Frequency and Earth Conductivity as Factors in MW Field Intensity

Richard J. Fry, CPBE

It is common knowledge and experience that, even for identical transmitter powers and antenna system parameters, the groundwave coverage areas of AM broadcast stations can vary significantly. AM stations at the lower end of the AM broadcast band have greater coverage areas than those at the upper end, other things equal

This variation in groundwave coverage area with frequency is related to the conductivity of the earth along the propagation path, and the differing loss that this conductivity produces for different AM broadcast frequencies.

Earth conductivity along a groundwave path is dependent on the basic composition, moisture and mineral content present at, and below the surface of the earth. Groundwave radiation in the AM broadcast band travels along the surface of the earth, and also can penetrate the earth to a depth of several tens of meters.

The portion of the radiated groundwave that penetrates the earth encounters losses, causing the wavefront to tip forward slightly in the direction of its travel – which is useful in providing coverage beyond the radio horizon. Poorer earth conductivities and higher broadcast frequencies result in greater losses.

Table 1 lists the descriptions, dielectric constants and conductivities for various land types common in the US, in descending order. For reference, sea water has a dielectric constant of 80, and conductivity of 5,000 mS/m.

Table 1

Type of Terrain	Dielectric Constant	Conductivity, mS/m
Pastoral low hills, rich soil, typical of Dallas, TX and Lincoln, NE	20	30
Pastoral low hills, rich soil, typical of Ohio and Illinois	14	10
Flat country, marshy, densely wooded, typical of Louisiana near Mississippi River	12	7.5
Pastoral, medium hills and forestation, typical of Maryland, Pennsylvania and New York State, except mountainous territory and seacoasts	13	6
Pastoral, medium hills and forestation, heavy clay soil typical of central Virginia	13	4
Rocky soil, steep hills typical of New England	14	2
City, industrial areas, average	5	1
City, industrial areas, maximum attenuation	3	0.1

Source: *Federal Register*, July 1939

The amount of AM broadcast coverage difference that results from earth conductivity and frequency can be difficult to appreciate fully, without a detailed analysis. For this reason a set of graphs is included as Figures 1 through 4 to show these effects visually.

The graphs lead to some interesting observations. For example, Figures 1-3 show that a 1 kW AM station on the lowest AM frequencies can have a greater radius to its 0.5 mV/m daytime contour than a 50 kW station on the highest AM frequencies.

However this does not mean that a high power, high frequency AM station has *no* advantage in comparison to a low power, low frequency station. The high power, high frequency station can have significantly more field intensity ranging to 40 or more miles from the transmit site, which serves a large portion of the city of license and surrounding area.

This effect is shown in Figure 4, where the distances to equal field intensities for a radius of at least 26 miles and conductivities of 8 mS/m and 15 mS/m are greater for a 50 kW station on 1600 kHz than for a 1 kW station on 600 kHz.

Probably this advantage to high power, higher frequency stations is more important to them and their local advertisers than the distances to their 0.5 mV/m contours.

Figure 1: 2 mS/m

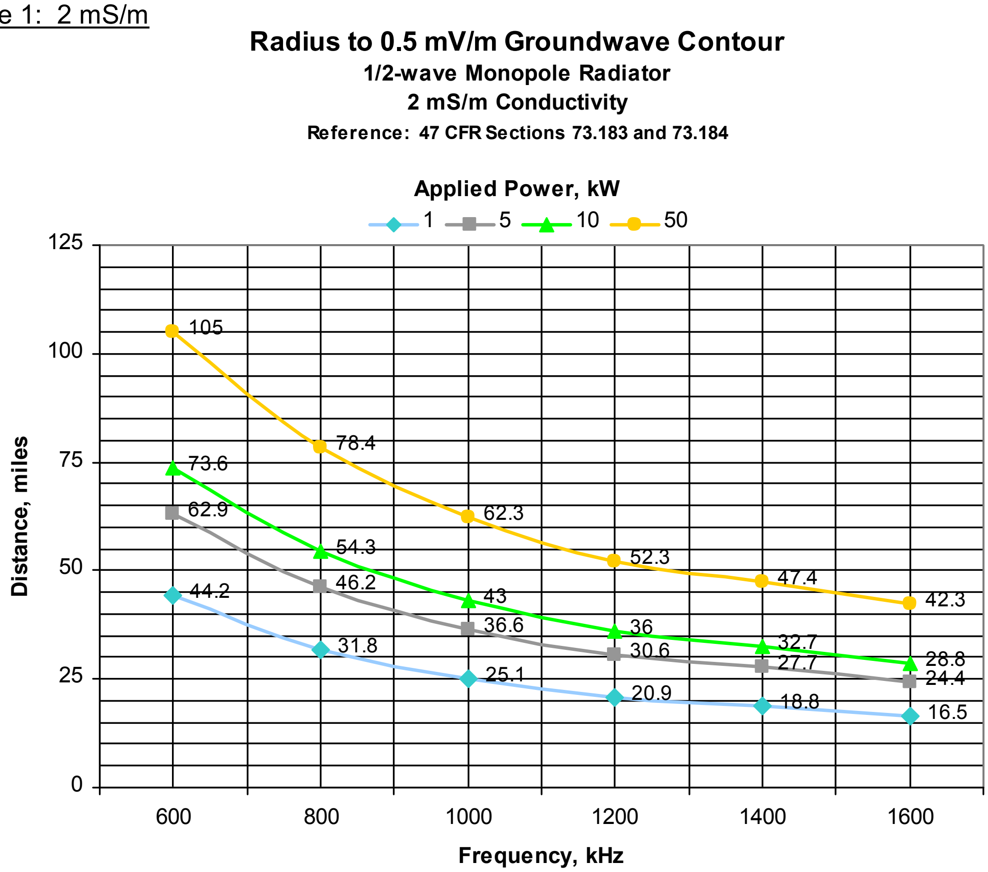

Figure 2: 8 mS/m

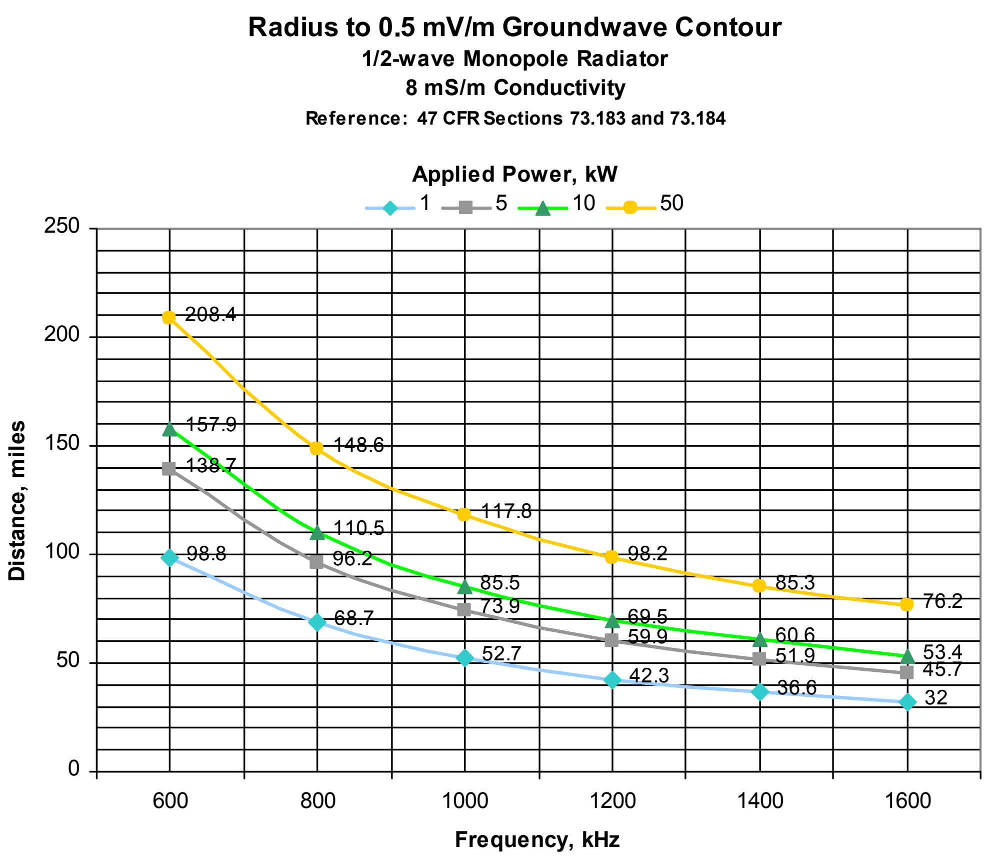

Figure 3: 15 mS/m

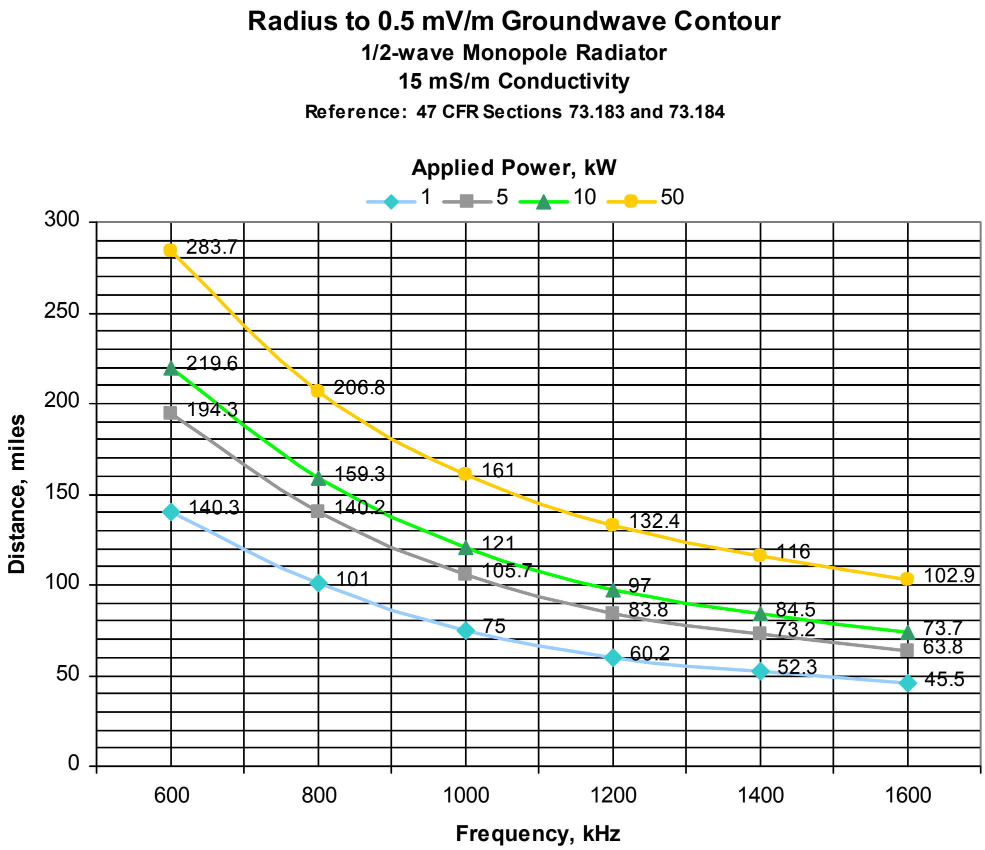

Figure 4