

Ground Loss At HF

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Initial Thoughts

- Since the 30's we have had very good analytical and experimental work on which to base BC vertical ground system design.
- This body of work has been adopted as gospel for hams even though we operate at frequencies well above the BC band and very often live with soil characteristics which a BC station would avoid if at all possible.
- Give the wealth of writing on the subject one would think there is little more to be said.

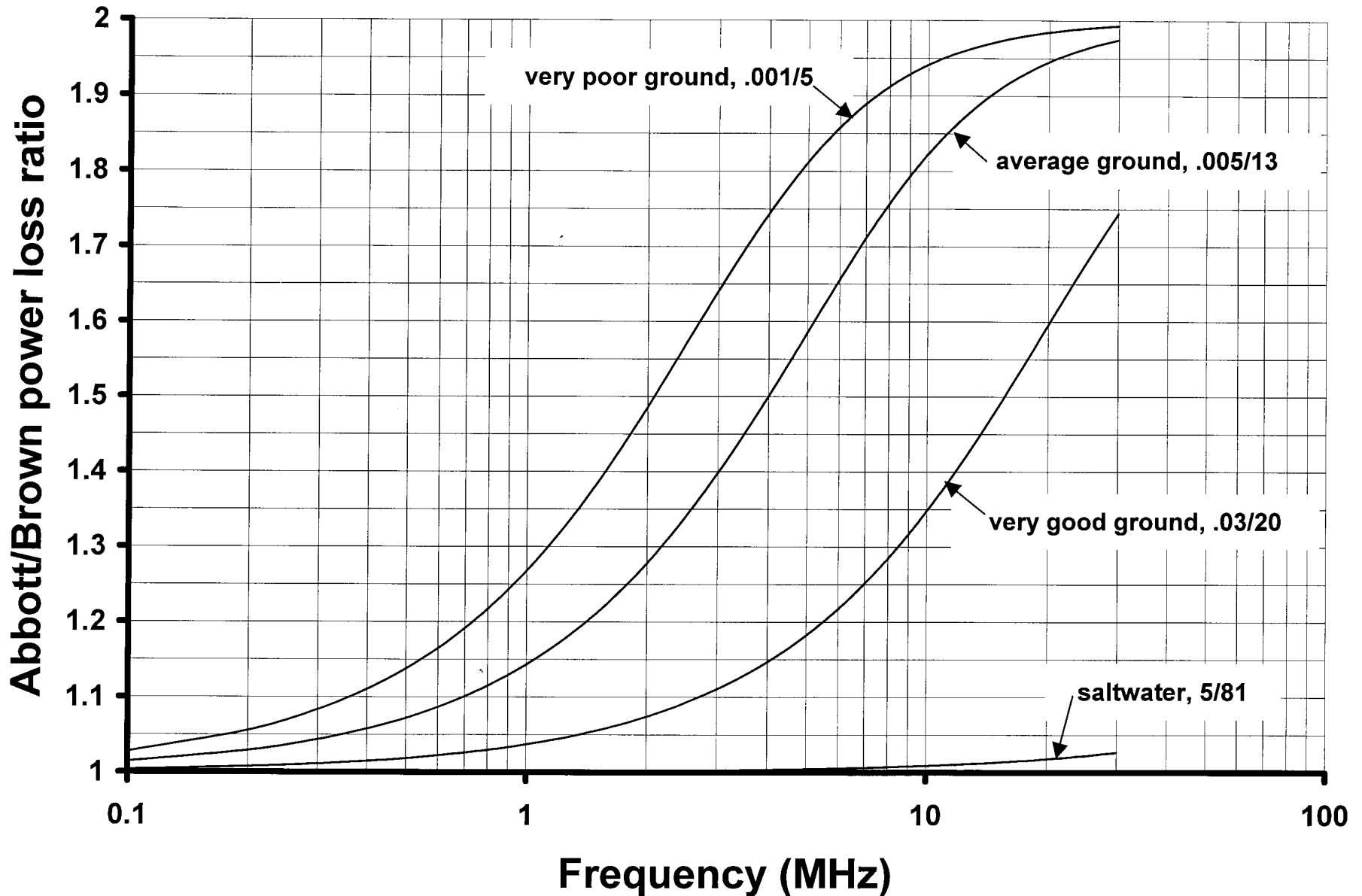
Second Thoughts

- However, a careful review of this work shows that some assumptions were generally made:
 - Soil is basically resistive in character
 - Generally true at BC frequencies but not true at HF where most soils behave more like an R-C network
 - The radial/ground current distribution follows Brown's work
 - This assumption has been questioned for many years
 - Experiment, NEC and other analytical work don't fit Brown
 - We can determine the ground loss resistance by measuring the base resistance and subtracting infinite, perfect ground value
 - Not in agreement with a large body of experiment and analysis
 - Ground system scales with frequency for the same ground constants
 - For a given soil and ground system there is a single value of R_g

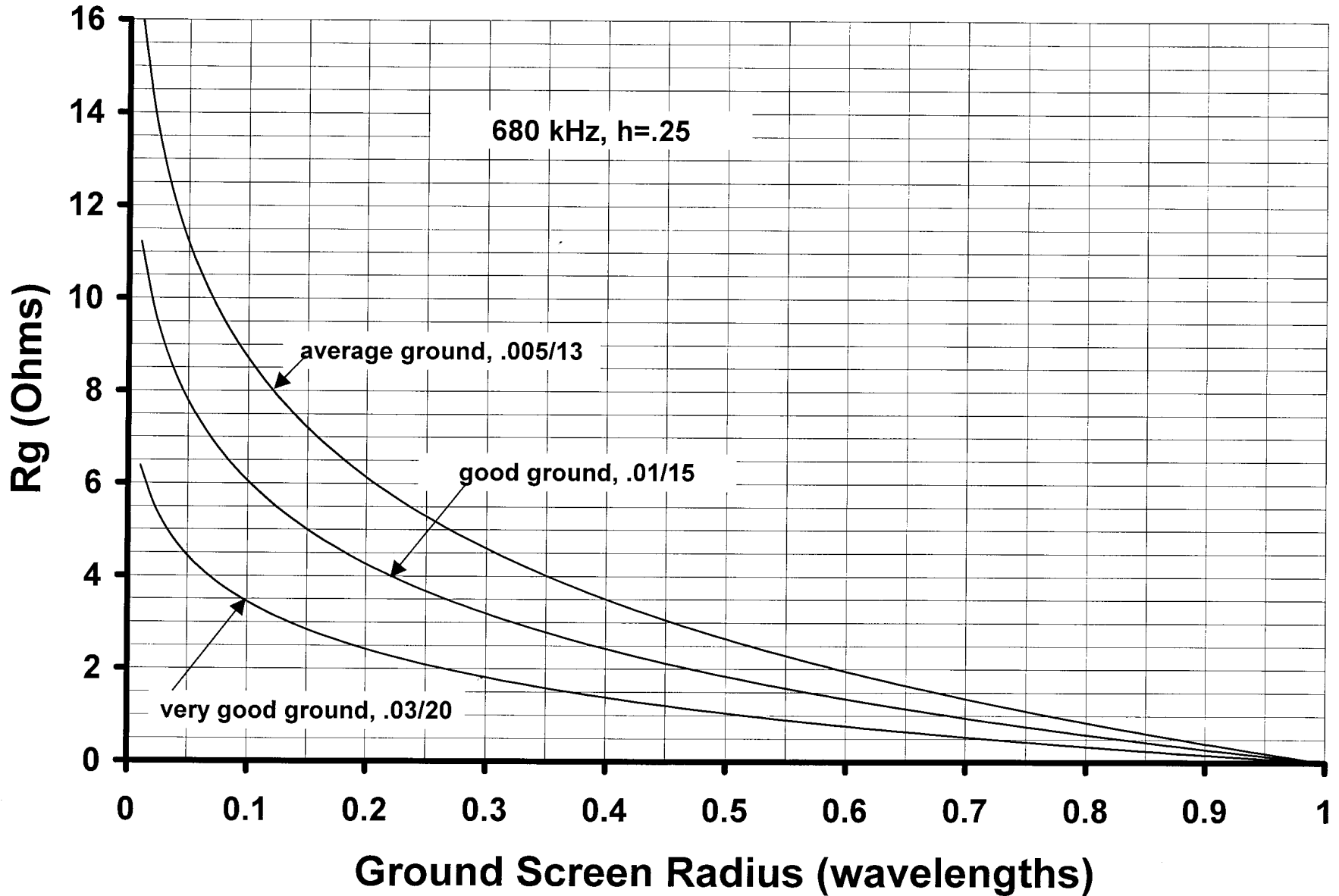
A Second Look

- I went carefully through the professional and amateur literature on ground loss and ground systems
- I started with Arnold Sommerfeld in 1909, went through Brown and company, Norton and many others in the 1930's, Frank Abbot 1952, James Wait, Carl Smith, and others in 1950-1970, etc, etc, plus any experimental data I could get my hands on
- Abbott's paper was representative of a more advanced way to calculate ground systems
- Even though 95% of the paper assumed a resistive ground, in one short paragraph he gave the expressions for general ground.
- He also uses a more widely accepted method for calculating the current division between soil and radial system
- Using his expressions I did ground loss and ground system calculations and compared them to Brown and to NEC4

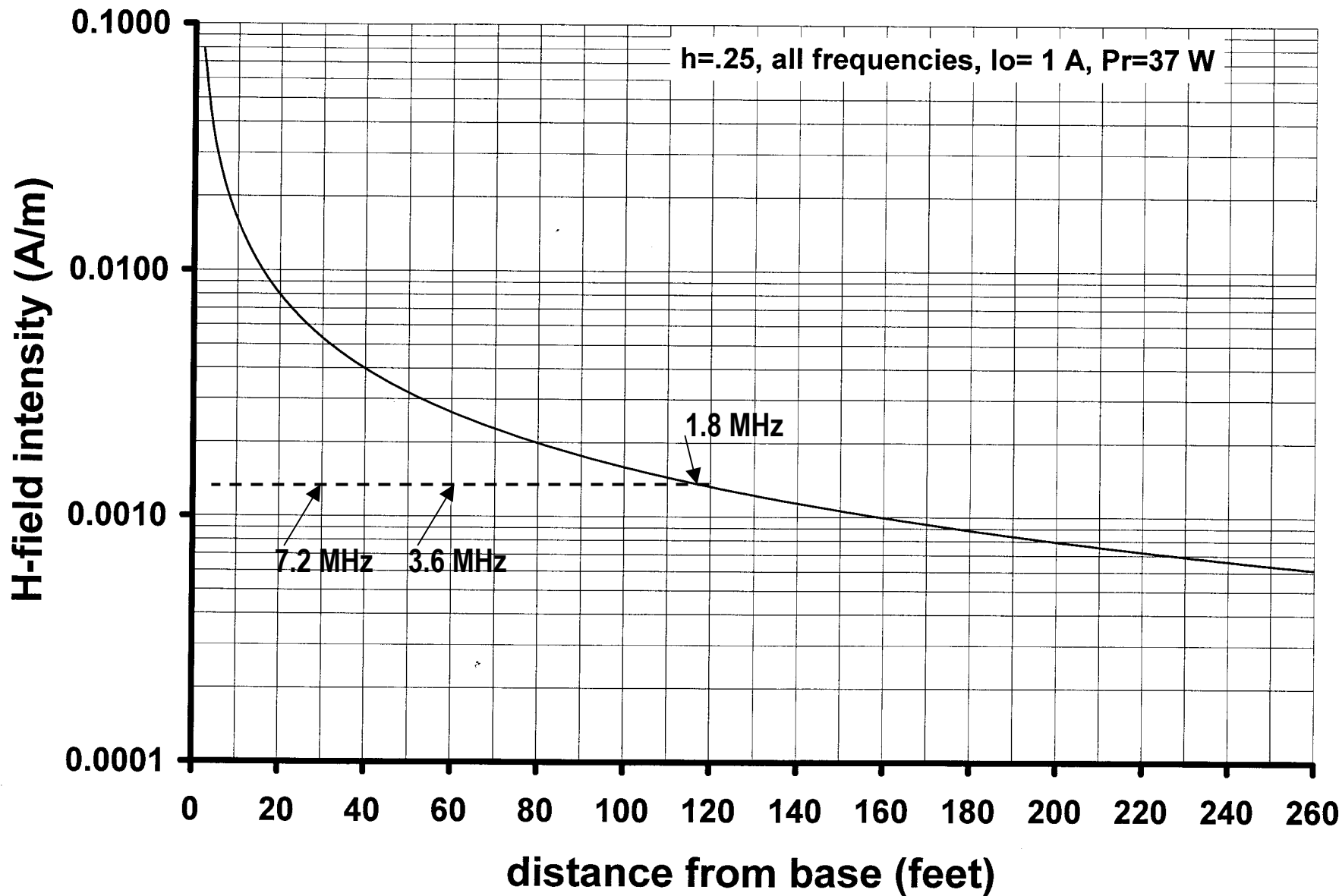
Effect Of Frequency On Ground Loss



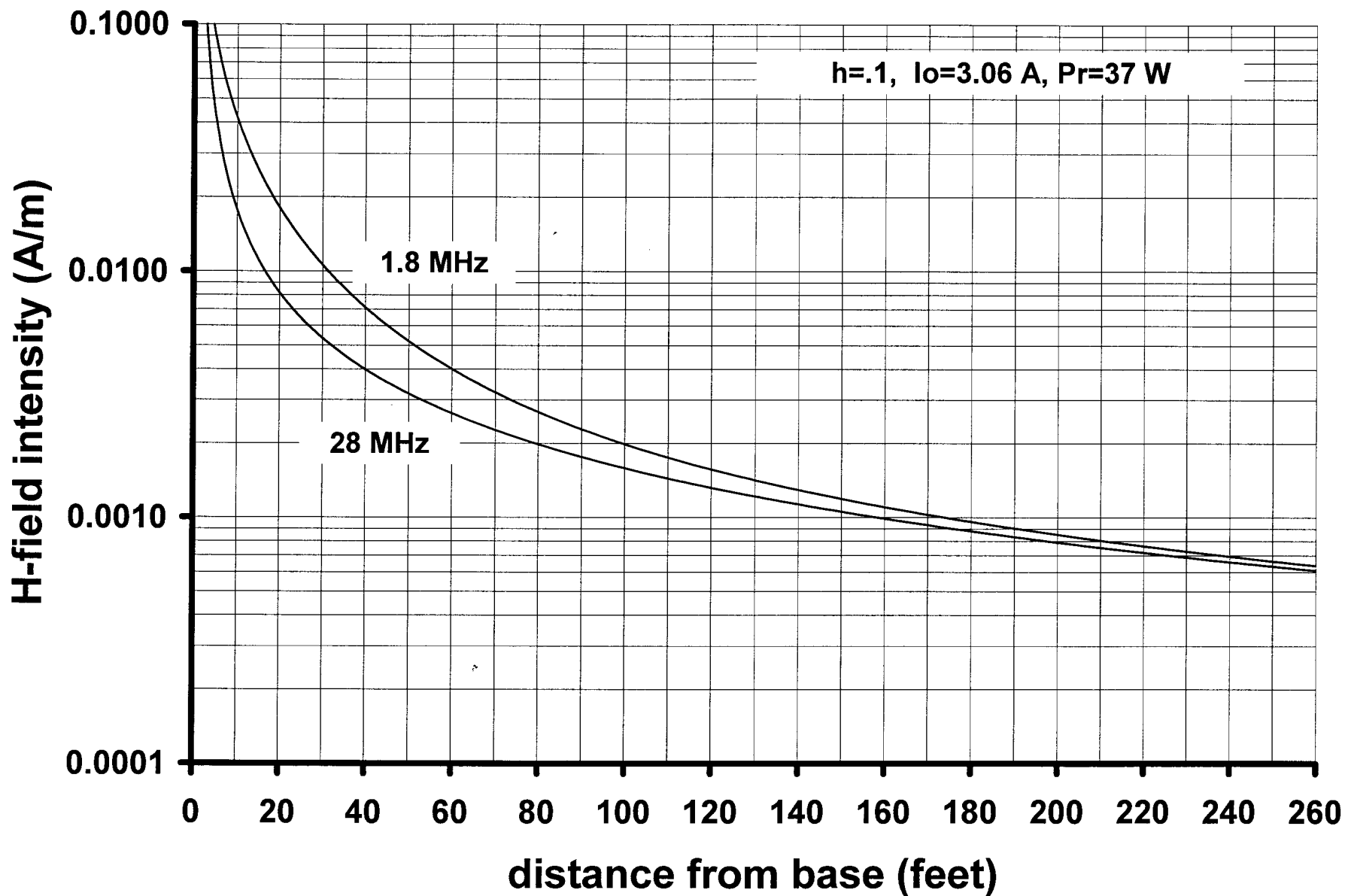
BC Frequency Rg Example



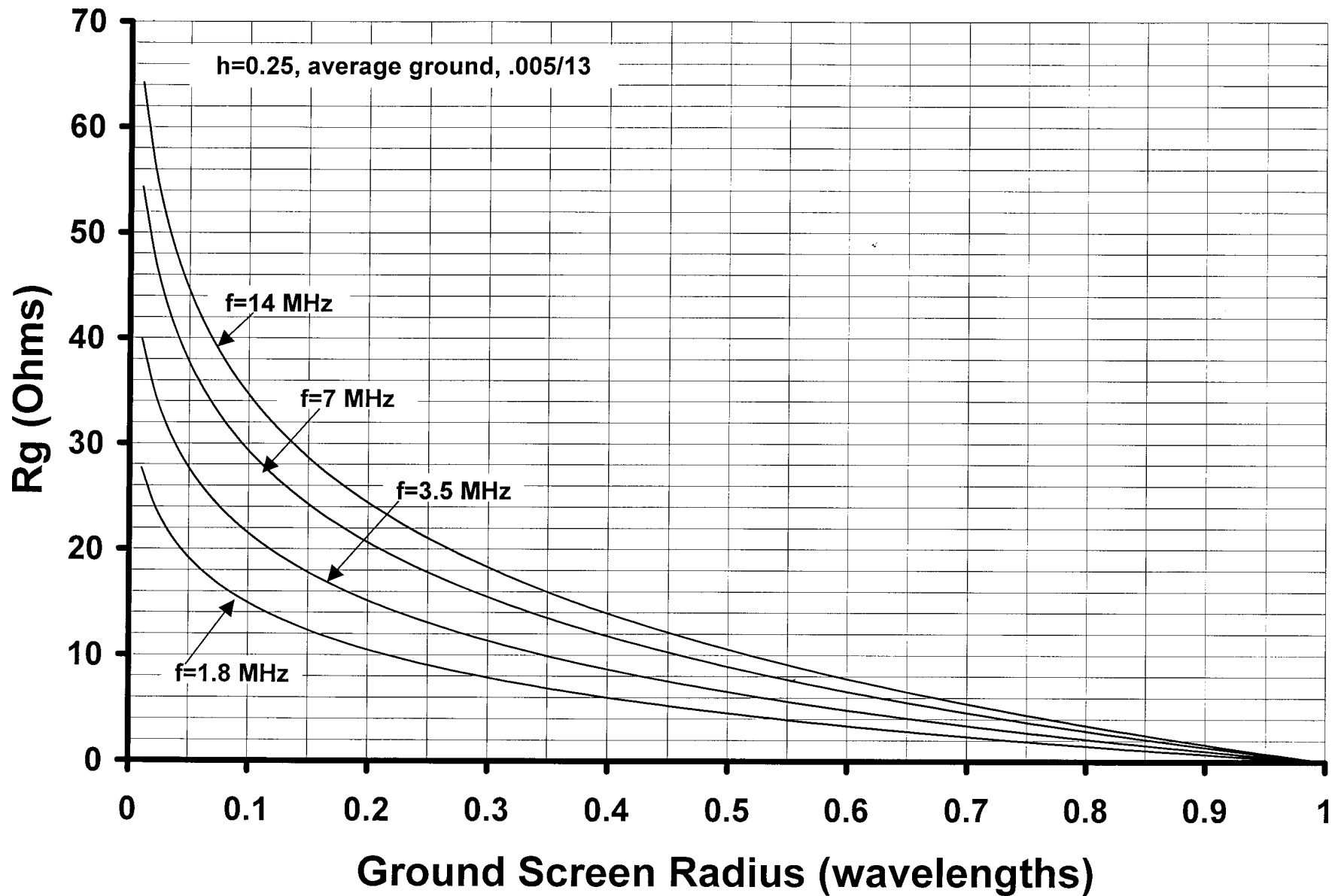
Magnetic Field Intensity Near A Vertical



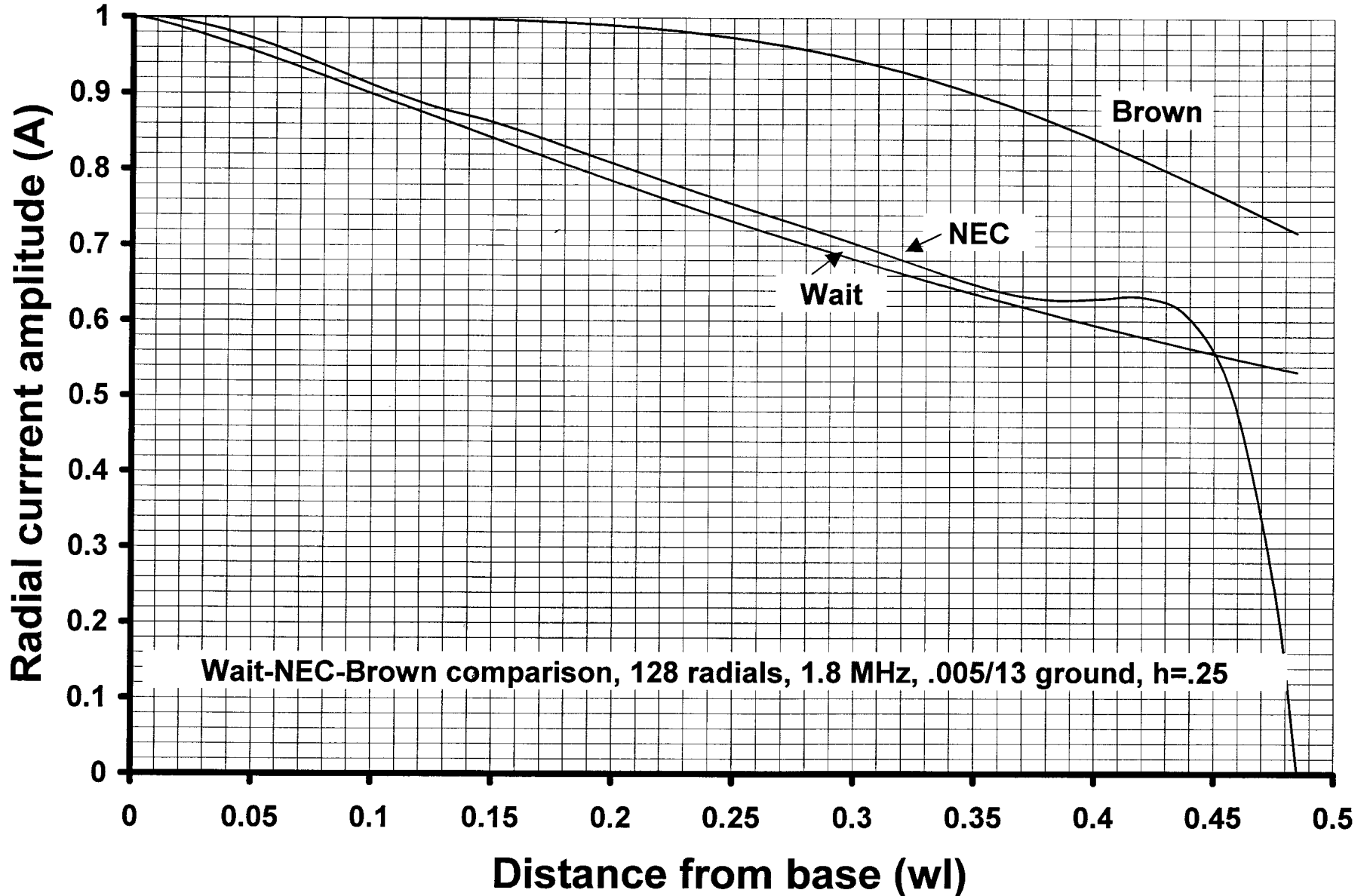
Magnetic Field Intensity Near A Vertical



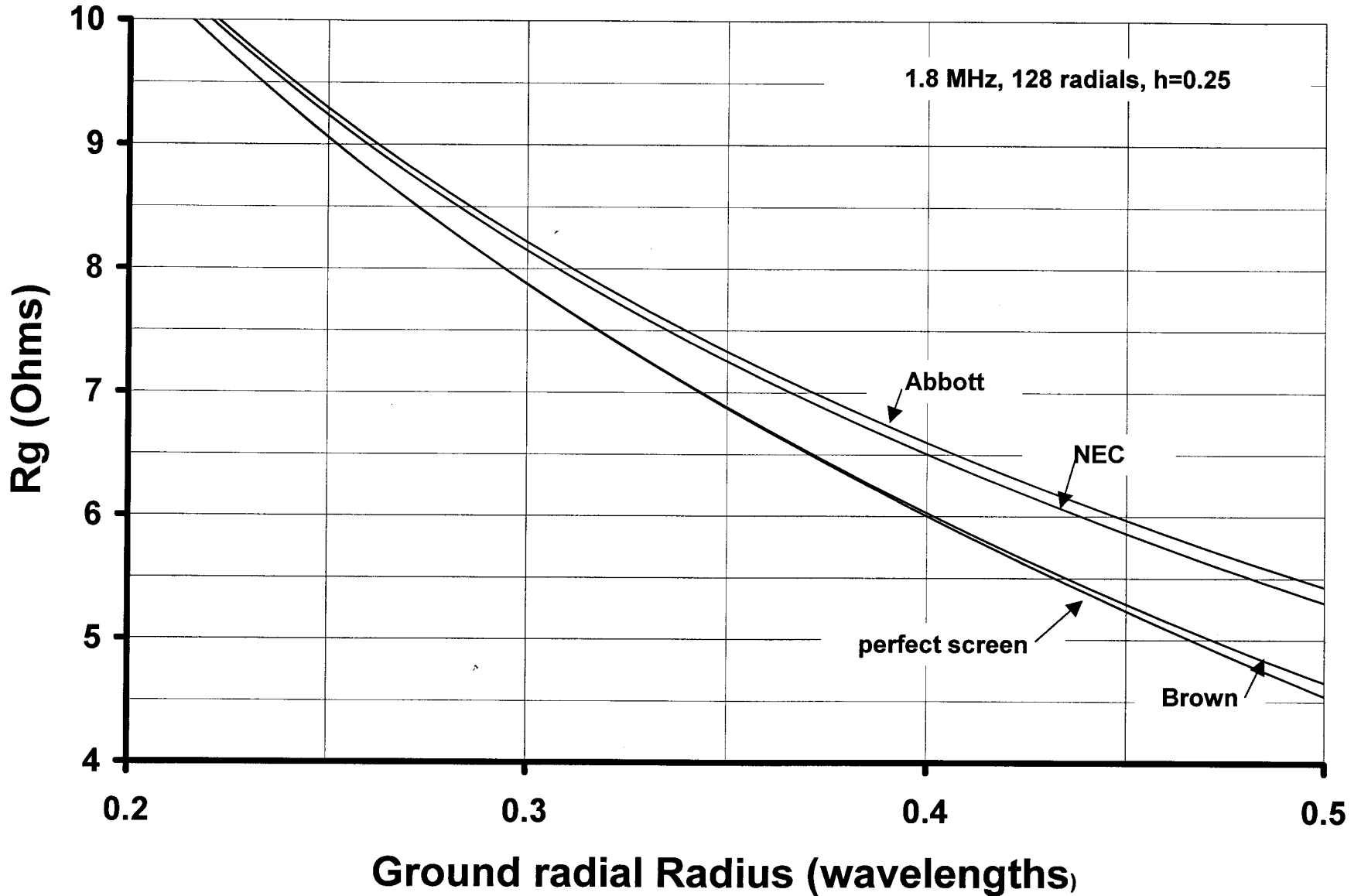
1/4-Wave Vertical Rg



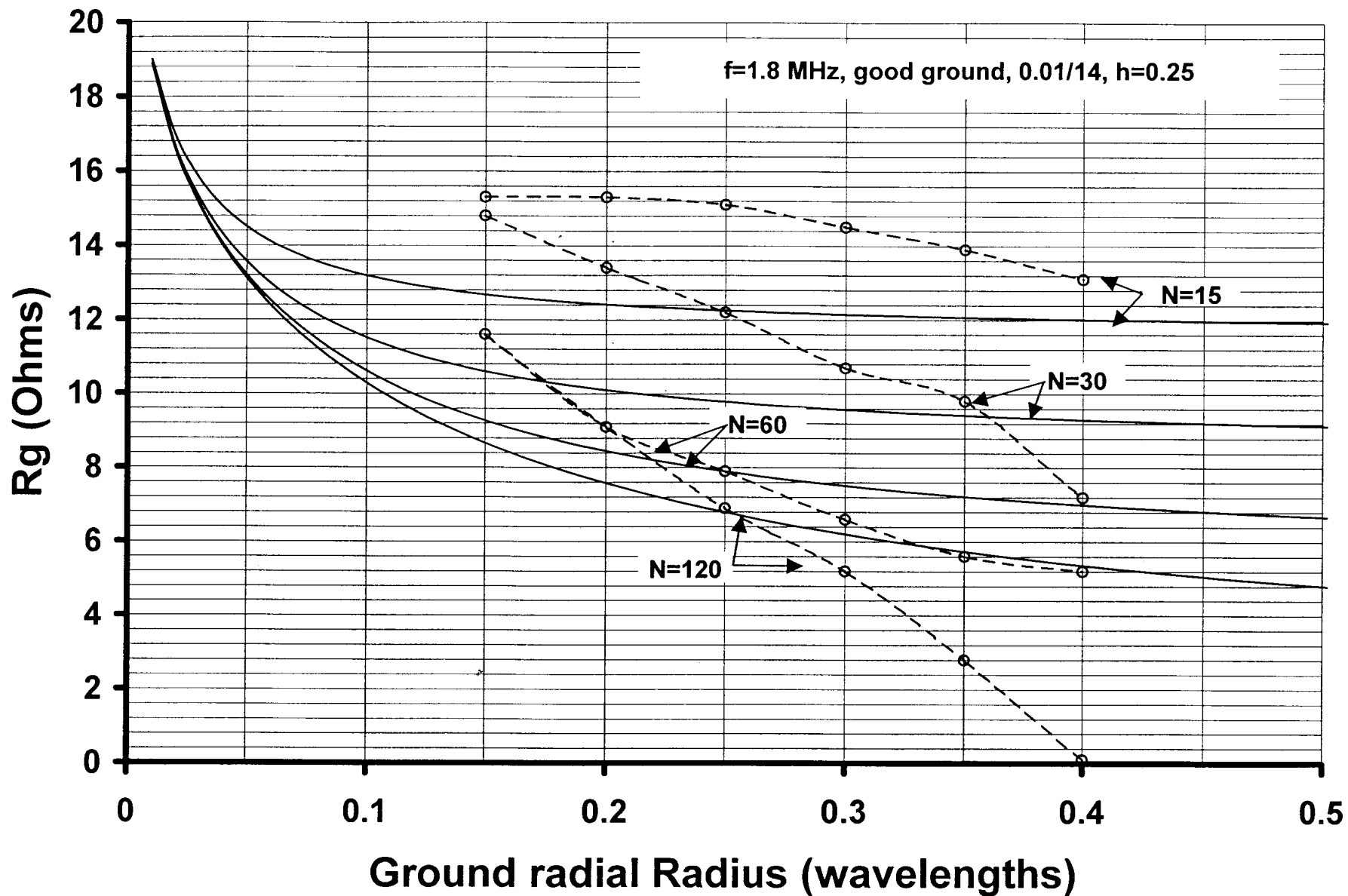
Radial Current Comparison



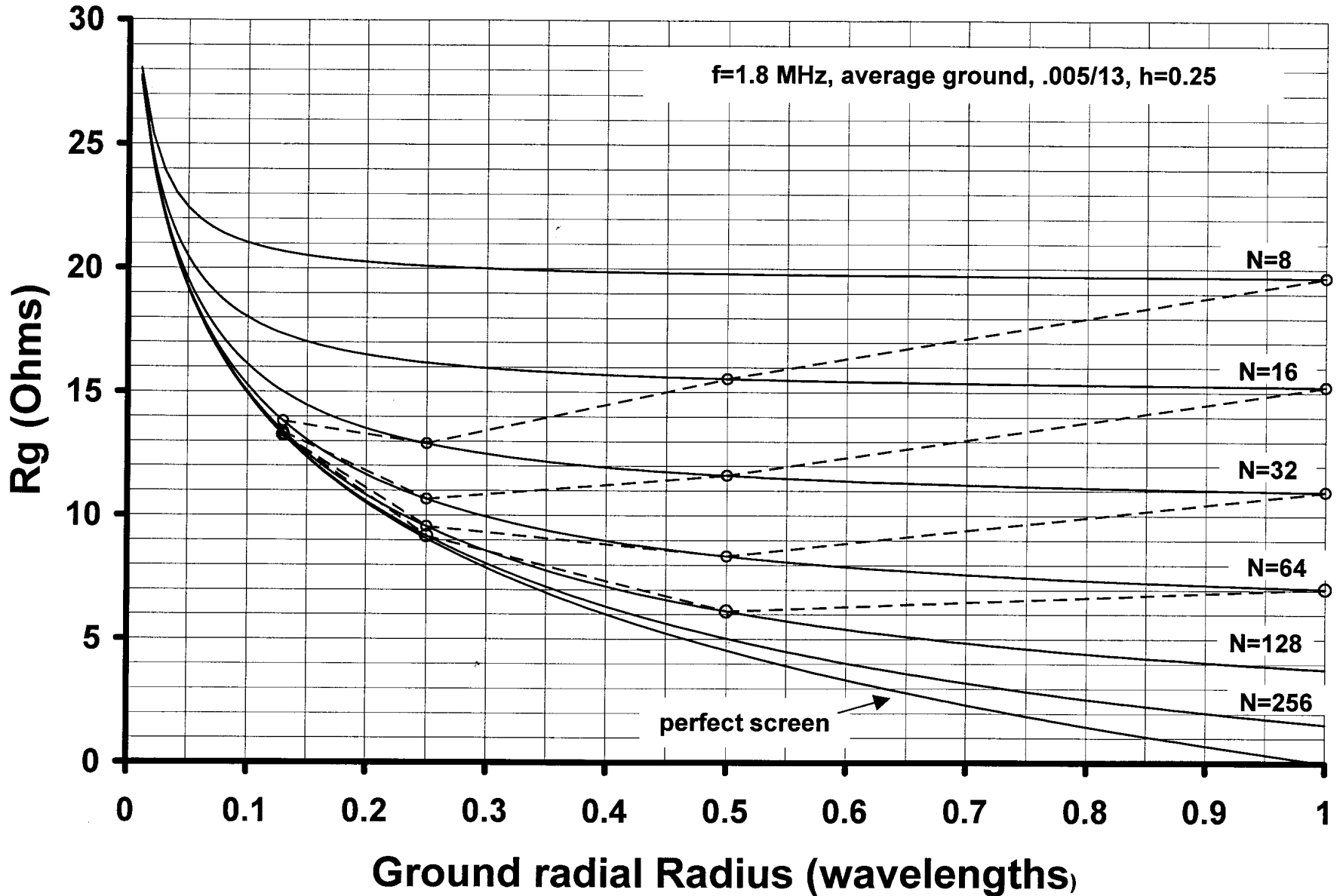
Rg Comparison



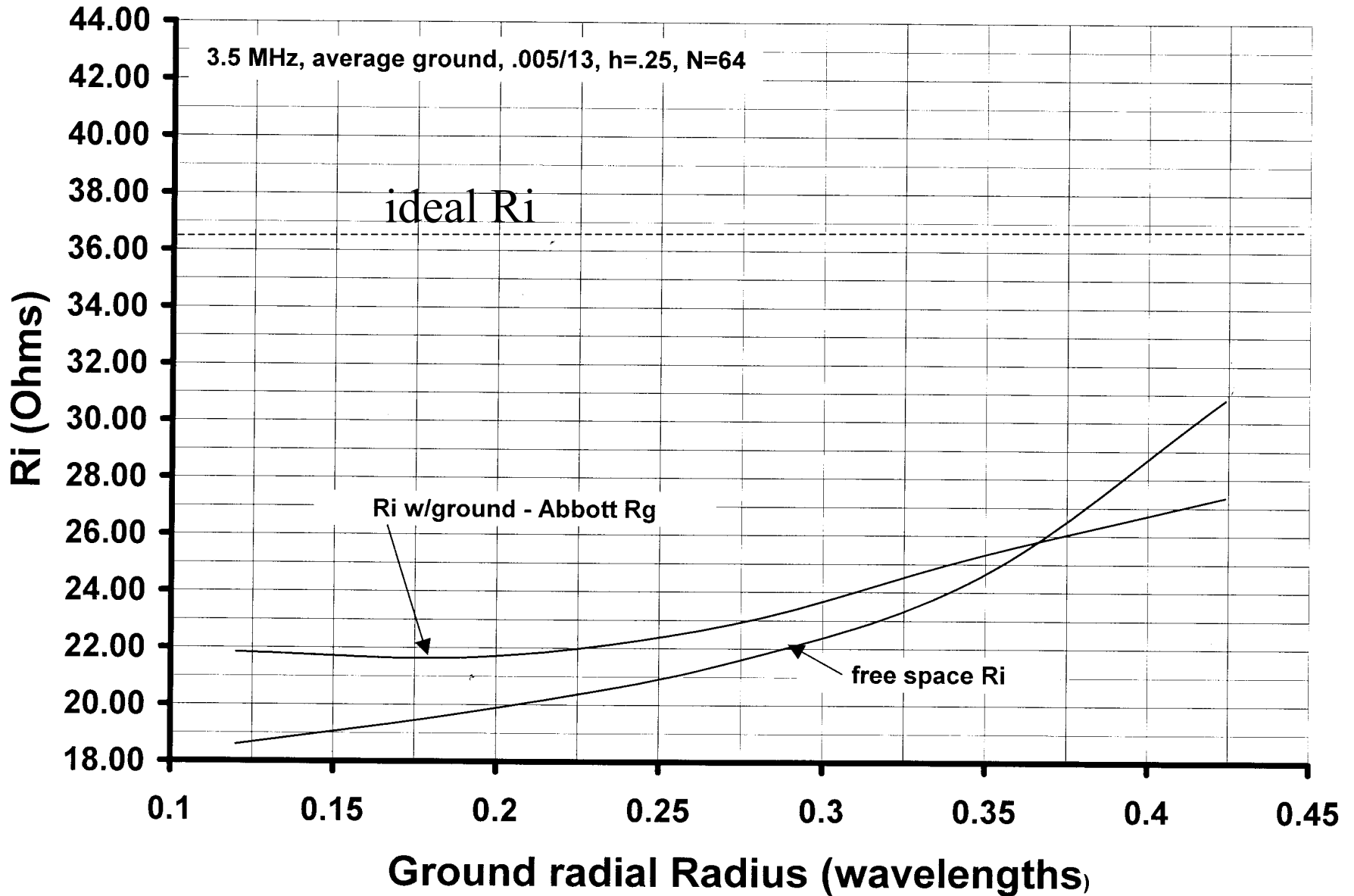
ON4UN Data Comparison



Optimum Ground Wire Usage



Free Space Rg Comparison



Summary

- For a given set of ground constants (conductivity and dielectric constant) ground loss increases as we go up in frequency
- Scaling the same ground system (radial number and length in wavelengths) as we go up in frequency leads to higher R_g
- The values for R_g at HF are substantially higher than what we would expect from BC data
- To maintain ground system efficiency we need to be more aggressive in the number and length of radials as we go up in frequency