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CALCULATING THE ELEVATION ANGLE OF THE TRANSMITTING ANTENNA

There are two ways (okay there are undoubtedly more) to calculate the elevation angle of the transmitting antenna. The first method is useful only for short paths (less than about 10 km). The first method is a bit easier, but assumes a "flat Earth". When the path exceeds about 10 km, the curvature of the earth begins to become significantly large enough to make this easier method inaccurate. If your path exceeds about 10 km use the **Long Path Method**. That formula takes the curvature of the earth into account.

SHORT PATH METHOD

$$\boldsymbol{Elevation\ Angle}\ (\emptyset) = \boldsymbol{TAN}^{-1}\left[\frac{(\boldsymbol{R_e} + \boldsymbol{R_h}) - (\boldsymbol{T_e} + \boldsymbol{T_h})}{\boldsymbol{D}}\right]$$

Where: $\boldsymbol{R_e} =$ Elevation of Receiver Site AMSL in meters

$\boldsymbol{R_h} =$ Height of Receiver Antenna AGL in meters

$\boldsymbol{T_e} =$ Elevation of Transmitter Site AMSL in meters

$\boldsymbol{T_h} =$ Height of Transmitter Antenna AGL in meters

$\boldsymbol{D} =$ Distance from Transmit to Receive Antenna in meters

NOTES:

1) Be certain the distance ($\boldsymbol{D}$) is in meters, not kilometers

2) The numerator is simply the difference in elevation of the two antennas

3) Most calculators and spreadsheets will return the angle in radians. To convert radians to degrees multiply the radians by $\frac{180}{\pi}$ or 57.296

LONG PATH METHOD

In 1964, the FCC specified a method for calculating the elevation of an antenna that is more precise than the "flat Earth" method shown above. The method contains some approximations but their effect on the calculated result is minimal over any practical path length.

LONG PATH METHOD (Continued)

$$Elevation\ Angle\ (\emptyset) = TAN^{-1}\left[\frac{[(R_e + R_h) - (T_e + T_h)] - 2E_r SIN^2(D/_{2E_r})}{D}\right]$$

Where: $R_e =$ Elevation of Receiver Site AMSL in meters

$R_h =$ Height of Receiver Antenna AGL in meters

$T_e =$ Elevation of Transmitter Site AMSL in meters

$T_h =$ Height of Transmitter Antenna AGL in meters

$E_r =$ 4/3 times the Earth Radius in meters

$D =$ Distance from Transmit to Receive Antenna in meters

NOTES:

1) Again, be certain the distance (D) is in meters, not kilometers

2) E_r was given by the FCC as equal to 5280 *miles* or 8,497,440 meters. The, now, generally accepted mean earth radius times 4/3 is 8,504,183 meters. This difference is less than 0.1% so either radius will work for this purpose.

3) The calculation $(D/_{2E_r})$ returns a value in radians. If your calculator or spreadsheet calculates a ***SIN*** in degrees multiply $(D/_{2E_r})$ by $\frac{180}{\pi}$ before taking the ***SIN***.

4) If your calculator or spreadsheet works in radians, multiply the final result by $\frac{180}{\pi}$ (or 57.296) to convert the elevation angle to degrees.

5) Unlike the "flat Earth" method, this method will return a different reverse angle (elevation angle of the receive antenna). That is okay, don't let it bother you if you happen to check. Because of this however, it is important to not interchange the transmit and receive elevations when entering data into the equation.

In 1964, and for many years thereafter, this calculation was performed by hand using trigonometric tables to find the sin and arctangent. A slide rule eliminated the need for the tables, but the accuracy of the result suffered.

Now, with a scientific calculator or computer spreadsheet, it can be calculated accurately in just seconds. This is good, because the FCC wants the elevation angle accurate to and rounded to the nearest tenth of a second.