

# SAFE DISTANCE FROM C BAND GROUND STATION

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## Revision History

Revision	Description of Changes	Date	Revised By
0	Initial version	8/8/2022	LA

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## INTRODUCTION

The purpose of this document is to provide information about the safe operating distances for personnel surrounding a C-band ground station. This information can be used to supplement FCC applications as well as to provide guidance for operations personnel and the setting up of protective equipment or marking keep out zones. Power density on the ground (dBm/cm<sup>2</sup>) surrounding the ground station will be calculated and compared to the FCC guidelines for acceptable radiation limitations. The assumptions used in the analysis are shown below in Table 1.

Table 1: Assumptions used in power density calculations.

Assumption #	Parameter	Value	Notes
1	Transmit Power	47 dBm (50 Watts)	Conservative: assumes 100% TX duty cycle at Psat of amplifiers with no cable loss
2	Antenna	RadioWaves SPD3-4.7 (3ft dish)	Max gain is 30 dBi, calculated front lobe patterns with data sheet backlobe level of -37 dB
3	Antenna height above ground	0 feet	Conservative: assumes that the antenna is pointed along the same elevation plane where personnel may be located
4	Antenna elevation pointing angle	0° (along horizon)	
5	RF Frequency	4.55 GHz	C band

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## CALCULATED POWER DENSITY ALONG THE GROUND

Figure 1 shows the calculated power density on the ground in units of dBm/cm<sup>2</sup>.

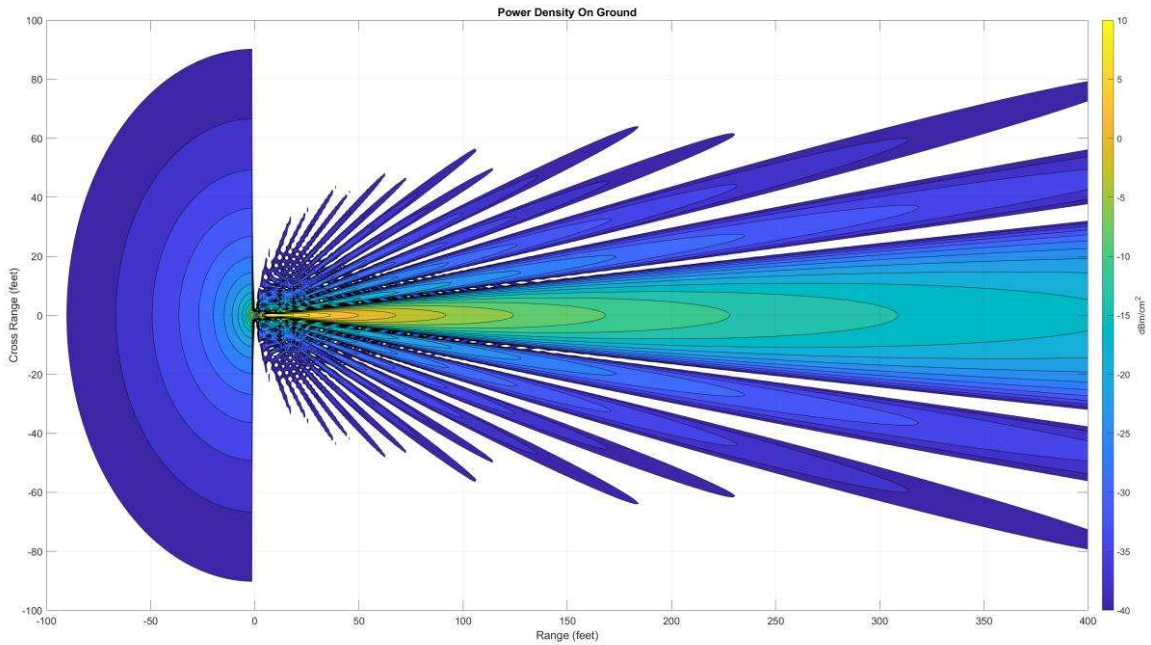


Figure 1: Power density on the ground surrounding the ground station antenna.

Figure 1 shows the power density is concentrated in the main beam of the antenna and the extent to which power density is located in the sidelobes. The “negative range” region toward the left of the plot shows where the backlobe gain level of -37 dB (relative to peak gain) is used for the antenna gain pattern.

## FCC REGULATION LIMITATIONS

Table 2 shows the FCC Part 56 power density limits for 4.55 GHz transmissions:

Table 2: FCC Part 56 power density limits for 4.55 GHz transmissions.

Limit Type	Parameter	Value	Notes
(A) Limits for Occupational/Controlled Exposure	Power Density	5 mW/cm <sup>2</sup> (7 dBm/cm <sup>2</sup> )	6 minutes averaging time
(B) Limits for General Population/Uncontrolled Exposure	Power Density	1 mW/cm <sup>2</sup> (0 dBm/cm <sup>2</sup> )	30 minutes averaging time

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## SAFE DISTANCES

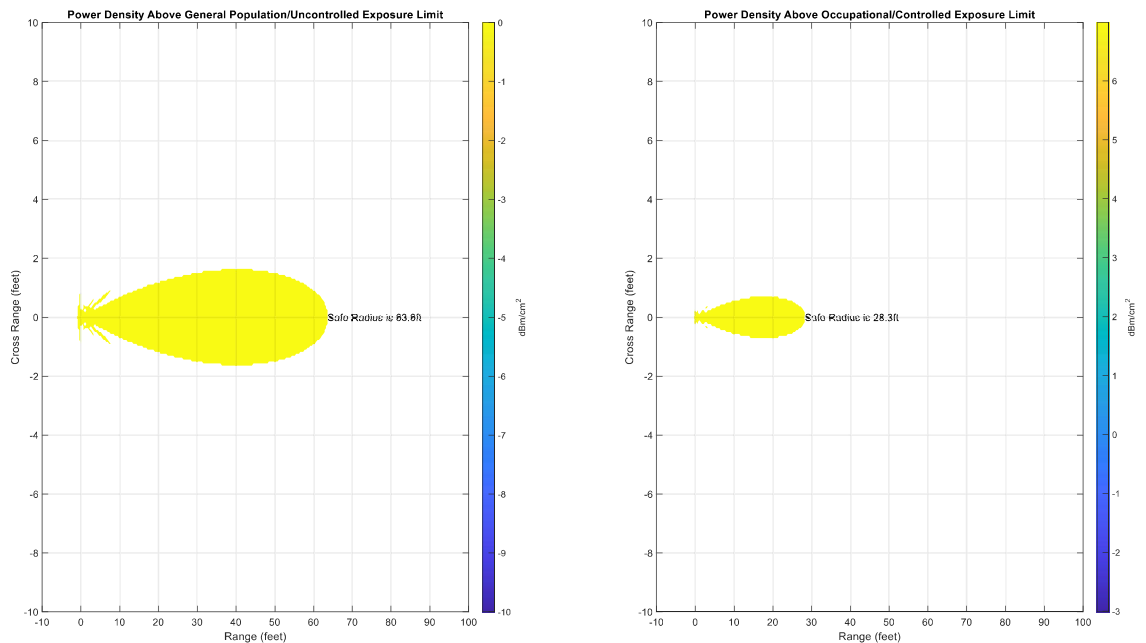


Figure 2: Power density on the ground surrounding the ground station antenna – zoomed in to highlight region where safe levels are exceeded.

### GENERAL POPULATION/UNCONTROLLED EXPOSURE LIMIT

The left side of Fig. 1 shows the region where the radiated power density exceeds the limit for exposure to general population. This region extends to about 64 ft from the radiating face of the antenna – in the direction the antenna is pointed. The averaging time for this exposure limit is 30 minutes. Given the environments where our ground stations are used it is difficult to imagine a scenario where a member of the general population would unknowingly wander into this region for any amount of time and so this exposure limit is probably less relevant.

### OCCUPATIONAL/CONTROLLED EXPOSURE LIMIT.

The right side of Fig. 1 shows the region where the radiated power density exceeds the limit personnel working around the ground station with the knowledge of it. This region extends to about 28 ft from the radiating face of the antenna – in the direction the antenna is pointed. The averaging time for this exposure limit is 6 minutes. However, in the following section it will be recommended that personnel should not be found in this region for any amount of time while the antenna is radiating.

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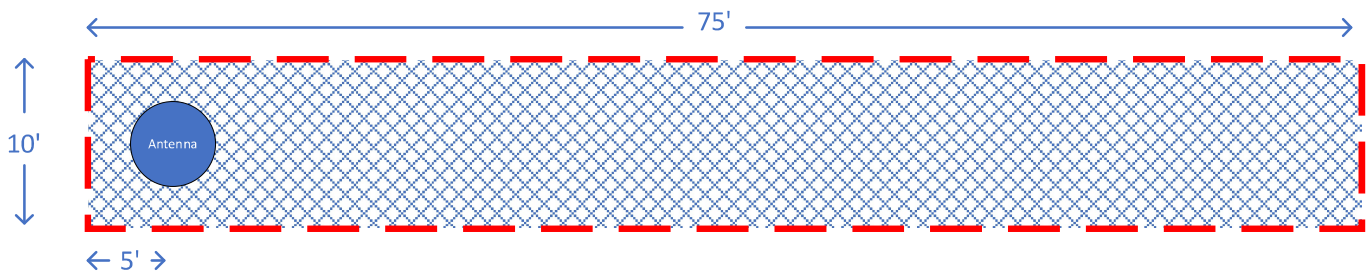
## RECOMMENDATION FOR INDICATING A "RADIATION HAZARD ZONE"

It is recommended that a "radiation hazard zone" be marked out around the ground station antenna any time that is or may be in use. The edge of this zone should be marked with visible objects like bright orange cones with appropriate signage such as is shown in Fig. 3.



Figure 3: Example of radiation hazard zone signage.

This zone should be marked off 5' to the sides and back of the radiated antenna and extending out 75'. This is shown in Fig. 4. This zone is in excess of either of the unsafe regions shown in Fig. 2 simply for the reason that while going through the effort of marking out this unsafe region it's reasonable to simply error on the side of safety.



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Figure 4: Recommended keep out zone for signage and hazard marking.

Some common sense allowances will need to be made for scenarios where the ground station antenna is located at the edge of a region where it is known there will be no people. Examples may include large bodies of water or perhaps a cliff. In cases like this, obviously allowances should be made with regard to marking out the hazard zone.

## ADDITIONAL MITIGATING FACTORS

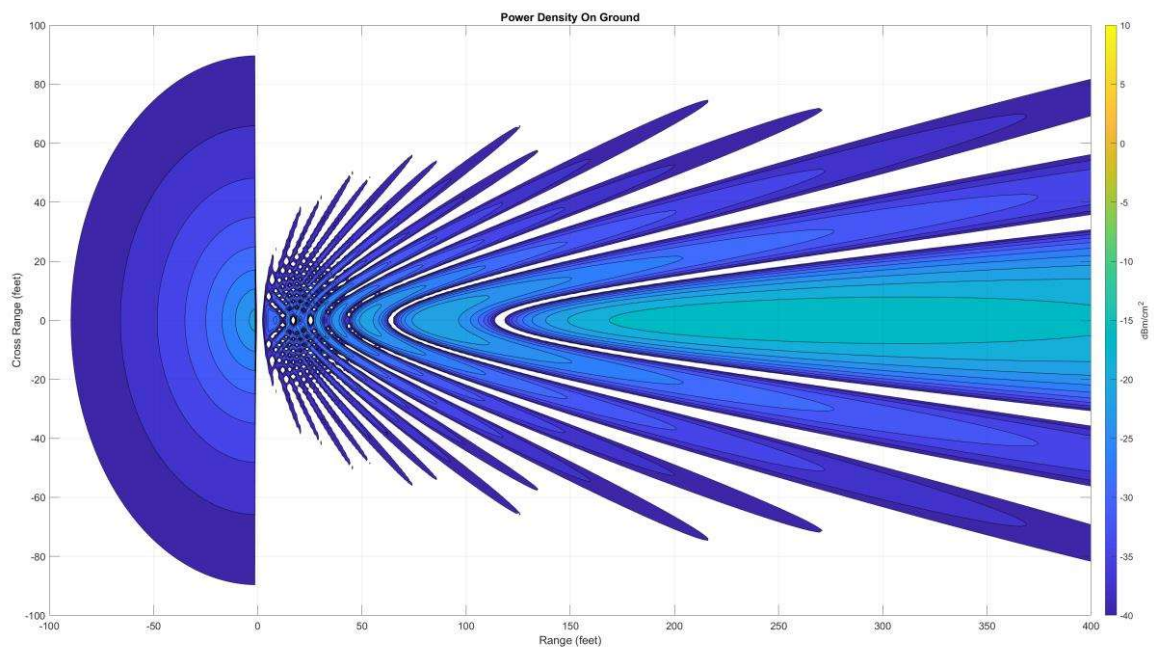
The analysis used to produce the results and recommendations above included what is essentially a worst-case scenario regarding the height of the antenna and the elevation angle where it is pointed. In real use scenarios, typical antenna heights and elevation angles also play a part in mitigating danger. This does not supersede the need for appropriate hazard marking but is included simply to give operations personnel a sense of the actual hazards which are likely less severe than might be indicated in the previous analysis.

## ELEVATION ANGLES

This is somewhat self-explanatory. The region of high power density exists in the direction the dish antenna is pointed. While it is pointed up there is less of a hazard to people on the ground.

## ANTENNA HEIGHT

Often, the antenna is mounted on top of a shipping container or other large object to give it a clearer view along the horizon. This is done primarily to improve link quality but also serves to mitigate the radiation hazard quite effectively. If we assume for example that the antenna is mounted at a height of 10' above the ground level where personnel are found, then the power density result of Fig. 1 becomes the result shown in Fig. 5.



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Figure 5: Power density on the ground surrounding the ground station antenna – if the antenna were mounted at a height of 10'.

In this case, only the sidelobes of the antenna touch the ground and no significant region exists where the FCC exposure limits are exceeded.

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