

ABA Engineering Academy Continuing Educational Series: Understanding Degree

Ever looked at your AM license, especially a directional license and scratched your head over how do I figure out how tall are these towers and how far apart are they spaced in feet? They are listed in degrees.

Tower No.	Field Ratio	Phasing (Deg.)	Spacing (Deg.)	Orientation (Deg.)	Tower Ref Switch *	Height (Deg.)
1	1.0000	0.000	0.0000	0.000	0	78.5
2	0.8390	98.800	105.0000	35.000	0	78.5

Well it is just simple math. But first you must know what frequency these towers will be operating on. Radio waves travel at the speed of light which is 300,000,000 meters a second. The basic formula to determine the wavelength is 300,000,000 divided by the frequency in Hertz. Let's assume the station is operating on 740 kHz. The length of one wave at this frequency would be 405.4 meters.

Now we all know that you can convert that to feet by multiplying by 3.28. This would give you a wavelength of 1,329.73 feet. Engineers over the years have simplified the formula to 984 divided by the frequency in Megahertz. This gives you the answer in feet. It's the same formula just using smaller numbers. In our sample 984 divided by .740 MHz equals the same 1,329.73 feet.

Oh, we wanted to know how tall the towers were and how far apart they were spaced. Simple math again. We know there are 360 degrees in one wavelength. Then dividing 1,329.73 feet by 360 would equal 3.69 feet per degree. The FCC license indicates the towers are 78.5 degrees tall. 3.69 multiplied by 78.5 gives you the height of the towers 289.66 feet. The distance between the towers? 3.69 multiplied by 105 = 387.45 feet.

Another area we find degrees used in broadcasting is describing a location, such as when measuring things like latitude and longitude. The degree is divided in to 60 minutes. For even finer measurements the minute is divided again into 60 seconds. These minutes and seconds have nothing to do with time. They are just smaller and smaller parts of a degree.

You might notice that all these numbers are tied a base 60 numbering system. For you history geeks, this originated with the Babylonians around 2000 B.C. which was loosely tied to the earth's rotation around the sun.

FCC dictates in section 73.1690 that any variation of tower location of more than 3 seconds requires notification to the Commission. How far is that in feet?



Suppose your tower is located at these coordinates.
32-24-13N / 86-11-47W.

In the case of latitude $1^\circ = 69$ miles regardless of where you are located since latitude lines are equally spaced. However, longitude varies due to the fact these lines get closer together as you move north.

69 miles per degree or 101 feet per second. The above FCC rules indicates you cannot relocate a tower over 3 seconds without notification to the Commission. Therefore you can't relocate a tower by more than 303 ft. (north or south) from its licensed location.

Calculating the distance for longitude is somewhat different.

It doesn't matter at what longitude you are. What matters is what latitude you are.
Length of 1 degree of Longitude = cosine (latitude in decimal degrees) * length of degree (miles) at equator.

Convert your latitude into decimal degrees = 32.40

Cosine of 32.40 = .844

1 degree of Longitude = $0.844 * 69.172 = 58.403$ miles

1 sec of longitude = $(58.403 / 3600) * 5280 = 84.48$ ft.

3 sec of longitude = $84.48 \text{ ft} * 3 \text{ sec} = 253.44$ ft.

All this math indicates that you cannot relocate this tower over 303 ft North or South and no more than 253.44 ft East or West.

Wow that was a lot of numbers.... but interesting. I love this type of stuff. Prop your feet up and enjoy a cup of coffee with me.