Pinnacle Telecom Group
*Professional and Technical Services*

# Antenna Site FCC RF Compliance Assessment and Report

prepared for

## Crown Castle

## Pole-mounted DAS Operations
## Project 384474

## 1616 Whitestone Bridge
## Whitestone, NY

May 26, 2017

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# Contents

## Executive Summary

At the request of Crown Castle, Pinnacle Telecom Group has performed an independent expert assessment of radiofrequency (RF) levels and related FCC compliance for "distributed antenna system" (DAS) operations in the New York market area. The pole-mounted DAS antennas will support the provision of wireless services with transmission in the 1900 and 2100 MHz frequency bands.

The FCC requires antenna operators to perform an assessment of the RF emissions from their antennas, and to ensure compliance with the FCC's Maximum Permissible Exposure (MPE) limit. That limit, described in some detail in Appendix A, has been set in such a manner that continuous exposure to RF levels up to and including 100 percent of the MPE limit is safe for humans of either sex, any size, any age, and under any conditions.

The analysis described herein examines FCC compliance for the Crown Castle antenna operation for three possible exposure situations: (1) for people standing at street level below the antenna installation; (2) for antenna technicians or other workers close to the antennas; and (3) for people in buildings adjacent to and at the same general height as the antennas.

The analyses for each area of interest employ standard FCC formulas for calculating the RF effects of the antennas in a very conservative manner, in order to ensure "safe-side" (i.e., intentionally overstated) results and thus great confidence in conclusions regarding compliance with the applicable MPE limit.

The results of compliance analyses can be described in layman's terms by expressing the calculated RF levels as simple percentages of the applicable FCC MPE limit. If the reference for that limit is "normalized" to 100 percent, then calculated RF levels higher than 100 percent indicate the MPE limit is exceeded and there is a need to mitigate the potential exposure. On the other hand, calculated RF levels consistently below 100 percent serve as a clear and sufficient demonstration of compliance with the MPE limit.

Because of the conservatism encouraged by the FCC, calculations showing RF levels up to and even including 100 percent of the applicable MPE limit serve as proof of compliance.

The results of the RF compliance assessment in this case are as follows:

- ***For People Standing at Street Level around the Antennas:*** The conservatively calculated maximum RF level from the Crown Castle antenna operation is 0.7983 percent of the FCC general population MPE limit – well below the 100-percent reference for compliance.
- ***For Workers Close to the Antennas:*** The same-height analysis shows that the applicable FCC occupational MPE limit is satisfied at all same-height distances from the antennas, and the general population MPE limit is satisfied at a same-height distance of three feet. We recommend that a "Notice-type" RF alert sign be posted at each antenna location, with a specified standoff distance of tree feet for purposes of potential exposure of the general public.
- ***For People in an Adjacent Building:*** For someone inside a building at a distance of as little as 10 feet away from the antennas and at the same height as the antennas, the conservatively calculated RF level is 17 percent of the FCC general population MPE limit – well below the 100-percent reference for compliance. At distances greater than 10 feet from the antennas, or in positions lower or higher than the antennas, the RF levels are even less significant.

The results of the analyses of RF levels, along with the recommended RF alert signage, combine to satisfy the FCC's regulations and associated guidelines concerning the control of potential RF exposure. Moreover, because of the conservative methodology and assumptions incorporated in the analysis, RF levels actually caused by the antennas in each area of interest will be even less significant than the calculation results indicate.

The remainder of this report provides the following:

- relevant technical data on the Crown Castle DAS antenna operation;
- a description of the applicable FCC mathematical models for assessing compliance, and application of the technical data to those models; and
- the results of the analysis, and the compliance conclusion for the proposed Crown Castle DAS operation.

In addition, two Appendices are included. Appendix A provides background on the FCC MPE limit, as well as a list of key FCC references on compliance. Appendix B provides a summary of the qualifications of the expert certifying RF compliance for the described Crown Castle DAS operations.

## Antenna and Transmission Data

Transmission parameters for the DAS antenna operation are provided below.

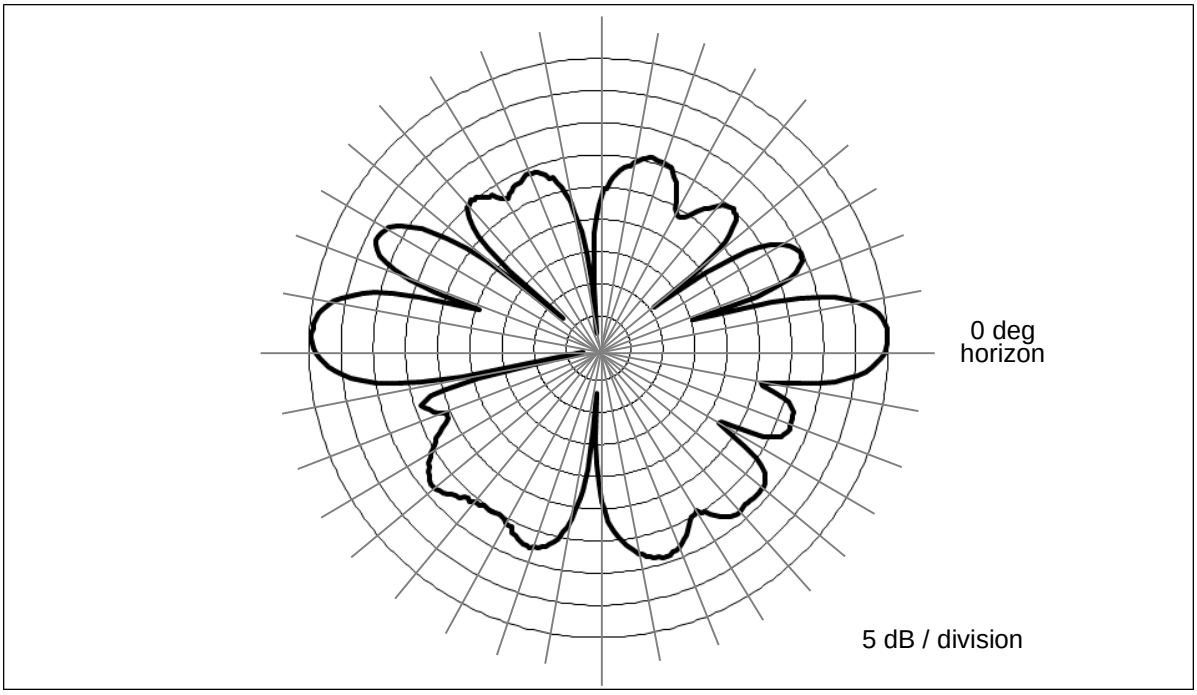
| | |
|---|---|
| ***General Data*** | |
| Frequency Bands | 1900 MHz and 2100 MHz |
| Mounting Type | Pole-mounted |
| Antenna Type | Omni Directional |
| Antenna Model | Phazar AWSBRS360T-698/1710-7/2/7-T0M-MD |
| Antenna Length | 60 in. |
| Antenna Height AGL | 28 ft. |
| ***1900 MHz Verizon*** | |
| Tot. Available RF Power | 30 watt |
| Antenna Line Loss | 1.0 dB |
| Max. Antenna Input Power | 23.83 watts |
| Max. Antenna Gain | 7 dBi |
| ***2100 MHz Verizon*** | |
| Tot. Available RF Power | 30 watt |
| Antenna Line Loss | 1.0 dB |
| Max. Antenna Input Power | 23.83 watts |
| Max. Antenna Gain | 7 dBi |

| ***2100 MHz T-Mobile*** | |
|---|---|
| Tot. Available RF Power | 40 watt |
| Antenna Line Loss | 1.0 dB |
| Max. Antenna Input Power | 31.77 watts |
| Max. Antenna Gain | 7 dBi |

Note that the total amount of amplifier output power to the antenna is 100 watts.

The vertical-plane emission pattern of the antenna is used in the analysis of street-level compliance. Figure 1 that follows shows the manufacturer-specified vertical-plane pattern for the proposed antenna model in the 2100 MHz band.
Note that the use of a decibel scale to describe the relative pattern at different angles incidentally serves to significantly understate the actual focusing effects of the antenna. Where the antenna pattern reads 20 dB, for example, the relative RF energy emitted at the corresponding downward angle is 1/100$^{th}$ of the maximum that occurs in the main beam (at 0 degrees); at a 30 dB point, the level is 1/1,000$^{th}$ of the maximum. Note, finally, that the automatic pattern-scaling feature of our internal software may skew side-by-side visual comparisons of different antenna models, or even different parties' depictions of the same antenna model.

**Figure 1. Phazar AWSBRS360T-698/1710-7/2/7-T0M-MD – 2100 MHz Vertical-plane Pattern**



The areas at street level around an antenna installation are clearly open to unrestricted public access, and are subject to the FCC MPE limit for "uncontrolled" exposure, commonly called the "general population" limit. At street-level, the RF levels from antennas are directly proportional to the total antenna input power and the relative antenna gain in the downward direction of interest – and the RF levels are otherwise inversely proportional to the square of the straight-line distance to the antenna.

Conservative calculations also assume the potential RF exposure is enhanced by reflection of the RF energy from the intervening ground. Our calculations will assume a 100% "perfect" ground reflection, the absolute worst-case approach.

The formula for street-level RF compliance calculations for any given wireless antenna operation is as follows:

$$MPE\% = (100 * InputPower * 10^{(Gmax-Vdisc/10)} * 4 ) / ( MPE * 4\pi * R^2 )$$

where

| | | |
|---|---|---|
| MPE% | = | RF level, expressed as a percentage of the MPE limit applicable to continuous exposure of the general public |
| 100 | = | factor to convert the raw result to a percentage |
| InputPower | = | maximum net power into antenna, in milliwatts, a function of the number of RF channels, the transmitter power, and line loss |
| $10^{(Gmax-Vdisc/10)}$ | = | numeric equivalent of the relative antenna gain in the downward direction of interest; data on the antenna vertical-plane pattern is taken from manufacturer specifications |
| 4 | = | factor to account for a 100-percent-efficient energy reflection from the ground, and the squared relationship between RF field strength and power density ($2^2 = 4$) |
| MPE | = | FCC general population MPE limit |
| R | = | straight-line distance from the RF source to the point of interest, centimeters |

We will conservatively perform the MPE% calculations out to a distance of 500 feet from the facility to points six feet off the ground, with the latter figure representing human standing height. The calculation geometry is illustrated in Figure 2, below.

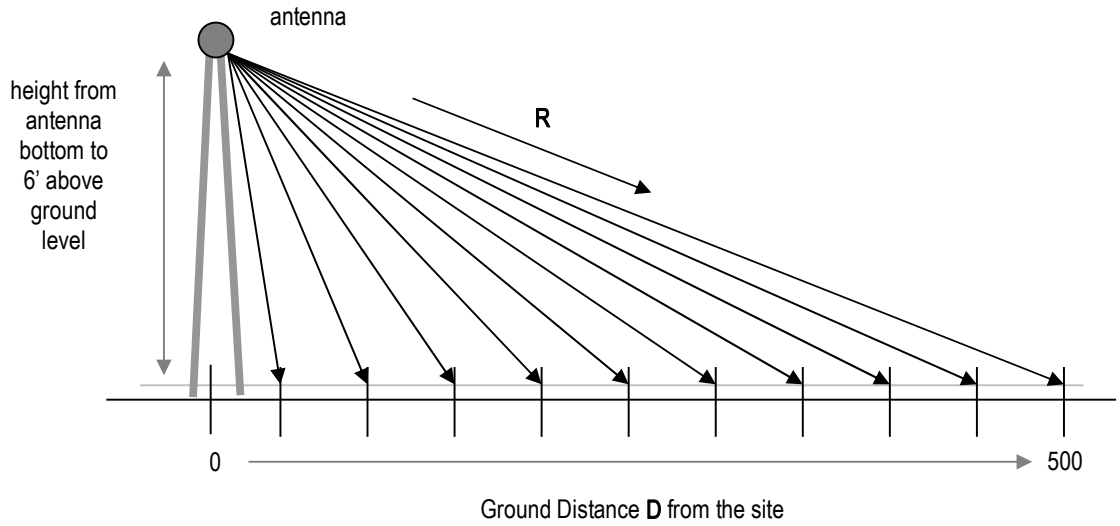



**Figure 2. Street-level MPE% Calculation Geometry**

It is popularly understood that the farther away one is from an antenna, the lower the RF level – which is generally but not universally correct. The results of MPE% calculations fairly close to the base of the installation will reflect the variations in the vertical-plane antenna pattern as well as the variation in straight-line distance to the antennas.

Therefore, RF levels may actually increase slightly with increasing distance within the range of zero to 500 feet from the site. As the distance approaches 500 feet and beyond, though, the antenna pattern factor becomes less significant, the RF levels become primarily distance-controlled, and as a result the RF levels generally decrease with increasing distance, and are well understood to be in compliance.

Street-level FCC compliance for a multiple-band antenna operation is assessed in the following manner. At each distance point along the ground, an MPE% calculation is made for the RF effect in each frequency band, and the sum of the individual MPE% contributions at each point is compared to 100 percent, which serves as the normalized reference for the FCC MPE limit. We refer to the sum of the individual MPE% contributions as "total MPE%", and any calculated MPE% total MPE% result exceeding 100 percent is, by definition, higher than the FCC limit and represents non-compliance and a need to mitigate the RF levels. If, on the other hand, all results are below 100 percent, that set of results serves as a demonstration of compliance with the MPE limit.

The following conservative methodology and assumptions are incorporated into the MPE% calculations on a general basis:

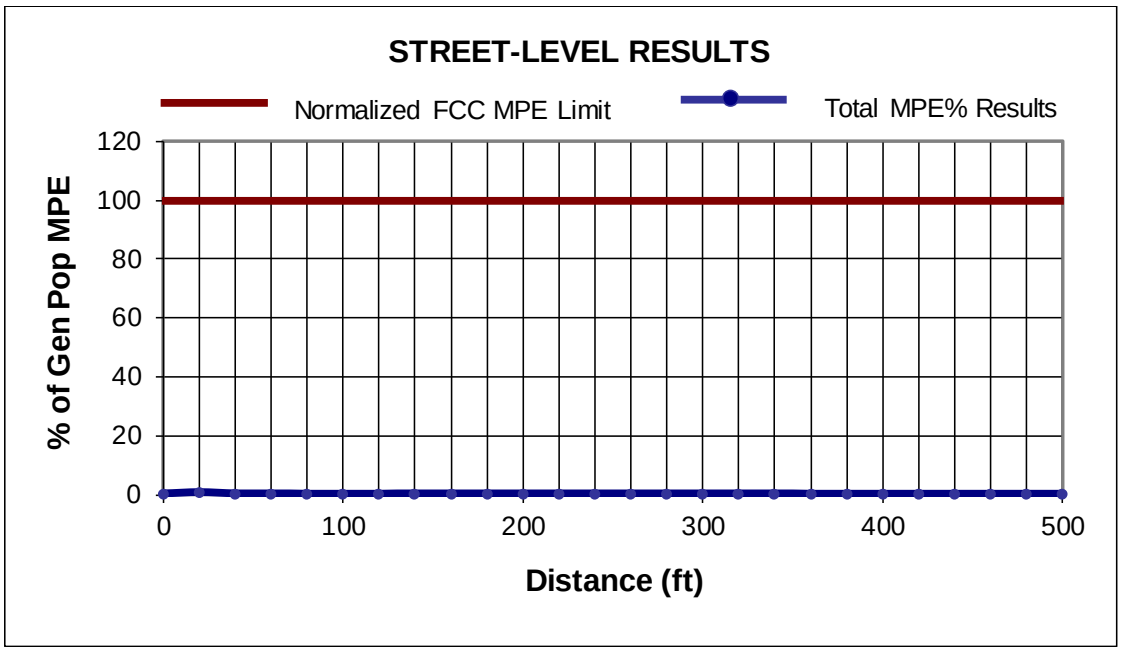
1. The antennas are assumed to operate continuously at maximum power.
2. The power-attenuation effects of shadowing or other obstructions to the line-of-sight path from the antenna to the point of interest are ignored.
3. The calculations intentionally minimize the distance factor (R) by performing the calculations from the bottom (rather than the centerline) of the antenna.
4. The potential RF exposure at ground level around the site is assumed to be enhanced (increased) via a "perfect" mirror-like 100-percent field reflection from the intervening ground.

The net result of these assumptions is to significantly overstate the calculated RF exposure levels relative to the levels that will actually occur – and the purpose of this conservatism is to allow very "safe-side" conclusions about compliance.
The table that follows provides the results of the street-level MPE% calculations for the antennas in each of the frequency bands, with the maximum (worst-case) overall calculated total MPE% effect highlighted in bold.

| **Ground Distance** (ft) | **T-Mobile 2100 MHz MPE%** | **Verizon 1900 MHz MPE%** | **Verizon 2100 MHz MPE%** | **Total MPE%** |
|---|---|---|---|---|
| | | | | |
| 0 | 0.0472 | 0.0388 | 0.0354 | 0.1215 |
| 20 | 0.4156 | 0.0709 | 0.3117 | **0.7983** |
| 40 | 0.0687 | 0.0897 | 0.0516 | 0.2100 |
| 60 | 0.0681 | 0.0315 | 0.0511 | 0.1506 |
| 80 | 0.0237 | 0.0177 | 0.0178 | 0.0593 |
| 100 | 0.0064 | 0.0168 | 0.0048 | 0.0279 |
| 120 | 0.0180 | 0.0287 | 0.0135 | 0.0602 |
| 140 | 0.0450 | 0.0486 | 0.0338 | 0.1273 |
| 160 | 0.0521 | 0.0517 | 0.0391 | 0.1429 |
| 180 | 0.0575 | 0.0537 | 0.0431 | 0.1543 |
| 200 | 0.0467 | 0.0436 | 0.0350 | 0.1254 |
| 220 | 0.0517 | 0.0449 | 0.0388 | 0.1354 |
| 240 | 0.0435 | 0.0378 | 0.0327 | 0.1140 |
| 260 | 0.0464 | 0.0387 | 0.0348 | 0.1199 |
| 280 | 0.0401 | 0.0334 | 0.0300 | 0.1035 |
| 300 | 0.0349 | 0.0291 | 0.0262 | 0.0902 |
| 320 | 0.0359 | 0.0292 | 0.0269 | 0.0920 |
| 340 | 0.0318 | 0.0258 | 0.0238 | 0.0815 |
| 360 | 0.0284 | 0.0231 | 0.0213 | 0.0727 |
| 380 | 0.0255 | 0.0207 | 0.0191 | 0.0653 |
| 400 | 0.0230 | 0.0187 | 0.0173 | 0.0589 |
| 420 | 0.0244 | 0.0187 | 0.0183 | 0.0613 |
| 440 | 0.0222 | 0.0170 | 0.0167 | 0.0559 |
| 460 | 0.0203 | 0.0156 | 0.0152 | 0.0511 |
| 480 | 0.0187 | 0.0143 | 0.0140 | 0.0470 |
| 500 | 0.0172 | 0.0132 | 0.0129 | 0.0433 |

As indicated, the overall maximum calculated RF level is 0.7983 percent of the FCC MPE limit –well below the 100-percent reference for compliance, especially given the conservatism applied in the analysis.

A graph of the overall calculation results, provided below, probably provides a clearer *visual* illustration of the relative insignificance of the calculated RF levels. The results line shows an obviously clear and consistent margin to the FCC MPE limit.




The results of this street-level compliance analysis are not at all unexpected, because of the low power level used by the antennas, the mounting of the antennas well overhead, and the vertical-plane directional characteristics of the antennas. Moreover, because of the conservative nature of the FCC's mathematical model, along with the operational assumptions we applied in the analysis, RF levels actually caused by the antennas will be less significant than these calculation results indicate.

***Same-Height Analysis***

There are two considerations in the analysis of the RF levels close to and at the same relative height as the antennas. The first consideration involves the possible exposure of a utility worker or antenna technician whose work requires being close to the antennas.

The potential exposure for workers close to antennas is considered "controlled" because such workers are required to have had RF safety training and thus know how to ensure personal RF safety around antennas.

As a result, the FCC “occupational” MPE limit applies to the analysis (see Appendix A). The second consideration involves the possible exposure of individuals in a building adjacent to an antenna installation (and at the same approximate height as the antennas). In this case the exposure is classified as “uncontrolled” and the FCC “general population” MPE limit applies, as can an assumption of a greater distance from the antennas than that which might apply to a worker.

The only differences in the analysis for each area of interest will be the range of assumed exposure distances and the applicable MPE limit. Note that the particular mounting height of the antennas above ground level does not affect the results of same-height RF exposure analyses.

Close to and at the same height of an antenna, the RF levels depend on the frequency band, antenna size, antenna input power, lateral distance from the antenna, and whether or not there is a difference between standing height and the subtended height of the antenna. The same-height compliance analysis was performed using the Richard Tell Associates *RoofView* program, which is based on the same-height models in FCC Bulletin OET65 and which is considered an industry standard and is accepted by the FCC for rooftop compliance analyses.

The *RoofView* program’s primary output is a color-coded depiction of the calculated RF levels in the vicinity of antennas. The color-coding scheme uses green for areas found to be subject to RF levels satisfying the FCC general population MPE limit, red for areas where the FCC occupational limit is exceeded, and yellow for RF levels between those extremes. In a grayscale printout, green appears as medium gray, yellow is a lighter gray, and red is a dark gray. Note that as the minimum calculation distance is one foot, the color-coding of the pixels surrounding the antenna location are significant to the RF analysis, but any color-coding of a pixel with a dot identifying an antenna location is not significant.

Note, too, that when multi-band antennas are used, the program requires individual entries for each operator and frequency band, and displays additional "antenna location dots" below and to the right of the actual antenna location. The additional dots are not significant to the analysis.

The graphic output of the *RoofView* program for potential same-height exposure from the antenna is reproduced in Figure 3. This is a "top-down" view, and reflects the omni directional characteristic of the antenna in the horizontal plane. Note that the distance between the gridlines in the *RoofView* output is 10 feet.

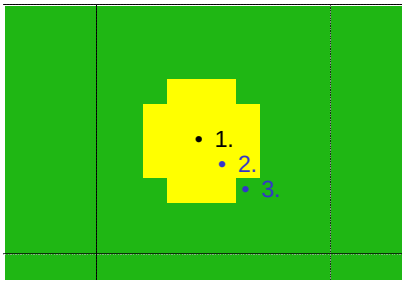



**Figure 3. *RoofView* Graphic Output for Same-height Exposure**

As indicated by the color-coding, the applicable FCC occupational MPE limit is satisfied at all same-height distances from the antenna, and the FCC general population MPE limit is satisfied at a same-height distance of three feet.

The *RoofView* program includes a feature that provides one-at-a-time "pop-up" readouts of the calculation results for any specifically identified location. We used that feature to quantify the results of the analysis, which are summarized in the table that follows.

| *Lateral Distance (ft)* | *Same-Height Occup. MPE%* | *Same-Height Gen. Pop. MPE%* |
|---|---|---|
| | | |
| 1 | 45.36 | 226.80 |
| 2 | 22.68 | 113.40 |
| 3 | 15.12 | 75.60 |
| 4 | 11.34 | 56.70 |
| 5 | 9.07 | 45.35 |
| 6 | 7.56 | 37.80 |
| 7 | 6.48 | 32.40 |
| 8 | 5.32 | 26.60 |
| 9 | 4.20 | 21.00 |
| 10 | 3.40 | 17.00 |

The results in the table confirm that the applicable FCC occupational MPE limit is satisfied at all same-height distances from the antenna, and the FCC general population MPE limit is satisfied at a same-height distance of three feet.

Based on these results, we will recommend the posting of an appropriate RF alert sign at each antenna location. (See later Section.)

The same-height analysis for potential exposure to individuals inside a building adjacent to (and at the same height as) a Crown Castle antenna operation relies on the same same-height model, but with the “general population” MPE limit applied instead of the “occupational” limit. In addition, we can assume in this case that no building would be closer than 10 feet from an antenna, and will perform the calculations for a horizontal distance range of 10 to 20 feet, and we will further assume a clear line-of-sight to the antenna.

The table that follows provides the results of the calculations for people inside a building adjacent to, and at the same subtended height as, one of the Crown Castle antenna installations.

| *Lateral Distance (ft)* | *Adjacent-Building Same-Height Gen. Pop. MPE%* |
|---|---|
| | |
| 10 | 17.00 |
| 11 | 14.05 |
| 12 | 11.80 |
| 13 | 10.05 |
| 14 | 8.70 |
| 15 | 7.55 |
| 16 | 6.65 |
| 17 | 5.90 |
| 18 | 5.25 |
| 19 | 4.70 |
| 20 | 4.25 |

As indicated in the table, even as the closest assumed distance of 10 feet, the conservatively calculated RF level – on a clear line-of-sight basis – is 17.00 percent of the FCC MPE limit, well below the 100-percent reference for compliance. Moreover, as the distance from the antennas increases, the RF levels decrease, and the RF levels inside a building at any distance from the antenna would be 10 times lower. Note, too, that at heights lower than or higher than the subtended antenna height, the RF levels are less significant than the results of these calculations.

## RF Alert Signage

The FCC recognizes RF alert signage as an effective component of compliance, as it alerts individuals to the presence of antennas and the potential for RF levels to exceed applicable the applicable MPE limit – so that caution may exercised to control one's potential exposure.

Given the results of the same-height analyses in this case, the applicable FCC occupational MPE limit is satisfied at all same-height distances from the antenna, and the FCC general population MPE limit is satisfied at a same-height distance of three feet.

Therefore, we recommend that the RF alert sign shown in Figure 4, below, be posted at each antenna location, with a specified standoff distance of three (3) feet for purposes of potential exposure of the general public

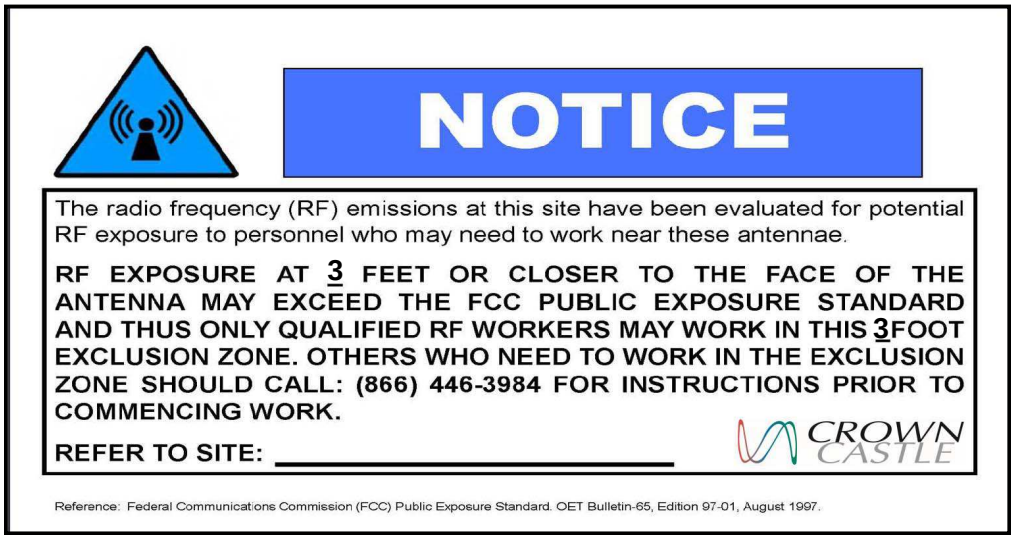



**Figure 4. Recommended RF Alert Signage**

## Compliance Conclusion

The results of the analyses of RF levels, along with the recommended RF alert signage, satisfy the FCC's regulations concerning the control of potential RF exposure.

Moreover, because of the conservative methodology and assumptions incorporated in the analysis, RF levels actually caused by the antennas in each area of interest will be even less significant than the calculation results indicate.

## Certification

The undersigned certifies as follows:

1. I have read and fully understand the FCC regulations concerning RF safety and the control of human exposure to RF fields (47 CFR 1.1301 *et seq*).
2. To the best of my knowledge, the statements and information disclosed in this report are true, complete and accurate.
3. The analysis of site RF compliance provided herein is consistent with the applicable FCC regulations, additional guidelines issued by the FCC, and industry practice.
4. The results of the analysis indicate that the subject antenna operations will be in compliance with the FCC regulations and applicable MPE limits.

Daniel Penesso

Daniel Penesso
Director- RF Engineering
Pinnacle Telecom Group, LLC

5/26/17
Date

# Appendix A. Background on the FCC MPE Limits

### *FCC Regulations*

As directed by the Telecommunications Act of 1996, the FCC has incorporated into its Rules and Regulations a set of limits for maximum continuous human exposure to RF emissions from antennas.

The FCC maximum permissible exposure (MPE) limits represent the consensus of federal agencies and independent experts responsible for RF safety matters. Those agencies include the National Council on Radiation Protection and Measurements (NCRP), the Occupational Safety and Health Administration (OSHA), the National Institute for Occupational Safety and Health (NIOSH), the American National Standards Institute (ANSI), the Environmental Protection Agency (EPA), and the Food and Drug Administration (FDA). In formulating its guidelines, the FCC also considered input from the public and technical community – notably the Institute of Electrical and Electronics Engineers (IEEE).

The FCC's RF exposure guidelines are incorporated in Section 1.301 *et seq* of its Rules and Regulations (47 CFR 1.1301-1.1310). Those guidelines specify MPE limits for both occupational and general population exposure.

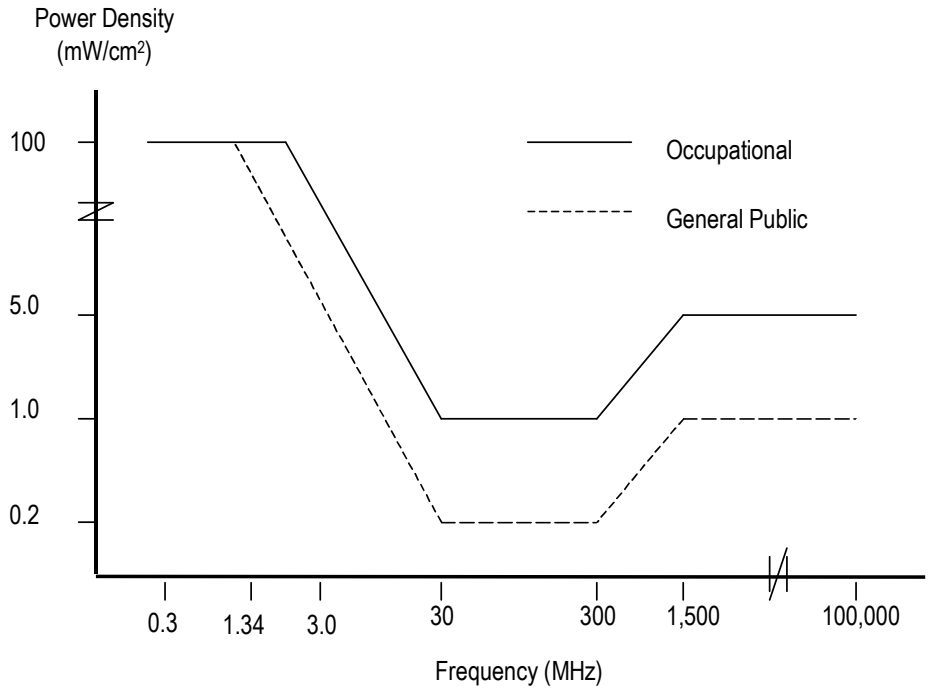
The specified continuous exposure MPE limits are based on known variation of human body susceptibility in different frequency ranges, and a Specific Absorption Rate (SAR) of 4 watts per kilogram, which is universally considered to accurately represent human capacity to dissipate incident RF energy (in the form of heat). The occupational MPE guidelines incorporate a safety factor of 10 or greater with respect to RF levels known to represent a health hazard, and an additional safety factor of five is applied to the MPE limits for general population exposure. Thus, the general population MPE limit has a built-in safety factor of more than 50. The limits were constructed to appropriately protect humans of both sexes and all ages and sizes and under all conditions – and continuous exposure at levels equal to or below the applicable MPE limits is considered to result in no adverse health effects or even health risk.

The reason for *two* tiers of MPE limits is based on an understanding and assumption that members of the general public are unlikely to have had appropriate RF safety training and may not be aware of the exposures they receive; occupational exposure in controlled environments, on the other hand, is assumed to involve individuals who have had such training, are aware of the exposures, and know how to maintain a safe personal work environment.

The FCC's MPE limits are expressed in two equivalent forms, using alternative units of field strength (expressed in volts per meter, or V/m), and power density (expressed in milliwatts per square centimeter, or $mW/cm^2$). The table on the next page lists the FCC limits for both occupational and general population exposures, using the $mW/cm^2$ reference, for the different radio frequency ranges.

| Frequency Range (F) (MHz ) | Occupational Exposure ( mW/cm$^2$ ) | General Public Exposure ( mW/cm$^2$ ) |
|---|---|---|
| 0.3 - 1.34 | 100 | 100 |
| 1.34 - 3.0 | 100 | 180 / F$^2$ |
| 3.0 - 30 | 900 / F$^2$ | 180 / F$^2$ |
| 30 - 300 | 1.0 | 0.2 |
| 300 - 1,500 | F / 300 | F / 1500 |
| 1,500 - 100,000 | 5.0 | 1.0 |

The diagram below provides a graphical illustration of both the FCC's occupational and general population MPE limits.




Because the FCC's RF exposure limits are frequency-shaped, the exact MPE limits applicable to the instant situation depend on the frequency range used by the systems of interest.

The most appropriate method of determining RF compliance is to calculate the RF power density attributable to a particular system and compare that to the MPE limit applicable to the operating frequency in question. The result is usually expressed as a percentage of the MPE limit.

For potential exposure from multiple systems, the respective percentages of the MPE limits are added, and the total percentage compared to 100 (percent of the limit). If the result is less than 100, the total exposure is in compliance; if it is more than 100, exposure mitigation measures are necessary to achieve compliance.

Note that the FCC "categorically excludes" all "non-building-mounted" wireless antenna operations whose mounting heights are more than 10 meters (32.8 feet) from the routine requirement to demonstrate compliance with the MPE limit, because such operations "are deemed, individually and cumulatively, to have no significant effect on the human environment". The categorical exclusion also applies to *all* point-to-point antenna operations, regardless of the type of structure they're mounted on. Note that the FCC considers any facility qualifying for the categorical exclusion to be automatically in compliance.

### *FCC References on RF Compliance*

47 CFR, FCC Rules and Regulations, Part 1 (Practice and Procedure), Section 1.1310 (Radiofrequency radiation exposure limits).

FCC Second Memorandum Opinion and Order and Notice of Proposed Rulemaking (FCC 97-303), *In the Matter of Procedures for Reviewing Requests for Relief From State and Local Regulations Pursuant to Section 332(c)(7)(B)(v) of the Communications Act of 1934 (WT Docket 97-192), Guidelines for Evaluating the Environmental Effects of Radiofrequency Radiation (ET Docket 93-62), and Petition for Rulemaking of the Cellular Telecommunications Industry Association Concerning Amendment of the Commission's Rules to Preempt State and Local Regulation of Commercial Mobile Radio Service Transmitting Facilities*, released August 25, 1997.

FCC First Memorandum Opinion and Order, ET Docket 93-62, *In the Matter of Guidelines for Evaluating the Environmental Effects of Radiofrequency Radiation*, released December 24, 1996.

FCC Report and Order, ET Docket 93-62, *In the Matter of Guidelines for Evaluating the Environmental Effects of Radiofrequency Radiation*, released August 1, 1996.

FCC Office of Engineering and Technology (OET) Bulletin 65, "Evaluating Compliance with FCC Guidelines for Human Exposure to Radiofrequency Electromagnetic Fields", Edition 97-01, August 1997.

FCC Office of Engineering and Technology (OET) Bulletin 56, "Questions and Answers About Biological Effects and Potential Hazards of RF Radiation", edition 4, August 1999.

# Appendix B. Summary of Expert Qualifications

***Daniel Penesso, Director – RF Engineering, Pinnacle Telecom Group, LLC***

| | |
|---|---|
| ***Synopsis:*** | • 19 years of experience in all aspects of wireless RF engineering, including network design and implementation, interference analysis, FCC and FAA regulatory matters, and antenna site compliance with FCC RF exposure regulations<br>• Have performed RF engineering and FCC compliance work for all the major wireless carriers – AT&T, Verizon Wireless, Sprint, T-Mobile, and MetroPCS, as well as Crown Castle<br>• Have served as an expert witness on RF engineering and/or FCC RF compliance more than 100 times before municipal boards in New Jersey and New York |
| ***Education:*** | • Bachelor of Science in Electrical Engineering, DeVry Institute of Technology, Chicago, IL, 1987 |
| ***Current Responsibilities*** | • Manages PTG staff work involving FCC RF compliance for wireless antenna sites, including the provision of math- and measurements-based site compliance reports, related expert testimony in municipal hearings, and compliance-related support in client meetings with prospective site landlords and in town meetings<br>• Provides math-based FCC compliance assessments and reports for PTG's wireless clients, including AT&T, Verizon Wireless, T-Mobile, Sprint, MetroPCS, and Crown Castle<br>• Responsible for providing client consulting and in-house training on FCC and OSHA RF safety compliance |
| ***Prior Experience:*** | • Have served as senior RF engineer for four of the five national wireless carriers – AT&T, T-Mobile, Sprint, and MetroPCS – in the New York and New Jersey markets<br>• Served as an RF engineer for Metricom, Triton PCS, Alltel Communications, and Western Wireless<br>• Have worked as an RF engineer for several engineering services companies, including Sublime Wireless, Amirit Technologies, Celcite, and Wireless Facilities Incorporated |