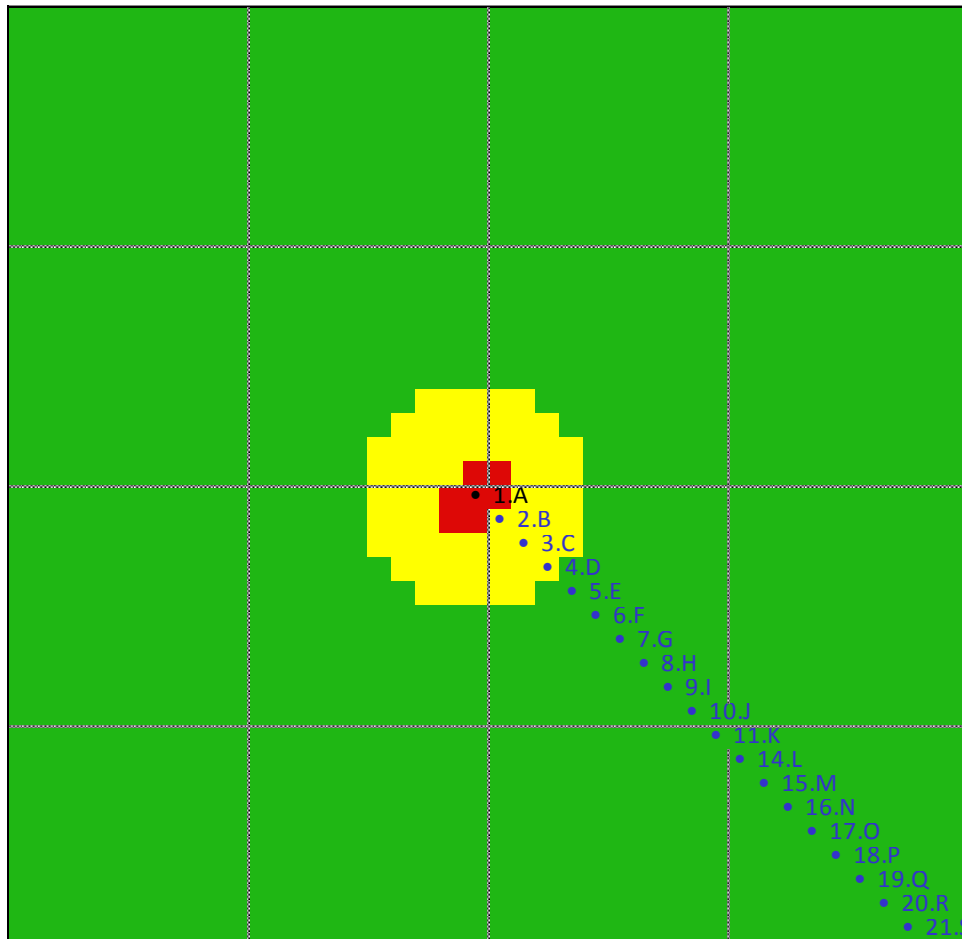


## Further Thoughts on Simulating the Time-Averaged RF Fields of Beam Forming Antennas with RoofView 5®

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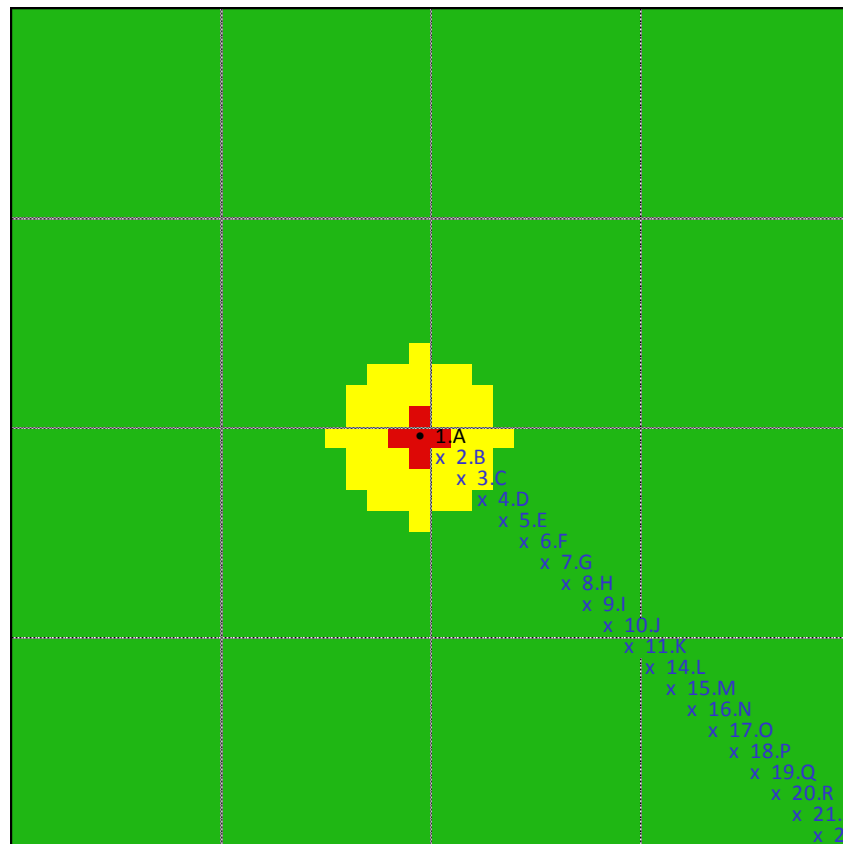
This document describes the use of RoofView® to simulate a beam-forming antenna to get the average RF power density, as a percentage of the MPE, at any given azimuth. The site is modeled as having three sectors with each having an antenna supporting multiple 12-degree wide beams. The transmitter is rated at 40 watts. The first figure shows the result of calculating the entire set of 30 antennas. The yellow/green boundary represents the FCC public MPE. Note that the spatial extent of the boundary appears to ~4 feet for this simulation. The purpose of this example is simply to illustrate the “composite” pattern produced by having a lot of beams “darting” around. A -8 dB duty cycle has been used for obtaining the time-averaged transmitter power in any given direction.



RoofView® 5 simulation with 30 12-degree beams, each with input power of 40 W X 0.16 (-8 dB duty factor)

Next, the site was modeled as having an omni antenna but the power into the antenna is increased to be  $40 \times (360/12) \times 0.16$ . The reasoning is that a single 12-degree beam will produce a power density proportional to the power input to the antenna times the ratio of 360 degrees/3 dB beamwidth (360/12 in this example). Finally, the factor of 0.16 represents a beam duty cycle of -8 dB used for this example. Alternatively, the duty cycle factor can be applied directly by adjusting the map display result simply by using the RoofView® 4 or RoofView® 5 “fudge factor” [Multiplier button on the AntennaMap screen] and entering 0.16 instead of the normal 1.0 to adjust for the duty cycle instead of using it to compute the antenna input power directly. If adjusting the effect of time-averaged power this way, the antenna input power should simply be  $40 \times (360/12)$ .

The neat thing about this is to note that the result is very close to the simulation using 30 narrow beams and is very close to the same shape. The spatial extent of the boundary is exactly the same as with the 30 beam assumption. The reason for the 30-beam example representing a slightly greater area that is yellow and red, compared to the omni example is, simply, that when assuming 30 beams to get the pattern, RoofView® sums the power density in any given pixel from ALL of the beams. While there will be only one beam, generally, that contributes the greatest amount of power density in a particular pixel, there will always be some modest contribution from the other beams, not much, but it will add to the total. Using the omni simulation approach with the appropriate adjustment for power (based on an assumed duty cycle for the time-averaged transmitter power) is the best and simplest way to go when simulating beam forming antennas if it is a full three-sector site. All it requires is an adjustment of the antenna input power based on beamwidth and duty cycle.



RoofView® simulated omni antenna with  $40 \times (360/12) \times 0.16$  antenna input power