THE GEOGRAPHIC REFERENCE SYSTEM, THE NATIONAL GRID SYSTEM AND THE UNIVERSAL TRANSVERSE MERCATOR GRID

Systems of Map Reference

1. A reporting organization must have a concise and unambiguous method of referring to a place on the surface of the earth, as represented on a map; clearly it is desirable that the method is common to all units concerned.

2. However, the particular method chosen for use by a service depends upon the degree of accuracy that is needed and upon the extent of the territory to be covered by the reference system. For instance, the commander of an Army mobile column requires a more precise reference to pin-point a rendezvous than does the RAF to plot a moving aircraft.

3. The basic principle of all such systems of map reference is the same: that of defining distances to be travelled from a known point, referred to as the point of reference, first in an easterly direction (known as "eastings") and thence in a northerly direction (known as "northings"), in order to arrive at the required location.

4. The Modified British Grid System was used during the Second World War by all units associated with the Fighter Command Control and Reporting Organization; this, however, was only applicable to England, Scotland and Wales and could not be extended without the variation between grid north and true north becoming intolerable. For this reason, coupled with the limitation of the map projection used, separate grids were necessary to cover Ireland and other European countries.

5. Since the Second World War the requirements of Western Union and The North Atlantic Treaty Organisation, together with a need for the close integration of allied air forces, made it necessary to evolve a map system for international use. The system finally decided upon is known as the Geographic Reference System or, for convenience, by the short title "Georef".

6. However, Home Defence and military land forces require a system which permits the precise pin-pointing of locations. They therefore use the National Grid Reference System which is similar to that used during the Second World War. Accordingly when information is reported to users of Georef and to users of National Grid, both types of reference are included in the message. National Grid is always given first.

7. Similarly, land forces on the Continent also require a system which permits the precise pin-pointing of locations. They use a grid system known as the Universal Transverse Mercator Grid (UTM). This system is used to define locations for Continental Liaison purposes. UTM is always given before the Georef.

Use for which Georef was Designed

8. Georef has world-wide application and was designed for use:

   a. Specifically in the control and direction of forces engaged in air defence.

b. In all other air operations (other than air support and amphibious land combat operations, when a military grid is used).

c. In seaward defences.

d. In inter-service and inter-allied reporting.

Basis and Construction of Georef

9. Georef is based on lines of longtitude (meridians) and on lines of latitude (parallels). The graticule formed by the intersection of the meridians and parallels divides the earth's surface into quadrangular areas the sides of which are a specific length of longtitude and latitude and which can be expressed in terms of degrees or minutes.

10. Because the meridians all converge on the Pole, it will be appreciated that in the Northern Hemisphere (ie, north of the Equator) the Georef areas of the same unit size will, in fact, gradually decrease in width as they become more northerly. A Georef area on, say, the south coast of England is appreciably wider, from east to west, than the same unit area in Scotland. For all practical purposes, however, a Georef area of the same unit size is considered to be standard throughout the Corps (Fig N1).

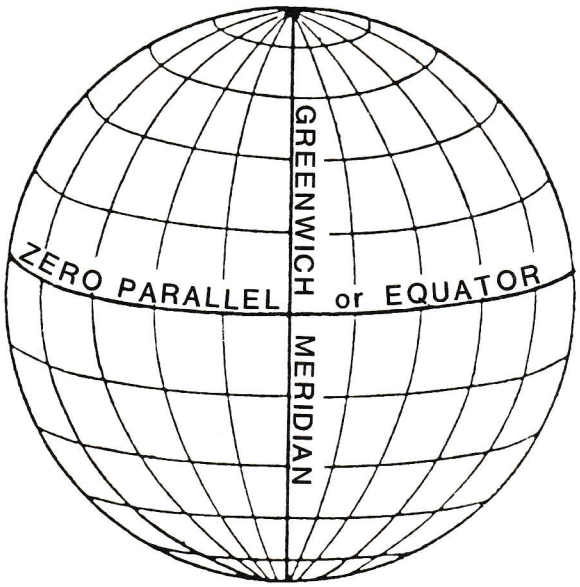

Fig N1

Illustrating the convergence of meridians and the resultant variation in the actual size of the same unit area according to its geographic location.

11. Degrees and Minutes. To understand fully the construction of Georef it is necessary to realise that the division and sub-division for lettering and for numbering is based on degrees and minutes of longitude and latitude. It must be realised that:

a. There are 360 degrees of longitude:

(1) 180 degrees East of the Greenwich Meridian.

(2) 180 degrees West of the Greenwich Meridian.

b. There are 180 degrees of latitude:

(1) 90 degrees North of the Equator.

(2) 90 degrees South of the Equator.

c. There are sixty minutes (60') in one degree (1°).

Lettering System

12. Point of Origin. In its world-wide application the lettering system originates on the 180° meridian at the South Pole: this point being known as the "Point of Origin".

13. Primary Letters. There are 24 longitudinal zones each of 15 degrees width extending eastwards from the 180 degree meridian around the globe through 360 degrees of longitude. These zones are lettered from A to Z inclusive (omitting I and O) eastwards from the 180 degree meridian. There are 12 bands of latitude each of 15 degrees depth, extending northwards from the South Pole to the North Pole. These bands are lettered from A to M inclusive (omitting I). This code divides the earth's surface into 288, 15 degree quadrangles each identified by two letters. The first letter is that of the longitude zone and the second the latitude band. (See Fig N2).

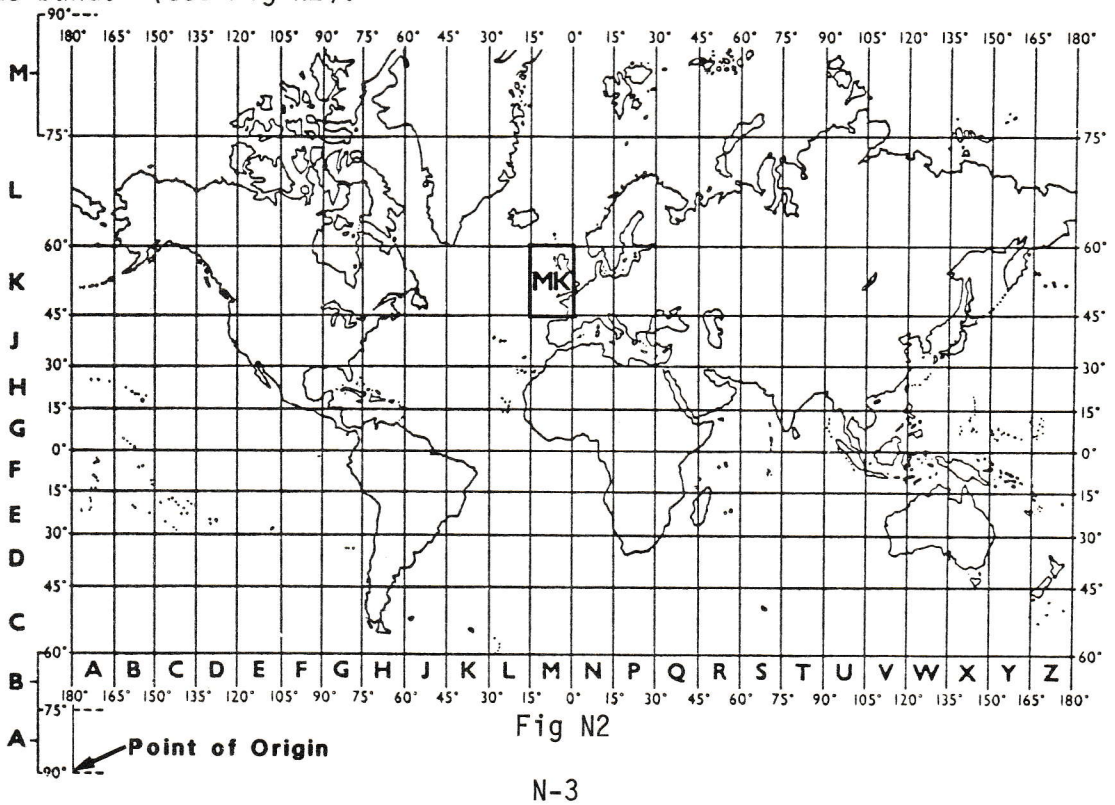

Fig N2

14. Secondary Letters. Each 15 degree quadrangle is subdivided into 15 one degree zones of longitude and latitude and lettered A to Q inclusive (omitting I and O) eastwards and northwards respectively. (See Fig N3).

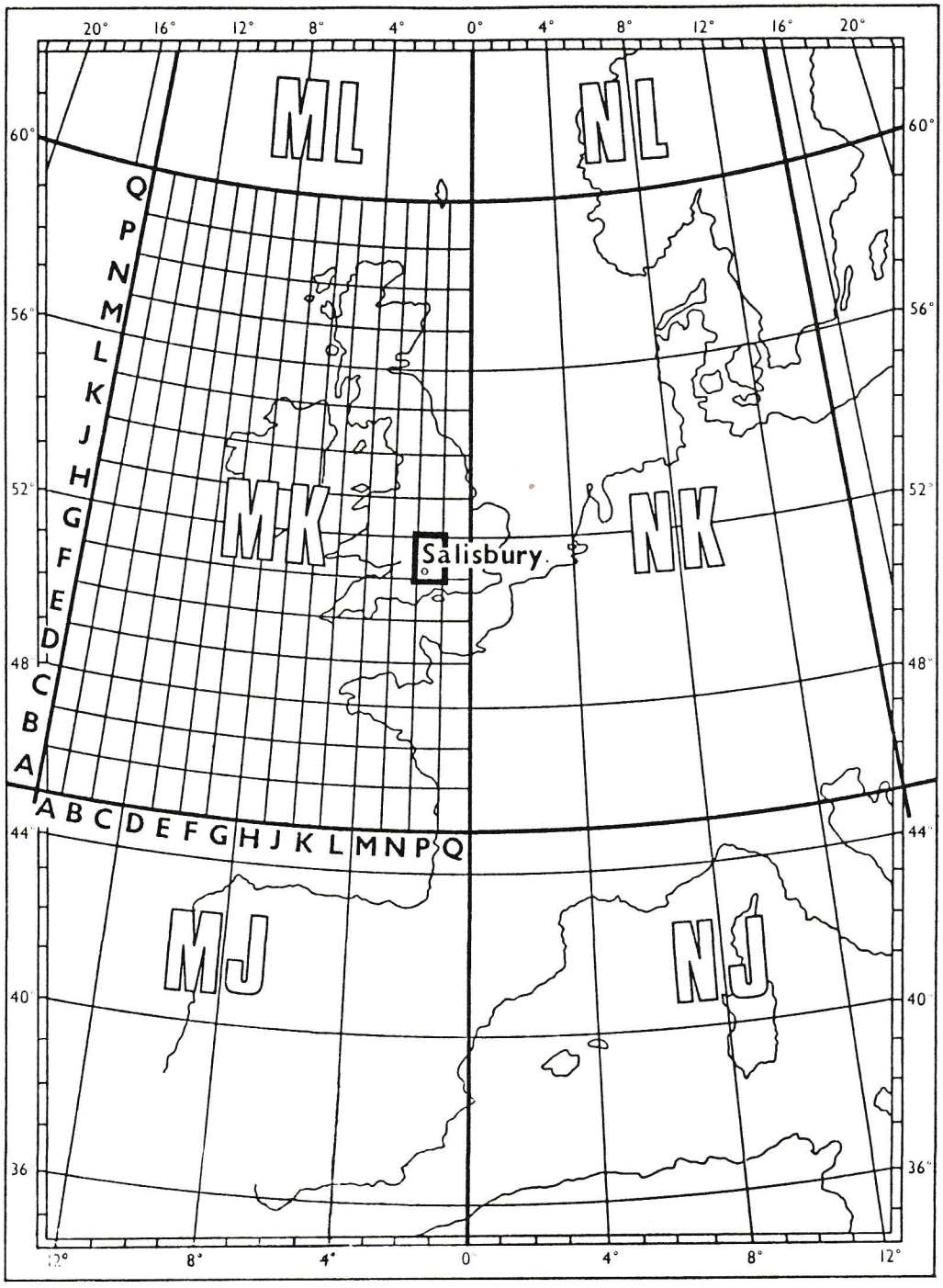

Fig N3

Illustrating Georef Primary and Secondary Letters in their application over the British Isles (15° areas MK and NK)

Numbering System

15. Each one degree quadrangle is divided into 60 minutes of longitude, numbered eastwards, and 60 minutes of latitude numbered northwards (See Fig N4). Thus a unique reference defining the position of a point to an accuracy of one minute of longitude and latitude (ie 2 kms or less) can now be given quoting four letters and four numbers. ie The Georef reference for Salisbury Cathederal is MK PG 12 04, See Fig N5. However since most of the Georef information used by the ROC is within the British Isles the primary letters 'MK' are not normally given, thus 'our' reference for Salisbury Cathederal would read PG 12 04.

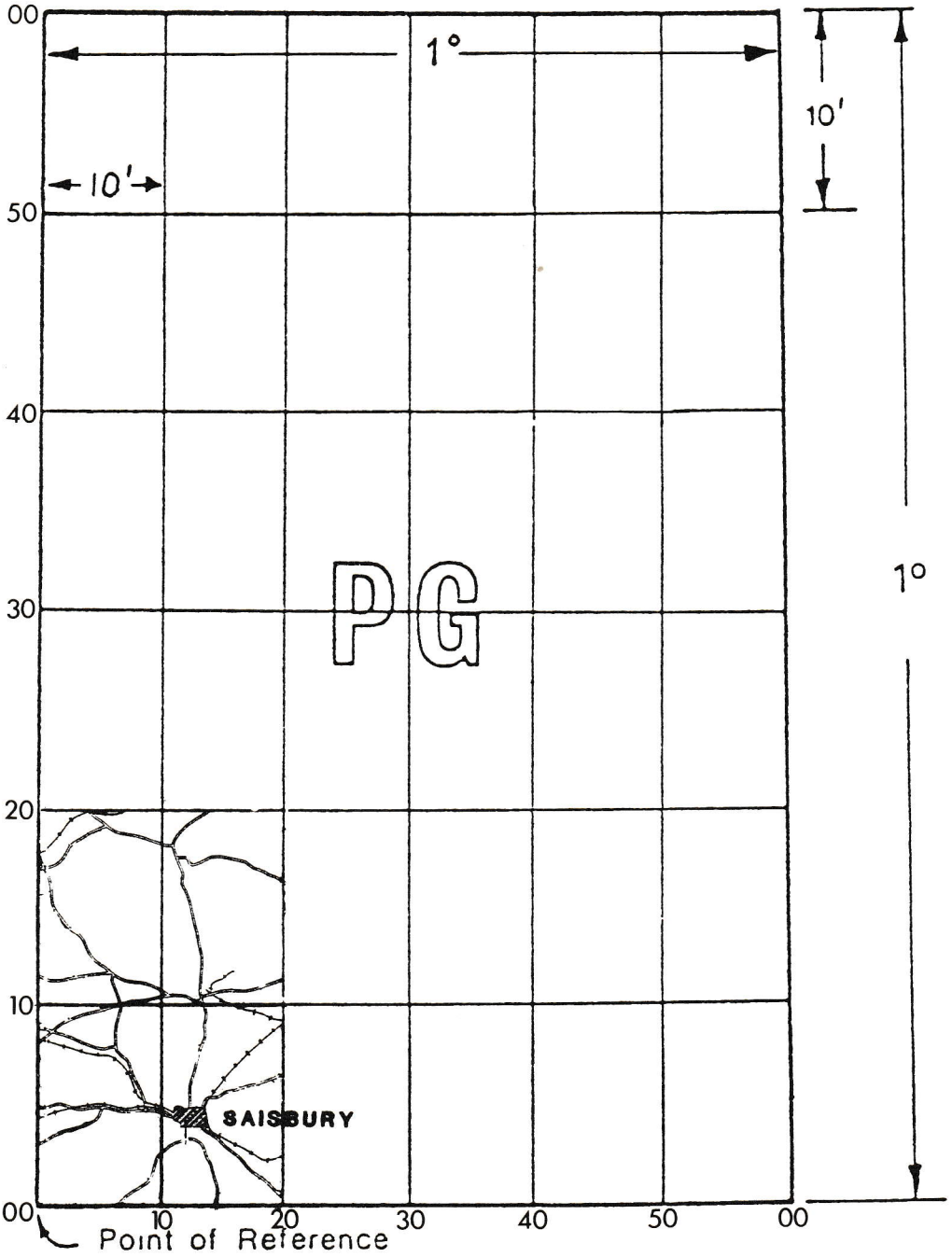

Fig N4

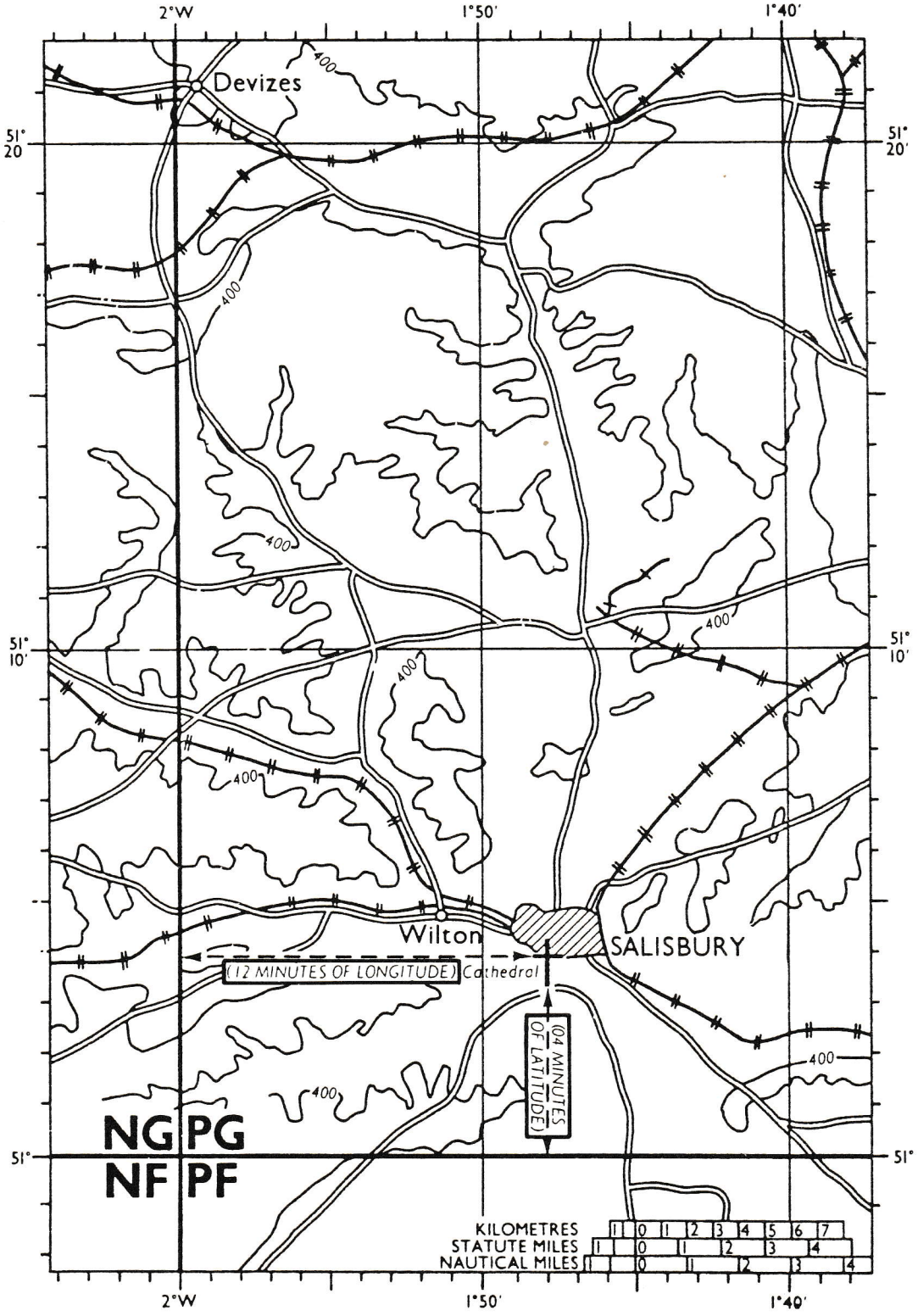
2°W
1°50'
1°40'
Devizes
51° 20'
51° 10'
51°
400
Wilton
SALISBURY
Cathedral
(12 MINUTES OF LONGITUDE)
(04 MINUTES OF LATITUDE)
NG PG
NF PF
KILOMETRES
STATUTE MILES
NAUTICAL MILES

Fig N5

Grid Reference Systems

16. The definition of a grid is a system of dividing a map or plan into a number of squares with a numbering system so that each may be identified with its own number.

17. The most simple form of map reference usually appears as a square grid drawn on a map and lettered in the margin from west to east and numbered from north to south. Its biggest advantage is that it is simple to use, for each square is immediately identified by a letter and a number, such as A2 or F4. Its disadvantage is that it serves only to localise points rather than to locate them accurately. This type of grid can usually be seen on town guide maps and street plans (See Fig N6).

	A	B	C	D	E	F
1						
2						
3						
4						

A Simple Form of Grid

Fig N6

18. Such a grid system has no value to anyone attempting to describe accurately the ground zero of a nuclear burst. The use of the National Grid Reference System (NGR) does, however, provide an accurate, quick and easily-definable system of plotting and because of its national coverage is ideally suited to use by the ROC and UKWMO.

19. Because of distortion in scale caused by the type of map projection NGR is limited to England, Scotland and Wales. Ireland is allocated its own grid called appropriately the Irish Grid. The Continent of Europe is gridded according to the Universal Transverse Mercator Grid (UTM).

20. The common feature to all these grids is that the squares used are all based on metric measurement. For example, the 1:50,000 Ordnance Survey Map (the modern equivalent to the 1 inch OS map) has a grid interval of 1 kilometre and continental maps of the same scale are also gridded at 1 kilometre intervals.

21. On the smaller scale maps used in UKWMO Controls, such as the Triangulation and BPI maps, Displays "B", "E" and "T", the grid interval is 10 kilometres instead of 1 kilometre. This is the reason why only four figure references are used to define the location of bomb bursts.

22. The point of reference for NGR is in the sea just west of the Scilly Isles off Cornwall and is shown as point "O" in Fig. N7. This is merely a datum point from which all references referred to in the lettering system are measured in an easterly direction (Eastings) and then in a northerly direction (Northings). It is of no consequence whether the references consist of four figures or ten figures - it will still be referring back to that point in the sea off Cornwall.

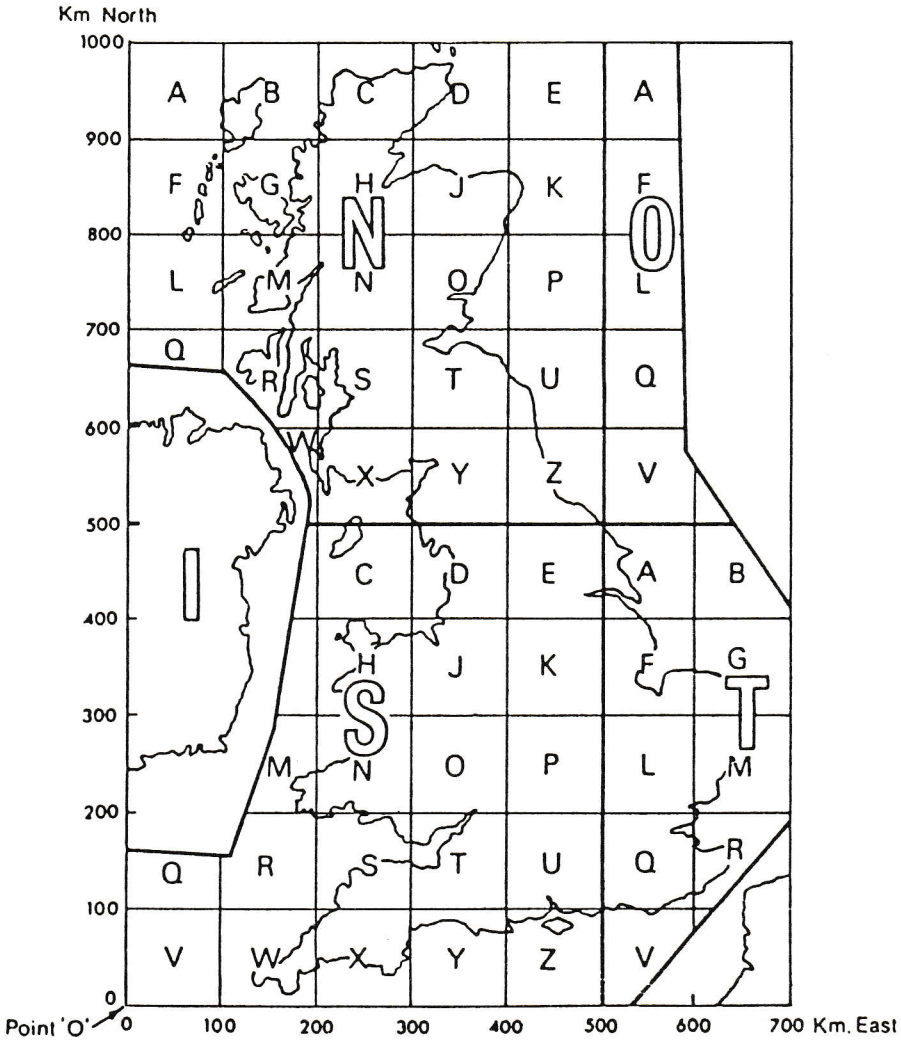

Fig N7
National Grid 500 km and 100 km Squares

23. The number of figures in a reference gives an indication of its accuracy. The more numbers there are the more accurate is the reference, but the scale of the map or plan on which it is to be plotted limits this accuracy.

Construction of NGR

24. The Area of the grid covering the mainland of Great Britain can be divided into four squares each of which is 500 km (or about 310 miles) square. These are lettered N, O, T and S as shown in Fig N7, and are in turn sub-divided into 25 squares, each one being 100 km by 100 km. These 100 km squares are lettered from A to Z omitting the letter I. This lettering is done from west to east and from north to south, again as shown in Fig N7.

25. Each of these 100 km squares is further sub-divided into 100 squares each being 10 km by 10 km. The numbers which are used to refer to them consist of the distance in kilometres x 10 from the point of reference of each 100 km square, the first figure being the distance east and the second the distance north. The point of reference of each numbered square is the south-west corner (See Fig N8).

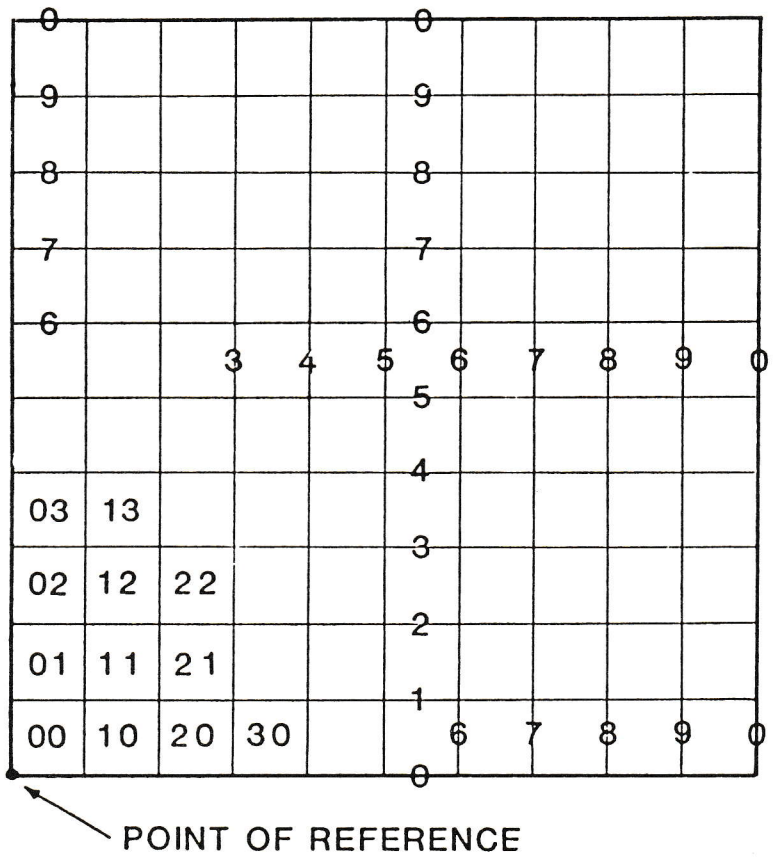

Fig N8
Numbering of 10 km squares within a 100 km square

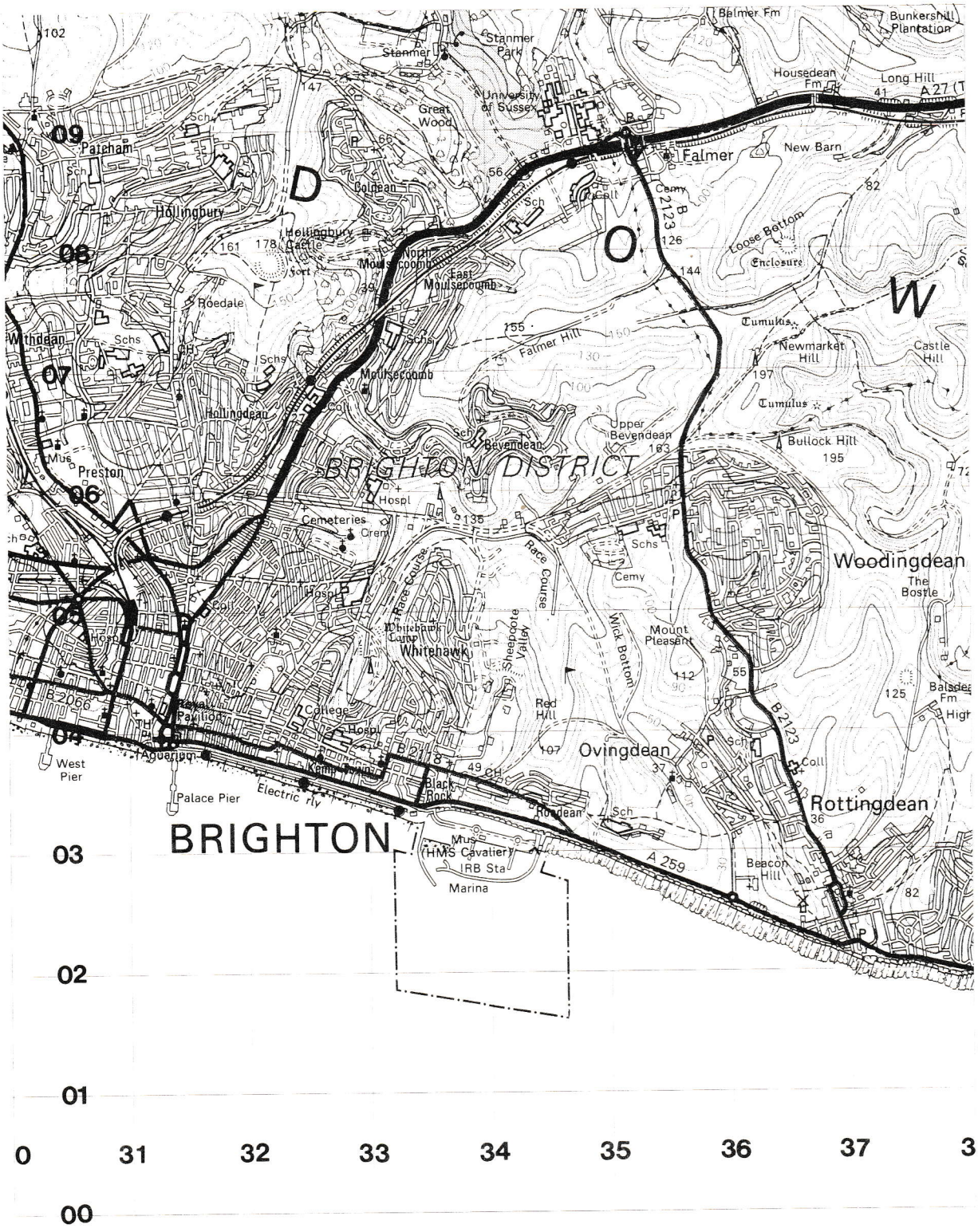

Fig N9

Section of 10 km square TQ 30

26. Fig N9 shows an extract from OS 1:50,000 sheet 198. It will be seen that this square is divided into 100 1km squares and these are numbered by two figures east and north on each line. Thus the village of Rottingdean lies within the square TQ 3603, this reference being the point at which these grid lines intersect.

27. To carry the reference a stage further it is necessary to estimate by eye the division of these 1 km squares into tenths to obtain a grid reference accurate to 100 metres. For example to give the co-ordinates of Rottingdean school refer first to the vertical line to the west and numbered "36", estimate the number of tenths to the east, in this case 2. The eastings value is said to be "362". Next go north from the line "03" and estimate the number of tenths to the north of this line, in this case 8, and the northings value becomes 038. Together with the eastings the six-figure reference of the centre of the school is 362038.

28. As this reference could recur within the National Grid, it is usual to limit it by prefixing the figures with the 100 km letter which is "Q" and to make it unique add the 500 km letter; thus the full reference, which cannot be repeated anywhere in Great Britain, would be TQ 362038. It is important to remember that references are always given in the same order, eastings first and northings second.

Construction of UTM

29. Once the NGR is understood, the Universal Transverse Mercator Grid should not offer any new complications. It is an ingenious system in that the whole world can be mapped without any noticeable distortion between the latitudes of 80° S and 84° N.

30. The use of the UTM Grid is exactly the same as that of NGR for it is, in effect, a metric grid. Where letters are required to provide a more precise location, they are determined in a different manner, but they will always be printed on the face of the map or given in marginal information.

31. To create UTM, the whole world between 80° S to 84° N is considered as a large number of north-south strips or zones, each one being 6° of longitude in width. The zones are widest at the Equator and have a curved taper to the north and south. For ease of explanation, only the zones to the north of the Equator will be described, but the same principles apply to those south of this line. The curved tapers would, if cut out and stuck together, form a shape similar to parachute panels when filled with air in a descent (see Fig N10).

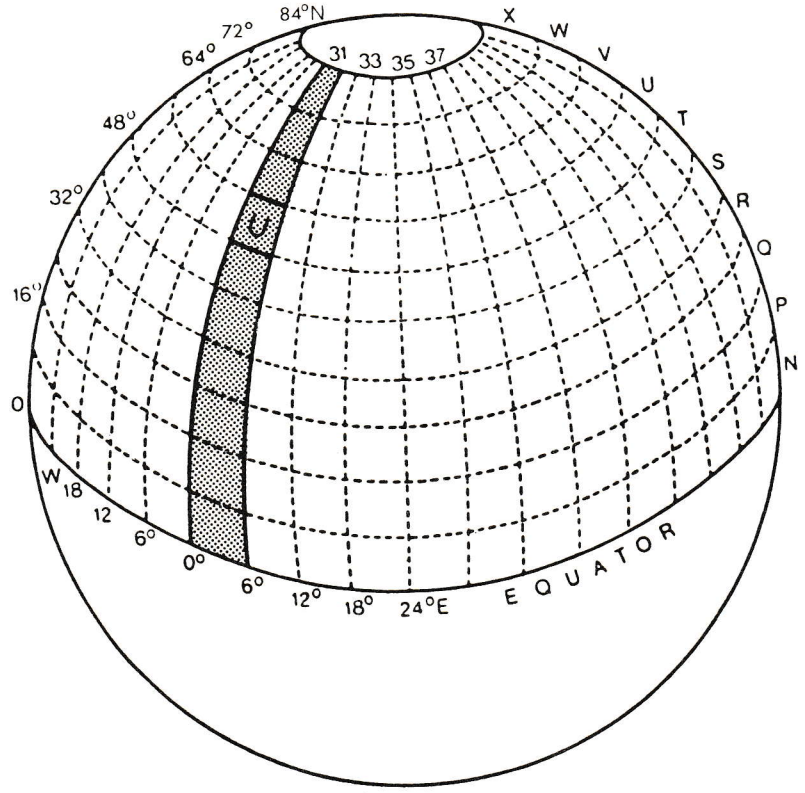

Fig N10
UTM Grid Zones

32. These zones of longitude are numbered from 1 to 60 commencing at the 180° meridian. The zones are divided into belts of 8°, except for the most northerly band which covers the 12 degrees of latitude from 72°N to 84°N. The quadrangles formed are allocated a letter for identification. The combination of these figures and letters are known as the Grid Zone Designation. Reference to Fig N10 will show that the area 0° - 6° and 48° - 56° is known as 31U and it covers Northern France, Belgium and Holland.

33. An enlargement of this at Fig N11 shows the area divided into 100 km squares east and west of the central (3° E) meridian. The squares are identified by a pair of letters, but these do not follow the same sequence as that in NGR. It is only necessary to know that the letters are not repeated within 18° of latitude or 2000 Kilometres north-south.

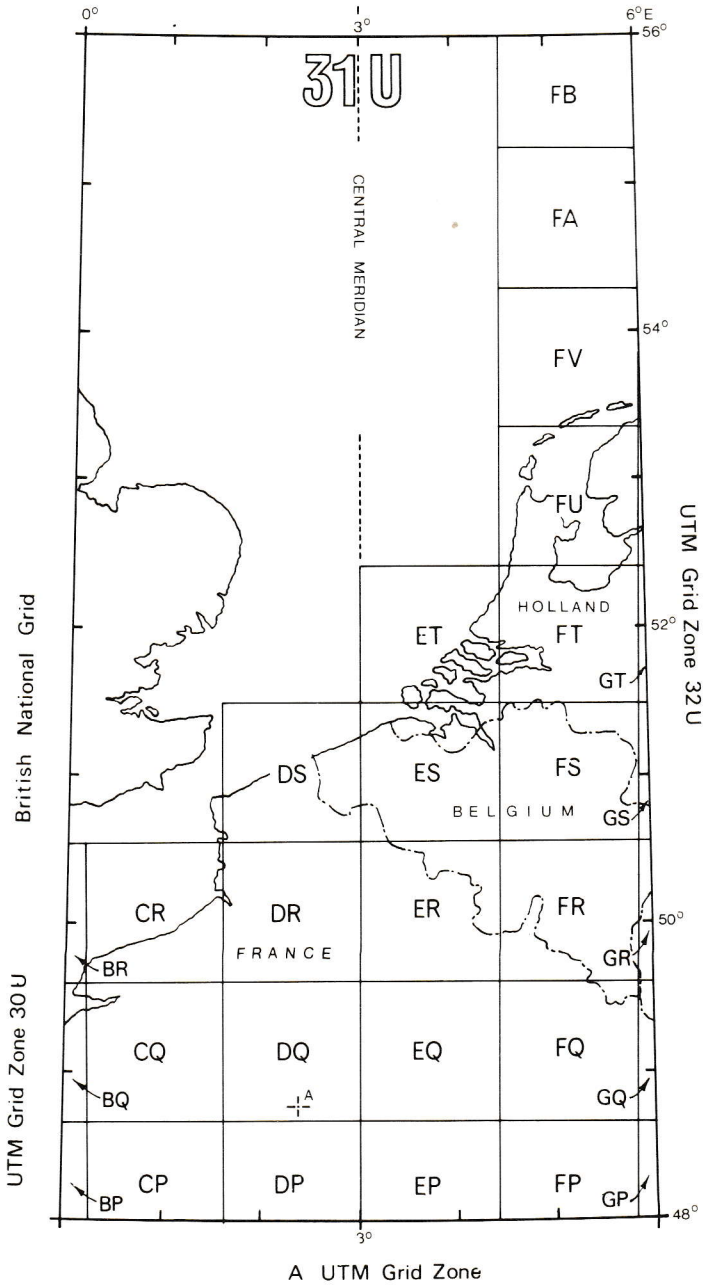

Fig N11

34. Although the 100 km letters are determined in a different way from NGR, the method used to describe a location reference within a 100 km square is the same and consists of a series of figures describing eastings and northings. A unique reference would be 31U DQ5510 and this position is shown in Fig N11 as "A".

35. To calculate or plot a reference is not a difficult task and does not require any special technical knowledge. Proficiency comes with practice and taking care not to transpose easting and northing components of the reference.

	Size of Grid →	100 000 metres	10 000 metres	1000 metres	100 metres
Reporting Distance ↓	Point located within →	10 000 metres	1000 metres	100 metres	10 metres
World-wide		**31UDQ51**	**31UDQ5510**	Not normally used	
Within Grid Zone Designation Area		**DQ51**	**DQ5510**	**DQ553106**	**DQ55321064**