it sinks, especially the tail plane Salvage all floating equipment and lash all equipment securely to the dinghy. One of the occupants should then securely attach himself to the dinghy with a length of line a safety precaution against losing the dinghy through its over-turning and drifting away.

Stream sea Drogues and Servicing Dinghy

4. Rendezvous with the other dinghy if more than one has been launched and secure the dingies together. About twenty-five feet of life between dinghies has been found to be the best length to avoid snatching. Stream the sea drogues to minimize dinghy drift. If necessary, top-up the buoyancy chambers using the topping-up bellows. Bale out with the bear and Viscose sponge.

Administer First Aid

5. First aid should be administered without delay to the injured and to those suffering from shock. Injured personnel usually require extra water, food and clothing-a point to be borne in mind when rationing. Wet clothes should be removed and dried, if there is any spare clothing.

Plan of Action in Dinghy

6. When the immediate actions after ditching have been completed the captain should then discuss a plan of action with the crew. If the captain is missing or badly injured, it will be necessary to appoint another captain before trying to formulated a plan of action.

7. **Factors Affecting the Plan of Action**

a. The state of W/T contact and the amount of information signaled before ditching.

b. The likelihood of air search and its probable efficiency in the prevailing weather.

c. The position of ditching in relation to the nearest land, surface craft, main shipping lanes and air routes.

d. Knowledge of and the advantage to be gained from, wing, current and tides. This will be important in the tropics where air search may be limited, and it may ultimately be decided to make a landfall.

e. Rations available, particularly water.

8. The decision must then be made whether to remain in the vicinity of the ditching, or to set course for an area where help is more likely. It is preferable to remain in the vicinity of the ditching for at least 72 hours; but should circumstances favour a departure of the cress initial fitness and energy. The plan of action should be adhered to, despite any temptation to change it later.

Dinghy log

9. All signaling gear should be checked and prepared for instant use, according to the instructions supplied with each item.

Allocation of Duties

11. Duties should be allotted by the captain to all occupants of the dinghy.

12. Duties should include signaler, navigator, aircraft spotter, and fieldsman, and in a large crew duties can be allocated by means of a watch system. A record of duties carried out should be entered in the log. The duty of distributing the rations is the responsibility of the captain, the issues being recorded in the log to avoid arguments.

Drinking Water

13. Drinking water is your most essential need. A man in good health can live form 20 to 30 days without food, without water he can live only for about 10 days and even less in the tropics. A man needs a minimum of a point (20 ounces) a day to keep fit, but he can survive on two to eight ounces a day. Therefore, the rationing of water must be instituted without delay and not relaxed until final rescue.

Water Rationing

14. While no hard and fast rules can be laid down for the rationing of water, the following method is recommended:

a. 1st Day, no water issued, except for the injured. The body acts as a reservoir and you can live off the water it has stored.

b. 2nd, 3rd and 4th Day. 14 ounces per head daily, if available.

c. 5th Day Onwards. Two to eight ounces per head daily, depending on the climate and the water available. Rain water and water obtained from any additional sources, must also be rationed except when it is raining.

Water Rules

15. To preserve the water in the body is almost as important as having water to drink. Here are a few very important rules for guidance :

a. Keep your shirt on to prevent the loss of body moisture through unnecessary perspiration and exposure.

b. Sleep and rest are most important during a shortage of water. In the tropics, keep your exercise to a minimum.

c. Prevent sea-sickness if possible Valuable water can be lost through being sick.

d. Do not drink sea water or attempt to make your fresh water last longer by adding sea water to it.

e. Do not drink urine.

f. Do not drink alcohol.

g. Keep smoking to a minimum.

h. To alley thirst, and keep the mouth moist by increasing saliva it may be found beneficial to suck a piece of cloth or a button.

j. Do not eat unless you have adequate water for digestion. Water and food in survival are closely related.

Food

16. This sufficient to follow three simply rules:

a. The quantity of the food and water rations must be varied in direct proportion to each other. If you have plenty of water you can increase the food ration, but as the water ration decreases the food ration must also be decreased.

b. Protein food, such as any raw fish, bird, or seaweed, will require more water than your emergency flying rations.

c. Live off natural foods if your ration of water will permit and save your emergency flying rations for the read emergency when your water supply is getting low.

Protection of Health

17. The ailments likely to effect survivors of sea are chiefly caused by exposure to weather and sea-water, and by shortage of fresh water.

a. **Sea Sickness**. Refrain from eating and drinking for some time, lie still and maintain bodily warmth.

b. **Immersion Foot**. Exposure of legs and feet to cold water for some time results in damage to be tissue. The affected part becomes red and painful and difficult to move. This is followed by swelling, the appearance of blisters and dark patches, and breaks in the skin. Prevention lies in keeping the feet as warm and dry as possible and in ensuring that the floor of the dinghy is dry.

c. **Salt Water Sores**. These are boils or ‘burns’ caused by exposure to salt water. Prevention is by keeping the body as dry as possible.

d. **Sore Eyes**. Sore eyes result from excessive exposure to glare from the sky and water, and should be treated with boric ointment and bandage lightly.

e. **Pared Lips and Cracked Skin**. These discomforts may be remedies by the application of any greasy ointment such as boric or Vaseline.

f. **Constipation or Difficult Urination**. These complaints should not give cause for alarm, as they are to be expected with shortage of food and fresh water.

g. **Frost Bite**. The symptoms of frost bite consist of small patches of white cream coloured skin, st5iff and firm to the touch. A prickling sensation may be felt. If the condition is allowed to become serious, tissues and bone may be come frozen and blood cells clot. When the affected part is warmed, there will be a swelling and redness of the skin with accompanying pain depending on the degree of frost bite usually is experienced in extreme cold exposed finger nose, cars being most susceptible. Protection obtained by keeping as warm and dry as possible, moving limbs, and exercising face muscles. Affected parts must not be rubbed to or massaged, but, armed gently with breath warm hands, or other warm parts of the body.

Dangerous Fish

18. Dangerous fish, such as the shark, barracuda, or swordfish, are most common in tropical waters. Without provocation they will not normally attack you or the dinghy. A few simple hints should help safeguard you from attack or injury.

Hints on Dealing with Dangerous Fish

19. Keep clothing on and keep a good look out.

20. Do not fish if sharks, barracuda or swordfish are in the vicinity.

21. Do not trail hands or feet over the side of the dinghy.

22. Do not throw waste food or scraps over board during the day time.

23. If dangerous fish are about, remain quiet, and the likelihood of attack will be negligible.

24. Survivors in the water without a dinghy should form a circle facing outwards and beat the water with strong regular strokes if sharks are about.

<u>Making A Landfall – Land Indication</u>

25. The presence of land may be detected sometimes long before it can be seen. Following are the few indications :

a. Cumulus clouds in an otherwise clear sky likely to have been formed overland.

b. Very few sea birds sleep on the water, and very rarely do they fly more than 100 miles from land. The recognition of those birds and their direction of flight will often indicate the direction and distance of land. They fly away from land before noon and return in the late afternoon and evening. Storms sometimes blow land birds far out to sea, so alone bird is not reliable indication.

c. Lagoon glare nigh a green nigh tint in the sky or on the underside of a cloud by the reflection of sunlight form the shallow water over, coral reefs.

d. Drifting wood or vegetation is often a sign of the proximity of land.