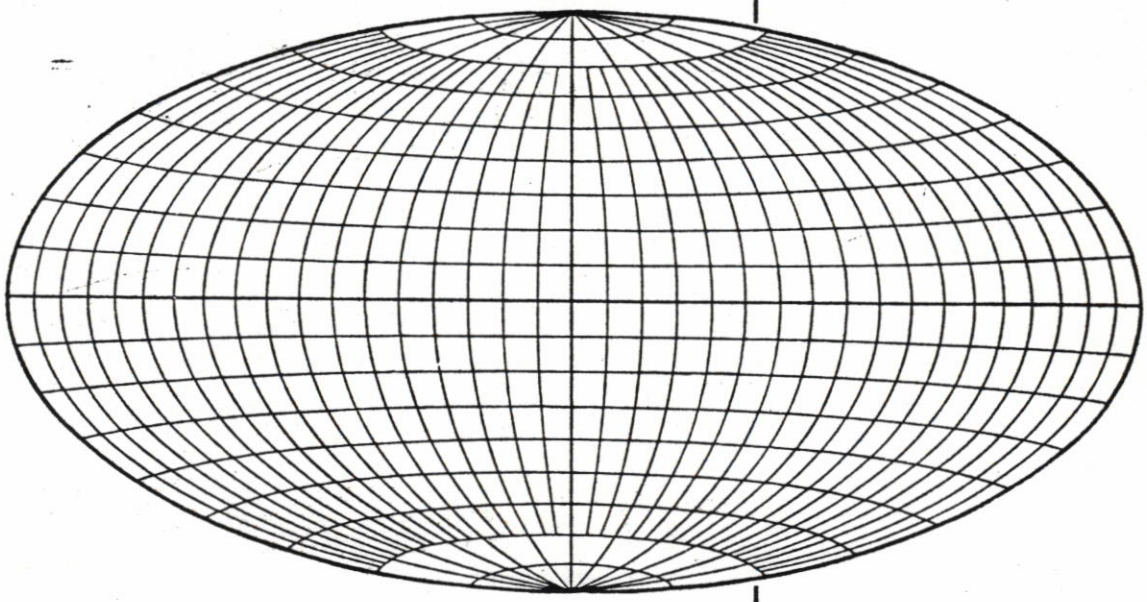
Army FM 34-85
Sept 81

Chapter 1

UNIVERSAL TRANSVERSE MERCATOR MAPS

General

Universal Transverse Mercator (UTM) maps are used by the United States and other North Atlantic Treaty Organization forces and are based upon the Hayford spheroidal concept. This concept assumes (mathematically) that the earth bulges slightly in the area of the equator.



This spherical shape of the earth presents many difficulties when attempting to represent it as a flat surface. The inherent difficulty in the earth's representation may best be appreciated by covering a ball-shaped object with a sheet of paper. The only area that will be accurately represented upon the paper is that which is not folded to conform to the spherical shape. One of the methods devised to overcome this difficulty is the use of projection.

Projection

To project literally means "to throw forward." A map projection is the network of coordinates picked off the globe and thrown upon a surface. The Mercator projection is a mathematical projection very similar to what would be formed by projecting lines from the center of the earth to a cylinder. The cylinder fits around the earth and touches at the Equator (fig 1-1). If the image of the earth could be projected against the cylinder and fixed there, the cylinder could be cut open and laid out flat. This would result in a sheet map that is comparatively accurate in the equatorial region, but more and more distorted as the polar regions are approached. The point of tangency of the Mercator projection is a horizontal line — the Equator.

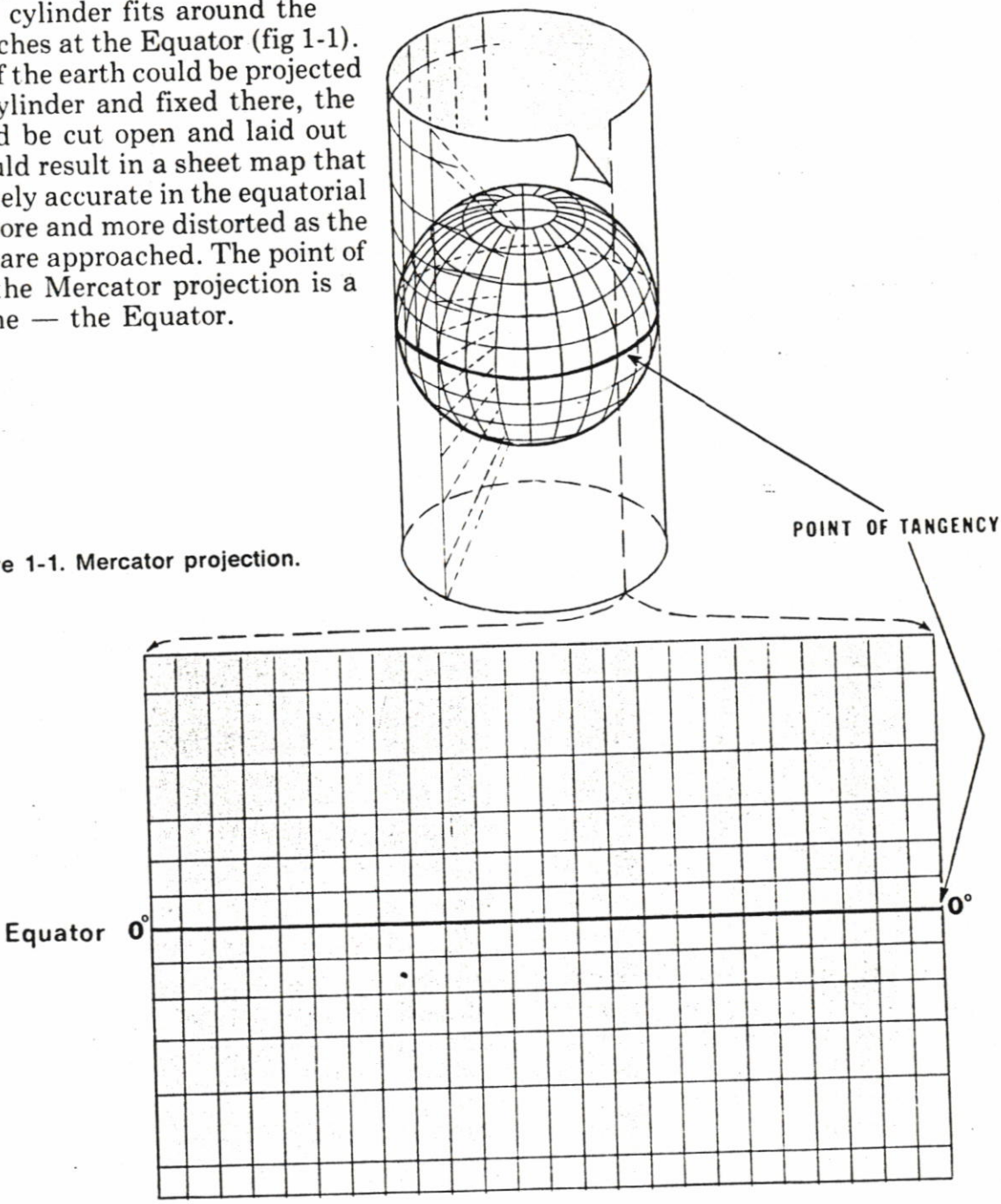


Figure 1-1. Mercator projection.

Turning the cylinder across its former horizontal line, that is transversing it, results in the transverse Mercator projection (fig 1-2).

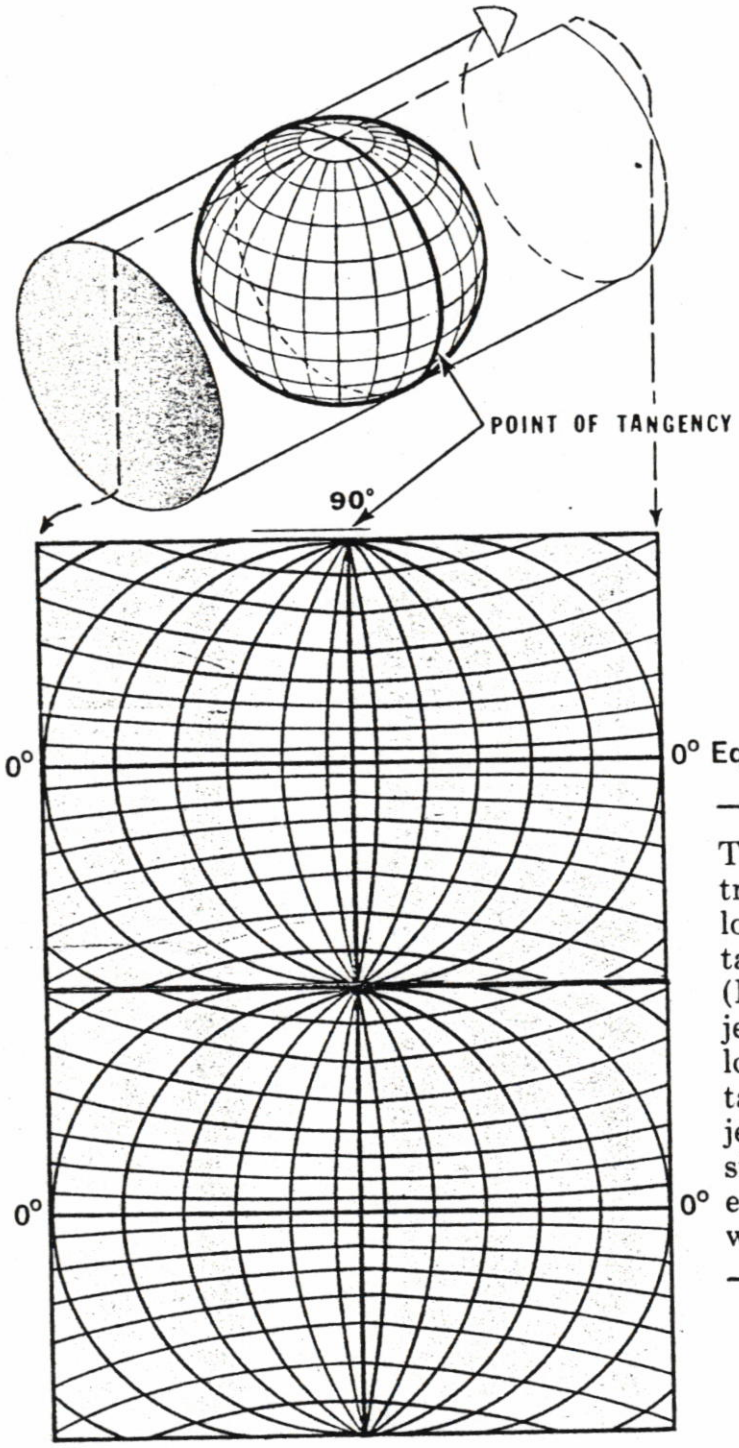


Figure 1-2.

Transverse Mercator projection.

The significant difference is that the transverse Mercator projection uses a longitudinal or a vertical line as its line of tangency in lieu of a horizontal line (Equator) used to project a Mercator projection. By choosing several lines of longitude or meridians as lines of tangency, several transverse Mercator projections can be constructed. When laid side by side, the entire land mass of the earth is mapped in north/south sections with a minimum of distortion.

Geographic Coordinates

A method used to locate specific points on a map by utilizing degrees of longitude and latitude is called the *geographic coordinate method.* By drawing a set of lines around the globe (parallel with the Equator) and another set of lines crossing the Equator at right angles and converging at the poles, a network of reference lines is formed from which any point on the surface of the earth can be located. Those lines parallel with the Equator are called *parallels of latitude* (fig 1-3). Those lines extending from pole to pole are called *meridians of longitude.* The meridian of longitude, from which longitudinal measurements are made, is called the *prime meridian.* The prime meridian of the system we use runs through Greenwich, England and is known as the *Greenwich Meridian.* Geographic coordinates are expressed in angular measurements. Each circle is divided into 360°; each degree into 60 minutes, and each minute into 60 seconds.

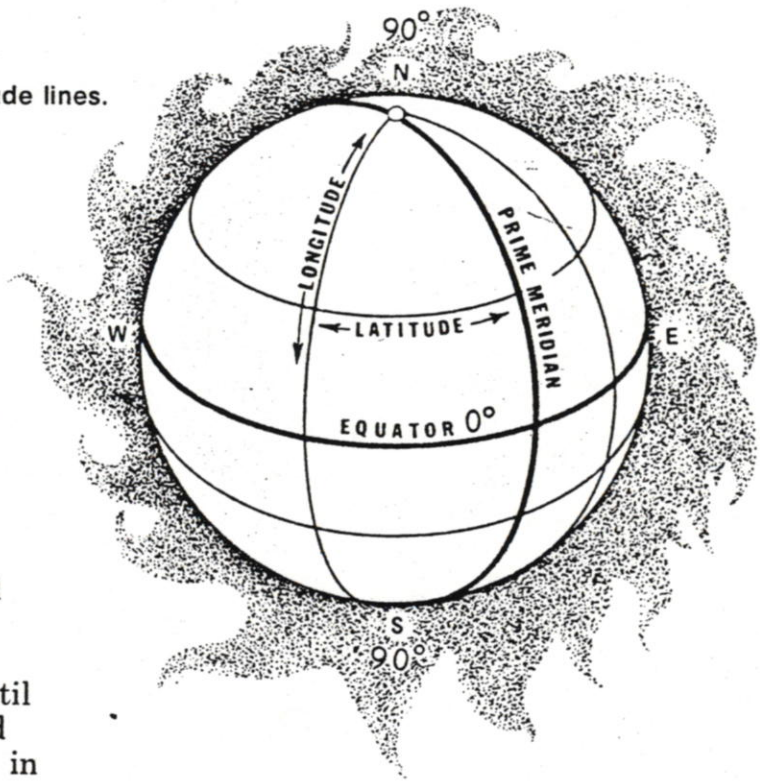


Figure 1-3.
Latitude and longitude lines.

The Equator is designated as *zero degrees* and measurements are made north or south of this line. The North Pole is 90° north latitude and the South Pole is 90° south latitude. To measure around the globe, one would start at the prime meridian and proceed both east and west around the globe until the 180° line is reached. Large and medium scale military maps have, in addition to geographic coordinates, a grid system for locating or referencing the locations of points. The grid system, rather than the geographic coordinates, is used by the military to express location because of its relative simplicity.

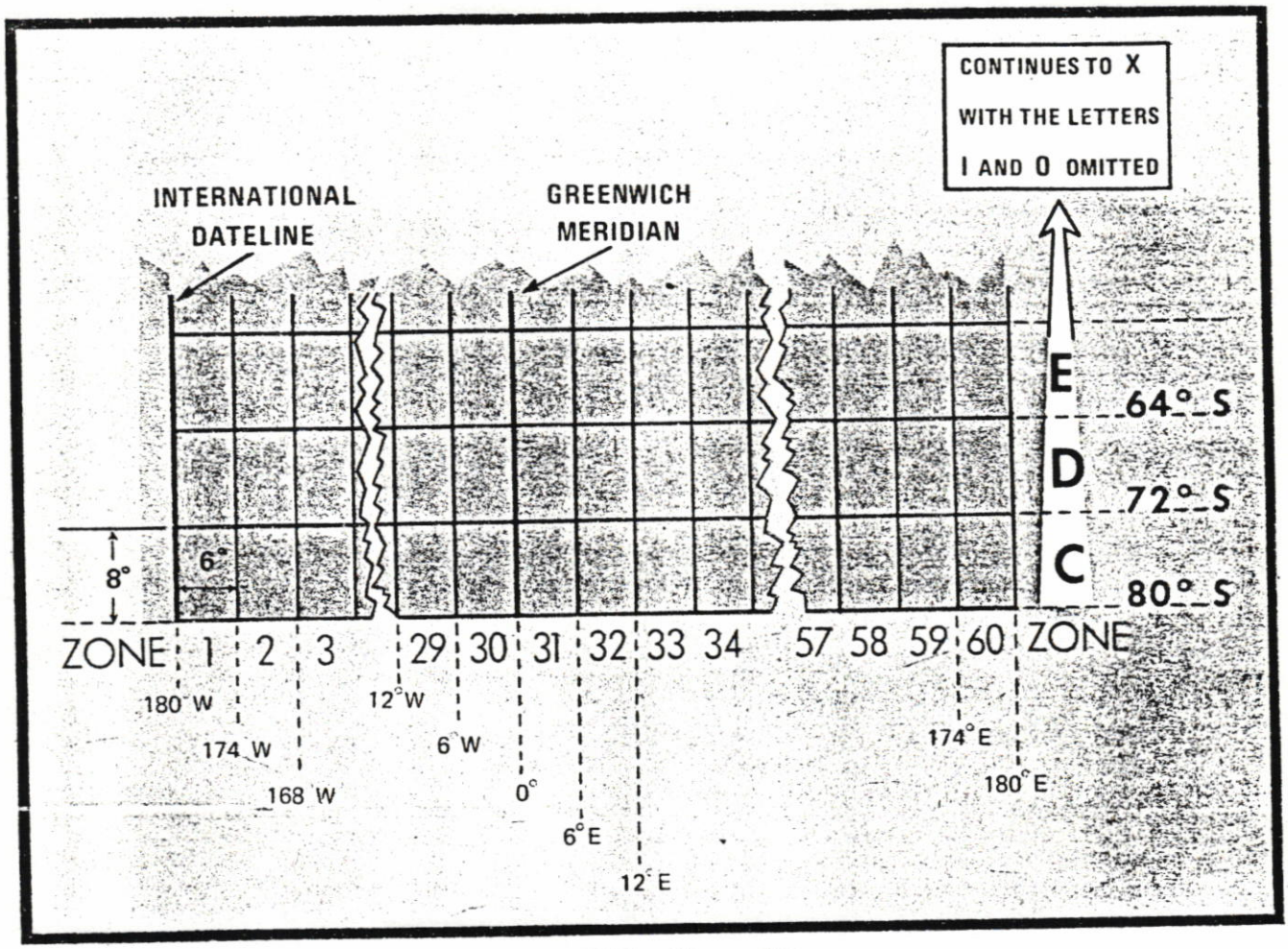


Figure 1-4. UTM military grid zones.

Universal Transverse Mercator Military Grid System

The Universal Transverse Mercator (UTM) military grid system uses the geographic lines of longitude to divide the globe vertically into grid zones. The zones are large regularly shaped geographic areas, each of which is given a unique identification called the grid zone designation. Initially a transverse Mercator is drawn for each zone. There are 60 zones completely encircling the globe, each being 6° of longitude wide. The zones are numbered 1 through 60, going in an easterly direction, with zone 1 beginning at the 180th meridian. Thus, zone 1 is from 180° W to 174° W; zone 32 is from 6° E to 12° E; zone 60 is from 174° E to 180° E (fig 1-4).

Going north and south from the Equator are horizontal lines of division for each zone (fig 1-5). From 80° S to the Equator, there are 10 rows in each zone, 8° high and 6° wide. From the Equator northward, there are 9 rows 8° high and 6° wide, with a 10th row 12° high and 6° wide. These zones become progressively narrower as they approach the poles; therefore, the **UTM military grid system is not used beyond 84° N and 80° S.** A polar projection is used to cover these areas. In the UTM military grid reference system, these horizontal zones are lettered south to north, beginning at 80° S with the letter "C" and ending with the letter "X" at 84° N. **The letters "I" and "O" are not used to avoid confusing them with the numbers one and zero.**

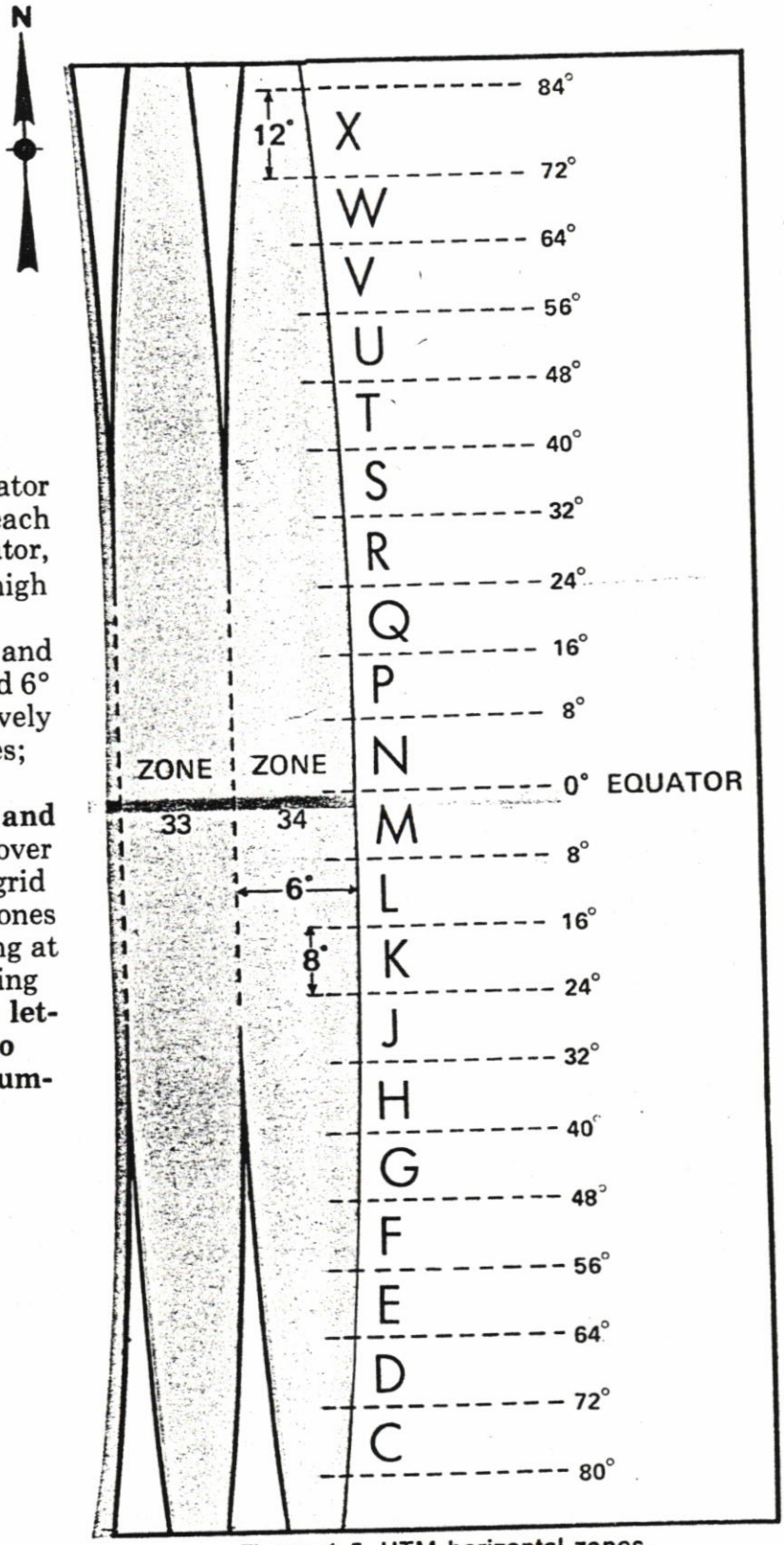


Figure 1-5. UTM horizontal zones.

Each 6° by 8° or 6° by 12° grid zone is then further divided by 100,000-meter squares, which are identified by the combination of two letters or digraphs (fig 1-7).

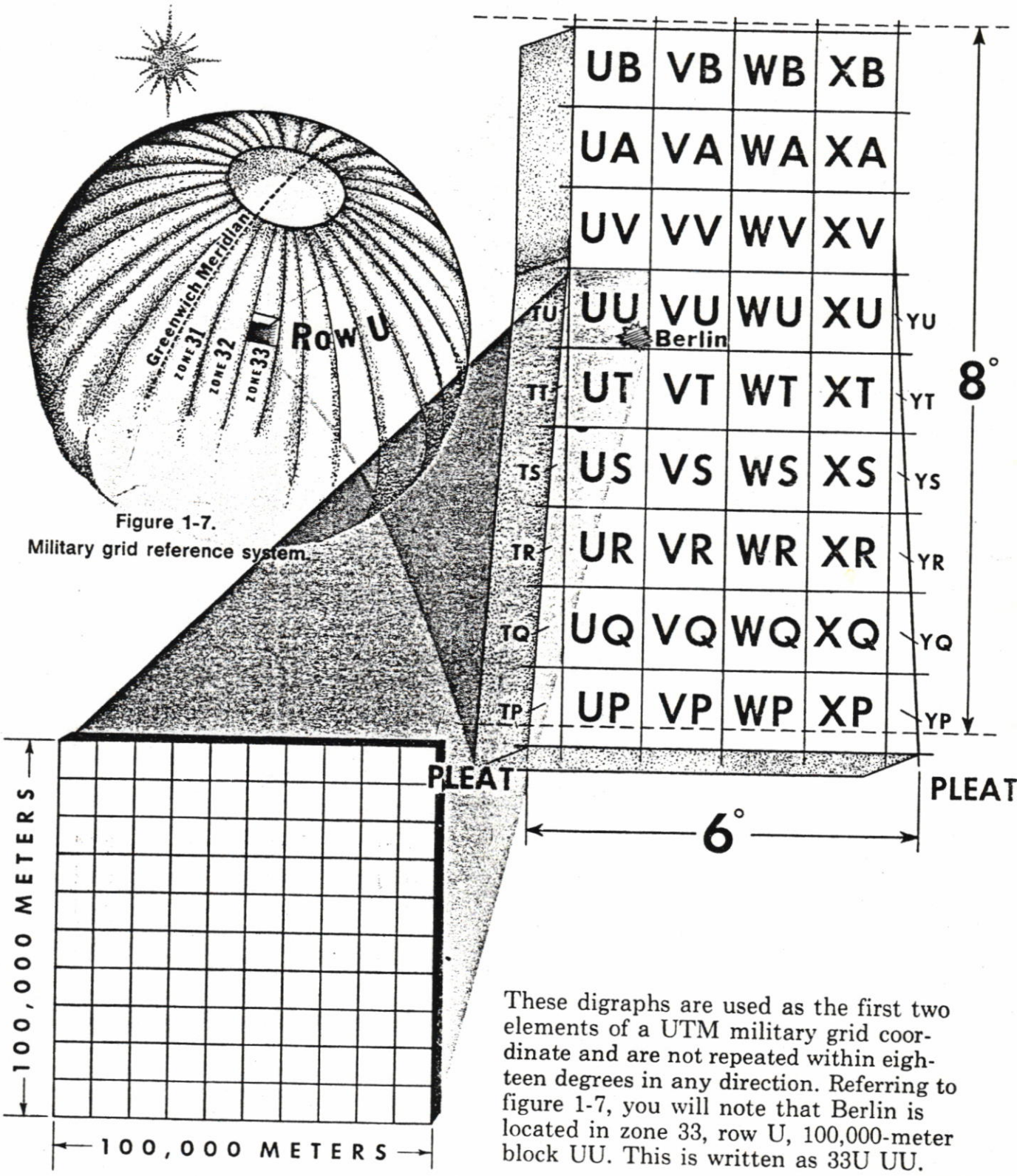


Figure 1-7.
Military grid reference system.

These digraphs are used as the first two elements of a UTM military grid coordinate and are not repeated within eighteen degrees in any direction. Referring to figure 1-7, you will note that Berlin is located in zone 33, row U, 100,000-meter block UU. This is written as 33U UU.

Each 100,000-meter square is further divided by grid lines which are placed at 10,000- or 1,000-meter intervals. Figure 1-7 illustrates that the 100,000-meter square UU can be divided into 100 of the 10,000-meter squares. Each 10,000-meter square within UU can then be further subdivided into 1,000-meter squares by dividing each side of the 10,000-meter square into 10 equal parts. This division will provide grid lines that are 1,000 meters apart. Through the use of a grid coordinate scale, division of the 1,000-meter square is possible, enabling the location of a point on the earth's surface to the nearest 10 meters.

In the subdivision of a 100,000-meter square, all readings are taken from the lower left-hand corner of the block. The location of any point within the block is stated as to how many meters it is to the RIGHT of the left-hand side of the block, and how many meters the point is UP from the bottom of the block. All UTM readings are given as easting portion first, and northing portion second.

The RIGHT and UP method can best be illustrated by figure 1-8. To determine the UTM location of point E, start at the left-hand corner of the grid square. Reading eastward, or RIGHT, to the vertical line that intersects point E, one would then read UP, or north, until point E is located on the horizontal line. The six-digit grid coordinate of point E is 355 RIGHT and 576 UP, or 355576.

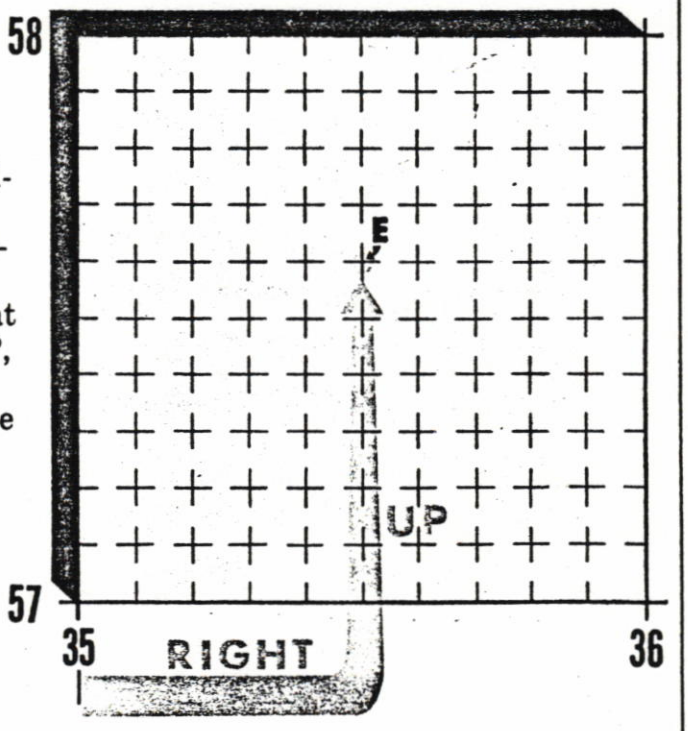
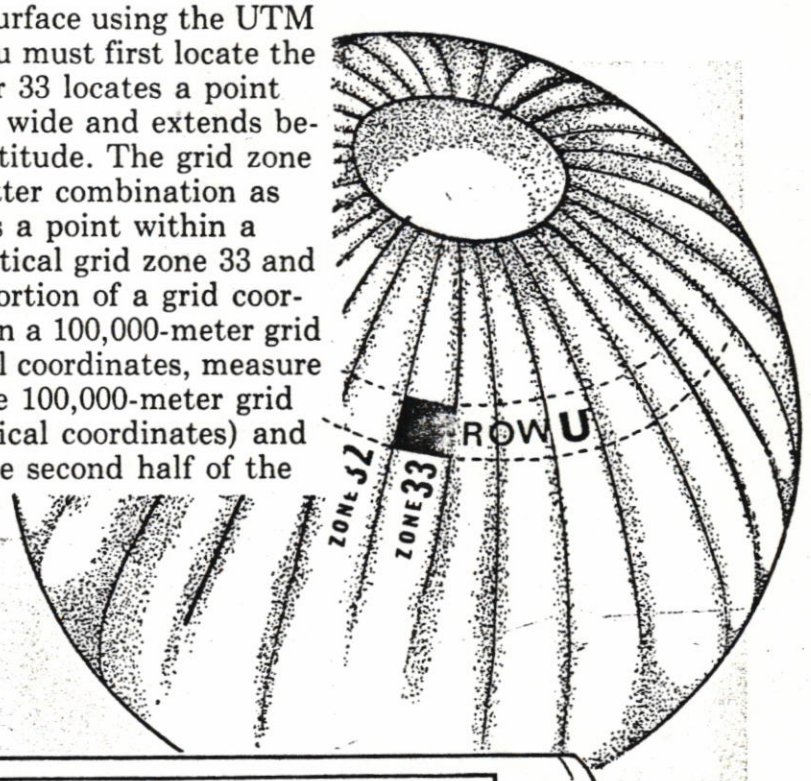


Figure 1-8. Military grid.

To locate any point of the earth's surface using the UTM military grid coordinate system, you must first locate the appropriate grid zone. The number 33 locates a point within zone 33 which is an area 6° wide and extends between 80° S latitude and 84° N latitude. The grid zone designation 33U, a number and letter combination as shown in figure 1-7, further locates a point within a quadrangle 6° wide by 8° high (vertical grid zone 33 and horizontal zone U). The digraph portion of a grid coordinate further defines a point within a 100,000-meter grid square. Finally, using the numerical coordinates, measure the easting metric value within the 100,000-meter grid square (the first half of the numerical coordinates) and then the northing metric value (the second half of the numerical coordinates).



The degree of accuracy is indicated as follows:

33U = a 6° by 8° area (grid zone designation).

33U UU = a 100,000-meter square.

33U UU91 = a 10,000-meter square.

33U UU9115 = a 1,000-meter square.

33U UU917155 = location to the nearest 100 meters.

33U UU91781557 = location to the nearest 10 meters.

33U UU9178515572 = location to the nearest meter.

Note!

It is beyond the scope of this manual to teach basic map reading. For further map reading information, see FM 21—26.