Grids & Datums

REPUBLIC OF ESTONIA

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The original Estonians were conquered by the Danes who founded Revel in 1219. Revel is the former name of Tallinn, the current capital of Estonia. Remains of the ancient Revel fort settlement survive to this day, a testament to the construction skills of the craftsmen under the rule of King Valdemar II. Developed as a trading port and member of the Hanseatic League in the 13th century, it was sold to the Teutonic Knights in 1346 and on dissolution of the order it passed to Sweden in 1546. Later taken by Russia in 1710 and except for the period of independence from 1918 to WWII, it remained a Russian annexation until its present independence in 1991 *(Merriam Webster's Geographical Dictionary, 3rd edition).* Estonia is slightly smaller than New Hampshire and Vermont, combined. Bordered on the north by the Gulf of Finland *(PE&RS, October 2006),* on the east by Russia, on the south by Latvia *(PE&RS, September 2002),* and on the west by the Gulf of Riga and the Baltic Sea, the total coastline is 3,794 km. The republic is comprised mostly of marsh and lowlands; the lowest point is the Baltic Sea (0 m), and the highest point is Suur Munamagi (318 m).

The first period of geodetic surveying and mapping in Estonia was from 1845 to 1920. The principal mapping agency for this period was the *Korpus Voyennykh Topografov – KVT* (Corps of Military Topographers) under the Russian Imperial General Staff. Survey activities in Estonia began with Struve's triangulation in 1811/1816-1819 and by Tenner's first order network of 1820-1832 published by Czarist Russia in 1843 and 1847. Tenner later supplemented his primary net with lower order stations. The Tenner chains were originally computed on the Walbeck 1819 ellipsoid where the semi-major axis (a) = 6,376,895 m, and $1/f$ = 302.7821565; they were later recomputed on the Bessel 1841 ellipsoid where: a = 6,377,397.155 m, and $1/f$ = 299.1528. The Triangulation of the Coast of the Baltic Sea Datum (1829-1838) was based on the origin point at the Observatory of Tallinn where: Λ_o = 24° 47' 32.55" East of Greenwich, and the ellipsoid of reference was on the Walbeck 1819. The fundamental point of both the Triangulation of Finland and St. Petersburg Territory Datum (1891-1903) and of the Baltic Sea Triangulation Datum (1910-1915) is the Pulkovo Observatory (1913 position) where: Φ_o = 59° 46' 18.54" N, Λ_o = 30° 19' 38.55" E, α_o = 200° 38' 35.0" Signal A to Kabosi. However, both of these old datums are referenced to the Bessel 1841 ellipsoid, as was the Pulkovo Datum of 1913. Dr. Gábor Timár, Raivo Aunap, and Gábor Molnár published a paper, *Datum Transformation Parameters Between the Historical and Modern Estonian Geodetic Networks (ISSN 1406-6092)* in 2004 that provided the following parameters: From Triangulation of the Coast of the Baltic Sea Datum To WGS84: ΔX = +822m, ΔY = +380m, ΔZ = +649m; From Triangulation of Finland and St. Petersburg Territory Datum To System 42 Datum (the current datum in Russia with origin

at Pulkovo Observatory where the new 1942 origin parameters of Pulkovo Observatory are: Φ_o = 59° 46' 18.55" N, Λ_o = 30° 19' 42.09" East of Greenwich, and the reference azimuth to Bugrō: α_o = 120° 06' 42.305", and is referenced to the Krassovsky 1940 ellipsoid where: a = 6,378,245 m, and $1/f$ = 298.3): ΔX = +389m, ΔY = +228m, ΔZ = +664m; From Baltic Sea Triangulation Datum To System 42 Datum ΔX = +361m, ΔY = +275m, ΔZ = +664m; From System 42 Datum (in Estonia) To WGS84 Datum: ΔX = +22m, ΔY = −128m, ΔZ = −87m; From Triangulation of Finland and St. Petersburg Territory Datum To WGS84 Datum: ΔX = +411m, ΔY = +100m, ΔZ = +577m; and From Baltic Sea Triangulation Datum To WGS84 Datum: ΔX = +383m, ΔY = +147m, ΔZ = +577m.

During these inter-war years the Russians were also actively re-computing their survey information in the Baltic States. Prior to 1932 the Russian horizontal control (used by Russia) of the Baltic States was always referenced to Dorpat Observatory at Tarbu in Estonia. In 1932 the Russians set up Pulkovo Observatory 1932 as their hori-

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zontal datum and origin reference to the Bessel 1841 ellipsoid, and later revised this to Pulkovo 1942, now properly termed "System 42" (datum) referenced to the Krassovsky 1940 ellipsoid. According to Dr. Timár, *et al.,* Ottomar Douglas established a new geodetic adjustment known as the Estonian 1937 System Datum with the fundamental point at Varesmäe where: Φ_o = 59° 18' 34.465" N, Λ_o = 26° 33' 41.441" East of Greenwich, and the reference azimuth to Aseri: α_o = 39° 54' 06.256". From Estonian 1937 System Datum To WGS 84 Datum: ΔX = +373m, ΔY = +149m, ΔZ = +585m, and the average horizontal transformation accuracy is estimated to be about one meter with maximum error less than 2 meters.

With regard to grid systems, the main coordinate system used for geodetic and cartographic activities in Estonia before the Soviet occupation was developed by Fritz Oja and is termed the Historical Lambert System or *Ajalooline Lamberti Süsteem* where: for the Estonian North Zone *(Põhja-Eesti),* the Central Meridian, λ_o = 25° East, the Latitude of Origin, φ_o = 59° 06' North, the Scale Factor at Origin,

m_o = 0.999975, the False Easting (Yo) = 200,000 m, and the False Northing (Xo) = 200,000 m. *(Ed. – note the transposition of "X" and "Y" component identifications – the Estonians are consistent with this convention for <u>all grid systems used in their nation, **including UTM**</u>)*! For the Estonian South Zone (*Lōuna-Eesti*), the Central Meridian, λ_o = 25° East, the Latitude of Origin, φ_o = 58° 06' North, the Scale Factor at Origin, m_o = 0.999975, the False Easting (Yo) = 200,000 m, and the False Northing (Xo) = 88,634.86 m. The ellipsoid of reference was the Bessel 1841. Apparently, this was used in connection with all of the Estonian Datums that were referenced to the Bessel 1841 ellipsoid.

The *"O-series maps"* were introduced by the Soviet military (O-34 & O-35), after the 7th of April 1946. Referenced to the System 42 Datum, the grid system was the "Russia Belts" on the Gauss-Krüger Transverse Mercator for Zone 34 (λ_o = 21° East, FE = 4,500,000m) and Zone 35 (λ_o = 27° East, FE = 5,500,000m), all zones having a False Northing of zero at the equator, and a scale factor at origin (m_o) = 1.0.

The *"C-series maps"* were introduced by the Soviets for civil use in Estonia in 1963, and were deliberately mantled in the typical Soviet penchant for obfuscation for the sake of obfuscation. Also referenced to the System 42 Datum, the grid system was a modification of the "Russia Belts" on the Gauss-Krüger Transverse Mercator where the interval spacing (zone widths) of the central meridians were at 3° intervals such that (λ_o = 21° 57' E, 24° 57' E, 27° 57' E), FE = 250,000m, all zones having a False Northing of zero NOT at the equator, but at φ = 00° 06' North, and a scale factor at origin (m_o) = 1.0.

In keeping with the Soviet penchant for obfuscation, Soviet legislation about construction activities for every town in Estonia had a local coordinate system based on a local geodetic network. Most of these goofy systems appear to continue to be a mystery to the local inhabitants as to how the local geodetic network was connected to the state geodetic system, or System 42 Datum. An example offered by the Estonian government for one of these "Local Urban Systems" *(Linnade Kohalikud Süsteemid)*, "designed" for the capital of Tallinn is as follows: Gauss-Krüger Transverse Mercator (*Faussi Mercatori Põiksilindriline*), λ_o = 24° East, FE (Y_o) = 24,000m), False Northing (X_o) = 6,536.000 m) at the equator, and a scale factor at origin (m_o) = 1.0.

"TM Baltic '93" is designed to give a common reference and mapping frame for Estonia, Latvia and Lithuania as follows: Gauss-Krüger Transverse Mercator, λ_o = 24° East, FE (Y_o) = 500,000m, False Northing (X_o) = 0 m) at the equator, and a scale factor at origin (m_o) = 0.9996, euphemistically referred to as a "modified UTM."

Finally, the main official coordinate system (grid system) currently in Estonia is based on the GRS80 ellipsoid, on EUREF-89, and the Lambert Conformal Conic projection. The origin of coordinate parameters "was chosen to match coordinates" with "TM Baltic '93" where: λ_o = 24° East, the Latitude of Origin, φ_o = 57° 31' 03.19415" N, the southern Standard Parallel, φ_S = 58° 00' N , the Northern Standard Parallel, φ_N = 59° 20' N ,the False Easting (Yo) = 500,000 m, and the False Northing (Xo) = 6,375,000 m.

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