

Basic Geodesy

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Transverse Mercator Projection

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This is the fourth article in a series discussing the projections commonly used by NGA. The Transverse Mercator projection is predominately used for large scale topographic mapping between 84° North and 80° South.

This conformal, cylindrical projection minimizes distortion in the N-S direction and can be visualized as the projection of the ellipsoid onto a cylinder with the cylinder's long axis perpendicular to the ellipsoidal polar axis. Although the Transverse Mercator (TM) projection can be used with the cylinder tangent to the ellipsoid, the preferred NGA method is to mathematically adjust the cylinder to make it secant to the ellipsoid as illustrated in Figure 1.

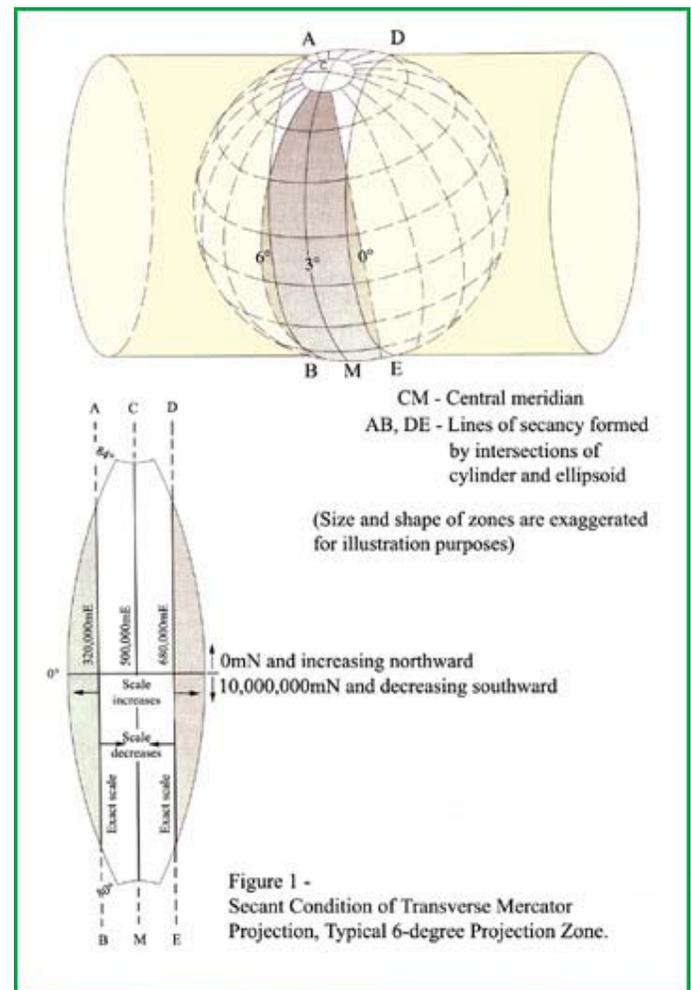
The Transverse Mercator projection used by NGA is defined by UTM (Universal Transverse Mercator) grid parameters. The UTM grid divides the world into 60 zones with each zone being 6° wide (See Figure 3). The top portion of the diagram graphically represents the TM projection for UTM Zone 30 which extends from 0° West to 6° West with a Central Meridian of 3° West.

The bottom portion of the diagram shows the Central Meridian is given a False Easting of 500,000 meters East. The mathematical adjustment to make the cylinder secant to the ellipsoid results in the cylinder intersecting at approximately 180,000 meters east and west of the Central Meridian. This minimizes the distortions. At these two locations (approximately 320,000 meters and 680,000 meters East), the scale is exact. (Wording is paraphrased from DMA TM 8358.1 DATUMS, ELLIPSOIDS, GRIDS, AND GRID REFERENCE SYSTEMS, Edition 1, various authors, p. 2-14)

The following parameters are needed when working with a [UTM-based Transverse Mercator projection](#) in various GIS software:

[Zone Number](#)
[Hemisphere \(N or S\)](#)

Latitude of Origin (Equator)
Longitude of Origin (Central Meridian (CM) of Zone)
False Easting (500,000 meters East)
False Northing (either 0 meters North for areas north of the Equator or 10,000,000 meters in the Southern Hemisphere)
Scale Factor (0.9996)



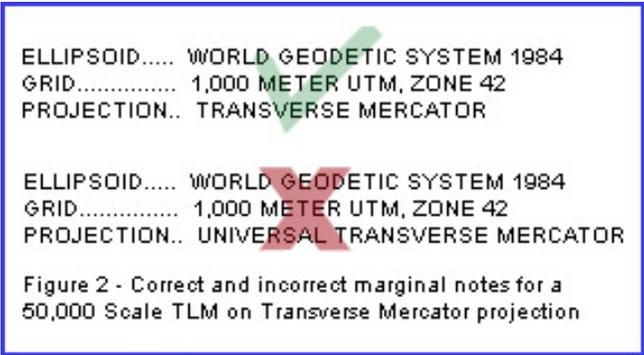
Other Transverse Mercator Projections

Many foreign maps and charts are on Transverse Mercator projections with grid parameters other than the UTM parameters typically used on NGA products. The most

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common of these is the Russian Gauss-Kruger grid system (also referred to as the Soviet Unified Reference System 42, System 42, or S-42). Another example of a TM projection using different parameters is the Bogota grid system. These projections often have different sized zones than the typical 6 degree wide UTM zones and could have different scale factors, origin points, and/or false Northing/Easting values. (Please contact the Coordinate System Analysis Team (CSAT) members in Bethesda or St. Louis if you have questions regarding TM projections and their associated parameters.)

Even though several textbooks and individuals refer to the Transverse Mercator projection as a UTM projection, this is incorrect. The UTM (Universal Transverse Mercator) is a grid system, not a projection. Figure 2 demonstrates the correct and incorrect marginal notes to use on a 50,000 scale TLM (Topographic Line Map) on the Transverse Mercator projection and having a UTM grid.



Next Article

The next article will provide a brief review of the four projections that are predominately used by NGA for maps and charts. This article will contain a table listing the products and scales for which the projections are most appropriate.

